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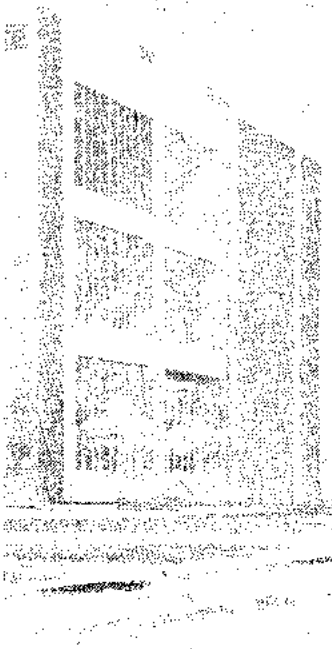
SERVICE

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97005

Serial Number _____

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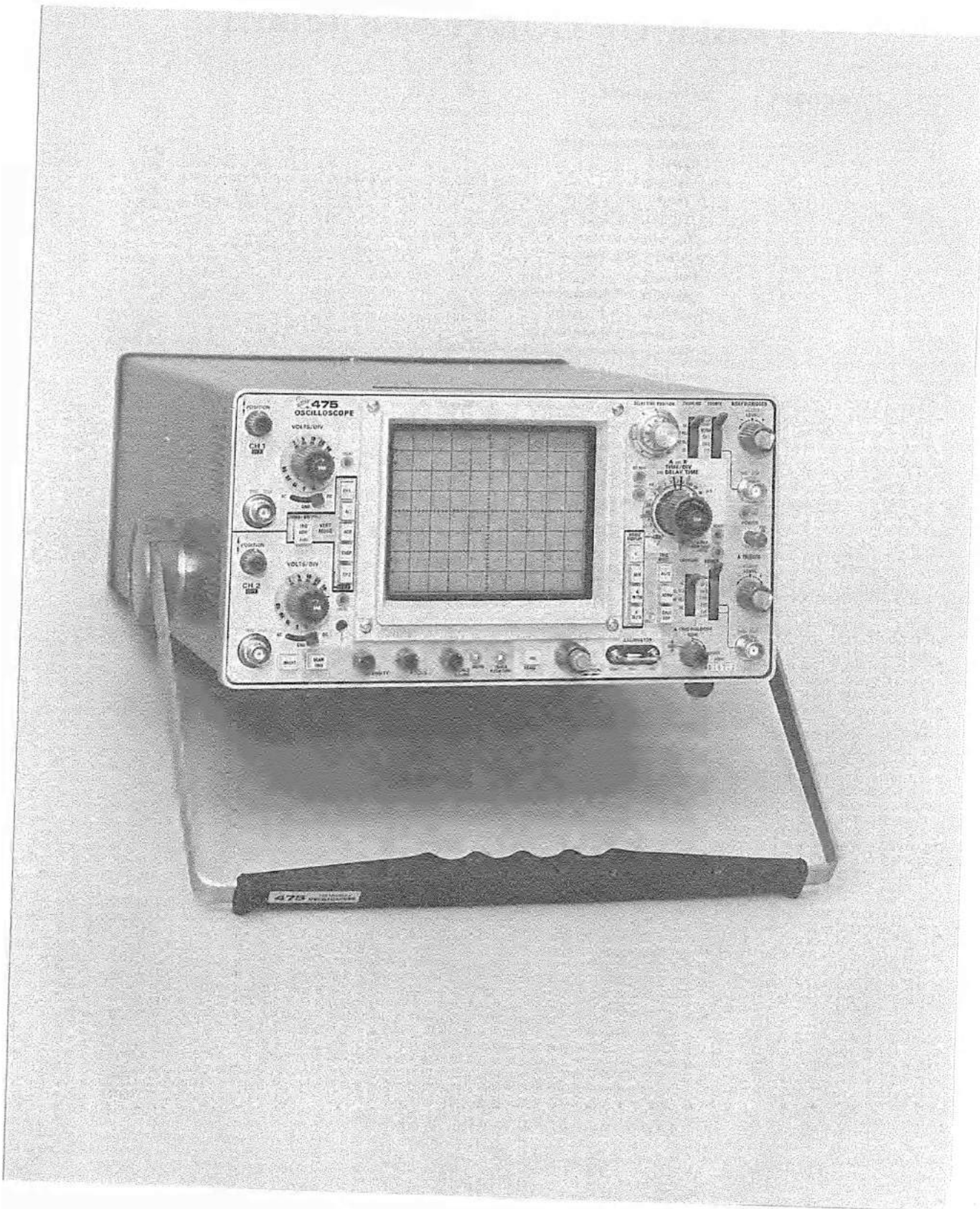
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475 Oscilloscope

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SPECIFICATION

Introduction

The 475 Oscilloscope is a wide bandwidth, portable oscilloscope designed to operate in a wide range of environmental conditions. The instrument is light in weight and compact of design for ease of transportation, yet capable of performance necessary for accurate high-frequency measurements. The dual-channel, DC-to-200 megahertz vertical deflection system provides calibrated deflection factors from 2 millivolts to 5 volts/division. The bandwidth limiting switch reduces interference from signals above about 20 megahertz for viewing low-frequency, low-level signals.

The trigger circuits provide stable sweep triggering to beyond the bandwidth of the vertical deflection system. Separate controls are provided to select the desired mode of triggering for the A and B sweeps. The A sweep can be operated in one of three modes; automatic triggering, normal triggering, or single sweep. A variable trigger holdoff control provides the ability for A sweep to trigger in a stable manner on aperiodic signals or complex digital words. The horizontal deflection system has calibrated sweep rates from .5 second to .01 microsecond/division. A X10 magnifier increases each sweep rate by a factor of 10 to provide a maximum sweep rate of one nanosecond/division in the .01 μs position. The delayed and mixed sweep features allow the start of B sweep to be delayed a selected amount from the start of A sweep to provide accurate relative-time measurements. Calibrated X-Y measurements can be made with Channel 2 providing the vertical deflection and Channel 1 providing the horizontal deflection (TIME/DIV switch fully counterclockwise and VERT MODE switch to CH 2). The regulated DC power supplies ensure that instrument performance is not affected by variations in line voltage and frequency. Maximum power consumption of the instrument is approximately 100 watts.

The following instrument specifications apply over an ambient termperature range of −15°C to +55°C unless otherwise specified. Warm-up time for specified accuracies is 20 minutes. The calibration procedure given in section 5, if performed completely, will allow an instrument to meet the electrical characteristics listed below.

VERTICAL DEFLECTION SYSTEM

Deflection Factor

Calibrated range is from 2 millivolts to 5 volts per division in 11 steps in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated VAR control provides deflection factors continuously variable between the calibrated settings. Extends deflection factor to at least 12.5 volts per division in the 5 volts/div position.

Frequency Response

Bandwidth in both Channel 1 and Channel 2 is DC to at least 200 megahertz. Risetime is 1.75 nanoseconds or less. The AC-coupled lower −3 dB point is 10 hertz or less (1 hertz or less when using a 10X probe). Vertical system bandwidth with the BW LIMIT pushbutton pulled is approximately 20 megahertz.

Chopped Mode Repetition Rate

Approximately one megahertz.

Input Resistance And Capacitance

One megohm within 2%, paralleled by approximately 20 picofarads.

Maximum Input Voltage

DC coupled: 250 V (DC + peak AC) or 500 V P-P AC at 1 kHz or less.

AC coupled: 500 V (DC + peak AC) or 500 V P-P AC at 1 kHz or less.

Cascaded Operation (CH 2 VERTICAL SIGNAL OUT connected to CH 1 OR X)

Bandwidth is DC to at least 50 MHz with a sensitivity of approximately 400 μV/division.

TRIGGERING

Sensitivity

DC Coupled: 0.3 division internal or 50 millivolts external from DC to 40 megahertz, increasing to 1.5 divisions internal or 250 millivolts external at 200 megahertz.

AC Coupled: 0.3 division internal or 50 millivolts external from 60 hertz to 40 megahertz, increasing to 1.5 divisions internal or 250 millivolts external at 200 megahertz. Attenuates all signals below about 60 hertz.

LF REJ Coupled: 0.3 division internal or 100 millivolts external from 50 kilohertz to 40 megahertz, increasing to 1.5 divisions internal or 500 millivolts external at 200 megahertz. Blocks DC and attenuates all signals below about 50 kilohertz.

HF REJ Coupled: 0.3 division internal or 100 millivolts external from 60 hertz to 50 kilohertz. Blocks DC and attenuates all signals below about 60 hertz and above about 50 kilohertz.

Trigger Jitter

0.2 nanosecond or less at 200 megahertz at 1 nanosecond/division (X10 MAG on).

External Trigger Input

Maximum input voltage is 250 V DC + peak AC or 250 V P-P AC (1 kilohertz or less). Input impedance is 1 megohm within 10%, paralleled by approximately 20 picofarads.

LEVEL Control Range

EXT: At least + and —2 volts, 4 volts peak to peak.

EXT ÷10: At least + and —20 volts, 40 volts peak to peak.

Exclude the LF REJ coupling mode.

Trigger View Deflection Factor

Approximately 50 millivolts/division.

HORIZONTAL DEFLECTION SYSTEM

Calibrated Sweep Range

A Sweep or B DLYD Sweep: from 0.5 second/division to 0.01 microsecond/division in 24 steps in a 1-2-5 sequence. X10 MAG extends maximum sweep rate to 1 nanosecond/division.

A Delaying Sweep: from 0.5 second/division to 0.05 microsecond/division in 22 steps in a 1-2-5 sequence.

Calibrated Sweep Accuracy (Over full ten horizontal divisions)

	X1 MAG	X10 MAG
+20°C to +30°C		
A or B DLYD Sweep		
5 ms/div to 0.01 μs/div	±1%	±2%
.5 s/div to 10 ms/div	±2%	±3%
A INT Sweep		
All rates	±2%	±3%
−15°C to +55°C		
All Sweeps, All Rates	±3%	±4%

X10 Magnified Sweep Accuracy

Within 5% over any two-division interval.

Mixed Sweep Accuracy

Within 3%

Variable Time/Division Control Range

Provides continuously variable (uncalibrated) sweep rates between the calibrated settings of the TIME/DIV switch. Extends the slowest A sweep rate to at least 1.25 seconds/division.

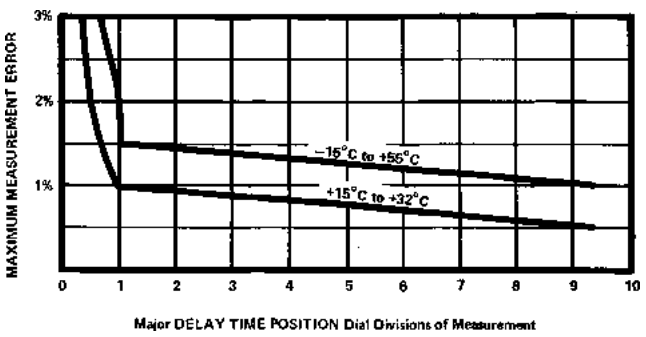
A Trigger Holdoff

Increases A sweep holdoff time to at least nine times the TIME/DIV switch setting.

Delay Time And Differential Time Measurement Accuracy (Simplified)

	+15°C to +35°C (+60°F to +95°F)	−15°C to +55°C (+5°F to +131°F)
Over One Or More Major Dial Divisions Over Less	±1%	±1.5%
Than One Major Dial Division	±0.01 Major Dial Division	±0.02 Major Dial Division

Delay Time And Differential Time Measurement Accuracy (Detailed)



Delay Pickoff Jitter

Within 0.002% (less than one part in 50,000) of the maximum available delay time when operating the instrument on power line frequencies other than 50 hertz.

Within 0.005% (less than one part in 20,000) of the maximum available delay time when operating the instrument on power line frequency of 50 hertz.

Maximum available delay time is ten times the setting of the A TIME/DIV switch.

Delay Range

From 0.05 microsecond or less to at least 5 seconds after the start of the delaying (A) sweep.

X-Y OPERATION

Sensitivity

Same as vertical deflection system.

Deflection Accuracy

Same as vertical deflection system.

Variable Range

Same as vertical deflection system.

X-Axis Bandwidth

DC to 3 MHz.

Input Resistance

Same as vertical deflection system.

Input Capacitance

Same as vertical deflection system.

Maximum Usable Input Voltage

Same as vertical deflection system.

CALIBRATOR

Output

An approximate 1 kilohertz repetition rate, 30 milliampere (±2%), 300 millivolt (±1%) square-wave signal.

Z AXIS INPUT

Sensitivity

A 5-volt peak to peak signal causes noticeable modulation at normal intensity.

Usable Frequency Range

From DC to 50 megahertz.

SIGNAL OUTPUTS

CH 2 VERT SIGNAL OUT

Output voltage is approximately 20 millivolts/division into a 1 megohm load (approximately 10 millivolts/division into 50 ohm load).

Bandwidth is DC to at least 50 megahertz into a 50 ohm load.

Output DC level is approximately zero volts.

A and B +GATE Outputs

Output voltage is approximately 5 volts positive-going.

POWER SOURCE

Line Voltages

110, 115, 120, 220, 230, or 240 VAC (all ±10%) depending on the settings of the Line Voltage Selector switch and the Regulating Range Selector assembly, with a

line frequency of 48 to 440 hertz. Maximum power consumption is 100 watts at 115 VAC, 60 hertz.

CATHODE-RAY TUBE

Graticule Area

Eight by ten centimeters.

Phosphor

P31 is the standard phosphor with P11 offered as an option.

ENVIRONMENTAL

Temperature

Operating: −15°C to +55°C; Storage: −55°C to +75°C.

Altitude

Operating: to 15,000 feet. Maximum operating temperature decreased 1°C/1,000 feet above 5,000 feet.

Storage: to 50,000 feet.

Humidity (Operating and Storage)

5 cycles (120 hours) referenced to MIL-E-16400F.

Vibration

15 minutes along each of three major axes at a total displacement of 0.025" peak to peak (4 g's at 55 hertz) with frequency varied from 10 hertz to 55 hertz to 10 hertz in one minute sweeps. After sweep vibration in each axis, hold the frequency steady at each major resonance for 3 minutes, or if no such resonances are found, hold at 55 hertz for 3 minutes.

Shock (Operating and Nonoperating)

30 g's 1/2 sine, 11 milliseconds duration, 2 shocks per axis each direction for a total of 12 shocks.

Transportation

Tested to National Safe Transit Committee Procedure 1A, with a 30-inch drop.

SUPPLEMENTAL INFORMATION

The supplemental information listed here represents limits that, when met, ensure optimum instrument operation. They are, however, not instrument specifications but are intended to be used only as maintenance or operational aids.

VERTICAL DEFLECTION SYSTEM

Low-Frequency Linearity

There should be no more than 0.1 division of compression or expansion of a two-division signal (at center screen) positioned to the upper and lower extremes of the graticule area.

Bandwidth Limiter Bandwidth

The −3 dB point should be between 15 and 25 megahertz.

Step Response Aberrations

There should be less than +4%, −4%, or a total of 4% peak to peak aberration on a positive-going step in the 5 mV/DIV position of the VOLTS/DIV switch. Add 3% when checking a negative-going step or when checking for aberrations while operating in the added mode.

Common-Mode Rejection Ratio

At least 20:1 at 1 kilohertz for common-mode signals of 8 divisions or less.

Trace Shift As Variable Is Rotated

Adjustable to 2 divisions or less.

INVERT Trace Shift

One division or less when switching from normal to inverted.

Input Gate Current

1 nanoampere or less (0.2 division at 5 mV/division) from +20°C to +30°C. Four nanoamperes or less (0.8 division at 5 mV/division) from −15°C to +55°C.

Channel Isolation

At least 100:1 at 50 megahertz.

POSITION Control Range

At least +12 and −12 divisions from graticule center.

Signal Delay Between Channel 1 and Channel 2

±0.25 nanosecond at 5 mV/DIV.

Input R and C Time Constant

Aberrations should be 2% or less using a one megohm, 20 picofarad input time-constant normalizer.

TRIGGERING

External Trigger Input Capacitance

Twenty picofarads within 30%.

TRIG VIEW Deflection Factor

50 mV/div ±20%. Exclude LF REJ and HF REJ trigger coupling modes.

TRIG VIEW Risetime

≤3.5 nanoseconds over the 10% to 90% part of the fast rise portion.

TRIG VIEW Delay Difference

≤2 nanosconds with 5 division signal having 1 nanosecond or less risetime from 25 ohm source, centered vertically with equal cable length from signal source to vertical channel and external trigger inputs, each terminated in 50 ohms.

TRIG VIEW Centering of Trigger Point

Adjustable to within one division of center screen.

HORIZONTAL DEFLECTION SYSTEM

Sweep Accuracy

Exclude the first 25 nanoseconds or 2 divisions (whichever is greater) and all beyond the 100th division of the sweep when checking 1 ns through 500 ns/division magnified sweep rates.

Mixed Sweep Accuracy

Exclude the first 0.5 division after the display start, and the first 0.2 division or 0.1 microsecond (whichever is greater) after the transition of A to B.

Differential Time Measurement Accuracy

Exclude DELAY TIME POSITION dial settings of 0.00 through 0.50 for 0.5 second through 1.0 microsecond/division delaying sweep rates.

Exclude DELAY TIME POSITION dial settings of 0.00 through 1.00 for 0.5 microsecond through 0.05 microsecond/division delaying sweep rates.

Sweep Length (A Only)

At least 10.1 divisions.

Magnifier Registration

Within 0.5 division from graticule center at 1 millisecond/division.

POSITION Control Range

Start of sweep must position to right of graticule center. End of sweep must position to left of graticule center. Check made at 1 millisecond/Division sweep rate.

Phase Difference between X and Y Axes Amplifiers

Within 1° from DC to 1 megahertz. Within 3° from 1 megahertz to 2 megahertz.

X Axis Low Frequency Linearity

0.2 division or less compression or expansion of a 2 division signal (at center screen) positioned to both horizontal extremes of the display area.

CALIBRATOR

Repetition Rate

Repetition Rate accuracy is typically within 25%.

Output Resistance

Approximately 9.4 ohms.

EXTERNAL Z AXIS INPUT

Maximum Input Voltage

Voltages applied to the EXT Z AXIS INPUT connector should be limited to less than 100 volts DC plus peak AC or 100 volts peak to peak AC at 1 kilohertz or less.

OUTPUT SIGNALS

Output Resistance

Output resistance of the CH 2 VERT SIGNAL OUT connector is approximately 50 ohms. Output resistance of +A and +B GATE outputs is approximately 500 ohms.

CATHODE-RAY TUBE

Resolution

Typically at least 15 lines per division horizontally and vertically.

Geometry

0.1 division or less of tilt or bowing.

Raster Distortion

0.1 division or less.

Nominal Accelerating Potential

Approximately 18,000 volts.

OPERATING INFORMATION

Introduction

This section of the manual is intended to allow the operator to become familiar with the instrument's power requirements, functions of controls and connectors, and how to obtain a few basic displays. For more complete operating information, refer to the 475 Operators Handbook.

Operating Voltage

CAUTION

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. It is not intended for operation from two phases of a multi-phase system, or across the legs of a single-phase three-wire system.

This instrument can be operated from either a 115-volt or 230-volt nominal line voltage source, 48 to 440 hertz. The Line Voltage Selector switch in the instrument converts the instrument from one nominal operating voltage to the other. The Regulating Range Selector assembly on the instrument rear panel selects one of three regulating ranges for each nominal line voltage, and also contains the line fuses for overload protection for both nominal line voltages. To select the correct nominal line voltage and regulating range, proceed as follows:

1. Disconnect the instrument from the power source.

2. To convert from 115-volts nominal to 230-volts nominal line voltage, set the selector switch to the 230 volts position (toward the rear of the instrument). Change the line-cord plug to match the power source or use a 115-to-230 volt adapter.

NOTE

Color-coding of the cord conductors is as follows (in accordance with National Electrical Code):

Line	*Black*
Neutral	*White*
Safety earth (ground)	*Green (or green with yellow tracer)*

3. To change regulating ranges, loosen the two captive screws which hold the cover onto the regulating range selector assembly; then pull to remove the cover.

4. Pull out the range selector switch bar (see Fig. 2-1). Slide the bar to the desired position and plug it back in. Select a range which is centered about the average line voltage to which the instrument is to be connected (see Table 2-1).

TABLE 2-1

Regulating Ranges

Range Selector Switch Position	Regulating Range	
	115-Volts Nominal	230-Volts Nominal
LO (switch bar in upper holes)	99 to 121 volts	198 to 242 volts
M (switch bar in middle holes)	104 to 126 volts	208 to 252 volts
HI (switch bar in lower holes)	108 to 132 volts	216 to 264 volts

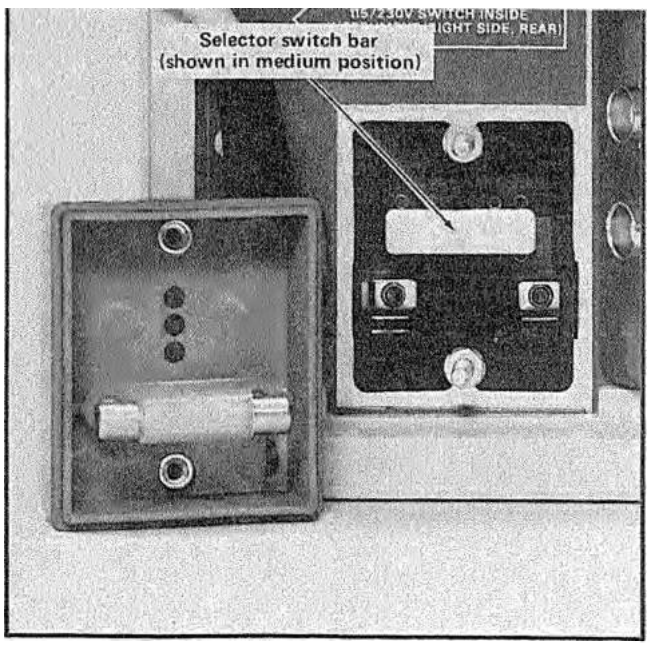


Fig. 2-1. Power supply regulating range selector.

5. Re-install the cover and tighten the two captive screws.

6. Before applying power to the instrument, check that the line voltage selector switch and the indicating tabs on the regulating range selector assembly are in the correct positions for the desired nominal line voltage and regulating range.

CAUTION

This instrument may be damaged if operated with the line voltage selector switch or the regulating range selector assembly set to incorrect positions for the line voltage applied.

The 475 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 and pose a shock hazard.

The feet on the rear panel provide a convenient cord wrap to store the power cord when not in use.

CONTROLS AND CONNECTORS

General

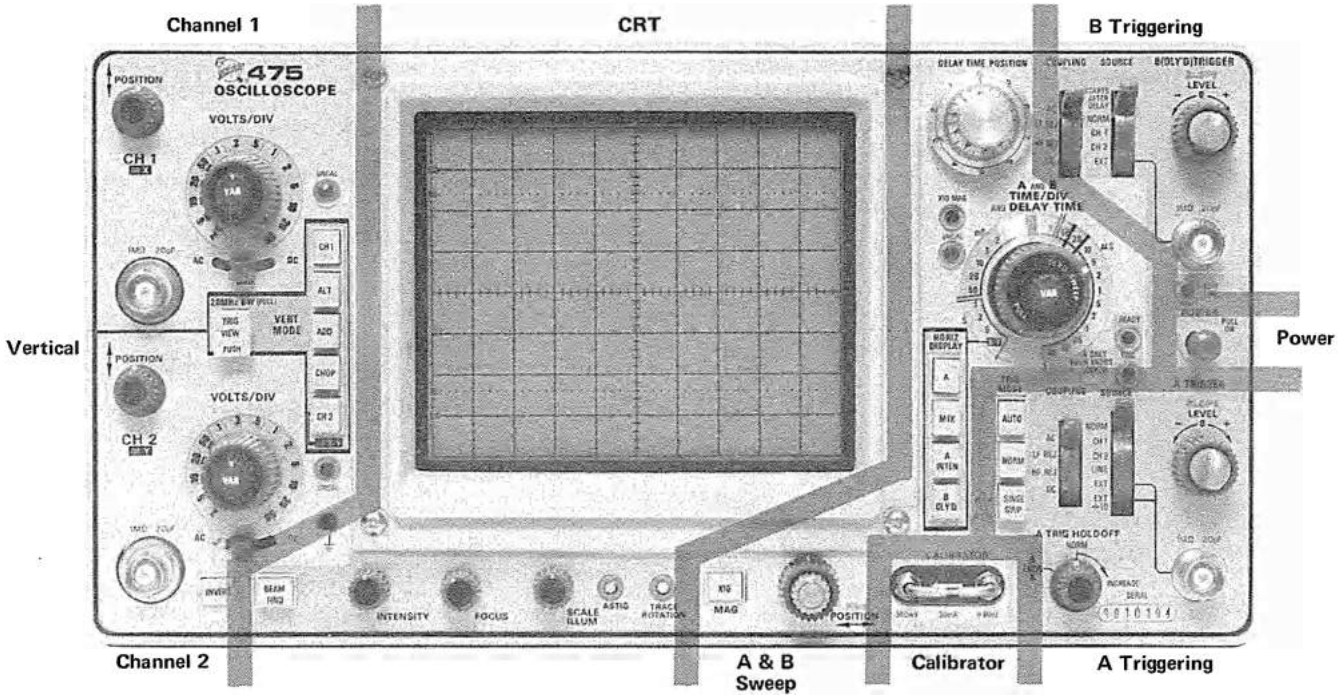
The major controls and connectors for operation of the 475 are located on the front panel of the instrument. A few auxiliary functions are provided on the rear panel. Fig. 2-2 shows the front and rear panels of the 475. A brief description of each control and connector is given here. More detailed operating information is given in the 475 Oscilloscope Operators Handbook.

Cathode-Ray Tube (CRT) and Display

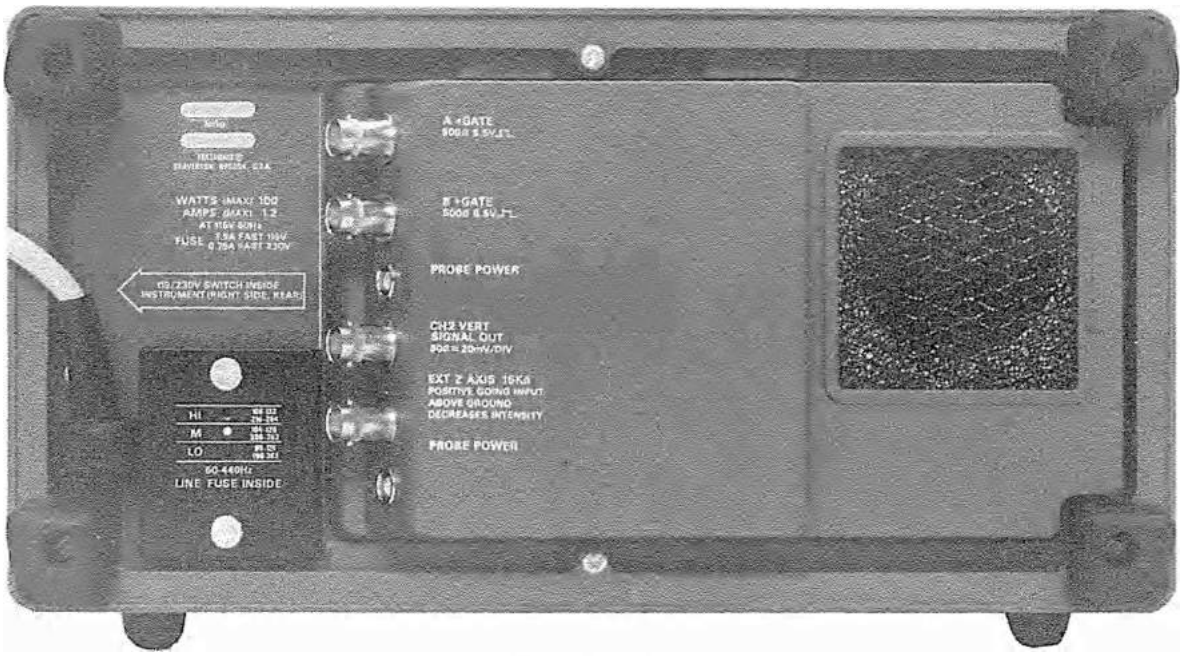
BEAM FIND	Compresses the display to within the graticule area, independently of display position or applied signals.
INTENSITY	Controls brightness of the display.
FOCUS	Provides adjustment for optimum display definition.
SCALE ILLUM	Controls graticule brightness.
ASTIG	Screwdriver adjustment used in conjunction with the FOCUS control to obtain a well-defined display. Does not require readjustment in normal use.
TRACE ROTATION	Screwdriver adjustment to align the trace with the horizontal graticule lines.

Vertical Deflection System (Channel 1 & Channel 2)

POSITION	Controls the vertical position of the trace. In the X-Y mode of operation, the CH 2 control positions on the Y-axis (vertically) and the CH 1 POSITION control positions on the X-axis (horizontally).
CH 1 OR X	Input connector for Channel 1 deflection signals or X-axis deflection in the X-Y mode of operation.
CH 2 OR Y	Input connector for Channel 2 deflection signals or Y-axis deflection in the X-Y mode of operation.
GAIN (2 and 5 mV)	Screwdriver adjustments to set the gain of the Vertical Preamp.
VOLTS/DIV	Selects vertical deflection factor in a 1-2-5 sequence (VAR control must be in the calibrated detent for the indicated deflection factor).
VAR	Provides continuously variable uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV switch.
UNCAL	Light indicates that the VAR control is not in the calibrated position.
Input Coupling (AC-GND-DC)	Selects the method of coupling signal to the input of the Vertical Amplifier.
	AC: Signal is capacitively coupled to the Vertical Amplifier. DC component of signal is blocked. Low-frequency limit (lower –3 dB point) is about 10 hertz.
	GND: Input signal is removed and the input circuit is grounded. Does not ground the input signal.



A. Front panel.



B. Rear panel.

Fig. 2-2. Front- and rear-panel controls and connectors.

DC: All components of the input signal are passed to the Vertical Amplifier.

20 MHz BW/ TRIG VIEW — Dual-purpose switch that limits the bandwidth of the complete Vertical Deflection System to approximately 20 MHz when pulled out, or causes signal present in A Trigger Generator circuit to be displayed on the CRT when pressed.

INVERT — Pushbutton switch that inverts the Channel 2 display.

VERT MODE — Selects the vertical mode of operation.

CH 1: Displays Channel 1 only.

ALT: Dual-trace display of signals on both channels. Display is switched between channels at the end of each sweep.

ADD: Signals applied to the CH 1 OR X and the CH 2 OR Y connectors are algebraically added and the sum is displayed on the CRT. The INVERT switch in Channel 2 allows the display to be CH 1 + CH 2 or CH 1 – CH 2.

CHOP: Dual-trace display of signals on both channels. Display is switched between channels at an approximate repetition rate of 1 megahertz.

CH 2 OR X-Y: Displays Channel 2 only. Must be pushed when operating in X-Y mode.

A and B Triggering (both where applicable)

COUPLING — Determines the method used to couple signal to input of trigger circuits.

AC: Rejects DC and attenuates signals below about 60 Hz. Accepts signals above about 60 Hz.

LF REJ: Rejects DC and attenuates signals below about 50 kHz. Accepts signals above about 50 kHz.

HF REJ: Accepts signals between 60 Hz and 50 kHz. Rejects DC and attenuates all signals outside the above range.

DC: Accepts all trigger signals between DC and 200 MHz or greater.

SOURCE — Selects source of trigger signal.

NORM: Internal trigger signal obtained from Vertical Deflection System. Actual source is signal(s) displayed on CRT.

CH 1: A sample of the signal connected to the CH 1 OR X input connector is used as a trigger signal.

CH 2: A sample of the signal connected to the CH 2 OR Y input connector is used as a trigger signal.

EXT: Trigger signal obtained from signal connected to the External Trigger Input connector.

EXT ÷10 (A trigger circuit only): External trigger signal attenuated by a factor of 10.

STARTS AFTER DELAY (B trigger circuit only): B sweep starts immediately after the delay time selected by the DELAY-TIME POSITION dial and the DELAY-TIME switch.

LINE (A trigger circuit only): Trigger signal obtained from a sample of the line voltage applied to the instrument.

SLOPE — Selects the slope of the trigger signal which starts the sweep.

+: Sweep can be triggered from the positive-going portion of the trigger signal.

–: Sweep can be triggered from the negative-going portion of the trigger signal.

LEVEL — Selects the amplitude point on the trigger signal at which the sweep is triggered.

A TRIG MODE

Determines the operating mode for the A Trigger Circuit.

AUTO: With the proper trigger control settings, A Sweep can be initiated by signals that have repetition rates above about 20 hertz and are within the frequency range selected by the COUPLING switch. In the absence of an adequate trigger signal or when the trigger controls are misadjusted, the sweep free-runs to produce a reference trace.

NORM: With the proper trigger control settings, A Sweep can be initiated by signals that are within the frequency range selected by the COUPLING switch. In the absence of an adequate trigger signal or when the trigger controls are misadjusted, there is no trace.

SINGL SWP: After a sweep is displayed, further sweeps cannot be presented until the SINGL SWP pushbutton is pressed again. The display is triggered as for NORM operation using the A Triggering controls.

A TRIG HOLDOFF

Provides control of holdoff time between sweeps to obtain stable displays when triggering on aperiodic signals (such as complex digital words). Variable can increase holdoff time up to at least 9 times the setting of the TIME/DIV switch. In the B ENDS A position (fully clockwise), the A sweep is reset at the end of the B sweep to provide the fastest possible sweep repetition rate for delayed sweep presentations.

External Trigger Input (not labeled)

Input connectors for external trigger signals.

A and B Sweep

DELAY-TIME POSITION

Provides variable sweep delay between 0.00 and 10.00 times the delay time indicated by the DELAY TIME switch.

A AND B TIME/DIV AND DELAY TIME

A TIME/DIV switch (clear plastic outer flange) selects the basic delay time (to be multiplied by the DELAY-TIME POSITION dial setting) for delayed-sweep operation. The B TIME/DIV switch (inner dark knob) selects the sweep rate for A only displays or for the B portion of a delayed sweep display. VAR control must be in the calibrated detent for calibrated sweep rates.

VAR

Provides continuously variable (uncalibrated) sweep rates between the calibrated settings of the TIME/DIV switch. Varies the A Time Base sweep rate in the non-delayed mode of horizontal operation and the B Time Base sweep rate in the delayed sweep mode. Extends the slowest sweep rate to at least 1.25 seconds/division. Sweep rate is calibrated when the control is rotated fully clockwise to the calibrated detent.

UNCAL

Light that indicates when the VAR TIME/DIV control is out of the calibrated detent and the horizontal sweep rate is uncalibrated.

X10 MAG Indicator

Light that indicates when the X10 MAG is turned on.

READY

Light that indicates that A Sweep has been prepared to present a single sweep upon receipt of an adequate trigger signal.

HORIZ DISPLAY

Selects the horizontal mode of operation.

A: Horizontal deflection provided by A Sweep. B Sweep inoperative.

MIX: The first part of the horizontal sweep is displayed at a rate set by the A TIME/DIV switch and the latter part of the sweep at a rate set by the B TIME/DIV switch. Relative amounts of the display allocated to each of the two rates are determined by the setting of the DELAY-TIME POSITION dial.

A INT: Displayed sweep rate determined by the A TIME/DIV

switch. An intensified portion appears on the display during the B sweep time. This switch position provides a check of the duration and position of the B sweep (delayed sweep) with respect to the delaying sweep (A).

B DLYD: Sweep rate determined by the B TIME/DIV switch with the delay time determined by the setting of the DELAY TIME (A TIME/DIV) switch and the DELAY-TIME POSITION dial.

Horizontal POSITION	Positions the display horizontally.
X10 MAG	Increases the displayed sweep rate by a factor of 10.

Calibrator and Power

CALIBRATOR	A combination current loop/squarewave voltage output device. Provides a 30 mA squarewave current, 300 mV squarewave voltage signal with a repetition rate of approximately 1 kHz.
POWER	Turns instrument power on and off.
LOW LINE	Light that indicates the applied line voltage is below the lower limit of the regulating range selected by the Regulating Range Selector assembly.

Rear Panel

A +GATE	Output connector providing a positive-going rectangular pulse coincident with the A sweep time.
B +GATE	Output connector providing a positive-going rectangular pulse coincident with the B sweep time.
CH 2 VERT SIGNAL OUT	Output connector providing a sample of the signal applied to the CH 2 input connector.
EXT Z AXIS INPUT	Input connector for intensity modulation of the CRT display.
Regulating Range Selector	Selects the regulating range of the internal power supplies (low, medium, high; determined by specific line voltage applied to instrument).
PROBE POWER	Connectors that make operating power available for active device probe systems.

OBTAINING BASIC DISPLAYS

Introduction

The following instructions will allow the operator who is unfamiliar with the operation of the 475 to obtain the basic displays commonly used. Before proceeding with these instructions, preset the instrument controls as follows:

Vertical Controls

VERT MODE Switch	CH 1
VOLTS/DIV Switches	Proper position determined by amplitude of signal to be applied.
VOLTS/DIV VAR Controls	Calibrated detent.
Input Coupling Switches	AC
Vertical POSITION Controls	Midrange
20 MHz BW Switch	Not limited
INVERT Switch	Button out
INTENSITY Control	Fully counterclockwise
FOCUS Control	Midrange
SCALE ILLUM Control	Midrange

Trigger Controls (both A and B if applicable)

SLOPE Switch	+
LEVEL Control	0
SOURCE Switch	NORM
COUPLING Switch	AC
TRIG MODE Switch	AUTO
A TRIG HOLDOFF Control	NORM

Horizontal Sweep Controls

TIME/DIV Switches	Locked together at 1 ms
TIME/DIV VAR	Calibrated detent
HORIZ DISPLAY Switch	A
X10 MAG Switch	Off (button out)
POSITION Control	Midrange

Normal Sweep Display

1. Set the POWER switch to on (button out). Allow several minutes for instrument warmup.

2. Connect the external signal to the CH 1 input connector.

3. Advance the INTENSITY control until the display is visible. If the display is not visible with the INTENSITY control at midrange, press the BEAM FIND pushbutton and adjust the CH 1 VOLTS/DIV switch until the display is reduced in size vertically; then center the compressed display with the vertical and horizontal POSITION controls; release the BEAM FIND pushbutton. Adjust the FOCUS control for a well-defined display.

4. Set the CH 1 VOLTS/DIV switch and CH 1 POSITION control for a display which remains in the display area vertically.

5. Adjust the A Trigger LEVEL control for a stable display.

6. Set the B TIME/DIV switch and the horizontal POSITION control for a display which remains in the display area horizontally.

Magnified Sweep Display

1. Preset the instrument controls and follow steps 1 through 6 for obtaining a Normal Sweep Display.

2. Adjust the horizontal POSITION control to move the area to be magnified to within the center graticule division of the CRT. If necessary, change the TIME/DIV switch setting so the complete area to be magnified is within the center division.

3. Set the X10 MAG switch to the on position (button in) and adjust the horizontal POSITION control for precise positioning of the magnified display.

Delayed Sweep Displays

1. Preset the instrument controls and follow steps 1 through 6 for obtaining a Normal Sweep Display.

2. Set the HORIZ DISPLAY switch to A INT and the B Trigger SOURCE switch to STARTS AFTER DELAY.

3. Pull out the B TIME/DIV switch knob and turn clockwise so the intensified zone on the display is the desired length. Adjust the INTENSITY control to achieve the desired display brightness.

4. Adjust the DELAY-TIME POSITION dial to position the intensified zone to the portion of the display to be delayed.

5. Set the HORIZ DISPLAY switch to B DLYD. The intensified zone on the display noted in step 3 is now being displayed in delay form. The delayed sweep rate is indicated by the dot on the B TIME/DIV switch knob.

6. For a delayed sweep display that will exhibit less jitter, set the B Trigger SOURCE switch to the same position as the A Trigger SOURCE switch and adjust the B Trigger LEVEL control for a stable display. If the A Trigger SOURCE switch is in the LINE position, a sample of the line voltage will have to be supplied to the B Trigger circuit externally.

Mixed Sweep Display

1. Preset the instrument controls and follow steps 1 through 6 for obtaining a Normal Sweep Display.

2. Pull out the B TIME/DIV switch knob and turn clockwise to the desired sweep rate. Adjust the INTENSITY control to achieve the desired display brightness.

3. Set the HORIZ DISPLAY switch to MIX. The CRT display now contains more than one time factor on the horizontal axis. The first portion of the display is at the A Time Base sweep rate and the latter part is at the B Time Base sweep rate. The start of the B Time Base portion of the display can be changed by adjusting the DELAY-TIME POSITION control.

X-Y Display

1. Preset the instrument controls and turn the instrument power on. Allow several minutes for instrument warm-up.

2. Set the TIME/DIV switch to X-Y and the VERT MODE to CH 2. Apply the vertical signal to the CH 2 OR Y input connector and the horizontal signal to the CH 1 OR X input connector. The CH 2 POSITION control will provide vertical positioning and the CH 1 POSITION control will provide horizontal positioning.

3. Advance the INTENSITY control until the display is visible. If the display is not visible with the INTENSITY control at midrange, press the BEAM FIND pushbutton and adjust the CH 1 and CH 2 VOLTS/DIV switches until the display is reduced in size both vertically and horizontally; then center the compressed display with the POSITION controls; release the BEAM FIND pushbutton. Adjust the FOCUS control for a well-defined display.

CIRCUIT DESCRIPTION

Introduction

This section of the manual contains a description of the circuitry used in the 475 Oscilloscope. The description begins with a discussion of the instrument, using the basic block diagram shown in Fig. 3-1. Then, each circuit is described in detail, using detailed block diagrams to show the interconnections between the stages in each major circuit and the relationship of the front panel controls to the individual stages.

A complete block diagram is located in the Diagrams Section at the back of this manual. This block diagram shows the overall relationship between all of the circuits. Complete schematics of each circuit are also given in the Diagrams Section. Refer to these diagrams throughout the following circuit description for electrical values and relationships.

Digital Logic

Digital logic techniques are used to perform many functions within this instrument. The function and operation of the logic circuits are described using logic symbology and terminology. All logic functions are described using the positive logic convention. Positive logic is a system of notation where the more positive of two levels (HI) is called the true or 1 state; the more negative level (LO) is called the false or 0 state. The HI-LO method of notation is used in this logic description. The specific voltages that constitute a HI or LO state vary between individual devices. Typical HI or LO logic levels are shown on the diagrams at the rear of this manual.

It should be noted that not all of the integrated circuit devices in this instrument are digital logic devices. The function of non-digital devices are described individually, using operating waveforms or other techniques to illustrate their function.

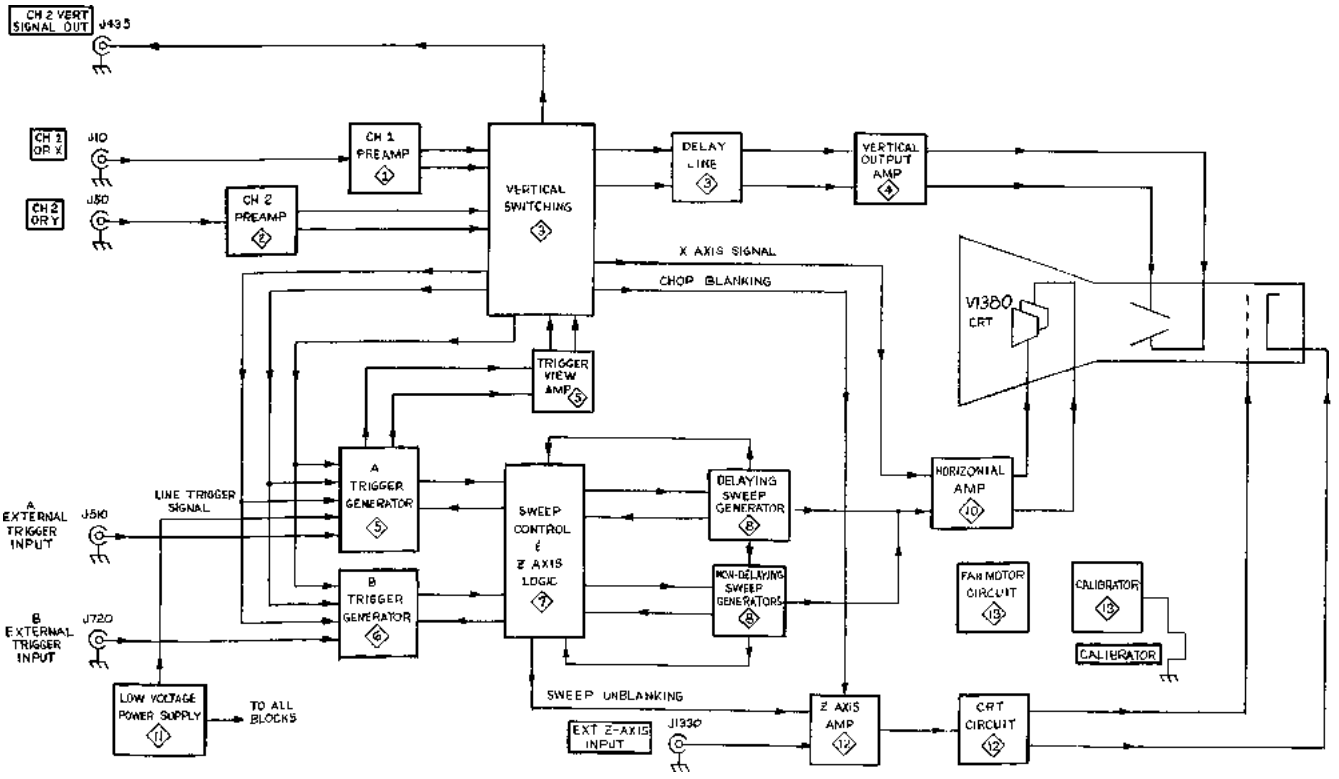


Fig. 3-1. Basic block diagram of the 475.

BLOCK DIAGRAM

General

The following discussion is provided to aid in understanding the overall concept of the 475 Oscilloscope before the individual circuits are discussed in detail. A basic block diagram of the 475 Oscilloscope is shown in Fig. 3-1. Only the basic interconnections between the individual blocks are shown on this diagram. Each block represents a major circuit within the instrument. The number on each block refers to the complete circuit diagram, which is located at the rear of this manual.

Signals to be displayed on the CRT are applied to the CH 1 OR X or CH 2 OR Y connectors. The input signals are then amplified by the Preamplifier circuits. Each Preamplifier circuit includes separate vertical deflection factor, input coupling, balance, gain, and variable attenuation controls. The Channel 2 Preamplifier circuit also contains an invert feature to invert the Channel 2 signal as displayed on the CRT.

The output of both Vertical Preamplifier circuits connects to the Vertical Channel Switching circuit. This circuit selects the channel(s) to be displayed. An output signal from this circuit connects to the Z Axis Amplifier circuit to blank out the switching transients between channels when in the chopped mode of operation. The Vertical Channel Switching circuit also provides the Channel 2 VERT SIG OUT signal (available on the instrument rear panel) as well as the signals used for sweep triggering in the NORM, CH 1, and CH 2 positions of the trigger SOURCE switches and the signal used for X-axis deflection in the X-Y mode of horizontal operation.

The output of the Vertical Channel Switching circuit connects to the Vertical Output Amplifier through the Delay Line. The Delay Line provides a fixed amount of signal delay through the vertical deflection system to allow viewing the leading edge of a triggering waveform. The Vertical Output Amplifier circuit provides the final amplification for the signal before it is connected to the vertical deflection plates of the CRT. This circuit includes the BEAM FIND switch which compresses the vertical and horizontal deflection to within the viewing area to aid in locating an off-screen display.

The A and B Trigger Generator circuits produce an output pulse that initiates generation of the sawtooth sweep signals produced by the A or B Sweep Generator circuits. The input signal to the Trigger Generator circuits can be individually selected from the Channel 1 signal, Channel 2 signal, the signal(s) displayed on the CRT (NORM), a signal connected to the external trigger input connectors, or a sample of the line voltage applied to the instrument. Each trigger circuit contains separate level, slope, coupling, and source controls.

There are three sweep generator circuits in the 475. For purposes of explanation, they are called Delaying, Slow Non-Delaying, and Fast Non-Delaying. The Delaying Sweep generates a range of sweep rates from 0.5 seconds to 0.05 microseconds/division. The Slow Non-Delaying Sweep generates sweeps from 0.5 seconds to 1 microsecond/division and the Fast Non-Delaying Sweep from 0.5 microsecond to 0.01 microsecond/division.

The Delaying Sweep runs only when the instrument is operated in a delayed-sweep mode (MIX, A INTEN, or B DLY'D) and is displayed as the A portion of a MIX or A INTEN display. The sweep rate for this generator is selected by the A TIME/DIV switch. One of the Non-Delaying Sweeps (depending on the sweep rate selected) will run and be displayed in the A or B DLY'D modes or as the B portion of a MIX or A INTEN display. In the A mode of operation, the sweep rate is selected by the B TIME/DIV switch. In the MIX, A INTEN, and B DLY'D modes of operation, the Non-Delaying (B) sweep rate is also selected by the B TIME/DIV switch.

The TRIG MODE switch controls the mode of operation of the sweep generator deriving the A portion of a display. In the AUTO position, the absence of an adequate trigger signal causes the sweep to free run. In the NORM position, a horizontal sweep is presented only when correctly triggered by an adequate trigger signal. Pushing the SING SWP pushbutton allows one (and only one) sweep to be presented. The Z Axis Logic circuit produces an unblanking gate signal to unblank the CRT so that the display can be presented. This gate signal is coincident with the sawtooth produced by the sweep generator. The Z Axis Logic Circuit also produces, at the end of each sweep, a gate signal that is supplied to the Vertical Channel Switching circuit. This pulse switches the display between channels at the end of each sweep when the Vertical Deflection System is operating in the ALT mode.

The outputs of the sweep generators are amplified by the Horizontal Amplifier to produce horizontal deflection for the CRT except in the fully counterclockwise (X-Y) position of the TIME/DIV switch. The Horizontal Amplifier contains a 10X magnifier to increase the sweep by a factor of 10 in any A or B TIME/DIV switch position. Other horizontal deflection signals can be connected to the Horizontal Amplifier by using the X-Y mode of operation. When the TIME/DIV switch is set to X-Y, the X-axis signal is connected to the Horizontal Amplifier circuit through the Channel 1 Vertical Preamplifier circuit.

The Z Axis Amplifier circuit determines the CRT intensity and blanking. The Z Axis Amplifier circuit sums the current inputs from the INTENSITY control, the Vertical Channel Switching circuit (chopped blanking), the Z Axis Logic circuit (unblanking), and the external Z AXIS INPUT connector. The output level of the Z Axis Amplifier circuit controls the trace intensity through the CRT circuit. The CRT circuit provides the voltages and contains the controls necessary for operation of the cathode-ray tube.

The Power Supply circuit provides the low voltage power necessary for operation of this instrument. This voltage is distributed to all of the circuits in the instrument as shown by the Power Distribution Diagram. The Calibrator circuit provides a square-wave output with accurate voltage and current amplitudes, which can be used to check the calibration of the instrument and the compensation of probes. The CALIBRATOR current loop provides an accurate current source for calibration of current measuring probe systems.

CHANNEL 1 PREAMP

General

Input signals for vertical deflection on the CRT can be connected to the CH 1 OR X input connector. In the X-Y mode of operation, the input signal connected to the CH 1 OR X connector provides the horizontal (X-axis) deflection (TIME/DIV switch set to X-Y, VERT MODE switch set to CH 2 OR X-Y). The Channel 1 Preamp circuit provides control of input coupling, vertical deflection factor, gain, and DC balance. Fig. 3-2 shows a detailed block diagram of the Channel 1 Preamp circuit. A schematic of this circuit is shown on Diagram 1 at the rear of this manual.

Input Coupling

Signals applied to the input connector can be AC coupled, DC coupled, or internally disconnected from the input to the Vertical Input Amplifier circuit. When Input Coupling switch S20A is set for DC coupling, the input signal is coupled directly to the Input Attenuator stage. When AC coupled, the input signal passes through capacitor C10. This capacitor prevents the DC component of the signal from passing to the amplifier. In the GND position, S20A opens the signal path and connects the input of the amplifier to ground. This provides a ground reference without the need to disconnect the applied signal from the input connector. Resistor R22, connected across the input coupling switch, allows C10 to be pre-charged in the ground position, which prevents generation of large voltage transients at the input to the amplifier and allows the trace to remain on screen when switched to the AC position.

Input Attenuator

The effective overall deflection factor of each channel of the 475 is determined by the appropriate VOLTS/DIV switch setting. The basic deflection factor of the Vertical Deflection System is 5 millivolts/division of CRT deflection. To achieve the deflection factor values indicated on the front panel, precision attenuators are switched into the circuit and, in the 2 mV position, the gain of the Second Cascode Amplifier stage is changed.

For the VOLTS/DIV switch positions above 5 mV, attenuators are switched into the circuit singly or in pairs to help produce the vertical deflection factors indicated. These attenuators are frequency-compensated voltage dividers. In addition to providing constant attenuation at all frequen-

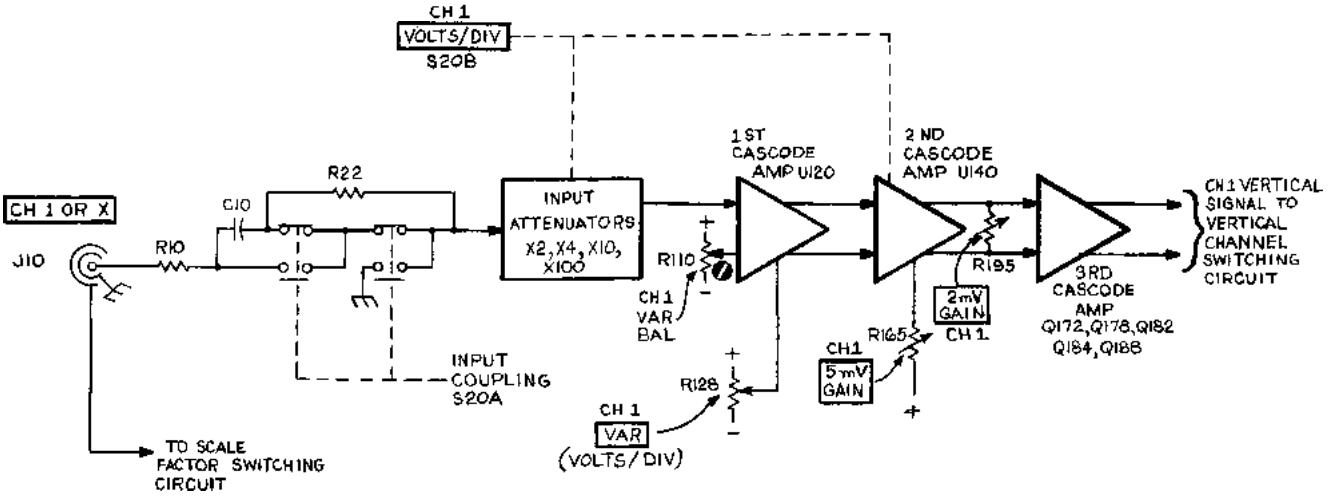


Fig. 3-2. Detailed block diagram of the Channel 1 Vertical Preamplifier circuit.

cies within the bandwidth of the instrument, the Input Attenuators are designed to maintain the same input RC characteristics for each setting of the VOLTS/DIV switch. Each attenuator contains an adjustable series capacitor to provide correct attenuation at high frequencies and an adjustable shunt capacitor to provide correct input capacitance.

NOTE

Each attenuator is a hybrid encapsulated plug-in assembly; therefore, replacement of individual components within the attenuator is not possible. Should defects occur, the attenuator must be replaced as a unit.

First Cascode Amplifier

The first amplifier stage in the Channel 1 Preamplifier circuit is hybrid circuit U120. U120 basically consists of an integrated emitter-coupled, push-pull, cascode amplifier cell and two discrete field-effect transistors (FET) mounted on a ceramic substrate with the thick-film resistors. The stage is configured as a paraphase amplifier and converts the single-ended input signal to push-pull output signals. CR104 and CR107 provide protection for the input to U120 if large negative-going signals or DC levels are applied to the CH 1 OR X input connector.

This input amplifier stage contains the CH 1 VAR VOLTS/DIV control. This control provides the ability to obtain continuously variable (uncalibrated) vertical deflection factors between the calibrated positions of the VOLTS/DIV switch. With the VAR control in its calibrated detent (wiper at ground), the output transistors of U120, whose collectors connect to pins 5 and 9 are conducting; the output transistors whose collectors connect to pins 6 and 8 are biased off. Thus, the current available to the following amplifier stage is that flowing from pins 5 and 9.

When the VAR control is rotated out of its calibrated detent, the transistors whose collectors connect to pins 6 and 8 begin to conduct. The current they conduct is robbed from the other output transistors. This causes two things to occur:

1. The current flowing in the collectors of the transistors connected to pins 5 and 9 is less now than when the VAR control was in its calibrated detent.

2. The current available to the following amplifier stage is the algebraic sum of the currents in the collectors tied together (i.e., pins 8 and 9 and pins 5 and 6). Since the two collectors tied together have signals of opposite polarity, the signal available to the following amplifier stage is less than that available when the VAR control was in its calibrated detent. The component values selected for the variable function provide a variable attenuation ratio of approximately 2.5 to 1. The Channel 1 Variable Balance adjustment R110 adjusts for no trace shift in the display when rotating the VAR control. The Channel 1 UNCAL light indicates when the Channel 1 VAR control is out of its calibrated detent. The components connected between pins 2 and 3 of U120 provide high-frequency compensation for the stage.

Second Cascode Amplifier

The second amplifier stage in the Channel 1 Preamplifier circuit is U140. U140 is the same integrated emitter-coupled, push-pull, cascode amplifier as the one used in U120. It is used as a push-pull amplifier and contains 2 mV and 5 mV gain adjustments that determine the overall gain of the Channel 1 Preamplifier circuit. The output signals available to the next stage for amplification are taken from pins 5 and 9 of U140.

The gain of U140 is determined by biasing the output transistors connected to pins 6 and 8 to conduct more or less current. As more current is conducted through the transistors connected to pins 6 and 8, that much less is conducted through the transistors connected to pins 5 and 9. The current conducted by the transistors connected to pins 5 and 9 in the 2 mV position of the VOLTS/DIV switch is approximately 2.5 times the current conducted by the same transistors in all of the other VOLTS/DIV switch positions. This results in increased gain and a DC level shift at the signal output terminals of U140. The VOLTS/DIV switch compensates for a shift in the DC level by shorting out part of the common-mode resistance (R157) when operating with 2 mV sensitivity. The Gain Switch Balance adjustment R135 adjusts the DC balance of the stage, so there is no baseline shift in the CRT display when switching between the 2 mV and 5 mV positions of the CH 1 VOLTS/DIV switch. The remainder of the components connected between pins 2 and 3 of U140 provide high-frequency compensation for the stage. Resistor-thermistor RT149 reduces in value with increases in temperature to compensate for losses in gain associated with increases in ambient temperature.

Third Cascode Amplifier

The third amplifier stage in the Channel 1 Preamplifier circuit is a discrete component cascode amplifier made up of Q172, Q178, Q182, Q184, and Q188. Q184 is a relatively constant current source for Q172 and Q182. Q172 and Q182 convert the input voltage signals into current signals which are in turn converted back to voltage signals by Q178 and Q188 respectively. R172 and R182 provide thermal compensation and C172 and C182 AC-couple the signal around R172 and R182 to reduce Miller effect. C175 and R175 are variable high-frequency compensation adjustments while CR170, CR174, and RT170

offset compensation changes associated with variations in ambient temperature. As temperature increases, the value of RT170 decreases. This results in a decrease in voltage across CR170 and CR174. CR170 and CR174 are voltage-variable capacitance semiconductors whose capacitance increases with a decrease in reverse voltage across them. Thus, CR170 and CR174 will provide more peaking at higher temperatures. L178 is a toroid inductor that cancels high-frequency common-mode signals generated by the previous stages. The Channel 1 Position Centering adjustment centers the range of control of the Channel 1 POSITION control.

CHANNEL 2 PREAMP

General

The Channel 2 Preamp circuit is virtually the same as the Channel 1 Preamp circuit. Only the differences between the two circuits are described here. Portions of this circuit not described in the following description operate in the same manner as for the Channel 1 Preamp circuit. Fig. 3-3 shows a detailed block diagram of the Channel 2 Preamp circuit. A schematic of this circuit is shown on Diagram 2 at the rear of this manual.

First Cascode Amplifier

Basically, the First Cascode Amplifier stage in Channel 2 operates as described for the First Cascode Amplifier stage in Channel 1. However, the Channel 2 First Cascode Amplifier also contains the INVERT switching function. This allows the Channel 2 signal to be inverted as displayed on the CRT. The INVERT switch, when pushed, changes the biasing on the output transistors of U220 so that the normally inactive transistors are now carrying the signal. Since their outputs are cross-coupled from side to side the output signal is of opposite polarity to that available in the normal (button out) position of the INVERT switch. The Channel 2 Invert Balance adjustment R215 adjusts the DC balance of the stage to eliminate baseline shift in the display when switching from a normal to an inverted display.

VERTICAL CHANNEL SWITCHING CIRCUIT

General

The Vertical Channel Switching Circuit determines whether the Channel 1 or the Channel 2 Preamp signal or both will be connected to the Vertical Output Amplifier circuit. In the ALT and CHOP modes of operation, both channels are alternately displayed on a shared-time basis. The Vertical Channel Switching Circuit also provides several internal trigger signals to the Trigger Generator circuits, the Channel 2 VERT SIGNAL OUT signal to a connector on the rear panel, and the chopped blanking signal to the Z Axis Amplifier. Fig. 3-4 shows a detailed block diagram of the Vertical Channel Switching Circuit. A schematic of this circuit is shown on Diagram 3 at the rear of this manual.

Channel Switch IC

The Channel Switch IC, U370, determines which of the Preamp signals will be passed to the Vertical Output Amplifier. The push-pull Preamp signals connect between pins 2 and 3 (Channel 2) and between pins 10 and 11

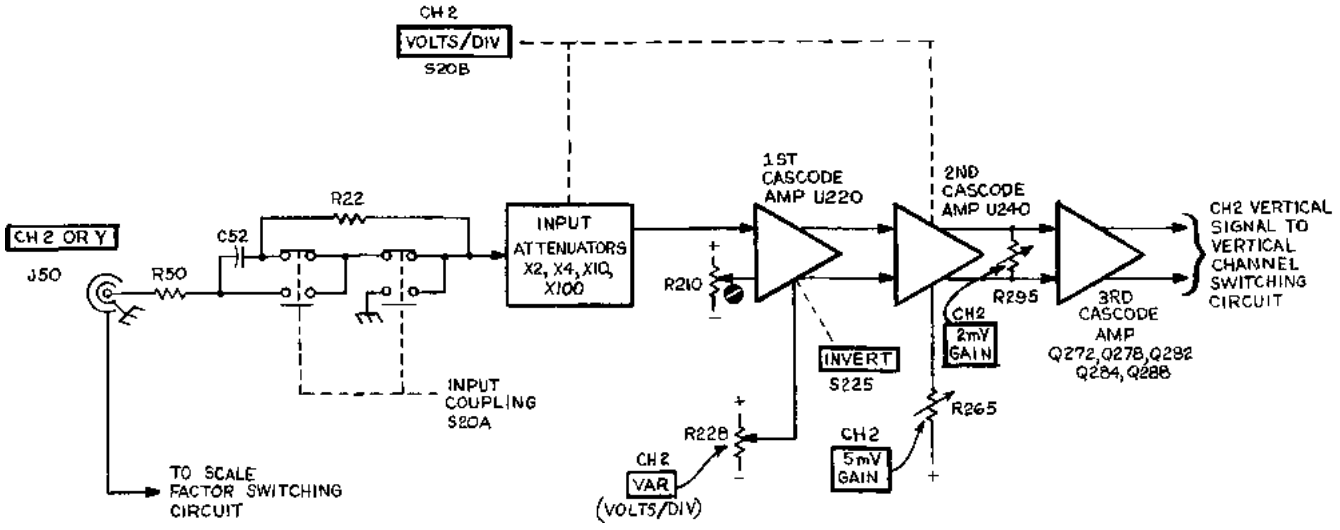


Fig. 3-3. Detailed block diagram of the Channel 2 Vertical Preamplifier circuit.

(Channel 1) of U370. The logic levels connected to pins 1, 12, 13, and 16 determine what signals are presented at output pins 14 and 15. The following logic truth table defines the switching function of U370.

Pin 1	Pin 12	Pin 13	Pin 16	Output Signal
1	0	1	0	Channel 1
0	1	0	1	Channel 2
1	1	0	0	Algebraic sum of CH 1 & CH 2

U370 also makes available samples of the Channel 1 signal at pins 8 and 9 and samples of the Channel 2 signal at pins 4 and 5. The output signals at pins 4, 5, 8, and 9 are always present when signals are applied to the channel inputs regardless of the switching logic levels applied to U370. The Channel 1 signal present at pin 9 provides drive to the Horizontal Amplifier in the X-Y mode of horizontal operation. The Channel 1 signal at pin 8 and the Channel 2 signal at pin 4 are used by the Trigger Generator circuits in the appropriate positions of the Trigger SOURCE switches. The Channel 2 signal at pin 5 connects to the Channel 2 Vertical Signal Out Amplifier.

Switching Logic Flip-Flops

U350A and U350B are edge-triggered flip-flops that derive the switching logic for the Channel Switch IC U370. In the CH 1, CH 2, and ADD positions of the VERT MODE switch the output logic from U350A and U350B is determined by the voltage levels applied to the clear (pins 1 and 13) and preset (pins 4 and 10) inputs. In the ALT mode of operation the flip-flops are switched by the alternate-trace sync pulse applied to their clock inputs through Q338 and U330B. In the CHOP mode, the clock pulse generated by U330C and U330D switch the flip-flops at a one-megahertz rate.

Two Megahertz Clock

U330C and U330D form an astable multivibrator having a repetition rate of two megahertz. The rectangular output waveform connects to the Switching Logic Flip-Flops through nand gate U330B. Only in the CHOP position of the VERT MODE switch is a LO level applied to the input to inverter U330A. This puts a logical HI on pin 13 of U330D, which permits the astable multivibrator to free-run. At the same time, Q338 is biased on, which puts a logical HI on pin 5 of U330B. Thus, the signal present at pin 6 of U330B will be the two-megahertz clock signal.

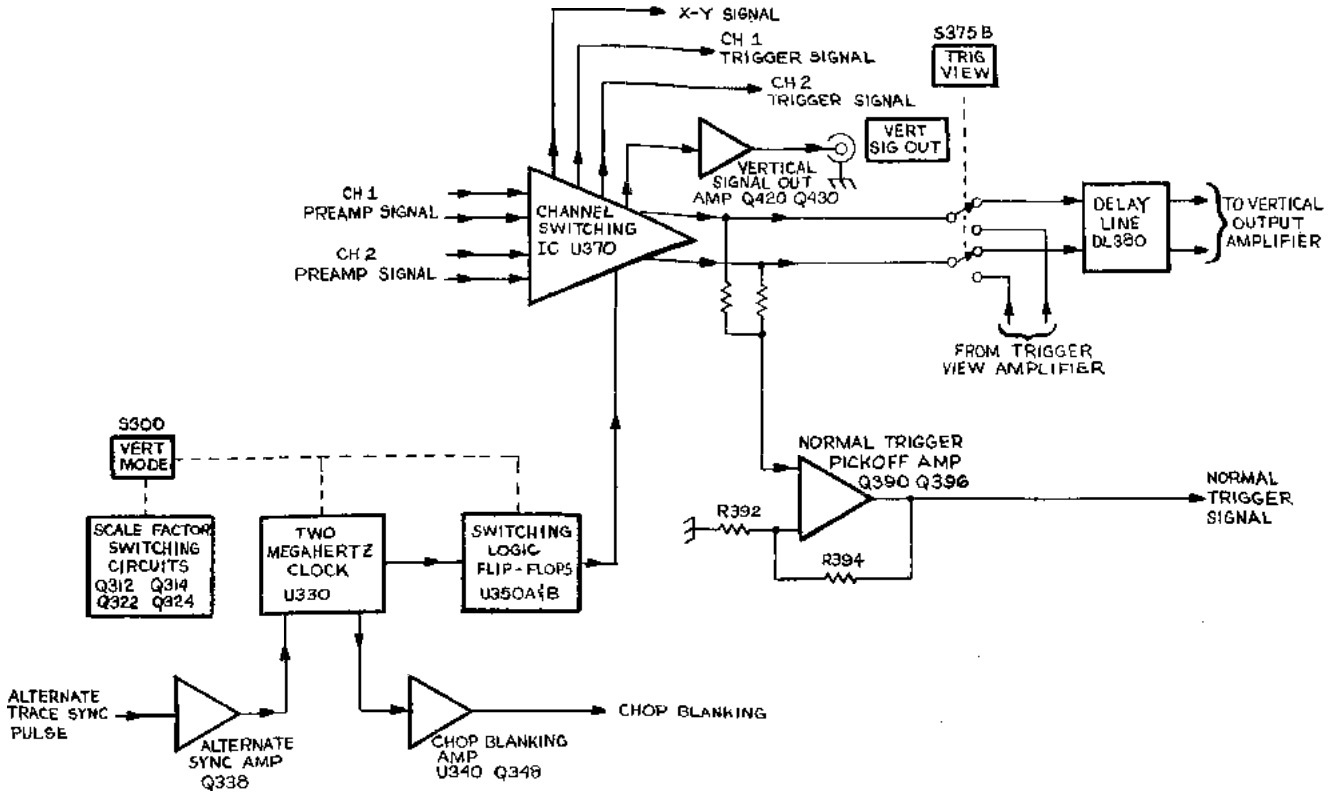


Fig. 3-4. Detailed block diagram of the Vertical Channel Switching circuit.

Chop Blanking Amplifier

The Chop Blanking Amplifier Q348 provides an output pulse to the Z Axis Amplifier circuit, which blanks out the transitions between the Channel 1 and Channel 2 traces when operating in the CHOP mode. The inherent propogation delay of inverters U340A, U340B, and U340C are used to provide some signal delay to the chop blanking signal. This allows the blanking signal and the channel switching transient to arrive in the CRT simultaneously.

Channel 2 Signal Output Amplifier

Q420 and Q430 compose the Channel 2 Vertical Signal Output Amplifier. A sample of the Channel 2 signal from pin 5 of Channel Switch IC U370 is amplified and inverted by Q420. CR422 provides thermal compensation for the base-emitter junction of Q420. Common-base amplifier Q430 provides the final amplification and isolates the output from the internal amplifier circuitry. Output impedance of the amplifier is equal to the parallel combination of R431 and R432 (approximately 50 ohms).

Normal Trigger Pickoff Amplifier

The trigger signal for NORM trigger operation is obtained from a sample of the vertical deflection signal that is available from pin 15 of U370. Normal Trigger DC Adjustment R425 sets the DC level of the normal trigger output signal so that the sweep is triggered at the 0 level of the displayed signal when the Triggering LEVEL control is set to 0. Q390 and Q396 are connected as a non-inverting feedback amplifier. Gain of the stage is approximately:

$$\frac{R392 + R394}{R392}$$

Scale-Factor Switching Circuits

The vertical deflection factor for each channel is indicated by back-lighting the appropriate figures imprinted on the flange of each VOLTS/DIV knob. For purposes of explanation, only the circuit action of the Channel 1 Scale-Factor Switching Circuit is discussed. When a X1 probe is connected to the CH 1 OR X input connector, the base level of Q312 is drawn positive by R316 toward the collector level of Q314. Q314 conducts heavily through X1 display factor bulb DS314 and Q312 is turned off. Therefore, the X1 display factor bulb is on and the X10 display factor bulb is off.

When a X10 probe with a scale factor switching connector is attached to the CH 1 OR X input connector, the base of Q312 is grounded through R311. Now, Q312 conducts very heavily through X10 display factor bulb DS312. The positive level at the collector of Q312 turns Q314 off (through the divider R313-R314); the X10 display factor bulb is on and the X1 display factor bulb is off.

VERTICAL OUTPUT AMPLIFIER

General

The Vertical Output Amplifier provides the final amplification for the vertical deflection signal. This circuit includes the BEAM FIND function. The BEAM FIND pushbutton, when pressed, compresses an overscan display to within the CRT viewing area. A schematic of the Vertical Output Amplifier is shown on Diagram 4 at the rear of this manual.

First IC Amplifier

The first amplifier stage in the Vertical Output Amplifier is integrated circuit U450. U450 is basically an emitter-coupled, push-pull, cascode amplifier cell. Biasing is arranged so that there is no phase-inversion through the stage. The signal from the delay line is applied to the amplifier through C441, L441, L442, C445, L445, and L444. These inductances and capacitances are part of the etched runs of the circuit board and provide some high-frequency peaking by forming a T-coil circuit without mutual coupling. Most of the components connected between pins 2 and 3 of U450 provide high-frequency compensation of the stage. RT452 varies in value with variations in ambient temperature to compensate for associated changes in amplifier gain. The BEAM FIND pushbutton, when pressed, removes −8 volts from the top of R459. This reduces the dynamic swing capabilities of the stage to limit the display on the CRT to within the viewing area. The gain of the Vertical Output Amplifier section is adjusted in this stage by adjusting Vertical Output Gain R449.

Second IC Amplifier

The second amplifier stage in the Vertical Output Amplifier is integrated circuit U470. U470 is a multi-stage cascode amplifier cell. The input signal is applied to pins 1 and 5 with the inverted output signal taken from pins 9 and 12. Pins 2 and 4 are emitter connections. Some of the components connected between pins 2 and 4 provide slower time constants to compensate for signal rolloff that occurs in the delay line, while the remaining components compensate for thermal considerations in the stage. The Output Bias adjust (R487) sets the DC levels within the stage to optimize the operating performance of U470. The output signal from U470 connects directly to the deflection plates of the CRT.

A TRIGGER GENERATOR

General

The A Trigger Generator circuit produces the trigger pulse used to start the Sweep Generator circuit that provides the A portion of the CRT display. The trigger pulse is derived from the internal trigger signal from the vertical deflection system, an external signal connected to

the external trigger input connector, or a sample of the line voltage connected to the instrument. Controls are provided to select trigger level, slope, coupling, and source. Fig. 3-5 shows a detailed block diagram of the A Trigger Generator circuit. A schematic of this circuit is shown on Diagram 5 at the rear of this manual.

Trigger Source

The Trigger SOURCE switch S505 selects the source of the trigger signal. The sources available to the A Trigger Generator circuit are the signal being displayed (NORM), Channel 1 (CH 1), Channel 2 (CH 2), the instrument line voltage (LINE), and external signals (EXT and EXT ÷10). Emitter followers Q502, Q504, and Q506 provide isolation between the input to the A Trigger Circuit and the output of the Vertical Channel Switching Circuit.

In the LINE mode of triggering, a sample of the power line frequency is obtained from the secondary of the power transformer T1400 in the Low Voltage Power Supply circuit. The Trigger COUPLING switches should not be in the LF REJ mode when using the instrument line voltage as a trigger signal source.

Trigger Coupling

The Trigger COUPLING switches offer a means of accepting or rejecting certain components of the trigger signal. In the AC, LF REJ, and HF REJ mode of trigger coupling, the DC component of the trigger signal is blocked by coupling capacitors C515 or C516. Frequency components below about 60 Hz are attenuated when using AC or HF REJ coupling and below about 50 kHz when using LF REJ coupling. The higher frequency components of the trigger signal are passed without attenuation. In the HF REJ mode of trigger coupling, the high frequency components of the trigger signal (above about 50 kHz) are attenuated, while the lower frequency components (between about 60 Hz and 50 kHz) are passed without attenuation. The DC mode of trigger coupling passes unattenuated all signals from DC to 200 MHz and above.

Input Source Follower

Transistor Q522 is an FET source follower. It provides a high input impedance (set primarily by R517) for the trigger signal; it also provides isolation between the Trigger Generator circuit and the trigger signal sources. CR519 provides input protection for Q522 if excessively high amplitude negative-going input signals are present. Q524 is a high-impedance, relatively constant current source for Q522 and provides a measure of temperature compensation for Q522. The output signal from the Source Follower is taken from Emitter Follower Q526.

Paraphase Amplifier

U520 is a paraphase amplifier stage that converts the single-ended input from Emitter Follower Q526 into a dual-ended push-pull output, which is applied to one of the Tunnel Diode Driver stages. Trigger Centering adjustment R534 sets the level at pin 14 of U520 (through emitter follower Q532) so that the display is correctly triggered when the LEVEL control is centered. The LEVEL control varies the level at pin 14 of U520 to select the point on a trigger signal where triggering occurs.

The slope of the input signal that triggers the Sweep Generator circuit is determined by the setting of the SLOPE switch S530. When the SLOPE switch is set to the + position, the output signal at pin 8 of U520 is inverted with respect to the input signal, and the output signal at pin 9 is

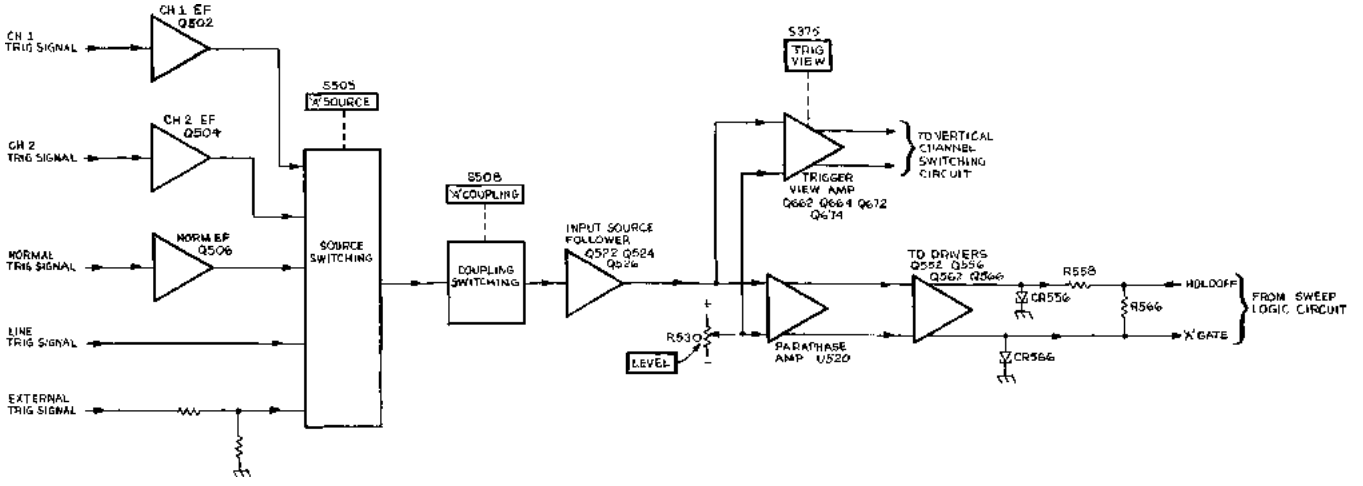


Fig. 3-5. Detailed block diagram of the A Trigger Generator.

in phase with respect to the input signal. When the SLOPE switch is set to the − position, the output signal at pin 8 is in phase with respect to the input signal, and the output signal at pin 9 is inverted with respect to the input signal.

Tunnel Diode Driver

Q552, Q556, Q562, and Q566 are common-emitter amplifier stages that provide the signal currents necessary to switch the triggering tunnel diodes. CR556 and CR566 are ten-milliampere tunnel diodes. Quiescently (i.e., after the sweep holdoff period has passed, but before triggering), CR556 and CR566 are biased into their low voltage states. When the input signal increases the current in Q556 slightly above its quiescent state, this current and the current thru R555 is sufficient to bias CR556 into its high voltage state. The anode of CR556 steps positive to an approximately +0.5 volt level. Since less current is required to maintain a tunnel diode in its high voltage state than is required to switch it to its high voltage state, approximately 6 mA of current is additionally available to switch CR566 to its high voltage state. Thus, the next time Q566 conducts signal current, CR566 steps to its high voltage state sending a positive pulse to the logic circuit to initiate sweep action. The A Trig Sensitivity adjustment, R565, adjusts the tunnel diode bias to the proper level that will not allow CR566 to be switched to its high voltage state until CR556 has been switched to its high voltage state. At the end of the sweep time and during holdoff, a negative level is applied to the junction of R558 and R566, thereby resetting both CR556 and CR566 to their low voltage states. The reset level remains during holdoff time to ensure that a sweep gating signal is not generated until the sweep circuit has returned to its quiescent state.

Trigger View Amplifier

The Trigger View Amplifier circuit amplifies a sample of the signal present in the A Trigger Generator circuit and passes it on to the Vertical Output Amplifier for display on the CRT when the TRIG VIEW pushbutton is pressed. This provides a method of making a quick and convenient check of the signal being used to trigger the oscilloscope and is intended primarily to be used to check the timing difference between the trigger signal and the vertical deflection signal.

The amplifier consists of two emitter-coupled push-pull amplifier stages. The emitter source voltage for Q662 and Q672 is switched on and off by the TRIG VIEW pushbutton. With the TRIG VIEW pushbutton not pushed, the emitters of Q662 and Q672 are returned to ground through R665. This reverse-biases the base-emitter junctions of the transistors, preventing any loading of the A Trigger Generator circuit. When the TRIG VIEW pushbutton is pushed, the emitters are now returned to +15 volts through R663. This forward biases Q662 and Q672 to allow signal amplification. R673 adjusts for correct DC balance in the circuit.

Normally, the output of the Vertical Channel Switching circuit is applied to the input of the Delay Line. When the TRIG VIEW pushbutton is pushed, the signal from the Vertical Channel Switching circuit is removed and the output from the Trigger View Amplifier is applied in its place.

B TRIGGER GENERATOR

General

The B Trigger Generator circuit produces the trigger pulse used to start the Sweep Generator circuit that provides the B portion of the CRT display. The B Trigger Generator circuit is virtually the same as the A Trigger Generator circuit and only the differences between the two are described here. A schematic of this circuit is shown on Diagram 6 at the rear of this manual.

Trigger Source

The B Trigger Generator circuit has no LINE or EXT ÷10 positions on its Trigger SOURCE switch. If the Generator is to be triggered from a line voltage signal or the external trigger signal is to be attenuated, it must be accomplished in some other manner. The B Trigger SOURCE switch does have a STARTS AFTER DELAY position, however, that the A Trigger SOURCE switch does not. This position allows the B portion of a display to start immediately after the selected delay time without waiting for a triggering signal.

SWEEP AND Z AXIS LOGIC CIRCUIT

General

The Sweep And Z Axis Logic Circuit derives the logic levels necessary to control the sequence of events associated with sweep generation and CRT unblanking. The +A and +B GATE signals are also generated in this circuit. Positive logic terminologies and symbologies are used in the following explanation of circuit operation. A schematic of this circuit is shown on Diagram 7 at the rear of this manual.

Sweep Control Integrated Circuit

U600 is the Sweep Control Integrated Circuit. Several functions are performed in this stage, depending on the mode of operation of the instrument sweep generators. The following is a brief explanation of the function associated with each pin of the IC.

Pin 1. This is the positive Auto Sense input. The signal connected here comes from the A Fire TD in the A Trigger Generator circuit.

Pin 2. This is the negative Auto Sense Input. A fixed DC level established by R602 and R603 is connected here.

Pin 3. This is the + auto gate terminal. In the AUTO mode of operation, if no trigger signals are applied to pin 1 of U600 during the ≈40 ms time period following the end of holdoff, the gate level at pin 3 steps LO to turn Q574 on, which initiates a sweep.

Pin 4. This is the – auto gate terminal, not used in this application.

Pin 5. Input terminal for negative voltage supply.

Pin 6. This is the auto gate timing terminal. R609 and C609 determine the amount of time between the end of holdoff and the generation of the auto gate.

Pin 7. This terminal lights the TRIG'D light when a triggering gate has occurred.

Pin 8. This is the holdoff timing terminal. The time between the end of a sweep and when a positive pulse is conducted at pin 8 is determined by RC components (selected by the TIME/DIV Switch) in the Holdoff Timing circuit.

Pin 9. Ground terminal.

Pin 10. Not used in this application.

Pin 11. This terminal lights the READY light when operating in the single sweep mode.

Pin 12. This is the single sweep mode terminal. When +5 volts is connected to this terminal, the sweep operates in the single sweep mode; when the terminal is left open or grounded, the sweep operates in the repetitive mode.

Pin 13. Not used in this application.

Pins 14 and 15. Single sweep reset terminals. Pushing the PUSH TO RESET button prepares the single sweep circuitry to respond to the next one triggering event. Also causes the READY light to be lit.

Pin 16. This is the holdoff start input terminal. The HI sweep reset gate pulse from the Holdoff Start circuit is applied here to initiate sweep holdoff.

Pin 17. This is the holdoff output terminal. The gate level at this terminal is HI during holdoff and LO otherwise.

Pin 18. Sweep disable input. +5 volts applied to this terminal disables all sweep action.

Pin 19. Auto mode terminal. Grounding this terminal enables auto sweep operation.

Pin 20. Input terminal for positive voltage supply.

Main Gate Comparator

Q572 and Q574 form the Main Gate Comparator and are connected as a voltage comparator, where both transistors do not conduct at the same time. The input signal to the stage is the positive-going trigger signal from the A Fire Trigger TD in the A Trigger Generator circuit. The signal at the collector of Q574 is inverted by Q588, is connected to the Z Axis Logic Multivibrator to control CRT blanking, and to Q584 to generate the A + GATE output signal. The signal at the collector of Q574 connects to the base of the Main Gate Amplifier stage (Q902) in the Sweep Generators circuit to initiate sweep generation.

Delayed Gate Comparator

Q802 and Q804 form the Delayed Gate Comparator and are connected as a voltage comparator where both transistors do not conduct at the same time. The input signal to the stage is the positive-going trigger signal from the B Fire Trigger TD in the B Trigger Generator circuit. The signal at the collector of Q804 is inverted by Q826 and is connected to the Z Axis Logic Multivibrator to control CRT blanking and to Q824 to generate the B + GATE output signal. The signal at the collector of Q802 connects to the base of the Delayed Gate Amplifier stage (Q996) in the Sweep Generators circuit to initiate sweep generation.

A Trigger TD Reset Circuit

Q612 and Q628 are connected as a voltage comparator and form the A Trigger TD Reset Circuit. At the start of holdoff, pin 17 of U600 steps HI. This turns on Q612 and turns Q628 off. The collector signal of Q612 connects to the Trigger Tunnel Diodes in the A Trigger Generator circuit and resets them to their LO state. At the end of holdoff pin 17 of U600 steps LO, Q612 turns off, and Q628 turns on.

Holdoff Start Circuit

Q594 and Q596 form the Holdoff Start Circuit. The input signal to the stage is the positive-going end-of-sweep signal from the Sweep Generators circuit or from the

Delayed Latch circuit. The positive-going signal turns Q594 on which in turn turns on Q596. The positive-going signal at the collector of Q596 is connected to pin 16 of U600 to start the holdoff period and is also used in the Vertical Switching Circuit to switch between channels in the ALT mode of operation.

Z Axis Logic Multivibrator

Q688 and Q698 are basically a Schmitt Multivibrator and form the Z Axis Logic Multivibrator. Quiescently, with the CRT display blanked, Q688 is on and Q698 is off. The signal to switch states of the multivibrator (and thereby unblank the CRT) can come from the Main Gate Comparator (via Q588 and CR681) or from the Delayed Gate Comparator (via Q826 and C684). The negative going signals turn off Q688 and cause Q698 to turn on. The positive going signals that return the multivibrator to its original state (thereby blanking the CRT display) come from Q588 via CR682 and CR683, or from Q680 via CR680 and CR683. Q680 is used primarily to ensure proper early turn-off of the CRT display at faster sweep rates. In the MIX or A INTEN positions of the HORIZ DISPLAY switch, some additive unblanking is accomplished to slightly increase the intensity of the B portion of the display. In these positions of the switch, −8 volts is connected to the cathode of either CR691 or CR692. Now, when the Z Axis signal from the collector of Q826 steps negative at the beginning of the B portion of the display, CR693 is made to conduct less current, which makes a slight amount of additional unblanking current available to the Z Axis Amplifier (via CR694, R692, and either CR691 or CR692).

Delayed Sweep Latch Circuit

Q788, Q794, and Q796 form the Delayed Sweep Latch Circuit. The circuit function is used during the three delayed sweep modes of operation that the instrument is capable of (MIX, A INTEN, and B DLY'D). Q938A, in the Delay Pickoff Comparator of the Delaying Sweep Generator, is the current source for the emitters of Q794 and Q796. Prior to the end of the delay time selected by the A TIME/DIV switch and the DELAY TIME POSITION control, Q938A is off, thereby causing both Q794 and Q796 to be off also. The base level of Q794 sits at a more negative level than does the base of Q796 so that when Q938A turns on, at the delay pickoff point, C749 will turn on and Q796 will remain off. The resultant positive movement at the collector of Q794 is connected to the B Trigger TD Reset Circuit.

The end-of-sweep pulse from the Non-Delaying Sweep Generators connects to the emitter of Q788. When this pulse steps positive at the end of a delayed sweep, Q788 turns off and the current through R788 pulls the base of Q794 positive. This turns off Q794 and causes Q796 to turn on. The circuit remains in this state until the Delaying Sweep Generator ends its sweep and resets the Delay Pickoff Comparator. In the B ENDS A position of the A TRIG HOLDOFF control +5 volts is connected to R798. This enables the diode gate composed of CR799 and CR592. Now, when the end-of-sweep pulse signals the end of a delayed sweep, the positive movement at the collector of Q796 is connected to the base of Q594. This starts the beginning of holdoff at the end of the delayed sweep instead of waiting until the end of the delaying sweep. This mode of operation gives the fastest possible sweep repetition rate when operating in the delayed sweep mode.

B Trigger TD Reset Circuit

Q790 and Q792 are connected as a voltage comparator and form the B Trigger TD Reset Circuit. At all times other than when the Non-Delaying Sweep Generators are running, Q790 is on, which holds the trigger tunnel diodes in the B Trigger Generator circuit in their LO states. At the end of the delay time selected by the A TIME/DIV switch and the DELAY TIME POSITION control, the positive movement at the collector of Q794 turns on Q792 and causes Q790 to turn off. The tunnel diodes in the B Trigger Generator are capable of being biased into their HI states. Also, if the B Triggering SOURCE switch is in the STARTS AFTER DELAY TIME position, the negative movement at the collector of Q792 reverse biases CR811, letting the −8 volt supply pull down on the base of Q804 in the Delayed Gate Comparator. This turns on Q804 and causes Q802 to turn off, which initiates a delayed sweep.

Delayed Sweep Override Amplifier

Q798 is the Delayed Sweep Override Amplifier. It is possible, with the right combination of control settings, to achieve a delayed sweep presentation where the delayed sweep would normally want to continue running after the end of the delaying sweep. For instance, if the TIME/DIV switches are set only one or two ranges apart and the DELAY TIME POSITION control is set to a 8.50 setting. Under these conditions the delaying sweep end-of-sweep pulse occurs before the delayed sweep end-of-sweep pulse. The positive movement on the collector of Q588 at the time of the delaying sweep end-of-sweep pulse turns Q798 on. The negative movement on the collector of Q798 pulls down on the collectors of Q794 and Q796, through CR793 and CR792 respectively, which in turn pulls down on the base of Q792. This turns off Q792 and causes Q790 to turn on, which resets the B Trigger Tunnel Diodes to their LO states, thereby terminating the delayed sweep.

A +GATE And B +GATE Amplifiers

Q584 and Q824 are the A +GATE and B +GATE amplifiers respectively. They provide the +GATE output signals available at the instrument rear panel. These output gate signals are positive-going rectangular waveforms, approximately 5 volts in amplitude, coincident with their respective sweep waveforms.

SWEEP GENERATORS

General

The Sweep Generators produce the sawtooth voltages that are amplified by the Horizontal Amplifier to provide horizontal deflection on the CRT. These sawtooth voltages are produced on command (trigger pulses) from the Trigger Generator circuits. The Sweep Generator circuits also produce gate waveforms that are used by the Z Axis Logic circuit to unblank the CRT during sweep time, and by the Sweep Logic circuit to terminate sweep generation. There are three Sweep Generator circuits in the instrument. Operation of all three is very similar; therefore only the operation of the Delaying Sweep Generator and the differences in operation of the three generators is discussed. Fig. 3-6 shows a detailed block diagram of the Sweep Generators. A schematic of the Sweep Generators is shown on Diagram 8 at the rear of this manual.

Delaying Sweep Generator

Basically the Delaying Sweep Generator is composed of Q904, Q920, Q922, and Q914. This generator only runs in the A INTEN, MIX, and B DLY'D positions of the HORIZ DISPLAY switch and generates the A portion of the display. The sweep rate is selected by the A TIME/DIV switch.

Main Gate Amplifier

Q902 is the Main Gate Amplifier stage. The negative-going Main Gate waveform from the Sweep Logic circuit is applied to the base of Q902. The amplified and inverted waveform at the collector of Q902 is applied to the Delaying Sweep Generator (through CR903), or to both of the Non-Delaying Sweep Generators (through Q992). This initiates sweep generation.

Sweep Disconnect Amplifier

Q904 is the Sweep Disconnect Amplifier. The biasing on the base of this stage determines whether the Delaying Sweep Generator will run. In the A position of the HORIZ DISPLAY switch, the anode of CR907 is connected to +5 volts through R908 and the HORIZ DISPLAY switch. This biases the base of Q904 far enough positive that the positive-going gates on the emitter cannot turn off Q904. Q904 therefore conducts all of the timing current through timing resistor R_t, keeping timing capacitance C_t discharged. When the HORIZ DISPLAY switch is in any position other than A, the anode of CR907 is connected to −8 volts. CR907 is now reverse-biased, which lets the base of Q904 be biased at a level that will allow the positive-going gates on the emitter of Q904 to interrupt the current flow through Q904. When Q904 turns off, the timing current starts to charge timing capacitance C_t.

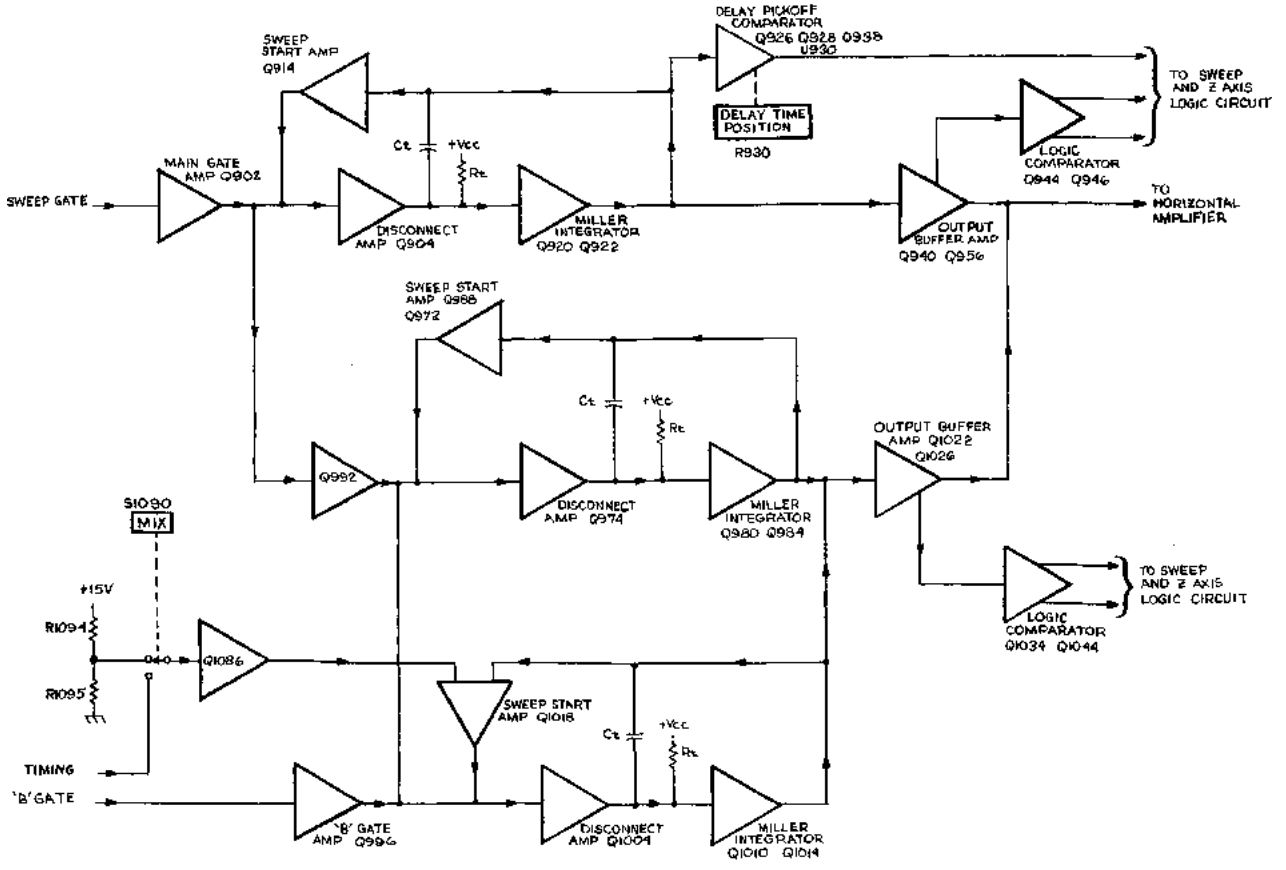


Fig. 3-6. Detailed block diagram of the Sweep Generator circuits.

Sawtooth Sweep Generator

Q920 and Q922 form a Miller Integrator circuit. When the current through the Sweep Disconnect Amplifier Q904 is interrupted, the timing capacitance begins to charge through the timing resistor. The timing resistor and capacitance are selected by the A TIME/DIV switch to provide the various sweep rates listed on the instrument front panel. The output signal at the collector of Q922 is a negative-going sawtooth voltage waveform.

Sweep Start Amplifier

Just before the sweep starts to run down, the levels at the bases of Q914 are approximately equal. When the sweep starts to run down, the base of Q914B goes negative, which increases the forward bias on CR914B. This in turn decreases the forward bias on CR914A, which very shortly after the start of the sweep, becomes reverse biased to interrupt the current through Q914A. The circuit remains in this condition until after the sweep retrace is complete. When the circuit returns to quiescence, Q914A begins to conduct through R904. This sets the current through Q904, which in turn establishes the DC level starting point for the sweep.

Output Buffer Amplifier

Q940 and Q956 form the Output Buffer Amplifier. Q940 is an emitter follower and Q956 is a common-base amplifier whose emitter is current-driven by the signal. The Output Buffer Amplifier provides the output sawtooth signal current to the Horizontal Amplifier and provides a measure of isolation between the Sawtooth Generator and the Horizontal Amplifier. Intensified Gain adjustment R950 adjusts the gain of the stage to match the output signal amplitude with that of the Non-Delaying Sweep Generators.

The Delaying Sweep Output Buffer Amplifier passes signal to the Horizontal Amplifier only when the HORIZ DISPLAY switch is in the A INTEN position and the TIME/DIV switches are not in the X-Y position. When the TIME/DIV switches are in the X-Y position the anode of CR956 is connected to +5 volts. This sets the base of Q956 at a positive enough level (about +6.3 volts in the A INTEN position; about +8.5 volts in the A, MIX, and B DLY'D positions) to reverse bias Q956 and prevent passage of the Delaying Sweep signal to the Horizontal Amplifier. With the TIME/DIV switches not in the X-Y position and the HORIZ DISPLAY switch in the A INTEN position R955 is connected to −8 volts and the anode of CR956 is not connected to any voltage. This forward biases CR955 and sets the base of Q956 at a DC level of approximately +4.3 volts. Now Q956 is forward biased and the Delaying Sweep signal is passed to the Horizontal Amplifier.

Logic Comparator

Q944 and Q946 are connected as a voltage comparator and generate the logic pulses that signal the end of sweep and blank the CRT display at the end of the sweep. Prior to the generation of a sawtooth voltage waveform by the Delaying Sweep Generator, the base of Q944 is at an approximate −1.6 volt level. The base of Q946 is held at about −3 volts by the divider made up of R948 and R949. Therefore, Q946 is reversed biased and not conducting and Q944 is forward biased and is conducting. Now, when the sweep voltage at the emitter of Q940 begins to go in a negative direction, the base of Q944 follows until the base of Q944 goes more negative than the base of Q946. Q944 turns off and Q946 turns on, generating a positive pulse at the collector of Q944 and a negative pulse at the collector of Q946. The positive pulse at the collector of Q944 signals the end of sweep and starts the holdoff period. The negative pulse at the collector of Q946 signals the Z-Axis Logic circuit to blank the CRT and prevent any further display.

Delay Pickoff Comparator

The Delay Pickoff Comparator stage allows selection of the amount of delay from the start of the Delaying Sweep Generator before one of the Non-Delaying Sweep Generators is turned on. The amount of delay available is variable from 0.00 to 10.00 times the setting of the A TIME/DIV switch. The sweep rate of the Delayed (non-delaying) Sweep Generator is determined by the setting of the B TIME/DIV switch.

Q926A and Q926B are connected as a voltage comparator. Q928 is a relatively constant current source for Q926. Q938 is also connected as a voltage comparator circuit and is used to improve the switching capabilities of the stage. The reference voltage for the Delay Pickoff Comparator stage is provided by DELAY-TIME POSITION control R930. U930 is an integrated circuit containing two high-gain amplifier cells used in a feedback amplifier configuration. They provide accurate fixed voltages to both ends of the DELAY-TIME POSITION control to allow precise delay pickoff. The instrument is calibrated so that the major dial divisions of the DELAY-TIME POSITION control correspond to major divisions of horizontal deflection on the CRT graticule. For example, if the DELAY-TIME POSITION control is set to 5.00, the Non-Delaying Sweep Generator is delayed five divisions of the Delaying Sweep time before it can produce a sweep.

The sawtooth voltage waveform from the Delaying Sweep Generator is connected to the gate of Q926B. The quiescent level of the delaying sawtooth biases Q926B on and its drain is negative enough to bias Q938B on. Q926A and Q938A are off and not conducting. As the Delaying Sweep sawtooth voltage goes down, the gate of Q926B also

goes down. When it goes more negative than the level at the gate of Q926A (established by the DELAY-TIME POSITION control), Q926A conducts and Q926B turns off. This also switches the states of Q938A and B and produces a positive-going rectangular pulse at the collector of Q938A. When the Delaying Sweep resets, Q926B again conducts and Q926A is turned off. This switches Q938A and B back to their original states.

Non-Delaying Sweep Generators

There are two Non-Delaying Sweep Generators. In any position of the HORIZ DISPLAY switch, one of these generators will be running. They generate the displayed sweep in the A position of the HORIZ DISPLAY switch and the B portion of a display in the remaining positions. The B TIME/DIV switch selects the sweep rate for these generators. One generator provides the 0.5 second through 1 microsecond sweep rates, while the other generator provides the 1 microsecond through 0.05 microsecond sweep rates.

Either the "Main" Gate or the "B" Gate can initiate sweep generation by the Non-Delaying Sweep Generators. When the HORIZ DISPLAY switch is in the A position, +5 volts is applied to the emitter of Q992, through R922. Q992 is forward biased, and the "Main" Gate is passed on to the Non-Delaying Sweep Generators through CR922 and CR971 or CR1001. In all the other positions of the HORIZ DISPLAY switch, −8 volts is connected to the emitter of Q992 through R922. This reverse-biases Q992 and prevents the "Main" Gate from reaching the generators. Now, only the "B" Gate can initiate sweep action in the Non-Delaying Sweep Generators.

"B" Gate Amplifier

Q996 is the "B" Gate Amplifier stage. The negative-going waveform from the Sweep Logic circuit is applied to the base of Q996. The amplified and inverted waveform at the collector of Q996 is applied to the Non-Delaying Sweep Generators through CR996 and CR971 or CR1001 to initiate sweep generation.

Non-Delaying Sweep Generator Differences

Basically the Non-Delaying Sweep Generators operate in the same manner as the Delaying Sweep Generator. The "fast" generator (Q1004, Q1010, Q1014, and Q1018) has only one timing capacitance (the parallel combination of C1008 and C1009). The capacitance is variable to achieve precise timing accuracy. Timing resistors are selected by the B TIME/DIV switch to provide the fastest six sweep speeds listed on the front panel.

Q988 and Q1018 are Sweep Start Amplifiers and establish the DC level starting points for the sweeps. The "slow" generator (Q974, Q980, Q984, Q988, and Q972) has an additional emitter follower (Q972). This emitter follower increases the current-gain of the loop to speed up the retrace time of the generator (determined by the time required to discharge the timing capacitor).

Mixed Mode Operation

Normally, Q1086 is an emitter follower, with a fixed DC level at its base established by R1094 and R1095. The fixed level at the emitter of Q1086, in turn, is applied to the base of Q1018 and Q988, through CR1017 and CR987, respectively. This established the quiescent current flow through Q988 and Q1018 to establish the DC level starting points for the sweeps as previously explained. However, when the HORIZ DISPLAY switch is in the MIX position, the fixed level at the base of Q1086 is replaced by the sawtooth voltage waveform being generated by the Delaying Sweep Generator. Now, the DC level starting point of the Non-Delaying Generator, that is running is constantly being changed by the Delaying Sweep sawtooth. The output waveform from the Non-Delaying Sweep Generator that is running will be a composite sawtooth waveform with the first and last parts occurring at a rate determined by the Delaying Sweep Generator (last part blanked out of CRT display) and the middle part occurring at a rate determined by one of the Non-Delaying Sweep Generators.

Logic Comparator

Q1044 and Q1034 are connected as a voltage comparator, and generate the same sort of logic pulses as the Logic Comparator in the Delaying Sweep Generator circuit. The positive-going pulse at the collector of Q1034 signals the end of the Non-Delaying Sweep, and the negative-going pulse at the collector of Q1044 blanks the display at the end of the Non-Delaying Sweep. However, the logic pulses from this comparator are not always allowed to pass to the Sweep and Z-Axis Logic circuits.

In the A INTEN position of the HORIZ DISPLAY switch, +5 volts is connected to the anode of CR1049 through R1049. This forward biases CR1044, which sets the collector of Q1044 at approximately +0.7 volts. This keeps CR1046 reverse-biased and prevents completely blanking the CRT at the end of the B portion of the display. In the A INTEN, MIX, and B DLY'D positions of the HORIZ DISPLAY switch, −8 volts is connected to the anode of CR1036. This disables the diode gate composed of CR1034 and CR1037 and does not allow the end-of-sweep pulse from Q1034 to pass to the Sweep Logic circuit. In the A position of the HORIZ DISPLAY switch, +5 volts is connected to the anode of CR1036. This enables CR1034-CR1037 and allows the end-of-sweep pulse to pass to the Sweep Logic circuit.

HORIZONTAL AMPLIFIER

General

The Horizontal Amplifier circuit provides the output signals to the CRT horizontal deflection plates. The signal applied to the input of the Horizontal Amplifier is determined by the TIME/DIV switch. The signal can be a sawtooth waveform generated within the instrument, or some external signal applied to the CH 1 OR X input connector (X-Y mode of operation). The Horizontal Amplifier also contains the X10 magnifier, horizontal positioning controls, and some beam finder circuitry. Fig. 3-7 shows a detailed block diagram of the Horizontal Amplifier circuit. A schematic of this circuit is shown on Diagram 10 at the rear of this manual.

Input Paraphase Amplifier

Q1124 and Q1134 form the Input Paraphase Amplifier. This is an emitter-coupled amplifier stage that converts the single-ended input signal to a push-pull output signal. The X10 Magnifier circuitry is in this stage and consists of a divide-by-ten attenuator R1106-R1107-R1108. When the X10 Magnifier is on, the input signal is applied unattenuated to the Input Paraphase Amplifier. When the X10 Magnifier is off, the input signal is applied to the Input Paraphase Amplifier through the attenuator. X10 MAG indicator DS1110 lights when the X10 Magnifier is being used. CR1121 and CR1122 limit signal amplitudes at the input to the amplifier to prevent amplifier overdrive. Q1140 is a relatively constant current source for Q1124 and Q1134. CR1140 provides temperature compensation for the base-emitter junction of Q1140. RT1123 varies in value with changes in temperature to compensate for associated changes in amplifier gain. Magnifier Registration adjustment R1130 balances quiescent DC current in Q1124 and Q1134 so that a center screen display does not change position when the X10 Magnifier is turned on.

Q1114 is a current-source that is an interruptable path for the horizontal positioning currents. When the TIME/DIV switch is in any position other than X-Y, the anodes of CR1103, CR1104, and CR1111 are connected to −8 volts through R1104, which reverse-biases them. In the X-Y position of the TIME/DIV switch, +5 volts is connected directly to the anodes of CR1103, CR1104, and CR1111. This accomplishes three things. First, the emitter-base junction of Q1114 is reverse biased which prevents the Horizontal POSITION and FINE controls from having any affect on the display. Second, relay K1103 is energized which connects the X-axis signal from the Channel 1 Preamplifier to the input to the Horizontal Amplifier. Third, +5 volts is connected to the Channel 1 Scale Factor Switching circuit so that both deflection factor indicators are operating. When operating in the X-Y mode, R1102 adjusts for correct X-axis gain and L1103 adjusts to reduce the phase differences between the horizontal (X) and vertical (Y) signal paths.

Gain Setting Amplifier

Q1152 and Q1162 are an emitter-coupled push-pull amplifier stage. The gain of this stage is adjusted to match the CRT sensitivity. When the BEAM FIND pushbutton is pushed R1168 is switched into the circuit. This reduces the dynamic swing capabilities of this stage, thereby limiting horizontal deflection to within the limits of the CRT viewing area. Q1152 and Q1162 operate in an overdriven mode. This means at the extremes of signal amplitude, one side will be turned off while the other side is still conducting. This condition generates some common-mode signal differences between Q1152 and Q1162. Q1164 monitors any common-mode signal differences (through R1165 and R1167) and conducts to minimize them.

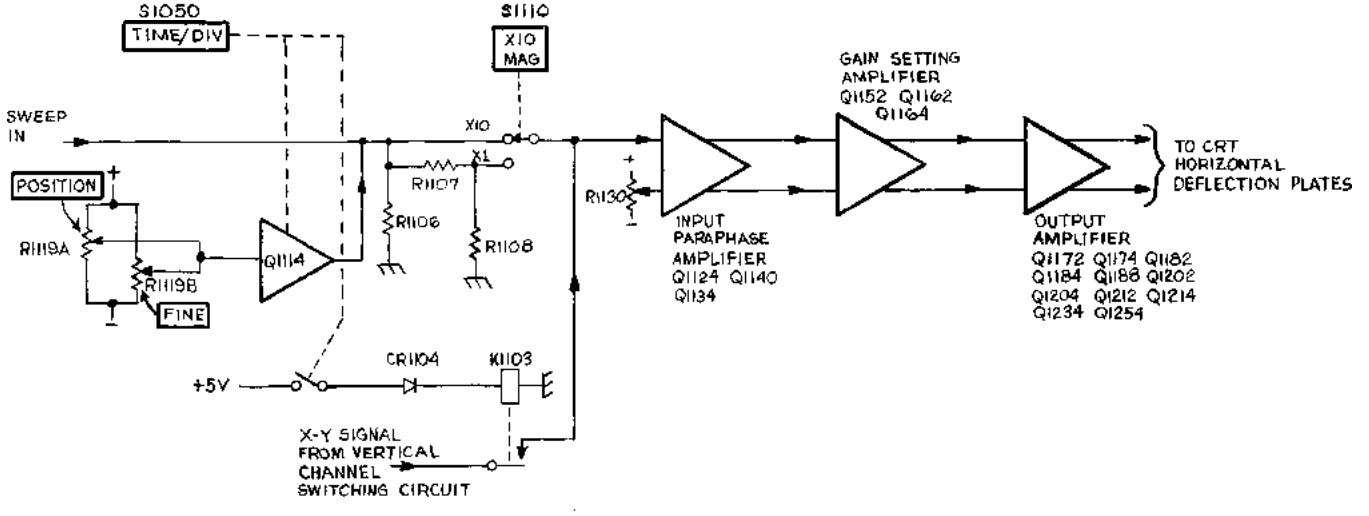


Fig. 3-7. Detailed block diagram of the Horizontal Amplifier.

Output Amplifier

The push-pull signal from the Gain Setting Amplifier is connected to the Output Amplifier. Each half of the Output Amplifier can be considered as a single-ended feedback amplifier, which amplifies the signal at its input to produce a voltage output to drive one of the horizontal deflection plates of the CRT. Both halves of the Output Amplifier are basically the same with only minor differences; therefore, only the upper amplifier (drives the + horizontal deflection plate) and the differences will be explained.

Q1172 and Q1174 are connected in a Darlington configuration. Q1234 is a feedback amplifier in the feedback path for the output amplifier. Q1234 sets DC levels and reduces the impedance of the feedback path. Q1202 and Q1204 form a complementary amplifier that provides the output signal to drive the + deflection plate of the CRT. CR1173 clips excessive signal amplitudes and also provides temperature compensation for several of the emitter-base junctions in the output amplifier. R1175, C1233, and C1179 are high-frequency compensation adjustments. R1256 centers the output signal swing within the dynamic swing capabilities of the output amplifier.

There are two signal paths through each half of the Output Amplifiers. Slow signal transitions are applied to the CRT through Q1172, Q1174, and Q1204 with feedback via R1233 and R1235. C1235, C1233, and C1178-C1179 compensate the amplifier and provide a fast AC signal path from one side of the amplifier to the other. The lower amplifier (drives the − horizontal deflection plate) is basically the same as the upper except for two things. Q1188 is a relatively constant current source for Q1182 and Q1184. VR1216 shifts the DC level of the signal from the collectors of Q1182 and Q1184 to the emitter level of Q1214.

LOW-VOLTAGE POWER SUPPLY

General

The Low-Voltage Power Supply circuit provides the operating power for this instrument from six regulated power supplies. Electronic regulation is used to provide stable, low-ripple output voltages. Fig. 3-8 shows a detailed block diagram of the Power Supply circuit. A schematic of this circuit is shown at the back of this manual.

Power Input

Power is applied to the primary of transformer T1400 through Line Fuse F1401, POWER switch S1401, Thermal Cutout S1402, Line Voltage Selector switch S1403, and the Regulating Range Selector. Line Voltage Selector switch S1403 connects the split primaries of T1400 in parallel for 115-volt nominal operation, or in series for 230-volt nominal operation. Line Fuse F1401 should be changed for each nominal line voltage (current rating of fuse for 230-volt operation is one-half the current rating of fuse for 115-volts).

The vacant windings between pins 10, 10A, 11, 12, and 12A of T1400 are intended for use with the optional Inverter Circuit Board (Option 7). This allows the instrument to be operated from an external DC power source or an 1106 Power Supply.

Secondary Circuit

The −8 volt, −15 volt, +5 volt, +15 volt, +50 volt, and +110 volt supplies are series-regulated supplies. U1418, U1454A and B, and U1464A and B are high-gain amplifier cells with differential inputs. These amplifiers monitor variations in the output voltages and generate error signals to maintain relative constant output levels. Additionally unregulated voltages are used from the +15 volt and +50 volt supplies.

Q1492, Q1498, and their associated circuitry monitor the unregulated voltage in the +50 volt supply and provide a visual indication (via the LOW LINE indicator on the front panel) when the applied line voltage falls below the lower regulating limit selected by the Regulating Range Selector assembly. Q1482 provides operating power to the CRT graticule lights that is adjustable via the SCALE ILLUM control R1480.

CRT CIRCUIT

General

The CRT Circuit provides the voltage levels and control circuits necessary for operation of the cathode-ray tube (CRT). Fig. 3-9 shows a detailed block diagram of the CRT Circuit. A schematic of this circuit is shown on Diagram 12 at the rear of this manual.

High-Voltage Oscillator

Q1318 and associated circuitry compose the high-voltage oscillator that produces the drive for high-voltage transformer T1320. When the instrument is turned on, current through Q1316 provides forward bias for Q1318. Q1318 conducts and the collector current increases, which develops a voltage across the collector winding of T1320. This produces a corresponding voltage increase in the feedback winding of T1320, which is connected to the base of Q1318, and Q1318 conducts even harder. Eventually the rate of collector current increase in Q1318 becomes less than that required to maintain the voltage across the collector winding and the output voltage drops. This turns

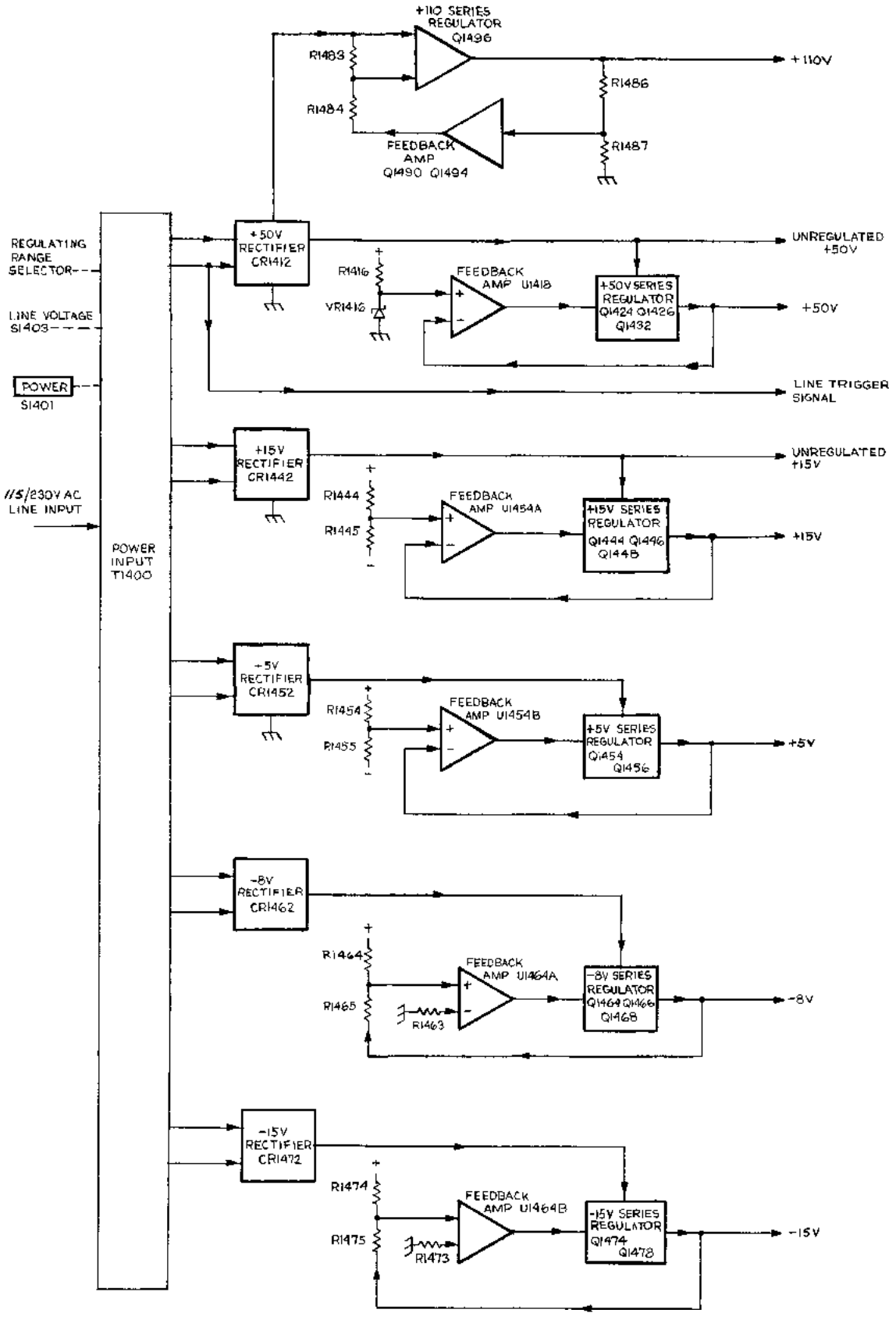


Fig. 3-8. Detailed block diagram of the Power Supply.

Q1318 off by way of the feedback voltage to the base. The voltage waveform at the collector of Q1318 is a sine wave at the resonant frequency of T1320. Q1318 remains off during the negative half cycle while the field collapses in the primary of T1320. When the field is collapsed sufficiently, the base of Q1318 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 Q1318. The frequency of oscillation is approximately 50 kilohertz. Fuse F1318 protects the +15 volts supply in the event the High-Voltage Oscillator stage becomes shorted. C1318 and L1318 decouple the +15 volt supply line and prevent the current changes present in the circuit from affecting the +15 volt regulator.

High-Voltage Regulator

Feedback from the CRT cathode −2450 volt supply is applied to the base of Q1306 through R1303A. Any change in the level at the base of Q1306 produces an error signal at the collector of Q1306, which is amplified by Q1308 and Q1316 and applied to the base of Q1318 through the feedback winding of T1320. Regulation occurs as follows.

If the output voltage at the −2450 volt test point starts to go positive (less negative), this positive-going change is applied to the base of Q1306. Q1306 conducts harder, which in turn causes Q1308 and Q1316 to conduct harder. This results in greater bias current to the base of Q1318 through the feedback winding of T1320. Now, Q1318 is biased closer to its conduction level so that it comes into conduction sooner to produce a larger induced voltage in the secondary of T1320. This increased voltage appears as a more negative voltage at the −2450 volt test point 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.

Q1312 and Q1310 compose an overvoltage protection circuit. In the event the regulating action of the circuit should cause the CRT cathode supply to approach approximately −3000 volts, the voltage level at the emitter of Q1316 will be very close to −6 volts. Normally Q1312 and Q1310 are biased off and do not conduct. When the voltage level at the emitter of Q1316 reaches approximately −6 volts, Q1312 is biased into conduction, which in turn biases Q1310 on. Q1310 now starts to reduce the base drive

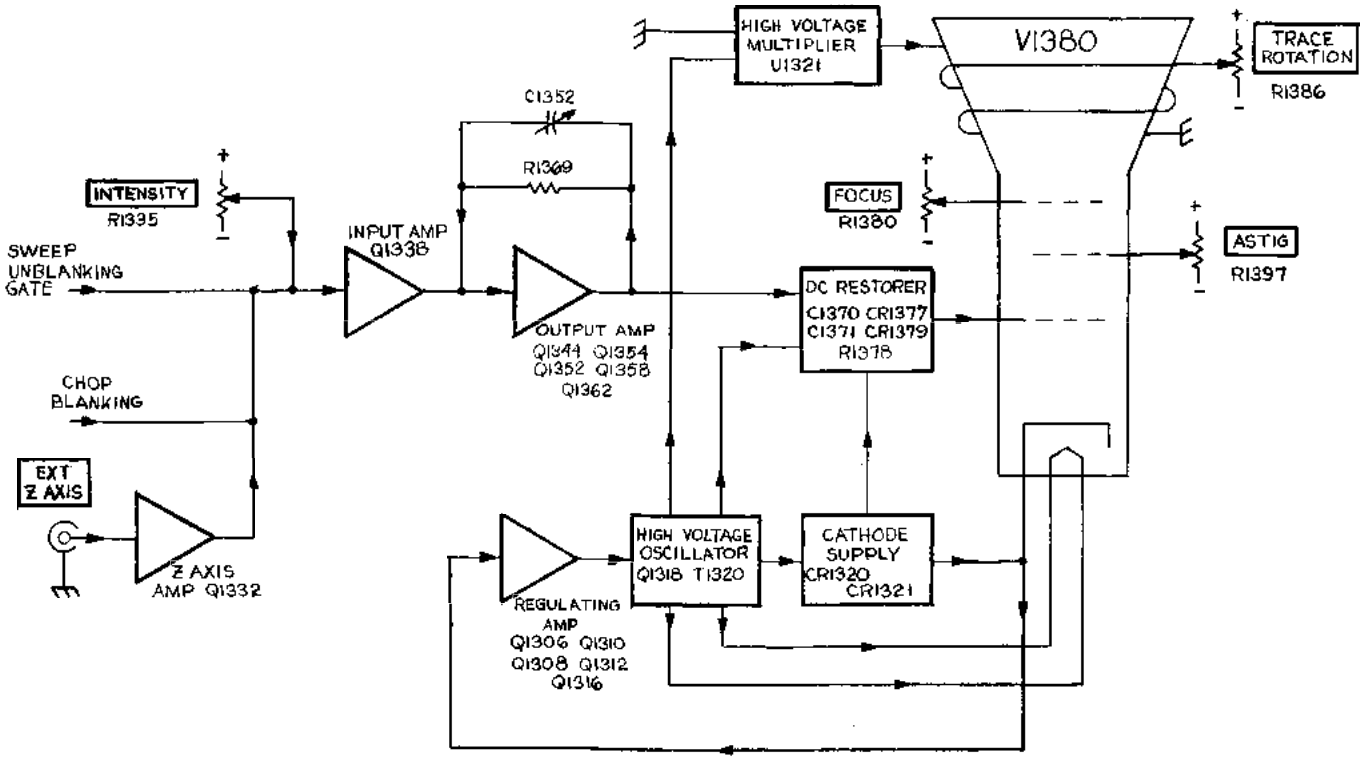


Fig. 3-9. Detailed block diagram of the CRT Circuit.

applied to Q1318 and prevents the amplitude of oscillations from increasing. This prevents the CRT cathode supply from going more negative than approximately −3300 volts.

High-Voltage Rectifiers and Output

The high-voltage transformer T1320 has two output windings. One winding provides filament voltage for the cathode-ray tube. The filament voltage can be supplied from the High-Voltage Supply, since the cathode-ray tube has a very low filament current drain. The filament of the cathode-ray tube is elevated to the cathode level to prevent cathode-to-filament arcing. The other winding of T1320 is used to derive both the negative cathode potential and the positive anode accelerating potential. The CRT grid bias voltage is derived by a DC restorer circuit that uses a sample of the signal in the high-voltage winding in conjunction with DC levels provided by the Z-Axis Amplifier and the negative CRT cathode potential.

The positive accelerating potential is supplied by High Voltage Multiplier U1321. Regulated output voltage is approximately +15,500 volts. The negative cathode potential is supplied by a voltage doubler circuit. Voltage output is −2450 volts. Variations in supply voltage are monitored by the High-Voltage Regulator circuit to provide a regulated high-voltage output.

In the 0.1 s, 0.2 s, 0.5 s, and X-Y positions of the TIME/DIV switch the anode of CR1337 is connected to ground. This limits how negative the operating level at the emitter of Q1338 can go to reduce the unblanking capabilities of the amplifier, thereby reducing the possibility of inadvertently burning the CRT phosphor. When the BEAM FIND pushbutton is pushed −8 volts is connected to the junction of R1342 and R1346. This biases Q1338 off which in turn causes CR1343 to be reverse biased. Now the output of the Z-Axis Amplifier is isolated from all of the circuit's normal signal inputs. The output level of the amplifier is set at a fixed level determined by the parallel value of R1343 and R1346 divided into the feedback resistance of the amplifier.

CRT Control Circuits

Focus of the CRT display is controlled by FOCUS control R1380. ASTIG adjustment R1397, which is used in conjunction with the FOCUS control to provide a well-defined display, varies the positive level on the astigmatism grid. Geometry adjustment R1390 varies the positive level 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 Align adjustment R1385 controls the current through L1385, 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 adjustment R1386 controls the current through L1386 and affects both vertical and horizontal rotation of the beam.

Z-Axis Amplifier

The Z-Axis Amplifier circuit controls the CRT intensity level from several inputs. The effect of these input signals is to either increase or decrease the trace intensity, or to completely blank portions of the display. The input transistor Q1338 is a current-driven, low input impedance amplifier. It provides termination for the input signals as well as isolation between the input signals and the following stages. The current signals from the various control sources are connected to the emitter of Q1338 and the algebraic sum of the signals determines the collector conduction level.

Q1344, Q1352, Q1354, Q1358, and Q1362 compose a feedback amplifier stage. R1369 is the feedback element, C1352 provides high-frequency compensation. Q1344 is an emitter follower that provides drive to the output complementary amplifier made up of Q1352, Q1354, and Q1358. Q1358 is a device with higher frequency characteristics than Q1354 and is used to improve the overall frequency capabilities of the Z-Axis Amplifier. On the fast positive-going output signal peaks, Q1358 depletes the charge on C1358. Then, on the negative-going signal peaks, Q1362 is pulsed on to renew the charge on C1358. CR1367 provides protection to the Z-Axis Amplifier circuitry in the event of short duration arcing in the CRT High-Voltage Power Supplies.

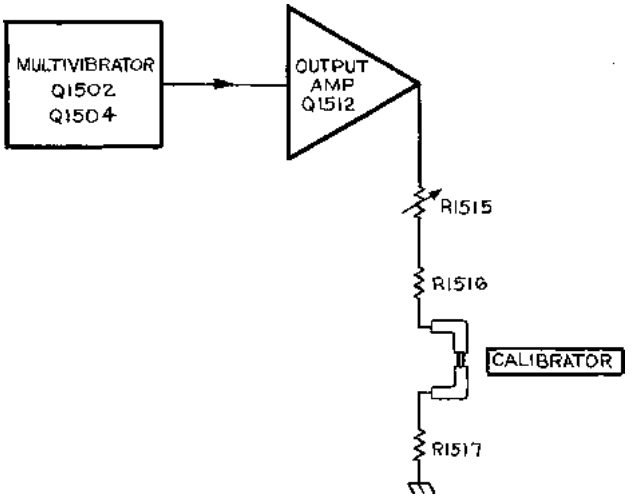


Fig. 3-10. Detailed block diagram of the Calibrator.

DC Restorer Circuit

C1372, C1371, CR1377, CR1379, and R1378 form a DC restorer circuit. All DC levels in this circuit are referenced to the negative potential of the CRT cathode. The voltage difference across R1378 approximately equals the voltage swing present at the junction of CR1371 and CR1373. The control grid end of R1378 is more negative than the end connected to CR1379. The amplitude of the voltage swings present at the junction of CR1371 and CR1373 is determined by the voltage levels established by the Z-Axis Amplifier and the CRT Bias adjust circuit. The output level of the Z-Axis Amplifier sets the limit of the negative excursion (through CR1371) and the Grid Bias adjust circuit sets the limit of the positive excursion (through CR1373).

CALIBRATOR

General

The Calibrator circuit produces a square-wave output signal with accurate voltage and current amplitudes. This output is available as a voltage or current at the CALIBRATOR current loop on the instrument front panel. Fig. 3-10 shows a detailed block diagram of the Calibrator circuit. A schematic of this circuit is shown on Diagram 13 at the back of this manual.

Multivibrator

Q1502 and Q1504 along with their associated circuitry compose an astable multivibrator. The basic frequency of the multivibrator is approximately one kilohertz and is essentially determined by the RC combination of C1505 and R1502. The multivibrator symmetry is set by R1502 and R1504. Q1502 and Q1504 alternately conduct, producing a square-wave signal that is taken from the collector of Q1504.

Output Amplifier

The output signal from the Multivibrator overdrives Output Amplifier Q1512 to produce a square wave at the output. When the base of Q1512 goes positive, Q1512 is cut off and the collector level drops down to ground. When the base goes negative, Q1512 is biased into saturation and the collector of Q1512 rises positive to about +5 volts. Amplitude adjustment R1515 adjusts the resistance between the collector of Q1512 and ground to determine the amount of current allowed to flow, which in turn determines the voltage developed across R1517.

FAN MOTOR CIRCUIT

General

The fan motor used in the 475 is a brushless DC fan motor using Hall Effect devices. The fan motor circuitry varies the rotational speed of the fan with variations in operating temperature. When the ambient temperature increases, the value of thermistor RT1696 reduces. This biases Q1698 on harder to conduct more current through the Hall devices. Higher currents through the Hall devices causes the potential difference across them (for instance between pins 6 and 8 of the fan) to increase. This potential difference biases one of a pair of transistors on and the other off. For instance, if pin 8 is more positive than pin 6 of the fan, Q1690A will be on and Q1690B will be off. The higher the potential difference between pin 8 and pin 6 the harder the on transistor will be conducting. The harder the transistor is conducting, the faster the fan rotates.

MAINTENANCE

Cabinet Removal

WARNING

Dangerous potentials exist at several points throughout this instrument. When the instrument is operated with the cover removed, do not touch exposed connections or components. Some transistors may have elevated cases. Disconnect power before cleaning the instrument or replacing parts.

The instrument wrap-around cabinet can be removed in the following manner:

1. Unwrap the power cord from the instrument feet.

2. Remove the six screws indicated in Fig. 4-1 and remove the instrument feet and rear ring assembly from the instrument.

3. Slide the wrap-around cabinet to the rear and remove the oscilloscope.

To replace the instrument in its wrap-around cabinet, reverse the removal procedure. The portable wrap-around cabinet should be installed with the carrying handle pivot points positioned toward the bottom of the instrument.

PREVENTIVE MAINTENANCE

General

Preventive maintenance consists primarily of cleaning and visual inspection. When performed on a regular basis, preventive maintenance can prevent instrument breakdown and will improve the reliability of this instrument. The severity of the environment to which the 475 is subjected will determine the frequency of maintenance. A convenient time to perform preventive maintenance is just prior to recalibration of the instrument.

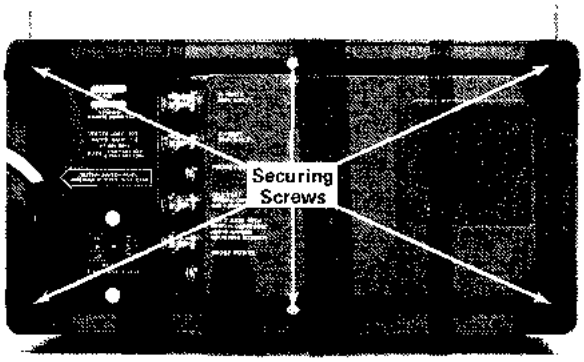


Fig. 4-1. Removing wrap-around cabinet.

Cleaning

General. The 475 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides an electrical conduction path which can result in instrument failure.

The cabinet provides protection against dust in the interior of 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.

CAUTION

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

Switch Contacts. Most of the switching in the 475 is accomplished with circuit-board mounted, cam-actuated contacts. Care must be exercised to preserve the high-frequency characteristics of these switches. Seldom is switch maintenance necessary, but if it is required, observe the following precautions.

Cleaning the switch contacts should only be done using isopropyl alcohol or a solution of one part Kelite to 20 parts water. In the absence of these cleaners it is safe to use petroleum ether, white kerosene, or a solution of 1% Joy detergent and 99% water. Do not use acetone, MEK, MIBK, benzol, toluol, carbon tetrachloride, trichlor, trichlene, methyl alcohol, methylene chloride, sulfuric acid, or Freon TC-TE-TF-22-TA-12.

Most spray circuit coolants and contact cleaners contain Freon 12 as a propellant. Because many Freons adversely affect the contacts, check the contents before using a spray cleaner or coolant. No Noise (Electronic Chemical) is an acceptable contact cleaner-restorer. The only recommended circuit coolants are dry ice or isopropyl alcohol. There are three recommended switch lubricants. They are Silicone Versilube (General Electric Co.), Rykon R (Standard Oil), and WD-40 (Rocket Chemical Co.).

Exterior. Loose dust accumulated on the outside of the 475 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 which remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should not be used.

CRT. Clean the blue and clear plastic light filters and the CRT face with a soft, lint-free cloth dampened with denatured alcohol or a mild detergent and water solution. The optional CRT mesh filter can be cleaned in the following manner.

1. Hold the filter in a vertical position and brush lightly with a soft No. 7 watercolor brush to remove light coatings of dust and lint.

2. Greasy residues or dried-on dirt can be removed with a solution of warm water and a neutral pH liquid detergent. Use the brush to lightly scrub the filter.

3. Rinse the filter thoroughly in clean water and allow to air dry.

4. If any lint or dirt remains, use clean low-pressure air to remove. Do not use tweezers or other hard cleaning tools on the filter as the special finish may be damaged.

5. When not in use, store the mesh filter in a lint-free dust-proof container such as a plastic bag.

Interior. Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-pressure air. Remove any dirt that remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning circuit boards.

Lubrication

The fan motor and most of the potentiometers used in the 475 are permanently sealed and generally do not require periodic lubrication. The switches used in the 475, both cam- and lever-type, are installed with proper lubrication applied where necessary and will only rarely require any additional lubrication. It is recommended that a regular periodic lubrication program not be performed on any of the components used in the 475.

Transistor Checks

Periodic checks of the transistors and other semiconductors in the 475 are not recommended. The best check of semiconductor performance is actual operation in the instrument.

Recalibration

To assure accurate measurements, check the calibration of this instrument after each 1000 hours of operation or every six months if used infrequently. In addition, replacement of components may necessitate recalibration of the affected circuits. Complete calibration instructions are given in the Calibration section.

The calibration procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed or corrected by recalibration.

CORRECTIVE MAINTENANCE

General

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

Obtaining Replacement Parts

Standard Parts. All electrical and mechanical part replacements for the 475 can be obtained through your local TEKTRONIX Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance in the instru-

ment, particularly at high frequencies. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Special Parts. In addition to the standard electronic components, some special components are used in the 475. These components are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. These special components are indicated in the Electrical Parts List by an asterisk preceding the part number. 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 the order to ensure receiving the proper parts.

1. Instrument type.

2. Instrument serial number.

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

4. TEKTRONIX Part number.

Soldering Techniques

WARNING

Always disconnect the instrument from the power source before attempting to solder in the instrument.

Ordinary 60/40 solder and a 35- to 40-watt pencil-type soldering iron can be used to accomplish the majority of the soldering to be done in the 475. 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.

CAUTION

The Vertical Preamplifier Attenuator circuit boards are made of material easily damaged by excessive heat. When soldering to these boards, do not use a soldering iron with a rating of more than approximately 15 watts. Avoid prolonged applications of heat to circuit-board connections. Use only isopropyl alcohol when cleaning this circuit board.

When soldering to the ceramic strips in the instrument a slightly larger soldering iron can be used. It is recommended that a solder containing about 3% silver be used when soldering to these strips to avoid destroying the bond to the ceramic material. This bond can be broken by repeated use of ordinary tin-lead solder or by the application of too much heat; however, occasional use of ordinary solder will not break the bond if excessive heat is not applied.

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 section entitled Switch Contacts under PREVENTIVE MAINTENANCE for recommended cleaners and procedures.

Component Replacement

WARNING

Always disconnect the instrument from the power source before attempting to replace components.

Circuit Board Replacement. Occasionally it may be necessary to gain access to the reverse side of a circuit board or to remove one circuit board to gain access to another. The following procedures outline the necessary steps to facilitate instrument disassembly. Most of the connections to the circuit boards in the instrument are made with pin connectors. However, some connections are soldered to the board. Observe the soldering precautions given under Soldering Techniques given in this section.

Vertical Preamp Circuit Board Removal

1. Unplug the delay line from the Vertical Preamp circuit board.

2. Unplug the six coaxial cables and one wire from the front side of the Vertical Preamp circuit board. Note wire color codes to facilitate correct reinstallation.

3. Unplug the two coaxial cables from the back side of the Vertical Preamp circuit board. Note wire color codes to facilitate correct reinstallation.

4. Unplug a 6-wire, a 7-wire, and a 10-wire ribbon cable from the Vertical Mode Switch circuit board.

5. Remove the shafts from the vertical POSITION potentiometers on the Vertical Preamp circuit board. Loosen the front setscrew in the couplers and pull the shafts out through the front panel.

6. Remove the attenuator shields.

7. Unsolder the two resistors that connect the Vertical Preamp circuit board to the Attenuator circuit boards.

8. Unsolder the two discaps that connect between the Vertical Preamp circuit board and the Interface circuit board.

9. Remove the actuator shaft from the 20 MHz BW/TRIG VIEW switch. Loosen the setscrew and remove the shaft through the front panel.

10. Remove the six securing screws from the Vertical Preamp circuit board and remove the board from the instrument.

To reinstall the Vertical Preamp circuit board, reverse the order of the removal steps.

Vertical Mode Switch Circuit Board Removal

1. Remove the Vertical Preamp circuit board as outlined previously.

2. Remove the two UNCAL light lenses. Pry them away from the front panel with a fingernail and pull them straight out.

3. Remove the knobs from both VAR controls and both VOLTS/DIV switches.

4. Remove the knobs from the Input Coupling switches. They can be removed by pulling them off by hand.

5. Unplug the ribbon cables from the Vertical Mode Switch circuit board that run to the VOLTS/DIV sensitivity lights.

6. Unplug all remaining connectors from the Vertical Mode Switch circuit board. Note wire color codes to facilitate correct reinstallation.

7. Remove the two securing screws from the rear of the Vertical Mode Switch circuit board.

8. Remove the four nuts that secure the attenuator assemblies to the front casting.

9. Remove the Vertical Mode Switch circuit board from the instrument.

To reinstall the Vertical Mode Switch circuit board, reverse the order of the removal steps. To align the VERT MODE switch pushbuttons, hold the assembly in place with a slight forward pressure and use a small tool to reach through the front panel to align the buttons. Install the remaining parts in the reverse order they were removed. Do not tighten the circuit board securing screws until the securing nuts at the front of the attenuator chassis are tight and the circuit board is aligned properly.

Trigger Generator And Sweep Logic Circuit Board Removal

1. Remove the LOW LINE, TRIG, and READY light lenses. Pry them away from the front panel with a fingernail and pull them straight out.

2. Disconnect the six coaxial cables, single wire, and two four-wire ribbon cables from the front of the Trigger Generator And Sweep Logic circuit board. Note wire color codes to facilitate correct reinstallation.

3. Disconnect the two coaxial cables and a five-wire ribbon cable from the back side of the Trigger Generator And Sweep Logic circuit board. Note wire color codes to facilitate correct reinstallation.

4. Remove the actuator shaft from the POWER switch coupler. Use a small flat-bladed screwdriver and exercise caution so as not to damage the switch coupler.

5. Remove the POWER switch mounting bracket from the Trigger Generator And Sweep Logic circuit board.

6. Unsolder the resistors from the External Trigger Input connectors.

7. Remove the five board securing screws and remove the circuit board from the instrument.

To reinstall the Trigger Generator And Sweep Logic circuit board, reverse the order of the removal steps.

Sweep Timing Circuit Board Removal

1. Remove the Trigger Generator And Sweep Logic circuit board as outlined previously.

2. Remove the X10 MAG and UNCAL light lenses. Pry them away from the front panel with a fingernail and pull them straight out.

3. Remove the knobs from the VAR TIME/DIV control and the A AND B TIME/DIV switches. Be careful not to lose the plastic bushing behind the knobs.

4. Remove the board mounting screw and the hex rod from the Sweep Timing circuit board.

5. Remove the Sweep Timing circuit board from the instrument. Use caution so as not to damage the connector pins.

To reinstall the Sweep Timing board, reverse the order of the removal steps.

Power Transformer Replacement. If the power transformer becomes defective, contact your local TEKTRONIX Field Office or representative for a warranty replacement (see warranty note in the front of this manual). Be sure to replace only with a direct replacement TEKTRONIX transformer. After the transformer is replaced check the performance of the complete instrument. The transformer is removed as follows:

1. Unsolder the power cord leads.

2. Remove the small blue panel from the rear of the instrument. It will be necessary to remove the cover from the Regulating Range Selector Assembly and the two feet from that side of the instrument.

3. Unsolder the transformer leads from the Interface Board and from the Regulating Range Selector Assembly. Note the wire color codes to facilitate correct reinstallation.

4. Remove the actuating shaft from the POWER switch coupler. Exercise caution so as not to damage the switch coupler.

5. Remove the POWER switch mounting bracket from the Trigger Board.

6. Remove the transformer leads from the Regulating Range Selector Assembly. It will be necessary to use a special pin removing tool available under TEKTRONIX Part Number 003-0707-00. It is only necessary to use this tool to remove the transformer leads from the Selector Assembly. The leads may be reinstalled by simply pushing them into place. Note wire color codes to facilitate correct reinstallation.

7. Remove the transformer bracket mounting hardware. This includes two screws on the Trigger Board, one screw on the Interface Board, two nuts on the U-channel (one on the transformer side and one on the CRT side), and two screws and nuts on the rear subpanel.

8. Thoroughly loosen the Trigger Board and remove the transformer assembly from the instrument.

9. Remove the thermal cutout and POWER switch from the old transformer and install on the new transformer. Note wire color codes to facilitate correct installation.

10. Install the new transformer assembly in the instrument, reversing the order of the removal steps.

Recalibration After Repair

After any electrical component has been replaced, the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuits. Since the power supply affects all circuits, calibration of the entire instrument should be checked if work has been done in the power supply or if the transformer has been replaced.

Instrument Repackaging

If the 475 is to be shipped for long distances by commercial means of transportation, it is recommended that the instrument be repackaged in the original manner for maximum protection. The original shipping carton can be saved and used for this purpose. The Repackaging illustration in the Mechanical Parts Illustrations shows how to repackage the 475 and gives the part numbers for the repackaging components. New shipping cartons can be obtained from Tektronix, Inc. Contact your local TEKTRONIX Field Office or representative.

CALIBRATION

Calibration Interval

To assure instrument accuracy, check the calibration of the 475 every 1000 hours of operation, or every six months if used infrequently. Before complete calibration, thoroughly clean and inspect this instrument as outlined in the Maintenance section of the manual.

Tektronix Field Service

Tektronix, Inc. provides complete instrument repair and recalibration at local Field Service Centers and the Factory Service Center. Contact your local Tektronix Field Office or representative for further information.

Using This Procedure

Outline. To aid in locating a step in the Performance Check or Calibration Procedure, an outline is given preceding Part I—Performance Check and Part III—Calibration procedure.

Performance Check. The performance of this instrument can be checked without removing the covers or making internal adjustments, by performing only Part I—Performance Check. This procedure does not check every facet of the instrument's calibration; rather it is concerned primarily with those portions of the instrument essential to measurement accuracy and correct operation.

Short-Form Calibration. A short-form calibration procedure is provided to the technician experienced with the 475 as guidelines for calibration of this instrument, in Part II—Short-Form Calibration.

Calibration Procedure. Completion of each step in Part III—Calibration procedure, ensures that this instrument meets the electrical specifications given in the front of this manual. Where possible, instrument performance is checked before an adjustment is made. For best overall instrument performance when performing a complete calibration procedure, make each adjustment to the exact setting, even if the CHECK— is within the allowable tolerance.

Partial Procedures. A partial check or adjustment is often desirable after replacing components or to touch up the adjustment of a portion of the instrument between major recalibrations. To check or adjust only part of the instrument, set the controls as given under the nearest Control Settings and use the Equipment Required list preceding the desired portion of the step. To prevent unnecessary recalibration of other parts of the instrument, readjust only if the tolerance given in the CHECK— part of the step is not met. If readjustment is necessary, also check the calibration of any steps listed in the INTERACTION— part of the step.

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories, or its equivalent, is required for complete calibration of the 475. Specifications given for the test equipment are the minimum necessary for accurate calibration. Therefore, some of the specifications listed here may differ from the actual performance capabilities of the test equipment. All test equipment is assumed to be correctly calibrated and operating within the listed specifications. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the instruction manual for the test equipment if more information is needed.

If only a Performance Check procedure or a Calibration procedure is performed, not all of the listed test equipment will be required. Items used only for the Calibration procedures are indicated by footnote 1. The remaining pieces of equipment are items common to both a Performance Check procedure and a Calibration procedure.

Special Calibration Fixtures

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

Calibration Equipment Alternatives

All of the listed test equipment is required to completely check and calibrate this instrument. However, complete checking or calibration may not always be necessary or desirable. The user may be satisfied with checking only selected characteristics, thereby reducing the amount of test equipment actually required.

The Performance Check and Calibration Procedures are based on the first item of equipment given as an example of applicable equipment. When other equipment is substituted, control settings or calibration setup may need to be altered to meet the requirements of the substitute equipment. If the exact item of test equipment given as an example in the Test Equipment list is not available, first check the Specifications column carefully to see if any other equipment is available which might suffice. Then check the Usage column to see what this item is used for. If used for a check or adjustment that is of little or no importance to your measurement requirements, the item and corresponding step(s) can be deleted.

TABLE 5-1

Test Equipment

Description	Minimum Specifications	Usage	Examples
1. Variable Autotransformer[1]	Capable of supplying 1.2 amperes over a range of 103.5 to 126.5 volts.	Power supply adjustment.	a. General Radio W10MT3W Variac Autotransformer.
2. Precision DC Voltmeter[1]	Range, zero to 150 volts; accuracy, within 0.05%.	Low voltage power supply check and adjustment.	a. Fluke Model 825A Differential DC Voltmeter.
3. DC Voltmeter (VOM)[1]	Range, zero to 2500 volts; accuracy, within 3%.	High Voltage check and adjustment.	a. Triplett Model 630-NA. b. Simpson Model 262.
4. Test Oscilloscope[1]	Bandwidth, DC to 100 megahertz; minimum deflection factor, five millivolts/division; accuracy, within 3%.	Power supply checks; Z-Axis compensation; Vertical gain adjustments; A Trigger Holdoff check; High-speed timing adjustment; A and B +Gate checks.	a. Tektronix 454A Oscilloscope with two P6054 probes and one P6022 probe.
5. Standard Amplitude Calibrator	Amplitude accuracy, within 0.25%; signal amplitude, five millivolts to 50 volts; output signal, one-kilohertz square wave and positive DC voltage.	Vertical deflection system checks; Trigger View deflection factor adjustment; X-Gain adjustment.	a. Tektronix calibration fixture Part Number 067-0502-01.
6. High-Frequency Constant-Amplitude Signal Generator	Frequency, 65 megahertz to above 200 megahertz; reference frequency, three megahertz; output amplitude, variable from 0.5 volt to 4 volts; amplitude accuracy, within 1%.	Vertical system bandwidth checks.	a. Tektronix calibration fixture Part Number 067-0532-01.
7. Medium-Frequency Constant-Amplitude Signal Generator	Frequency, 350 kilohertz to 50 megahertz; reference frequency 50 kilohertz; output amplitude, variable from five millivolts to 5 volts into 50 ohms or 10 volts unterminated; amplitude accuracy, within 3%.	Vertical system bandwidth and trigger circuits operation checks. X-Y phasing adjustment and EXT Z-AXIS operation check.	a. Tektronix Type 191 Constant-Amplitude Signal Generator. b. General Radio 1211-C with 1263-C Amplitude Regulating Power Supply.
8. Fast-Rise High-Amplitude Pulse Generator[1]	Risetime, 0.25 nanosecond or less; repetition rate, 550 to 720 pulses/second; amplitude, variable from 20 millivolts to 10 volts.	Vertical deflection system checks.	a. Tektronix Type 109 Pulse Generator.

[1] Used for calibration procedure only.

TABLE 5-1 (cont)

Description	Minimum Specifications	Usage	Examples
9. Square-Wave Generator[1]	Frequency, 10 hertz to one megahertz; risetime, one nanosecond or less from fast-rise output; output amplitude, about 120 volts unterminated or 12 volts into 50 ohms.	Vertical deflection system compensation checks.	a. Tektronix Type 106 Square-Wave Generator.
10. Low-Frequency Sine-Wave Generator[1]	Frequency, 10 hertz to 100 kilohertz; output amplitude, variable from 0.5 volt to 40 volts peak-to-peak; amplitude accuracy, within 3%.	Low frequency triggering checks.	a. General Radio 1310-A Oscillator.
11. Time-Mark Generator	Marker outputs, two nanoseconds to 0.5 second; marker accuracy, within 0.1%.	CRT geometry; Horizontal deflection system timing checks and adjustments.	a. Tektronix 2901 Time-Mark Generator. b. Tektronix 184 Time-Mark Generator.
12. Signal Insertion[1]	Connectors, GR874 input connector and output connectors to fit input jacks of the 475 delay line.	Vertical output amplifier frequency response adjustment.	a. Tektronix calibration fixture Part Number 067-0676-00.
13. Signal Pickoff	Connectors, GR874 thru-signal connectors and BNC signal-pickoff connector.	Trigger system checks and adjustments.	a. Tektronix Part Number 017-0061-00.
14. Cable	Impedance, 50 ohms; type RG 213; electrical length, five nanoseconds; connectors, GR874.	Used for signal interconnection.	a. Tektronix Part Number 017-0502-00.
15. Adapter	BNC female connector to GR connector.	Used for signal interconnection.	a. Tektronix Part Number 017-0063-00.
16. Cable (two required)	Impedance, 50 ohms; type RG-58/U; length, 42 inches; connectors, BNC.	Used for signal interconnection.	a. Tektronix Part Number 012-0057-01.
17. Cable (two required)	Impedance, 50 ohms; type RG-58/U; length, 18 inches; connectors, BNC.	Used for signal interconnection.	a. Tektronix Part Number 012-0076-00.
18. Attenuator	Attenuation ratio, X10; connectors, BNC; impedance, 50 ohms. 2cc	Vertical amplifier compensation and trigger checks and adjustments.	a. Tektronix Part Number 011-0059-01.
19. Attenuator	Attenuation ratio, X2; connectors, BNC; impedance, 50 ohms.	Trigger checks and adjustments.	a. Tektronix Part Number 011-0069-01.

TABLE 5-1 (cont)

Description	Minimum Specifications	Usage	Examples
20. Attenuator (two required)[1]	Attenuation ratio, X10; connectors, GR; impedance, 50 ohms.	Vertical system frequency response adjustments.	a. Tektronix Part Number 017-0078-00.
21. Attenuator[1]	Attenuation ratio, X5; connectors, GR; impedance, 50 ohms.	Vertical system frequency response adjustments.	a. Tektronix Part Number 017-0079-00.
22. Termination (two required)	Impedance, 50 ohms; accuracy, within 3%; connectors, BNC.	Vertical amplifier bandwidth check; trigger circuit operation checks and adjustments.	a. Tektronix Part Number 011-0049-01.
23. T-Connector[1]	Connectors, BNC.	Used for signal interconnection.	a. Tektronix Part Number 103-0030-00.
24. Input Normalizer[1]	RC time constant, 20 picofarads times 1 megohm.	Standardize input RC time constant.	a. Tektronix Part Number 067-0538-00.
25. Dual-Input Coupler (two required)	Connectors, BNC; matched signal transfer to each input.	Used for signal interconnection.	a. Tektronix calibration fixture Part Number 067-0525-00.
26. Screwdriver[1]	Three-inch shaft; 3/32-inch bit.	Used throughout procedure to adjust variable resistors.	a. Tektronix Part Number 003-0192-00.
27. Low-Capacitance Screwdriver[1]	1 1/2-inch shaft.	Used throughout procedure to adjust variable capacitors.	a. Tektronix Part Number 003-0000-00.

PRELIMINARY CONTROL SETTINGS

Preset the instrument controls to the settings given below when starting a Performance Check or a Calibration procedure.

Power Controls

POWER	ON

CRT Controls

INTENSITY	Midrange
FOCUS	Midrange
SCALE ILLUM	Midrange
BEAM FIND	Off (button out)

Vertical Controls (both Channels if applicable)

VOLTS/DIV	5 mV
VAR	Calibrated detent
POSITION	Midrange
AC-GND-DC	DC
VERT MODE	CH 1
INVERT	Off (button out)
20 MHz BW (PULL)	Off

Triggering Controls (both A and B if applicable)

LEVEL	Fully clockwise
SLOPE	+
COUPLING	AC
SOURCE	NORM
TRIG MODE	AUTO

Sweep Controls

HORIZ DISPLAY	A
DELAY TIME POSITION	Fully counterclockwise
A TIME/DIV	1 ms
B TIME/DIV	1 ms
VAR	Calibrated detent
X10 MAG	Off (button out)
POSITION	Midrange
FINE	Midrange
A TRIG HOLDOFF	NORM

PART I—PERFORMANCE CHECK

Introduction

The following procedure is intended to be used for incoming inspection 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 which are essential to measurement accuracy and correct operation. Removing the instrument dust cover is not necessary to perform this procedure. All checks are made from the front panel.

Outline for Part I—Performance Check

VERTICAL SYSTEM CHECK

1. Check Beam Finder Operation — Page 5-6
2. Check Channel 1 and 2 Gain Switch Balance — Page 5-6
3. Check Channel 1 and 2 Variable Volts/Division Balance — Page 5-6
4. Check Channel 2 Inverted Balance — Page 5-7
5. Check Channel 1 and 2 Position Range — Page 5-7
6. Check Channel 1 and 2 Gain — Page 5-7
7. Check Add Mode Operation — Page 5-7
8. Check Channel 1 and 2 Deflection Accuracy — Page 5-7
9. Check Channel 1 and 2 Variable Volts/Division Range — Page 5-8
10. Check Alternate Mode Operation — Page 5-8
11. Check Chop Mode Operation — Page 5-8
12. Check Vertical Amplifier Bandwidth — Page 5-8
13. Check Cascaded Bandwidth — Page 5-9

TRIGGER SYSTEM CHECK

14. Check A Triggering — Page 5-9
15. Check B Triggering — Page 5-10
16. Check A Normal Mode Operation — Page 5-10
17. Check Single Sweep Operation — Page 5-11
18. Check Trigger View Operation — Page 5-11

HORIZONTAL SYSTEM CHECK

19. Check Variable Time/Division Range — Page 5-11
20. Check Timing Accuracy — Page 5-12
21. Check Delay Time Accuracy — Page 5-12
22. Check Delay Time Jitter — Page 5-13
23. Check Mixed Sweep Timing Accuracy — Page 5-13
24. Check X Gain — Page 5-13
25. Check X-Y Phasing and Bandwidth — Page 5-13

Preliminary Procedure for Performance Check

NOTE

The performance of this instrument can be checked at any temperature within the 0°C to +40°C (+32°F to +104°F) temperature range unless stated otherwise.

1. Connect the 475 to a power source that meets the voltage and frequency requirements of this instrument.

2. Set the controls as given under Preliminary Control Settings.

3. Allow at least 20 minutes warmup before proceeding.

VERTICAL SYSTEM CHECK

Equipment Required	
1. Standard Amplitude Calibrator (067-0502-01).	4. GR to BNC Female Adapter.
2. High-Frequency Constant-Amplitude Signal Generator (067-0532-01).	5. 42-inch 50 Ω BNC cable (two).
3. Medium-Frequency Constant-Amplitude Signal Generator (Type 191).	6. X10 BNC Attenuator.
	7. 50 Ω BNC Termination (two).
	8. Dual Input Coupler.

Control Settings

Preset instrument controls to the settings given under Preliminary Control Settings.

1. Check Beam Finder Operation

a. Position the trace off screen with the CH 1 and horizontal POSITION controls.

b. Push the BEAM FIND button and hold it in.

c. CHECK–That the trace is compressed and brought into the CRT viewing area.

d. Release the BEAM FIND button.

2. Check Channel 1 and 2 Gain Switch Balance

a. Set both VOLTS/DIV switches to 2 mV and both AC-GND-DC switches to GND.

b. Position the trace to the center horizontal line with the CH 1 POSITION control.

c. CHECK–CRT display for minimum trace shift between 2 mV and 5 mV positions of the CH 1 VOLTS/DIV switch.

d. Set the VERT MODE switch to CH 2.

e. Position the trace to the center horizontal line with the CH 2 POSITION control.

f. CHECK–CRT display for minimum trace shift between 2 mV and 5 mV positions of the CH 2 VOLTS/DIV switch.

3. Check Channel 1 and 2 Variable Volt/Division Balance

a. Position the trace to the center horizontal line with the CH 2 POSITION control.

b. Rotate the CH 2 VAR control through its range.

c. CHECK–That the CH 2 UNCAL light comes on when the VAR control is out of the detent position.

d. CHECK–CRT display for 2 divisions or less of vertical trace shift when rotating the CH 2 VAR control through its range.

e. Set the VERT MODE switch to CH 1.

f. Position the trace to the center horizontal line with the CH 1 POSITION control.

g. Rotate the CH 1 VAR control through its range.

h. CHECK–That the CH 1 UNCAL light comes on when the VAR control is out of the detent position.

i. CHECK–CRT display for 2 divisions or less of vertical trace shift when rotating the CH 1 VAR control through its range.

j. Return both VAR controls to the detent position.

4. Check Channel 2 Inverted Balance

a. Set the VERT MODE switch to CH 2 and the CH 2 AC-GND-DC switch to GND.

b. Position the trace to the center horizontal line with the CH 2 POSITION control.

c. Push the INVERT switch.

d. CHECK—Trace does not vertically shift more than 1 division between the positions of the INVERT switch.

5. Check Channel 1 and 2 Position Range

a. Connect the Standard Amplitude Calibrator output to the CH 1 and CH 2 inputs via a 42-inch 50 Ω BNC cable and a dual input coupler.

b. Set both VOLTS/DIV switches to 2 mV and both AC-GND-DC switches to AC.

c. Adjust the Standard Amplitude Calibrator for a 50 mV output.

d. CHECK—That the top of the CRT display can be positioned below the center horizontal line, and the bottom of the display can be positioned above the center horizontal line.

e. Set the VERT MODE switch to CH 1.

f. CHECK—That the top of the CRT display can be positioned below the center horizontal line, and the bottom of the display can be positioned above the center horizontal line.

6. Check Channel 1 and 2 Gain

a. Set both VOLTS/DIV switches to 5 mV.

b. Adjust the Standard Amplitude Calibrator for a 20 mV square-wave output.

c. CHECK—CRT display for 4 divisions of deflection, within 0.12 division.

d. Set the VERT MODE switch to CH 2.

e. CHECK—CRT display for 4 divisions of deflection, within 0.12 division.

7. Check Add Mode Operation

a. Set both AC-GND-DC switches to DC.

b. Adjust the Standard Amplitude Calibrator for a 10 mV output.

c. Set the VERT MODE switch to ADD.

d. CHECK—CRT display for 4 divisions, within 0.12 division, of amplitude.

8. Check Channel 1 and 2 Deflection Accuracy

a. Set the VERT MODE switch to CH 1 and the CH 2 AC-GND-DC switch to GND.

b. CHECK—Using the CH 1 VOLTS/DIV switch and the Standard Amplitude Calibrator settings given in Table 5-2, check that the vertical deflection factor is within the given tolerance in each position of the CH 1 VOLTS/DIV switch.

TABLE 5-2

Vertical Deflection Accuracy

VOLTS/DIV Switch Setting	Standard Amplitude Calibrator Output	Vertical Deflection in Divisions	Maximum Error for 3% Accuracy
2 mV	10 mV	5	Previously set
5 mV	20 mV	4	Previously set
10 mV	50 mV	5	±0.15 div
20 mV	0.1 V	5	±0.15 div
50 mV	0.2 V	4	±0.12 div
0.1 V	0.5 V	5	±0.15 div
0.2 V	1 V	5	±0.15 div
0.5 V	2 V	4	±0.12 div
1 V	5 V	5	±0.15 div
2 V	10 V	5	±0.15 div
5 V	20 V	4	±0.12 div

c. Set the VERT MODE switch to CH 2.

d. Set the CH 1 AC-GND-DC switch to GND and the CH 2 AC-GND-DC switch to DC.

e. CHECK—Using the CH 2 VOLTS/DIV switch and the Standard Amplitude Calibrator settings given in Table 5-2, check that the vertical deflection factor is within the given tolerance in each position of the CH 2 VOLTS/DIV switch.

9. Check Channel 1 and 2 Variable Volts/Division Range

a. Set both VOLTS/DIV switches to 20 mV.

b. Adjust the Standard Amplitude Calibrator for a 0.1 volt output.

c. Rotate the CH 2 VAR control fully counterclockwise.

d. CHECK—CRT display reduces to less than 2 divisions.

e. Set the CH 1 AC-GND-DC switch to DC and the VERT MODE switch to CH 1.

f. Rotate the CH 1 VAR control fully counterclockwise.

g. CHECK—CRT display reduces to less than 2 divisions.

h. Return both VAR controls to the detent positions.

i. Disconnect the test setup.

10. Check Alternate Mode Operation

a. Set the VERT MODE switch to ALT and the A LEVEL control fully clockwise.

b. Position the traces 2 divisions apart.

c. CHECK—That the sweeps alternate in all settings of the TIME/DIV switch except X-Y.

11. Check Chop Mode Operation

a. Set the A TIME/DIV switch to 1 μs, the A SOURCE switch to NORM, and the VERT MODE switch to CHOP.

b. Position the two traces about 4 divisions apart.

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

d. CHECK—Duration of each cycle is about 1 division.

e. CHECK—CRT display for complete blanking of switching transients between chopped segments (see Fig. 5-1).

12. Check Vertical Amplifier Bandwidth

a. Set the TRIG MODE switch to AUTO, the A TIME/DIV switch to 0.2 ms, and both VOLTS/DIV switches to 5 mV.

b. Connect the output of the High-Frequency Constant-Amplitude Signal Generator (067-0532-01) to the CH 1 input via a GR-to-BNC adapter, X10 BNC attenuator, and a 50 Ω BNC termination.

c. Adjust the High-Frequency signal generator output amplitude for a five-division display of a 3 megahertz reference signal.

d. Without changing the output amplitude, increase the output frequency of the signal generator until the display is reduced to 3.5 divisions.

e. CHECK—Output frequency of the High-Frequency signal generator must be at least 200 megahertz.

f. Move the test signal to the CH 2 input and set the VERT MODE switch to CH 2.

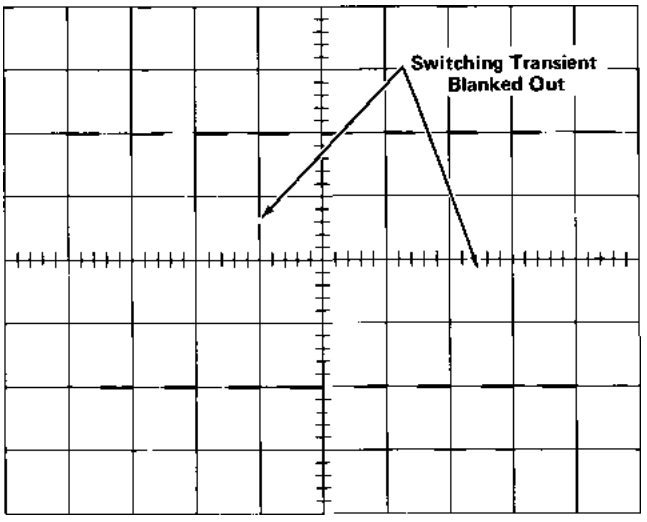


Fig. 5-1. Typical CRT display when checking chopped blanking.

g. Repeat the bandwidth check procedure, step 12-c through 12-e.

h. Disconnect the test setup.

13. Check Cascaded Bandwidth

a. Set both AC-GND-DC switches to DC, the A TIME/DIV switch to 1 ms, and the VERT MODE switch to CH 1.

b. Connect the CH 2 VERT SIGNAL OUT (on the rear panel) to the CH 1 input via a 42-inch 50 Ω BNC cable and a 50 Ω BNC termination.

c. Connect the output of the Medium-Frequency Constant-Amplitude Signal Generator (Type 191) to the CH 2 input via a GR-to-BNC adapter, 42-inch 50 Ω BNC cable, X10 BNC attenuator, and a 50 Ω BNC termination.

d. Adjust the Medium-Frequency signal generator for a five-division display of a 50 kilohertz signal.

e. Without changing the output amplitude of the signal generator, increase the output frequency until the display is reduced to 3.5 divisions.

f. CHECK—Output frequency of the Medium-Frequency signal generator must be at least 50 megahertz.

g. Disconnect the test setup.

TRIGGER SYSTEM CHECK

Equipment Required

1. Standard Amplitude Calibrator (067-0502-01).
2. Medium-Frequency Constant-Amplitude Signal Generator (Type 191).
3. 50 Ω Signal Pickoff Unit (Type CT-3).
4. 50 Ω 5 nanosecond GR Cable.
5. GR-to-BNC female Adapter.
6. 42-inch 50 Ω BNC Cable.
7. 18-inch 50 Ω BNC Cable.
8. X10 BNC Attenuator.
9. X2 BNC Attenuator.
10. 50 Ω BNC Termination (two).
11. Dual Input Coupler (two).

Control Settings

Preset instrument controls to the settings given under Preliminary Control Settings except as follows:

both TIME/DIV	0.05 μs

14. Check A Triggering

a. Connect the output of the Medium-Frequency Constant-Amplitude Signal Generator (Type 191) to the A External Trigger input via a 50 Ω 5 ns GR cable, 50 Ω Signal Pickoff Unit (Type CT-3) thru output, GR-to-BNC adapter, X10 BNC attenuator, X2 BNC attenuator, 50 Ω BNC termination, and a dual input coupler.

b. Connect the 10% BNC output connector of the 50 Ω Signal Pickoff Unit to the CH 1 and CH 2 inputs via an 18-inch 50 Ω BNC cable, a 50 Ω BNC termination, and a dual input coupler.

c. Adjust the Medium-Frequency signal generator to maintain a 0.3-division display of a 50 kilohertz signal.

d. Rotate the A SLOPE switch between + and —.

e. CHECK—A stable display can be obtained on both slopes of the displayed waveform in all positions of the A COUPLING switch by adjusting the A LEVEL control.

f. Set the A SOURCE switch to CH 1.

g. CHECK—Repeat steps 14-d and 14-e.

h. Set the VERT MODE switch to CH 2 and the A SOURCE switch to CH 2.

i. CHECK–Repeat steps 14-d and 14-e.

j. Set the A SOURCE switch to EXT and the CH 2 VOLTS/DIV switch to 20 mV.

k. Adjust the Medium-Frequency signal generator for a five-division display of a 50 kilohertz signal.

l. CHECK–That a stable display can be obtained, by adjusting the A LEVEL control, in both slopes of the displayed waveform in the AC and DC positions of the A COUPLING switch.

m. Remove the X2 BNC attenuator from the External Trigger signal test setup.

n. CHECK–That a stable display can be obtained, by adjusting the A LEVEL control, in both slopes of the displayed waveform in the HF REJ and LF REJ positions of the A COUPLING switch.

o. Replace the X2 BNC attenuator and set the A SOURCE switch to EXT ÷ 10.

p. Remove the X10 BNC attenuator from the External Trigger test setup.

q. CHECK–Repeat step 14-l through 14-n.

r. Replace both the X10 and X2 BNC attenuators to the External Trigger test setup.

s. Set the A SOURCE switch to NORM.

15. Check B Triggering

a. Move the External Trigger test signal to the B External Trigger input. Set the HORIZ DISPLAY switch to B DLY'D.

b. Adjust the Medium-Frequency signal generator to maintain a 0.3-division display of a 50 kilohertz signal.

c. Rotate the B SLOPE switch between + and –.

d. CHECK–A stable display can be obtained on both slopes of the displayed waveform in all positions of the B COUPLING switch by adjusting the LEVEL controls.

e. Set the B SOURCE switch to CH 2.

f. CHECK–Repeat steps 15-c and 15-d.

g. Set the VERT MODE and B SOURCE switches to CH 1.

h. CHECK–Repeat steps 15-c and 15-d.

i. Set the B SOURCE switch to EXT and the CH 1 VOLTS/DIV to 20 mV.

j. Adjust the Medium-Frequency signal generator for a five-division display of a 50 kilohertz signal.

k. CHECK–That a stable display can be obtained, by adjusting the LEVEL controls, in both slopes of the displayed waveform in the AC and DC positions of the B COUPLING switch.

l. Remove the X2 BNC attenuator from the External Trigger test setup.

m. CHECK–That a stable display can be obtained, by adjusting the LEVEL controls, in both slopes of the displayed waveform in the HF REJ and LF REJ positions of the B COUPLING switch.

16. Check A Normal Mode Operation

a. Set the HORIZ DISPLAY switch to A, the A COUPLING switch to AC, both SOURCE switches to NORM, and the TRIG MODE switch to AUTO.

b. Adjust the Medium-Frequency signal generator for a 50 kilohertz signal.

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

d. Switch the TRIG MODE switch to NORM.

e. CHECK–CRT for a stable display.

f. Remove the test signal from the CH 1 input.

g. CHECK—For no display in the absence of an adequate trigger signal.

17. Check Single Sweep Operation

a. Set the A COUPLING switch to AC and the TRIG MODE switch to AUTO.

b. Reconnect the test signal from the Medium-Frequency signal generator to the CH 1 input.

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

d. Remove the test signal from the CH 1 input.

e. Press the SINGL SWP button.

f. CHECK—READY light comes on when SINGL SWP button is pressed and remains on until the test signal is re-applied.

g. Reconnect the test signal to the CH 1 input.

h. CHECK—READY light is extinguished.

i. Press the SINGL SWP button.

j. CHECK—That a single-sweep display (one sweep only) is presented.

k. Disconnect the test setup.

18. Check Trigger View Operation

a. Set the CH 1 AC-GND-DC switch to DC, the CH 1 VOLTS/DIV switch to 10 mV, the VERT MODE switch to CH 1, the A COUPLING switch to DC, the A SOURCE switch to EXT, the A SLOPE switch to +, the A LEVEL control to 0, and the TRIG MODE switch to AUTO.

b. Connect the output of the Standard Amplitude Calibrator to the A External Trigger input via a 42-inch 50 Ω BNC cable.

c. Adjust the Standard Amplitude Calibrator for a 200 mV square-wave output.

d. Push the TRIG VIEW button and hold it in.

e. CHECK—For 3.2 to 4.8 divisions of display.

f. Release the TRIG VIEW button.

g. Disconnect the test setup.

HORIZONTAL SYSTEM CHECK

Equipment Required	
1. Standard Amplitude Calibrator (067-0502-01).	4. 42-inch 50 Ω BNC cable.
2. Medium-Frequency Constant-Amplitude Signal Generator (Type 191).	5. 50 Ω BNC Termination.
3. Time-Mark Generator (Type 2901).	6. Dual Input Coupler.

Control Settings

Preset instrument controls to the settings given under Preliminary Control Settings except as follows:

A TIME/DIV	2 ms
B TIME/DIV	5 μs
B SOURCE	STARTS AFTER DELAY

19. Check Variable Time/Division Range

a. Connect 5 ms time marks to the CH 1 input from the Time-Mark Generator (Type 2901) via a 42-inch 50 Ω BNC cable and a 50 Ω BNC termination.

b. CHECK—At least 1 time marker/division can be obtained by adjusting the VAR TIME/DIV control.

c. CHECK–That the UNCAL light comes on when the VAR TIME/DIV control is out of the detent position.

d. Return the VAR TIME/DIV control to the detent position.

20. Check Timing Accuracy

a. CHECK–Using the A TIME/DIV switch and the Time-Mark Generator settings given in Table 5-3, check that A SWEEP timing is within the given tolerance over entire 10 divisions.

TABLE 5-3

A and B Timing Accuracy

A TIME/DIV Switch Setting	Time-Mark Generator Output	CRT Display (markers/divisions)	Accuracy	
			+20°C to +20°C	−15°C to +55°C
0.01 μs	10 ns	1	1%	3%
0.02 μs	10 ns	2	1%	3%
0.05 μs	50 ns	1	1%	3%
0.1 μs	0.1 μs	1	1%	3%
0.2 μs	0.1 μs	2	1%	3%
0.5 μs	0.5 μs	1	1%	3%
1 μs	1 μs	1	1%	3%
2 μs	1 μs	2	1%	3%
5 μs	5 μs	1	1%	3%
10 μs	10 μs	1	1%	3%
20 μs	10 μs	2	1%	3%
50 μs	50 μs	1	1%	3%
0.1 ms	0.1 ms	1	1%	3%
0.2 ms	0.1 ms	2	1%	3%
0.5 ms	0.5 ms	1	1%	3%
1 ms	1 ms	1	1%	3%
2 ms	1 ms	2	1%	3%
5 ms	5 ms	1	1%	3%
10 ms	10 ms	1	2%	3%
20 ms	10 ms	2	2%	3%
50 ms	50 ms	1	2%	3%
0.1 s	0.1 s	1	2%	3%
0.2 s	0.1 s	2	2%	3%
0.5 s	0.5 s	1	2%	3%

21. Check Delay Time Accuracy

a. Set the B SOURCE switch to STARTS AFTER DELAY, the A TIME/DIV switch to 0.05 μs, the B TIME/DIV switch to 0.01 μs, and the HORIZ DISPLAY switch to B DLY'D.

b. CHECK–Using the A TIME/DIV switch, the B TIME/DIV switch and the Time-Mark Generator settings given in Table 5-4, check that delayed sweep accuracy is within the given tolerance. First set the DELAY TIME POSITION dial to 1.00 and rotate the dial until the sweep starts at the top of the second time marker. Note the control setting and then set the dial to 2.00 and rotate it slightly until the sweep starts at the top of the third time marker. The error for intervals less than 1 dial division cannot exceed 0.01 dial division. Continue to rotate the DELAY TIME POSITION dial to check between the 1.00 and 9.00 settings for all A sweep speeds from 0.05 μs to 0.5 s. The difference between any two time markers greater than 1 dial division apart cannot exceed 1%.

NOTE

Sweep will start at the top of the third time marker at 1.00 and at the top of the nineteenth time marker at 9.00 for sweep rates that are multiples of 2 (e.g., 2 μs, 20 μs, 0.2 ms, etc.). If in doubt as to the correct setting of the DELAY TIME POSITION dial, set the HORIZ DISPLAY switch to A INTEN and check which time marker is intensified.

TABLE 5-4

Delayed Sweep Accuracy

A TIME/DIV Switch Setting	B TIME/DIV Switch Setting	Time-Mark Generator Output
0.05 μs	0.01 μs	0.05 μs
0.1 μs	0.01 μs	0.1 μs
0.2 μs	0.05 μs	0.1 μs
0.5 μs	0.05 μs	0.5 μs
1 μs	0.1 μs	1 μs
2 μs	0.1 μs	1 μs
5 μs	0.1 μs	5 μs
10 μs	1 μs	10 μs
20 μs	1 μs	10 μs
50 μs	1 μs	50 μs
0.1 ms	10 μs	0.1 ms
0.2 ms	10 μs	0.1 ms
0.5 ms	10 μs	0.5 ms
1 ms	0.1 ms	1 ms
2 ms	0.1 ms	1 ms
5 ms	0.1 ms	5 ms
10 ms	1 ms	10 ms
20 ms	1 ms	10 ms
50 ms	1 ms	50 ms
0.1 s	10 ms	0.1 s
0.2 s	10 ms	0.1 s
0.5 s	10 ms	0.5 s

22. Check Delay Time Jitter

a. Set the DELAY TIME POSITION dial to 1.00, the HORIZ DISPLAY switch to B DLY'D, the A TIME/DIV switch to 1 ms, and the B TIME/DIV switch to 0.2 μs.

b. Position the time marker near the center of the display area with the DELAY TIME POSITION dial.

c. CHECK—Jitter on the leading edge of the time marker does not exceed 1 division.

d. Turn the DELAY TIME POSITION dial to 9.00 and adjust it so that the time marker is displayed near the center of the display area.

e. CHECK—Jitter on the leading edge of the time marker does not exceed 1 division.

23. Check Mixed Sweep Timing Accuracy

a. Set the A TIME/DIV switch to 1 ms, the B TIME/DIV switch to 0.5 ms, the HORIZ DISPLAY switch to A, the B SOURCE switch to STARTS AFTER DELAY, and the DELAY TIME POSITION dial fully clockwise.

b. Select 1 ms time marks from the Time-Mark Generator.

c. CHECK—Timing between the second and tenth time markers.

d. Set the HORIZ DISPLAY switch to MIX.

e. CHECK—The timing between second and tenth time markers is within ±0.3 division.

f. Disconnect the test setup.

NOTE

Exclude first 0.5 division of sweep after display start and first 0.2 division, or 0.1 μs (whichever is greater) after the transition of A to B.

24. Check X Gain

a. Set the A TIME/DIV switch to X-Y, the VERT MODE switch to CH 2, both VOLTS/DIV switches to 5 mV, and the CH 1 AC-GND-DC switch to DC.

b. Apply a 20 mV square wave from the Standard Amplitude Calibrator to the CH 1 or X input through a 42-inch 50 Ω BNC cable.

c. CHECK—CRT display for 4 divisions of deflection between the two displayed dots.

d. Disconnect the test setup.

25. Check X-Y Phasing and Bandwidth

a. Set both VOLTS/DIV switches to 5 mV and both AC-GND-DC switches to AC.

b. Connect the output of the Medium-Frequency Constant-Amplitude Signal Generator (Type 191) to the CH 1 and CH 2 inputs through a 42-inch 50 Ω BNC cable, 50 Ω BNC termination, and a dual input coupler.

c. Adjust the Medium-Frequency signal generator for an eight-division horizontal display of 50 kilohertz signal.

d. Center the display vertically and horizontally with the CH 1 and CH 2 POSITION controls.

e. CHECK—CRT display for an opening at the center horizontal line of 0.14 division or less.

f. Increase the output frequency of the Medium-Frequency signal generator to 2 megahertz.

g. CHECK—CRT display for an opening at the center horizontal line of 0.42 division or less.

h. Remove the dual input coupler from the test setup.

i. Reconnect the test signal to the CH 1 input.

j. Adjust the signal generator for a four-division horizontal display of 50 kilohertz signal.

k. Increase the output frequency of the signal generator until the display is reduced to 2.8 divisions.

l. CHECK—Output frequency of the signal generator is at least 3 megahertz.

m. Disconnect the test setup.

PART II—SHORT-FORM CALIBRATION

Introduction

The following procedure is intended to be used as guidelines for calibration of the 475 by experienced technicians familiar with the instrument. Only essential information is given. Test Equipment Required is the same as that given for Part III—Calibration.

Preliminary Procedure for Short-Form Calibration

NOTE

This instrument should be adjusted at an ambient temperature of +25°C (±5°C) for best overall accuracy.

1. Remove the dust cover from the 475.

2. Connect the 475 to the autotransformer and set the line voltage to 115 VAC.

3. Set the controls as given under Preliminary Control Settings (given prior to Part I—Performance Check). Allow at least 20 minutes warmup before proceeding.

NOTE

Titles for external controls of this instrument are capitalized in this procedure (e.g., INTENSITY). Internal adjustments are initial capitalized only (e.g., Grid Bias).

POWER SUPPLIES and DISPLAY CALIBRATION

1. Low Voltage Power Supplies

a. ADJUST— +50 V supply, R1430, ±0.5%.

b. Check— +110 V supply, ±3%.

c. Check— +15 V supply, ±1.5%.

d. Check— +5 V supply, ±1.5%.

e. Check— −15 V supply, ±1.5%.

f. Check— −8 V supply, ±1.5%.

g. Check ripple on supplies (except +110 V supply) is 2 mV P-P maximum; +110 V supply ripple is 1 V P-P maximum.

h. Check regulation between 126.5 V and 103.5 V line.

i. Check LOW LINE indicator comes on below 103 VAC.

2. High Voltage Power Supply

−2450 volts, ±49 volts.

3. Adjust CRT Grid Bias

a. TRIG MODE to NORM.

b. Connect DC Voltmeter to TP1364 and adjust INTENSITY for a reading of +15 volts.

c. ADJUST—CRT Grid Bias, R1375, for dimmest dot.

4. Check Display Controls

a. ASTIG

b. SCALE ILLUM

c. FOCUS

d. INTENSITY

5. Adjust Trace Alignment

a. Connect time markers to CH 1 input.

b. ADJUST—TRACE ROTATION to align trace with center horizontal line.

c. ADJUST—Y Axis Alignment, R1385, to align center time marker with the center vertical line.

d. Check for no more than 0.1 division curvature.

e. ADJUST—Geometry, R1390, for no more than 0.1 division curvature of the time markers.

f. Remove the time markers and check the trace at top and bottom graticule lines: no more than 0.1 division bowing or tilt.

6. Z-Axis Compensation

a. Connect X10 probe from Test Oscilloscope to TP1366.

b. A TIME/DIV to 0.05 μs.

c. Connect A +GATE to External Trigger input of Test Oscilloscope.

d. ADJUST—C1353 for optimum square corner on positive step, 1 volt display of signal.

VERTICAL SYSTEM CALIBRATION

7. Adjust Vertical Output Bias

a. Connect a 200 MHz sine wave to CH 1 from the High-Frequency Constant-Amplitude Signal Generator (067-0532-01).

b. ADJUST—Output Bias, R488, for maximum signal deflection.

8. Adjust Vertical Shield Volts

a. Vertically center the trace.

b. Using DC Voltmeter, measure voltage at each CRT vertical deflection plate. Add together and divide by two.

c. Connect DC Voltmeter between TP1395 and ground.

d. ADJUST—Vertical Shield Volts, R1395, for a reading equal to that calculated in step 8-b.

9. Adjust Delay-Line Driver Centering

a. Using DC Voltmeter, monitor the sides of the delay line until readings are equal while adjusting the CH 1 POSITION.

b. ADJUST—Delay-Line Driver Centering, R385 for reading of 0 volts on both sides of the delay line.

10. Check BEAM FIND Operation

11. Adjust CH 1 Switch Balance

a. Vertically center the trace.

b. ADJUST—CH 1 Var Bal, R110, for no more than 2 divisions trace shift when rotating the CH 1 VAR control through its range.

c. ADJUST—CH 1 Gain Switch Bal, R135, for minimum trace shift when switching between 2 mV and 5 mV.

d. Check CH 1 UNCAL light.

12. Check Probe Indicator Lights

a. Connect X10 probe to CH 1 input.

b. Check that the left light goes out and the right comes on.

c. Repeat for CH 2.

13. Check CH 1 and 2 AC-GND-DC Switches

14. Adjust CH 2 Switch Balance

a. Vertically center the trace.

b. ADJUST—CH 2 Var Bal, R210, for no more than 2 divisions trace shift when rotating the CH 2 VAR control through its range.

c. ADJUST—CH 2 Gain Switch Bal, R235, for minimum trace shift when switching between 2 mV and 5 mV.

d. Check CH 2 UNCAL light.

15. Adjust CH 1 and 2 Position Centering

a. Both VOLTS/DIV to 20 mV,

both AC-GND-DC to AC.

b. Connect a 50 mV signal from the Standard Amplitude Calibrator to the CH 1 input.

c. ADJUST—CH 1 Position Centering, R176, so the top and bottom of the display can be positioned past the center horizontal line.

d. Repeat the above for CH 2 — adjust R276.

16. Adjust CH 2 Invert Balance (R215) and Check Operation

17. Adjust CH 1 Gain

a. CH 1 VOLTS/DIV to 5 mV.

b. Connect 20 mV signal from Standard Amplitude Calibrator to CH 1 input.

c. ADJUST—CH 1 5 mV Gain, R165, for 200 mV push-pull signal between preamp sides of the delay line.

d. CH 1 VOLTS/DIV to 2 mV.

e. ADJUST—CH 1 2 mV Gain, R125, for 100 mV push-pull signal between preamp sides of the delay line.

f. ADJUST—R449 for 5 divisions of deflection.

g. Check all attenuator ranges for proper deflection, within 3%.

h. Check Variable Range: CH 1 VAR control must reduce a 5 division signal to less than 2 divisions.

18. Adjust CH 2 Gain

a. CH 2 VOLTS/DIV to 5 mV.

b. Connect 20 mV signal from Standard Amplitude Calibrator to CH 2 input.

c. ADJUST—CH 2 5 mV Gain, R265, for 4 divisions deflection, within 3%.

d. CH 2 VOLTS/DIV to 2 mV; test signal to 10 mV.

e. ADJUST—CH 2 2 mV Gain, R225, for 5 divisions deflection, within 3%.

f. Check all attenuator ranges for proper deflection, within 3%.

g. Check Variable Range: CH 2 VAR control must reduce a 5 division signal to less than 2 divisions.

19. Check ADD Operation

a. Both VOLTS/DIV to 5 mV,

both AC-GND-DC to DC.

b. Connect a 10 mV signal from the Standard Amplitude Calibrator to both CH inputs.

c. VERT MODE to ADD.

d. Check for 4 divisions deflection, within 3%.

20. Check Compression and Expansion

a. Position a 2 division signal to top and bottom of graticule.

b. Check for no more than 0.1 division of compression or expansion.

21. Check ALT Operation

22. Check CHOP Operation

a. TIME/DIV to 0.2 μs,

VERT MODE to CHOP.

b. Check for blanking of transients at normal INTENSITY level.

c. Check duration of each cycle is about 5 divisions.

23. Adjust Vertical Output High-Frequency Response

a. VERT MODE to CH 1.

b. Connect preamp end of delay line to Signal Insertion Unit (067-0676-00).

c. Connect +15 V and −8 V to Signal Insertion Unit.

d. Connect 5 divisions, + polarity, from Fast-Rise High-Amplitude Pulse Generator (Type 109) to Signal Insertion Unit via a GR cable, X5 GR attenuator, Signal Pickoff Unit (Type CT-3), and GR-to-BNC adapter.

e. Connect 10% output of Signal Pickoff unit to A External Trigger input via a terminated cable.

f. ADJUST—C450, R450, C466, R466, C470, and R470 for best flat-top waveform.

24. Adjust High-Frequency Compensation

a. VOLTS/DIV to 5 mV,

AC-GND-DC to DC.

b. Adjust for 5 division display of 10 kHz signal from fast-rise output of Square-Wave Generator (Type 106) to CH 1 input.

c. ADJUST—R139 and R475 for no more than 4% aberrations.

d. Adjust Square-Wave Generator for 5 divisions of 100 kHz signal.

e. ADJUST—C471 and C477 for no more than 4% aberrations.

f. Move the test signal to CH 2,

VOLTS/DIV to 5 mV,

AC-GND-DC to DC.

g. Adjust Square-Wave Generator for 5 divisions of 10 kHz signal.

h. ADJUST—R239, R475, C471, and C477 for no more than 4% aberrations.

i. Disconnect Square-Wave Generator.

j. Connect output of Fast-Rise High-Amplitude Pulse Generator (Type 109) to the CH 1 input.

k. Adjust for 5 divisions of deflection.

l. ADJUST—C175, R175, C133, R133, C112, and R112 for no more than 4% aberrations.

m. Move test signal to CH 2.

n. ADJUST—C275, R275, C233, R233, C212, and R212 for no more than 4% aberrations.

25. Adjust VOLTS/DIV Compensation

a. Adjust CH 1 VOLTS/DIV compensation for no more than 2% aberrations. Use a 20 pF normalizer and a 5 division signal.

5 mV	C10 or C50
2 mV	Check
10 mV	C36, C37
20 mV	C34, C35
50 mV	C32, C33
0.1 V	Check
0.2 V	Check
0.5 V	C30, C31

b. Repeat for CH 2.

26. Check Vertical Amplifier Bandwidth

a. Use High-Frequency Constant-Amplitude Signal Generator (067-0532-01): 5 division display of 3 MHz reference signal.

b. At 5 mV setting of both VOLTS/DIV switches, check frequency is at least 200 MHz when display is reduced to 3.5 divisions.

27. Check Cascaded Bandwidth

a. CH 2 VERT SIGNAL OUT to CH 1 input through a terminated cable.

b. Check bandwidth is at least 50 MHz.

28. Check Vertical Channel Isolation

At least 100:1 at 50 MHz.

29. Check Bandwidth Limit Operation

a. Connect a 6 division display of a 50 kHz signal to the CH 1 input.

b. Check frequency is 20 MHz, within 5 MHz, when display is reduced to 4.2 divisions.

TRIGGER SYSTEM CALIBRATION

30. Adjust A and B Trigger Sensitivity

a. VOLTS/DIV to 0.1 V,

A SOURCE to EXT,

A COUPLING to AC.

b. Connect the Medium-Frequency Constant-Amplitude Signal Generator (Type 191) to the A and B External Trigger inputs via a 50 Ω 5 ns GR cable, 50 Ω Signal Pickoff Unit, GR-to-BNC adapter, X10 attenuator, 50 Ω termination, and a dual input coupler.

c. Connect the 10% BNC output of the Signal Pickoff Unit to both channel inputs via a terminated dual input coupler.

d. ADJUST–A and B Sensitivity, R565, R785, to just obtain a stable display with a 0.35 division, 350 kHz signal.

31. Adjust Trigger Centering and Symmetry

a. VOLTS/DIV to 50 mV,

SOURCE to NORM,

TIME/DIV to 10 μs.

b. Position a 2 division display of 350 kHz signal to the center horizontal line.

c. ADJUST–B Trigger Symmetry, R547, so trigger point is the same in both slopes.

d. ADJUST–B Trigger Center, R543, for a triggering point at graticule center.

e. ADJUST–A Trigger Symmetry, R767, so triggering point is the same in both slopes.

f. ADJUST–A Trigger Center, R754, for triggering point at graticule center.

32. Adjust A Trigger DC Balance

a. A COUPLING to DC,

A SOURCE to NORM,

A LEVEL to 0.

b. Use a 0.3 division display.

c. ADJUST–Normal Trigger DC Balance, R425, to obtain a stable display in both slopes.

d. Change A SOURCE to CH 1.

e. ADJUST–CH 1 Trigger DC Balance, R403, to obtain a stable display in both slopes.

f. VERT MODE to CH 2,

A SOURCE to CH 2.

g. Check for stable display in both slopes.

33. Check B Trigger DC Balance

a. B COUPLING to DC,

B SOURCE to NORM,

B LEVEL to 0,

VERT MODE to CH 1.

b. Use a 0.3 division display.

c. Check for stable display in both slopes.

d. Set B SOURCE to CH 1 and repeat part c.

e. Set B SOURCE to CH 2, VERT MODE to CH 2, and repeat part c.

34. Check Triggering

a. High-frequency triggering:

Internal	40 MH	200 MHz
AC	0.3 div	1.5 div
LF REJ	0.3 div	1.5 div
DC	0.3 div	1.5 div
External		
AC	50 mV	250 mV
LF REJ	100 mV	500 mV
DC	50 mV	250 mV

Multiply by 10 for EXT ÷ 10 sensitivity.

b. HF REJ—Triggers on 0.3 division at 50 kHz; does not trigger at 1 MHz.

c. LF REJ—Triggers on 0.3 division at 50 kHz; does not trigger on 60 Hz.

d. Check SINGL SWP operation and READY light.

e. Check A NORM triggering.

f. Check LINE triggering.

g. Check AUTO recovery time.

35. Check External LEVEL Range

a. EXT: at least ±2 V (4 V P-P) for both A and B.

b. EXT ÷ 10: at least ±20 V (40 V P-P) for A only.

36. Adjust TRIG VIEW

a. ADJUST—Trigger View Centering, R673, so trace is at center horizontal line, within 1 division.

b. Connect 200 mV square-wave signal from Standard Amplitude Calibrator to A External Trigger input.

c. Check for 3.2 to 4.8 divisions of display with TRIG VIEW in.

HORIZONTAL SYSTEM CALIBRATION

37. Adjust Delay Start and Delay Stop

a. A TIME/DIV to 1 ms,

B TIME/DIV to 5 μs,

HORIZ DISPLAY to A INTEN,

B SOURCE to STARTS AFTER DELAY,

DELAY TIME POSITION to 1.00.

b. Use 1 ms time markers.

c. ADJUST—Delay Start, R938, to intensify the left side of the 2nd time marker.

d. DELAY TIME POSITION to 9.00.

e. ADJUST—Delay Stop, R936, to intensify the left side of the 10th time marker.

f. HORIZ DISPLAY to B DLY'D.

g. DELAY TIME POSITION to 1.00.

h. ADJUST—Delay Start, R938, so the 2nd time marker starts at the beginning of the sweep.

i. DELAY TIME POSITION to 9.00.

j. ADJUST—Delay Stop, R936, so the 10th time marker starts at the beginning of the sweep.

38. Check Differential Time Accuracy

a. Accuracy within 0.01 division from +15°C to +35°C.

b. Accuracy within 0.02 division from −15°C to +55°C.

39. Adjust Horizontal Gain

a. HORIZ DISPLAY to A,

both TIME/DIV to 1 ms.

b. Use 1 ms time markers.

c. ADJUST–Horizontal Gain, R1155, for 1 time marker/division, within 1%, from +20°C to +30°C; for 1 time marker/division, within 3%, from –15°C to +55°C.

d. Use 0.1 ms time markers.

e. Push X10 MAG in.

f. Check that the X10 MAG light is on.

g. Check for 1 time marker/division, within 2%, from +20°C to +30°C; for 1 time marker/division, within 4%, from –15°C to +55°C.

40. Adjust Magnifier Registration

a. Use 5 ms time markers.

b. ADJUST–Magnifier Registration, R1130, to position the second time marker to the center vertical line, within 0.4 division, between positions of X10 MAG switch.

41. Check VAR TIME/DIV Range

a. A TIME/DIV to 2 ms.

b. Use 5 ms time markers.

c. Check for 1 time marker/division by rotating the VAR TIME/DIV control.

d. Check UNCAL light.

42. Check Horizontal POSITION Control Range

43. Adjust 10 μs Timing

a. Both TIME/DIV to 10 μs.

b. Use 10 μs time markers.

c. ADJUST–C1064 for 1 time marker/division, within 1%, from +20°C to +30°C; 1 time marker/division, within 3%, from –15°C to +55°C.

d. HORIZ DISPLAY to A INTEN,

B TIME/DIV to 0.01 μs.

e. ADJUST–C1023 for 1 time marker/division, within 1%, from +20°C to +30°C; 1 time marker/division, within 3%, from –15°C to +55°C.

44. Adjust 0.1 μs Timing

a. DELAY TIME POSITION to 1.00,

HORIZ DISPLAY to A INTEN,

B TIME/DIV to 0.1 μs.

b. Use 0.1 μs time markers.

c. ADJUST–C1025 for 1 time marker/division, within 2%, from +20°C to +30°C; 1 time marker/division, within 3%, from –15°C to +55°C.

d. HORIZ DISPLAY to A,

both TIME/DIV to 0.1 μs.

e. ADJUST–C1009 for 1 time marker/division, within 1%, from +20°C to +30°C; 1 time marker/division, within 3%, from –15°C to +55°C.

45. Adjust Horizontal Output Centering

a. A TIME/DIV to X-Y,

HORIZ DISPLAY to A.

b. Horizontally center the dot.

c. Adjust the CH 1 POSITION until the voltage on the collector of Q1214 equals that on the collector of Q1204.

d. ADJUST–Horizontal Output Center, R1256, for +50 V on the collectors of Q1214 and Q1204.

46. Adjust High Speed Timing–Visual Method

a. A TIME/DIV to 0.05 μs,

X10 MAG pushed in,

A SOURCE to EXT,

A COUPLING to LF REJ.

b. Use 5 nanosecond time markers and 0.1 μs triggers.

c. ADJUST–C1233 and C1253 for 1 cycle/division, within 2%, from +20°C to +30°C; 1 cycle/division, within 4%, from –15°C to +55°C.

d. A TIME/DIV to 0.02 μs.

e. Use 2 nanosecond time markers.

f. ADJUST–C1179 for 1 cycle/division, within 2%, from +20°C to +30°C; 1 cycle/division, within 4%, from –15°C to +55°C.

g. A TIME/DIV to 0.01 μs.

h. ADJUST–R1075 for 1 cycle/2 divisions, within 2%, from +20°C to +30°C; 1 cycle/2 divisions, within 4%, from –15°C to +55°C.

NOTE

If timing cannot be adjusted within 2% from +20°C to +30°C, or 4% from –15°C to +55°C, proceed to step 47. If timing is within given tolerance, proceed to step 48.

47. Adjust High Speed Timing–Current Probe Method

a. A TIME/DIV to 0.05 μs,

X10 MAG pushed in.

b. Use 5 nanosecond time markers and 0.1 μs triggers.

c. Hook the P6022 current probe, with passive termination, around the crossed horizontal deflection leads on the 475. Connect the P6022 to the test oscilloscope.

d. Set Test Oscilloscope: VOLTS/DIV to 5 mV, TIME/DIV to 0.5 μs, X10 MAG engaged.

e. ADJUST–R1175 to midrange, R1185 to midrange, C1233 and C1253 half-closed, and C1179 one turn from fully clockwise.

f. ADJUST–R1175 and R1185 for symmetrical waveform.

g. ADJUST–C1233 and C1253 for 1 time marker/division.

h. A TIME/DIV to 0.02 μs.

i. Use 2 nanosecond time markers.

j. Set Test Oscilloscope: VOLTS/DIV to 10 mV, TIME/DIV to 0.2 μs.

k. ADJUST–C1179 for 1 time marker/division.

l. A TIME/DIV to 0.01 μs.

m. Set Test Oscilloscope: VOLTS/DIV to 20 mV, TIME/DIV to 0.1 μs.

n. ADJUST–R1075 for 1 time marker/2 divisions.

o. ADJUST–R1175 and R1185 for flat-top symmetrical waveform.

48. Check A and B Timing Accuracy

a. From 0.01 μs to 5 ms, at +20°C to +30°C, accuracy is 1%.

b. From 10 ms to 0.5 s, at +20°C to +30°C, accuracy is 2%.

c. From –15°C to +55°C, accuracy of all sweep settings is 3%.

49. Check A INTEN Timing Accuracy

a. From +20°C to +30°C, from 0.05 μs to 0.5 s, accuracy is within 2%.

b. From –15°C to +55°C, from 0.05 μs to 0.5 s, accuracy is within 3%.

50. Check A and B Magnified Timing Accuracy

a. From +20°C to +30°C, from 0.01 μs to 5 ms, accuracy is within 2%.

b. From +20°C to +30°C, from 10 ms to 50 ms, accuracy is within 3%.

c. From –15°C to +55°C, from 0.01 μs to 50 ms, accuracy is within 4%.

d. Exclude the following portions of the sweep, from 0.01 μs to 1 μs:

First 25 nanoseconds and all beyond the 100th magnified division.

51. Check Delay Time Accuracy

a. Error for intervals less then 1 dial division cannot exceed 0.01 dial division.

b. Error between any two time markers greater than 1 dial division apart cannot exceed 1%.

52. Check Delay Time Jitter

a. HORIZ DISPLAY to B DLY'D,

A TIME/DIV to 1 ms,

B TIME/DIV to 0.2 μs.

b. Check for no more than 1 division jitter.

53. Check MIX Sweep Accuracy

a. Use 1 ms time markers.

b. Check for proper timing within 0.24 division.

NOTE

Exclude first 0.5 division of sweep after display start and first 0.2 division, or 0.1 μs (whichever is greater) after the transition of A to B.

54. Adjust X Gain

a. A TIME/DIV to X-Y,

both VOLTS/DIV to 5 mV,

VERT MODE to CH 2.

b. Apply 20 mV square wave from Standard Amplitude Calibrator to CH 1 or X input.

c. ADJUST–X Gain, R1102, for 4 divisions of deflection between the dots, within 3%.

55. Check X-Y Phasing and Bandwidth

a. Connect an 8 division display of 50 kHz signal from Medium-Frequency Constant-Amplitude Signal Generator to the CH 1 and 2 inputs.

b. Check X-Y phase shift is no more than 0.14 division.

c. Increase output frequency of signal generator to 2 MHz.

d. Check X-Y phase shift is no more than 0.42 division.

e. ADJUST–L1103 for minimum phase shift.

f. Check bandwidth is at least 3 MHz.

56. Check B ENDS A Operation

57. Check A TRIG HOLDOFF

Should increase holdoff to nine times the TIME/DIV setting.

CALIBRATOR, + GATES, AND EXT Z-AXIS CALIBRATION

58. Adjust CALIBRATOR Amplitude

a. Short emitter to base of Q1504.

b. Check for +0.3 V DC, within 3 mV, from CALIBRATOR current loop to ground.

c. ADJUST–R1515 for +0.3 V DC, within 1% from 0°C to +40°C; for +0.3 V DC, within 1.5% from –15°C to +55°C.

d. Remove the short from emitter to base of Q1504.

59. Check A and B +GATES

a. A + GATE: +5.5 V P-P, within 0.5 V.

b. B + GATE: +5.5 V P-P, within 0.5 V.

60. Check EXT Z-AXIS Operation

a. Connect 5 V 50 kHz signal to CH 1 input and EXT Z-AXIS input.

b. Check for noticeable intensity modulation of the positive peaks.

PART III—CALIBRATION

Introduction

The following procedure returns the 475 to correct calibration. All limits and tolerances given in this procedure are calibration guides and should not be interpreted as instrument specifications except as specified in the Specifications section of this manual. Where possible, instrument performance is checked before an adjustment is made. For best overall instrument performance when performing a complete calibration procedure, make each adjustment to the exact setting even if the CHECK— is within the allowable tolerance.

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2. Check High Voltage Power Supply — Page 5-26

DISPLAY and Z-AXIS CALIBRATION

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52. Check B 60 Hertz and LF REJ Triggering Page 5-46

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Preliminary Procedure for Calibration

NOTE

This instrument should be adjusted at an ambient temperature of +25°C (±5°C) for best overall accuracy.

1. Remove the dust cover from the 475 as outlined in the Disassembly Instructions in the Maintenance section of the manual.

2. Connect the autotransformer to a suitable power source.

3. Connect the 475 to the autotransformer output.

4. Set the autotransformer output voltage to the center of the voltage range selected by the Line Voltage Selector.

5. Set the controls as given under Preliminary Control Settings (given prior to Part I—Performance Check). Allow at least 20 minutes warmup before proceeding.

NOTE

Titles for external controls of this instrument are capitalized in this procedure (e.g., INTENSITY). Internal adjustments are initial capitalized only (e.g., CRT Grid Bias).

POWER SUPPLY CALIBRATION

Equipment Required	
1. Precision DC Voltmeter	4. Three-inch Screwdriver
2. DC Voltmeter	
3. Test Oscilloscope	5. Variable Auto-Transformer

Control Settings

Preset instrument controls to the settings given under Preliminary Control Settings.

1. Check Power Supply DC Levels and Ripple

a. Connect the Precision DC Voltmeter between test point +50 V and GND (negative meter lead to ground) on the main interface board. See Fig. 5-2.

b. CHECK—Meter for a reading of +50 volts, within 0.5% or ±250 mV.

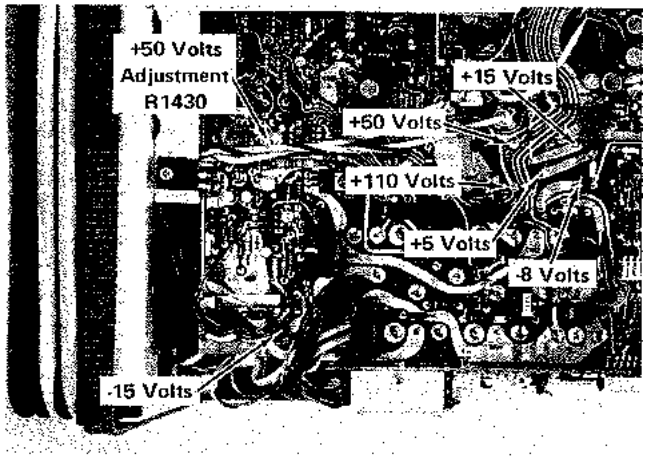


Fig. 5-2. Low voltage power supply test points and +50 V adjustment.

c. ADJUST—+50 volt supply adjustment, R1430, (see Fig. 5-2) for a meter reading of +50 volts, within 0.1% or 50 mV.

d. Using the Precision DC Voltmeter, measure the low voltage power supplies given in Table 5-5. Observe proper meter polarity. See Fig. 5-2 for test point locations.

e. Using the Test Oscilloscope, check for correct ripple as given in Table 5-5, while varying the autotransformer between 103.5 VAC and 126.5 VAC.

TABLE 5-5

Power Supply Tolerance and Ripple

Power Supply	Tolerance	Typical Ripple (peak-to-peak)
+110 V	3% (3.3 V)	1 V
+50 V	0.5% (250 mV)	2 mV
+15 V	1.5% (225 mV)	2 mV
+5 V	1.5% (75 mV)	2 mV
–15 V	1.5% (225 mV)	2 mV
–8 V	1.5% (120 mV)	2 mV

f. CHECK—For LOW LINE indicator light to turn on when the autotransformer is below 103 volts.

g. Return the autotransformer for a 115 VAC output.

2. Check High Voltage Power Supply

a. Connect the DC Voltmeter between the −2450-volt test point and ground (positive meter lead to ground). See Fig. 5-3.

b. CHECK—Meter for a reading of −2450 volts, within ±49 volts.

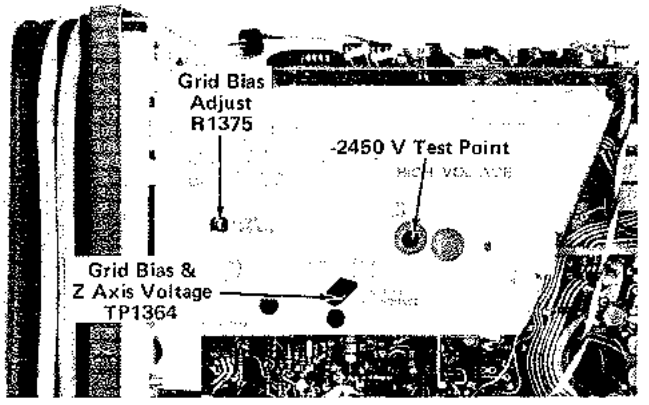


Fig. 5-3. Location of high-voltage and Grid Bias test points and adjustments.

DISPLAY and Z-AXIS CALIBRATION

Equipment Required	
1. DC Voltmeter	5. 42-inch 50 Ω BNC Cable
2. Time-Mark Generator (Type 2901)	6. 50 Ω BNC Termination
3. Test Oscilloscope	7. Three-inch Screwdriver
4. X10 Probe	8. Low-Capacitance Screwdriver

Control Settings

Preset instrument controls to the settings given under Preliminary Control Settings except as follows:

INTENSITY	Fully Counterclockwise
TRIG MODE	NORM

3. Adjust CRT Grid Bias

a. Connect the DC Voltmeter between TP1364 and ground. (Negative meter lead to ground.) See Fig. 5-3.

b. Set the INTENSITY control for a meter reading of +15 volts.

c. CHECK—CRT display for the dimmest, well-defined dot.

d. ADJUST—CRT Grid Bias adjustment, R1375 (see Fig. 5-3) for dimmest, visible dot.

e. Turn CH 1 POSITION, FOCUS, and INTENSITY controls fully clockwise.

f. CHECK—Meter reading is between +20 volts and +30 volts.

g. Push BEAM FIND pushbutton.

h. CHECK—Meter for a reading of approximately +25 volts.

i. Release BEAM FIND button and remove DC Voltmeter connections.

j. Turn FOCUS, INTENSITY, and CH 1 POSITION controls to mid-range.

k. Adjust FOCUS and INTENSITY controls for a well-defined dot of nominal intensity.

4. Check ASTIG Control

a. Rotate ASTIG control (front panel screwdriver adjustment) through its range.

b. CHECK—For dot de-focus at both extremes of the ASTIG control.

c. Reset the ASTIG control for a well-defined dot.

5. Check Display Controls

a. Rotate SCALE ILLUM control through its range.

b. CHECK—For a smooth increase in illumination.

c. Set the INTENSITY control to mid-range.

d. Rotate the FOCUS control through its range.

e. CHECK—For trace de-focus at both extremes of the FOCUS control.

f. Rotate the INTENSITY control from fully counter-clockwise to fully clockwise.

g. CHECK—For trace intensity to increase smoothly from minimum to maximum intensity.

h. Reset the INTENSITY and FOCUS controls for a well-defined trace.

6. Adjust Trace Alignment

a. Position the trace to the center horizontal graticule line.

b. CHECK—That the trace is parallel with the center horizontal line.

c. ADJUST—TRACE ROTATION adjustment (front panel adjustment) to make the trace parallel to the center horizontal line.

7. Adjust Y Axis Alignment

a. Connect 0.1 ms time marks from the Time-Mark Generator (Type 2901) to the CH 1 input via a 42-inch 50 Ω BNC cable and a 50 Ω BNC termination.

b. Set the CH 1 AC-GND-DC switch to DC and the CH 1 VOLTS/DIV switch to 0.1 V.

c. Adjust the A LEVEL control for a stable display, the ASTIG and FOCUS controls for a well-defined display.

d. Adjust the VAR TIME/DIV control for 1 time marker/division.

e. CHECK—For no more than 0.1 division of tilt of the center time marker as compared with the center vertical graticule line.

f. ADJUST—Y Axis Alignment adjustment, R1385, (see Fig. 5-4) to align the center time marker with the center vertical line.

g. INTERACTION—Between Y Axis Alignment and TRACE ROTATION adjustments. Adjust both for total optimum response.

8. Adjust Geometry

a. CHECK—CRT display for no more than 0.1 division vertical curvature of the time markers across the viewing area.

b. ADJUST—Geometry adjustment, R1390 (see Fig. 5-4) for minimum curvature of the time markers across the viewing area.

c. Remove the test signal from CH 1 input.

d. CHECK—For no more than 0.1 division of curvature of the trace when positioned from top to bottom of the graticule area.

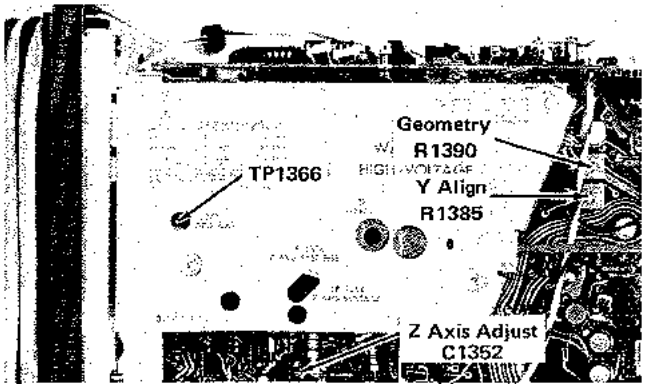


Fig. 5-4. Location of Y-Axis Align, Z-Axis, and Geometry adjustments and test point.

e. INTERACTION—Between Geometry and Y Axis Alignment adjustments. Adjust both for optimum response.

9. Adjust Z-Axis Compensation

a. Set A TIME/DIV switch to 0.05 μs.

b. Connect the X10 probe from the Test Oscilloscope to TP1366 (see Fig. 5-4).

c. Connect the A +GATE output to the External Trigger input of the Test Oscilloscope via a 42-inch 50 Ω BNC cable.

d. Adjust the Test Oscilloscope trigger controls to view the positive step of a 1 volt display of the Z-Axis signal.

e. CHECK—Test Oscilloscope display for optimum square corner on the unblanking gate.

f. ADJUST—Z-Axis Compensation adjustment, C1352, using a low capacitance screwdriver, (see Fig. 5-4) for optimum square corner on the unblanking gate.

g. Disconnect the test setup.

VERTICAL SYSTEM CALIBRATION

Equipment Required	
1. Standard Amplitude Calibrator (067-0502-01)	12. GR-to-BNC Female Adapter
2. Test Oscilloscope	13. 42-inch 50 Ω BNC Cable (two)
3. High-Frequency Constant-Amplitude Signal Generator (067-0532-01)	14. 18-inch 50 Ω BNC Cable
4. Medium-Frequency Constant-Amplitude Signal Generator (Type 191)	15. X10 BNC Attenuator
5. Fast-Rise High-Amplitude Pulse Generator (Type 109)	16. X10 GR Attenuator (two)
6. Square-Wave Generator (Type 106)	17. X5 GR Attenuator
7. Precision DC Voltmeter	18. 50 Ω BNC Termination (two)
8. X10 Probe (two)	19. GR 50 Ω Termination
9. Signal Insertion Unit (067-0676-00)	20. 20 Picofarad Normalizer
10. 50 Ω Signal Pickoff Unit (Type CT-3)	21. Dual Input Coupler
11. GR 5 Nanosecond Cable	22. Three-inch Screwdriver
	23. Low-Capacitance Screwdriver

Control Settings

Preset instrument controls to the settings given under Preliminary Control Settings except as follows:

VOLTS/DIV	0.1 V

10. Adjust Vertical Output Bias

a. Connect the High Frequency Constant-Amplitude Signal Generator (067-0532-01) output to the CH 1 input via a GR-to-BNC female adapter and a 50 Ω BNC termination.

b. Adjust the High-Frequency signal generator for a 200 MHz sine-wave output on the 0.5 V amplitude range.

c. ADJUST—Vertical Output Bias adjustment, R488 (see Fig. 5-5) for maximum deflection of the signal.

d. Disconnect the test setup.

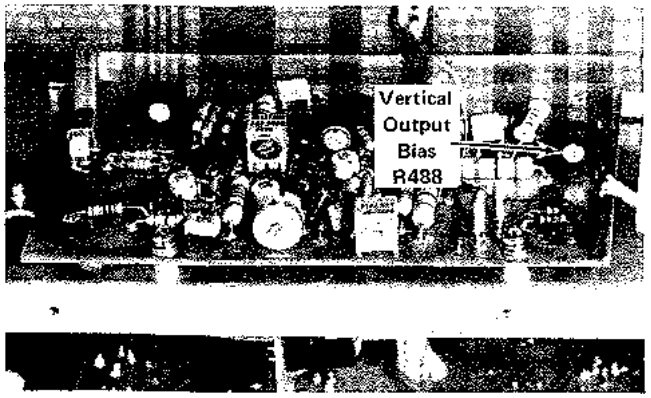


Fig. 5-5. Location of Vertical Output Bias adjustment.

11. Adjust Vertical Shield Voltage

a. Vertically position the trace to the center horizontal graticule line.

b. Using the Precision DC Voltmeter, measure the voltage on each vertical deflection plate of the CRT with respect to ground. (Negative meter lead to ground.) Note the meter reading.

c. Add both readings noted in step 11-b together and divide by two. Note the calculated voltage.

d. Connect the Precision DC Voltmeter between TP1395 and ground. (Negative meter lead to ground.)

e. CHECK–Meter reading is equal to the voltage calculated in step 11-c, within ±0.5 volt.

f. ADJUST–Vertical Shield Volts adjustment, R1395 (see Fig. 5-6), for a meter reading equal to the voltage calculated in step 11-c.

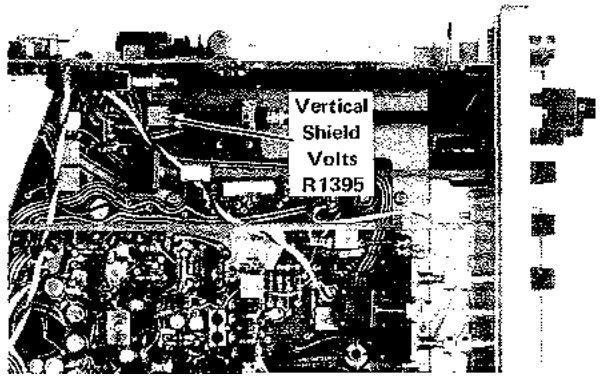


Fig. 5-6. Location of Vertical Shield Voltage adjustment.

g. Remove the Precision DC Voltmeter connections.

12. Adjust Delay-Line Driver Centering

a. Using the Precision DC Voltmeter, monitor both ends of the delay line until the readings are equal, while adjusting the CH 1 POSITION control.

b. CHECK–Precision DC Voltmeter for a reading of 0 volts.

c. ADJUST–Delay-Line Driver Centering adjustment, R385 (see Fig. 5-7), for a reading of 0 volts at both ends of the delay line.

d. Remove the Precision DC Voltmeter connections.

13. Check BEAM FIND Operation

a. Position the trace off-screen with the CH 1 POSITION and horizontal POSITION controls.

b. Push the BEAM FIND pushbutton and hold it in.

c. CHECK–That the trace is brought into the CRT viewing area.

d. Release the BEAM FIND.

14. Adjust CH 1 Variable Volts/Division Balance

a. Set the CH 1 VOLTS/DIV switch to 5 mV.

b. Position the trace to the center horizontal line.

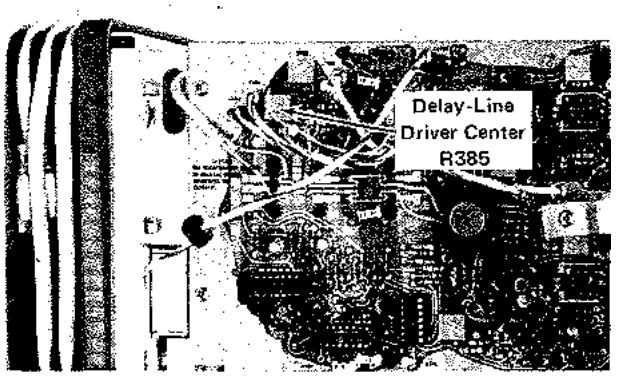


Fig. 5-7. Location of Delay-Line Driver Centering adjustment.

c. CHECK–That the CH 1 UNCAL light turns on when the VAR control is out of the detent position.

d. CHECK–CRT display for 2 divisions or less of trace shift when rotating the CH 1 VAR control through its range.

e. ADJUST–CH 1 Variable Balance adjustment, R110 (see Fig. 5-8) for minimum trace shift when rotating the CH 1 VAR control through its range.

f. Return the CH 1 VAR control to the detent position.

15. Adjust CH 1 Gain Switch Balance

a. Set the CH 1 VOLTS/DIV switch to 2 mV.

b. Position the trace to the center horizontal line.

c. CHECK–CRT display for minimum trace shift between 2 mV and 5 mV positions of the CH 1 VOLTS/DIV switch.

d. ADJUST–CH 1 Gain Switch Bal adjustment, R135 (see Fig. 5-8), for minimum trace shift between 2 mV and 5 mV positions of the CH 1 VOLTS/DIV switch.

16. Check Probe Indicator Lights

a. Set both VOLTS/DIV switches to 5 mV.

b. Connect a X10 probe to the CH 1 input.

c. CHECK–Light under 5 mV setting is extinguished and the light under 50 mV setting turns on.

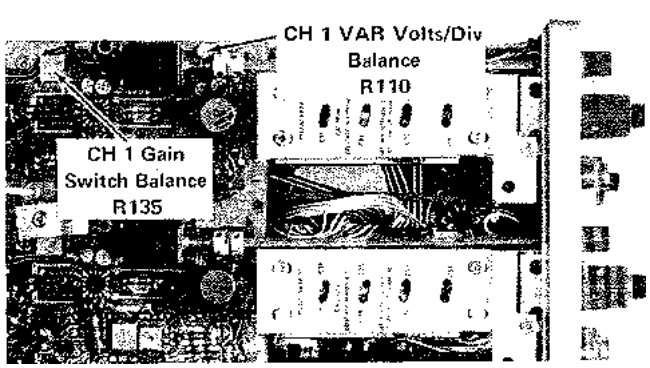


Fig. 5-8. Location of CH 1 Var Volts/Div Balance and Gain Switch Balance adjustments.

d. Set the VERT MODE switch to CH 2.

e. Move the X10 probe to the CH 2 input.

f. CHECK–Light under 5 mV setting is extinguished and the light under 50 mV setting turns on.

g. Remove the X10 probe.

17. Check AC-GND-DC Switches

a. Set both AC-GND-DC switches to DC.

b. Connect the Standard Amplitude Calibrator output to the CH 2 input via a 42-inch 50 Ω BNC cable.

c. Adjust the Standard Amplitude Calibrator for a 20 mV output.

d. Position the bottom of the display to the center horizontal line.

e. Set CH 2 AC-GND-DC switch to GND.

f. CHECK–For no vertical deflection, trace is at the center horizontal line.

g. Set the CH 2 AC-GND-DC switch to AC.

h. CHECK–That the display is centered about the center horizontal line.

i. Move the test signal to the CH 1 input.

j. Set the VERT MODE switch to CH 1.

k. Position the bottom of the display to the center horizontal line.

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

m. Repeat step 17-f.

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

o. Repeat step 17-h.

18. Adjust CH 1 Position Centering

a. Set the CH 1 VOLTS/DIV switch to 2 mV.

b. Adjust the Standard Amplitude Calibrator for a 50 mV output.

c. CHECK–The top of the CRT display can be positioned below the center horizontal graticule line, and that the bottom of the display can be positioned above the center horizontal graticule line.

d. ADJUST–CH 1 Position Centering adjustment, R176 (see Fig. 5-9), so the top of the CRT display can be positioned below the center horizontal graticule line, and the bottom of the display can be positioned above the center horizontal graticule line.

19. Adjust CH 2 Variable Volts/Division Balance

a. Set the CH 2 VOLTS/DIV switch to 5 mV and the VERT MODE switch to CH 2.

b. CHECK–That the CH 2 UNCAL light turns on when the VAR control is out of the detent position.

c. CHECK–CRT display for 2 divisions or less of trace shift when rotating the CH 2 VAR control through its range.

d. ADJUST–CH 2 Variable Balance adjustment, R210 (see Fig. 5-10), for minimum trace shift when rotating the CH 2 VAR control through its range.

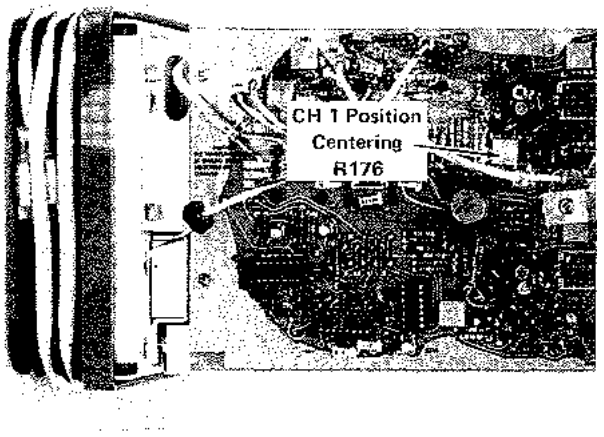


Fig. 5-9. Location of CH 1 Position Centering adjustment.

e. Return the CH 2 VAR control to the detent position.

20. Adjust CH 2 Gain Switch Balance

a. Set the CH 2 VOLTS/DIV switch to 2 mV.

b. Position the trace to the center horizontal line.

c. CHECK–CRT display for minimum trace shift between 2 mV and 5 mV positions of the CH 2 VOLTS/DIV switch.

d. ADJUST–CH 2 Gain Switch Balance adjustment, R235 (see Fig. 5-10), for minimum trace shift between 2 mV and 5 mV positions of the CH 2 VOLTS/DIV switch.

21. Check CH 2 INVERT Balance

a. Set the CH 2 AC-GND-DC switch to GND.

b. Position the trace to the center horizontal graticule line.

c. Push the INVERT pushbutton.

d. CHECK–For less than 1 division of trace shift when switching from normal to inverted.

e. ADJUST–Invert Balance adjustment, R215 (see Fig. 5-10), for minimum trace shift between positions of the INVERT switch.

f. Return the INVERT to the normal (out) position.

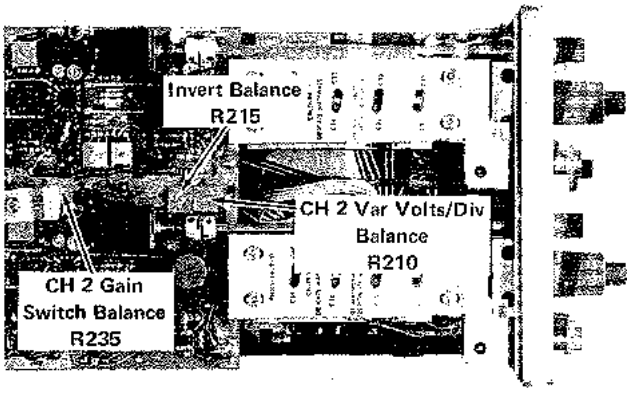


Fig. 5-10. Location of CH 2 Var Volts/Div Balance, Gain Switch Balance, and Invert Balance adjustments.

22. Adjust CH 2 Position Centering

a. Set the CH 2 VOLTS/DIV switch to 2 mV.

b. Move the test signal to the CH 2 input.

c. CHECK—The top of the CRT display can be positioned below the center horizontal graticule line, and that the bottom of the display can be positioned above the center horizontal graticule line.

d. ADJUST—CH 2 Position Centering adjustment, R276 (see Fig. 5-11), so the top of the CRT display can be positioned below the center horizontal graticule line, and the bottom of the display can be positioned above the center horizontal graticule line.

23. Adjust CH 1 Gain

a. Set the VERT MODE switch to CH 1, the CH 1 VOLTS/DIV switch to 5 mV, and the CH 1 AC-GND-DC switch to DC.

b. Move the test signal to the CH 1 input.

c. Adjust the Standard Amplitude Calibrator for a 20 mV output.

d. Set the Test Oscilloscope: Vertical Mode to ADD, Channel 2 to INVERT, and both VOLTS/DIV switches to 5 mV.

e. Connect two X10 probes from the Test Oscilloscope to the preamp side of the delay line.

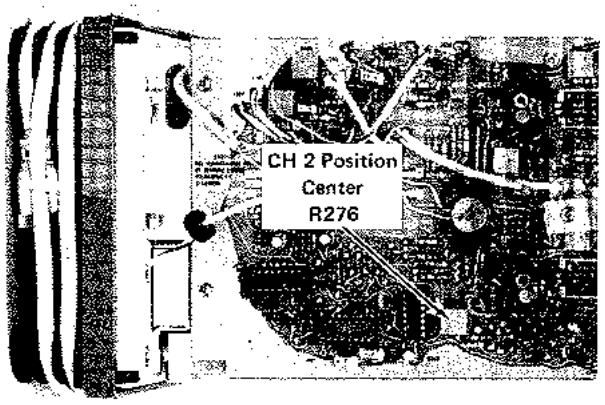


Fig. 5-11. Location of CH 2 Position Centering adjustment.

f. CHECK—The Test Oscilloscope for a 200 mV (peak-to-peak) signal.

g. ADJUST—CH 1 5 mV Gain adjustment, R165 (see Fig. 5-12) for a 200 mV (peak-to-peak) display on the Test Oscilloscope.

NOTE

200 mV value is dependent on the CRT sensitivity.

h. Set the CH 1 VOLTS/DIV to 2 mV and adjust the Standard Amplitude Calibrator for a 10 mV output.

i. CHECK—The Test Oscilloscope for a 100 mV (peak-to-peak) signal.

j. ADJUST—CH 1 2 mV Gain adjustment, R125 (see Fig. 5-12) for a 100 mV (peak-to-peak) display on the Test Oscilloscope.

k. Remove the X10 probes from the delay line.

l. CHECK—CRT display for 5 divisions of deflection.

m. ADJUST—Vertical Output Gain adjustment, R449 (see Fig. 5-13) for 5 divisions of deflection.

n. CHECK—Accuracy of the CH 1 VOLTS/DIV switch using the settings given in Table 5-6 to see if the deflection factor accuracy for each position is within 3%.

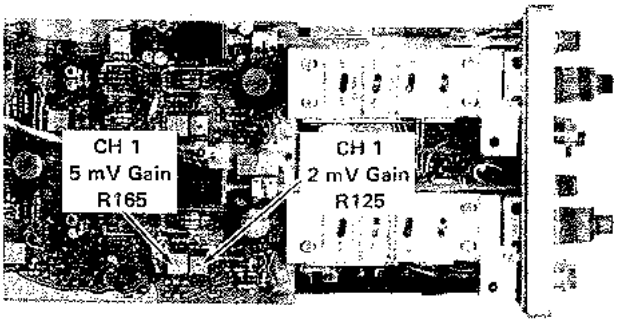


Fig. 5-12. Location of Gain adjustments for Channel 1.

24. Adjust CH 2 Gain

a. Set the VERT MODE switch to CH 2, the CH 2 VOLTS/DIV switch to 5 mV, and the AC-GND-DC switch to DC.

b. Move the test signal to the CH 2 input.

c. Adjust the Standard Amplitude Calibrator for a 20 mV output.

d. CHECK—CRT display for 4 divisions of deflection, within 3%.

e. ADJUST—CH 2 5 mV Gain adjustment, R265 (see Fig. 5-14), for 4 divisions of deflection.

f. Set the CH 2 VOLTS/DIV switch to 2 mV and adjust the Standard Amplitude Calibrator for a 10 mV output.

g. CHECK—CRT display for 5 divisions of deflection, within 3%.

h. ADJUST—CH 2 2 mV Gain adjustment, R225 (see Fig. 5-14), for 5 divisions of deflection.

i. CHECK—Accuracy of the CH 2 VOLTS/DIV switch using the settings given in Table 5-6. Deflection factor accuracy to be within 3% in all switch positions.

25. Check CH 2 and CH 1 Variable Volts/Division Ranges

a. Adjust the Standard Amplitude Calibrator for 5 divisions of deflection.

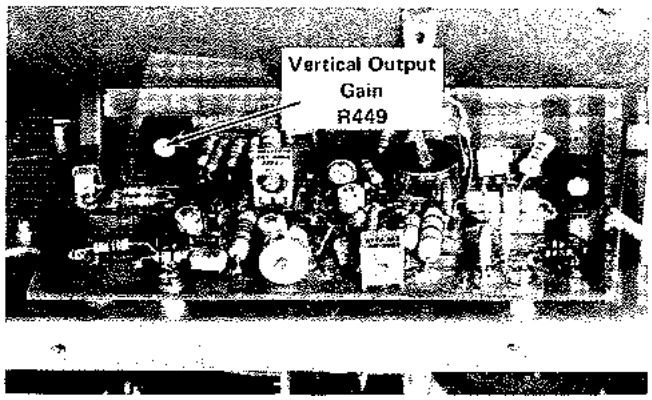


Fig. 5-13. Location of Vertical Output Gain adjustment.

TABLE 5-6

Vertical Deflection Accuracy

VOLTS/DIV Switch Setting	Standard Amplitude Calibrator Output	Vertical Deflection in Divisions	Maximum Error for 3% Accuracy
2 mV	10 mV	5	Previously set
5 mV	20 mV	4	Previously set
10 mV	50 mV	5	±0.15 div
20 mV	0.1 V	5	±0.15 div
50 mV	0.2 V	4	±0.12 div
0.1 V	0.5 V	5	±0.15 div
0.2 V	1 V	5	±0.15 div
0.5 V	2 V	4	±0.12 div
1 V	5 V	5	±0.15 div
2 V	10 V	5	±0.15 div
5 V	20 V	4	±0.12 div

b. Rotate the CH 2 VAR control fully counterclockwise.

c. CHECK—CRT display reduces to less than 2 divisions.

d. Move the test signal to CH 1.

e. Set the VERT MODE switch to CH 1.

f. Adjust the Standard Amplitude Calibrator for 5 divisions of deflection.

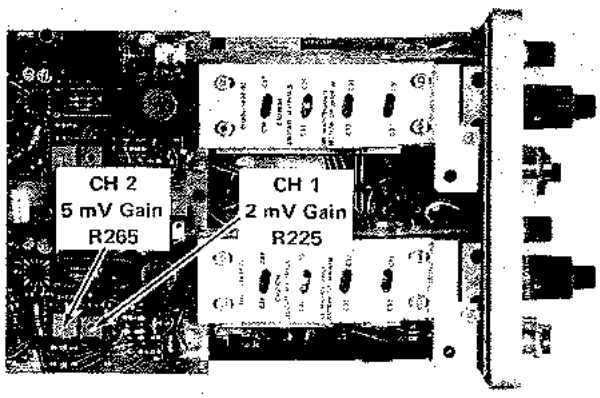


Fig. 5-14. Location of Gain adjustment for Channel 2.

g. Rotate the CH 1 VAR control fully counterclockwise.

h. CHECK—CRT display reduces to less than 2 divisions.

i. Return the VAR controls to the detent position.

26. Check ADD Mode Operation

a. Set both VOLTS/DIV switches to 5 mV and both AC-GND-DC switches to DC.

b. Connect the Standard Amplitude Calibrator output to both channel inputs via a dual input coupler.

c. Adjust the Standard Amplitude Calibrator for a 10 mV output.

d. Set the VERT MODE switch to ADD.

e. CHECK—For 4 divisions of deflection, within 0.12 division.

27. Check Compression and Expansion

a. Set the CH 2 AC-GND-DC switch to GND and the VERT MODE switch to CH 1.

b. Adjust the CH 1 VAR control for 2 divisions of deflection centered about the center horizontal line.

c. Position the top of the display to the top graticule line.

d. CHECK—CRT display for 0.1 division or less of compression or expansion.

e. Position the bottom of the display to the bottom graticule line.

f. CHECK—CRT display for 0.1 division or less of compression or expansion.

g. Return the CH 1 VAR control to the detent position.

h. Disconnect the test setup.

28. Check ALT Mode Operation

a. Set the VERT MODE switch to ALT and the A LEVEL control fully clockwise.

b. Position the two traces 2 divisions apart.

c. CHECK—That the sweeps alternate at all settings of the A TIME/DIV switch, except X-Y.

29. Check CHOP Mode Operation

a. Set the A TIME/DIV switch to 0.2 μs, the A SOURCE switch to NORM, the A SLOPE switch to +, the VERT MODE switch to CHOP, and both AC-GND-DC switches to GND.

b. Position the two traces 4 divisions apart.

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

d. CHECK—For complete blanking of switching transients between chopped segments (see Fig. 5-15).

e. CHECK—Duration of each cycle is about 5 divisions.

30. Adjust Vertical Output Amplifier High-Frequency Response

a. Set the VERT MODE switch to CH 1.

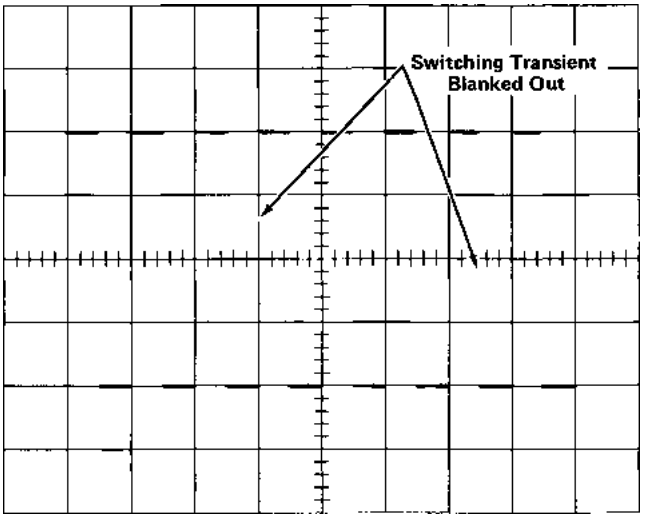


Fig 5-15. Typical CRT display when checking chopped blanking.

b. Connect the preamp end of the delay line to the output of the Signal Insertion Unit (067-0676-00).

c. Connect the Signal Insertion Unit to +15 volts and −8 volts from the 475.

d. Connect the Fast-Rise High-Amplitude Pulse Generator (Type 109) to the Signal Insertion Unit via a 50 Ω 5 ns GR cable, a X5 GR attenuator Signal Pickoff Unit (Type CT-3), and a GR-to-BNC adapter.

e. Connect the 10% output BNC connector of the Signal Pickoff Unit (Type CT-3) to the A External Trigger input via an 18-inch 50 Ω BNC cable and a 50 Ω BNC termination.

f. Adjust the Pulse Generator for 5 divisions of deflection, + Polarity.

g. CHECK—CRT display for flat-top waveform with no more than 10% overshoot on the leading edge.

h. ADJUST—C450, R450, C466, R466, C470, R470 (see Fig. 5-16), for best flat-top waveform.

i. CAL AID—Adjust C450 and R450 for minimum aberrations; C466 and R466 for flat response over the first 5 ns; C470 and R470 for flat response over the first 15 ns. R450 should be adjusted as far counterclockwise as possible.

j. INTERACTION—Between all adjustments in this step. Re-adjust for best flat-top response.

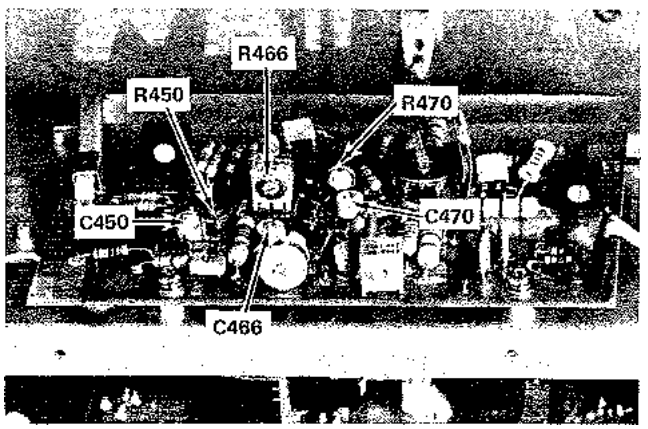


Fig. 5-16. Location of vertical output high-frequency adjustments.

k. Disconnect the test setup and reconnect the Delay Line to the Vertical preamp.

31. Adjust High-Frequency Compensation

a. Connect the fast-rise output of the Square-Wave Generator (Type 106) to the CH 1 input via a 42-inch 50 Ω BNC cable and a 50 Ω BNC termination.

b. Set the CH 1 AC-GND-DC switch to DC and the VOLTS/DIV switch to 5 mV.

c. Adjust the Square-Wave Generator for a 5 division display of a 10 kHz signal.

d. CHECK—CRT display for flat-top waveform within +4%, −4%, or a total of 4% aberrations.

e. ADJUST—R139 and R475 (see Fig. 5-17 & 5-18) for the best flat-top waveform.

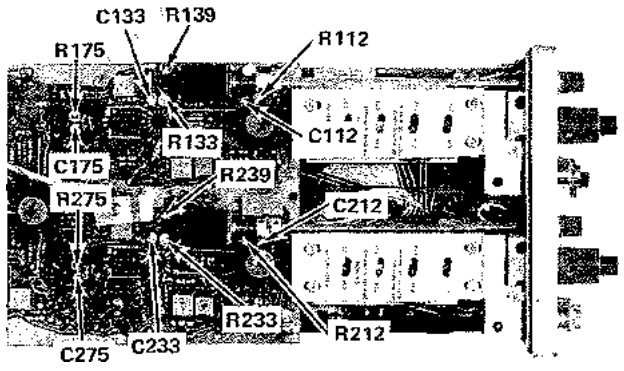


Fig. 5-17. Location of high-frequency compensation adjustments.

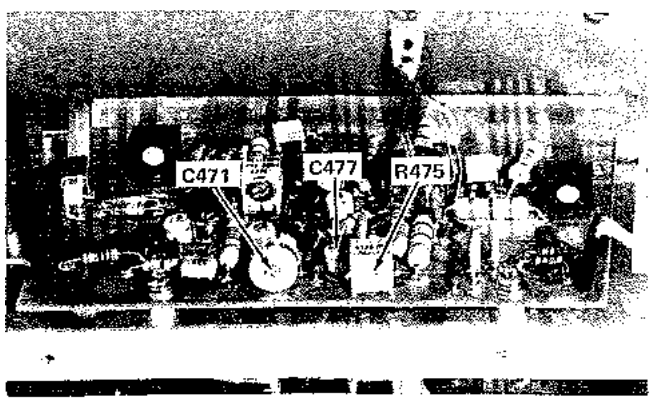


Fig. 5-18. Location of R475, C471, and C477.

f. Adjust the Square-Wave Generator for 5 divisions of a 100 kHz signal.

g. CHECK—Repeat step 31-d.

h. ADJUST—C471 and C477 (see Fig. 5-18) with a low-capacitance screwdriver, for the best flat-top waveform.

i. Move the test signal to CH 2 input.

j. Set the VERT MODE switch to CH 2, the CH 2 AC-GND-DC switch to DC, and the CH 2 VOLTS/DIV switch to 5 mV.

k. Adjust the Square-Wave Generator for a 5 division display of a 10 kHz signal.

l. CHECK—Repeat step 31-d.

m. ADJUST—R239, R475, C471, and C477 (see Fig. 5-17 & 5-18), for the best flat-top waveform.

n. CAL AID—Compromise the adjustment of R475, C471, and C477 for the best response for both CH 1 and CH 2.

o. Disconnect the test setup from the Square-Wave Generator to the CH 2 input.

p. Connect the output of the Fast-Rise High-Amplitude Pulse Generator (Type 109) to the CH 1 input via a 50 Ω 5 ns GR cable, (2) X10 GR attenuators, X5 GR attenuator, a 50 Ω GR termination, and a GR-to-BNC adapter.

q. Set the Pulse Generator polarity to + and the voltage range to 50 V.

r. Adjust the Pulse Generator for five divisions of deflection.

s. CHECK—Repeat step 31-d.

t. ADJUST—C175, R175, C133, R133, C112, and R112 (see Fig. 5-17), with a low-capacitance screwdriver, for the best flat-top waveform.

u. CAL AID—C175 and R175 affect aberrations 10 ns from the leading edge; C133 and R133 affect aberrations 2 ns from the leading edge; C112 and R112 affect the front corner aberrations.

v. Move the test signal to the CH 2 input.

w. Set the VERT MODE switch to CH 2 and adjust the Pulse Generator for five divisions of deflection.

x. CHECK—Repeat step 31-d.

y. ADJUST—C275, R275, C233, R233, C212, and R212 (see Fig. 5-17), with a low-capacitance screwdriver, for the best flat-top waveform.

z. CAL AID—C275 and R275 affect aberrations 10 ns from the leading edge; C233 and R233 affect aberrations 2 ns from the leading edge; C212 and R212 affect the front corner aberrations.

aa. Disconnect the test setup.

32. Adjust CH 2 VOLTS/DIV Compensation

a. Set the VERT MODE switch to CH 2, both AC-GND-DC switches to DC, both VOLTS/DIV switches to 5 mV, and the A TIME/DIV switch to 0.2 ms.

b. Connect the high-amplitude output of the Square-Wave Generator (Type 106) to the CH 2 input via a GR-to-BNC adapter, 42-inch 50 Ω BNC cable, X10 BNC attenuator, 50 Ω BNC termination, and a 20 pF normalizer.

c. Adjust the Square-Wave Generator for a five division display of a 1 kHz signal. Add or remove attenuators as necessary to maintain a five division display throughout this step.

d. CHECK—CRT display for flat-top waveform with no more than 2% overshoot or roll-off on the leading edge.

e. ADJUST—C10 (see Fig. 5-19) with a low-capacitance screwdriver for best flat-top waveform.

f. Turn the CH 2 VOLTS/DIV switch to 2 mV.

g. CHECK—Repeat step 32-d.

h. Turn the CH 2 VOLTS/DIV switch to 10 mV.

i. CHECK—Repeat step 32-d.

j. ADJUST—Channel 2's C36 and C37 (see Fig. 5-19) with a low-capacitance screwdriver, for best corner and flat-top waveform.

k. CAL AID—Remove the 20 pF normalizer when adjusting or checking the corner response.

l. INTERACTION—Between Channel 2's C36 and C37. Re-adjust both for optimum response.

m. Turn the CH 2 VOLTS/DIV switch to 20 mV.

n. CHECK—Repeat step 32-d.

o. ADJUST—Channel 2's C34 and C35 (see Fig. 5-19), with a low-capacitance screwdriver, for best corner and flat-top waveform.

p. INTERACTION—Between Channel 2's C34 and C35. Re-adjust both for optimum response.

q. Turn the CH 2 VOLTS/DIV switch to 50 mV.

r. CHECK—Repeat step 32-d.

s. ADJUST—Channel 2's C32 and C33 (see Fig. 5-19) with a low-capacitance screwdriver, for best corner and flat-top waveform.

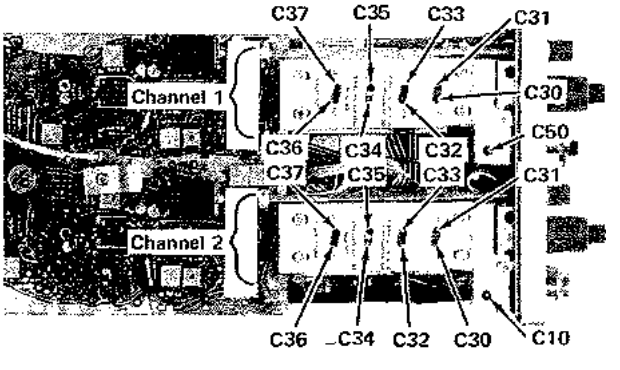


Fig. 5-19. Location of VOLTS/DIV Compensation adjustments.

t. INTERACTION—Between Channel 2's C32 and C33. Re-adjust both for optimum response.

u. Turn the CH 2 VOLTS/DIV switch to 0.1 V.

v. CHECK—Repeat step 32-d.

w. Turn the CH 2 VOLTS/DIV switch to 0.2 V.

x. CHECK—Repeat step 32-d.

y. Turn the CH 2 VOLTS/DIV switch to 0.5 V.

z. CHECK—Repeat step 32-d.

aa. ADJUST—Channel 2's C30 and C31 (see Fig. 5-19) with a low-capacitance screwdriver, for best corner and flat-top waveform.

ab. INTERACTION—Between Channel 2's C30 and C31. Re-adjust both for optimum response.

ac. Repeat step 32-z for 1 V, 2 V, and 5 V positions of the CH 2 VOLTS/DIV switch.

33. Adjust CH 1 VOLTS/DIV Compensation

a. Set the VERT MODE switch to CH 1 and move the test signal to the CH 1 input.

b. Adjust the Square-Wave Generator (Type 106) for a five division display of a 1 kHz signal. Add or remove attenuators as necessary to maintain a five division display.

c. CHECK—CRT display for flat-top waveform with no more than 2% overshoot or roll-off on the leading edge.

d. ADJUST—C50 (see Fig. 5-19) with a low-capacitance screwdriver for best flat-top waveform.

e. Turn the CH 1 VOLTS/DIV switch to 2 mV.

f. CHECK—Repeat step 33-d.

g. Turn the CH 1 VOLTS/DIV switch to 10 mV.

h. CHECK—Repeat step 33-d.

i. ADJUST—Channel 1's C36 and C37 (see Fig. 5-19) with a low-capacitance screwdriver, for best corner and flat-top waveform.

j. CAL AID—Remove the 20 pF normalizer when adjusting or checking the corner response.

k. INTERACTION—Between Channel 1's C36 and C37. Re-adjust both for optimum response.

l. Turn the CH 1 VOLTS/DIV switch to 20 mV.

m. CHECK—Repeat step 33-d.

n. ADJUST—Channel 1's C34 and C35 (see Fig. 5-19) with a low-capacitance screwdriver, for best corner and flat-top waveform.

o. INTERACTION—Between Channel 1's C34 and C35. Re-adjust both for optimum response.

p. Turn the CH 2 VOLTS/DIV switch to 50 mV.

q. CHECK—Repeat step 33-d.

r. ADJUST—Channel 1's C32 and C33 (see Fig. 5-19) with a low-capacitance screwdriver, for best corner and flat-top waveform.

s. INTERACTION—Between Channel 1's C32 and C33. Re-adjust both for optimum response.

t. Turn the CH 1 VOLTS/DIV switch to 0.1 V.

u. CHECK—Repeat step 33-d.

v. Turn the CH 1 VOLTS/DIV switch to 0.2 V.

w. CHECK—Repeat step 33-d.

x. Turn the CH 1 VOLTS/DIV switch to 0.5 V.

y. CHECK—Repeat step 33-d.

z. ADJUST—Channel 1's C30 and C31 (see Fig. 5-19) with a low-capacitance screwdriver, for best corner and flat-top waveform.

aa. INTERACTION—Between Channel 1's C30 and C31. Re-adjust both for optimum response.

ab. Repeat step 33-d for 1 V, 2 V, and 5 V positions of the CH 1 VOLTS/DIV switch.

ac. Disconnect the test setup.

34. Check Vertical Amplifier Bandwidth

a. Connect the output of the High-Frequency Constant-Amplitude Signal Generator (067-0532-01) to the CH 1 input via a GR-to-BNC adapter, X10 BNC attenuator, and a 50 Ω BNC termination.

b. Set the TRIG MODE switch to AUTO, the A TIME/DIV switch to 0.2 ms, and both VOLTS/DIV switches to 5 mV.

c. Adjust the High-Frequency signal generator output amplitude for a five division display of a 3 megahertz reference signal.

d. Without changing the output amplitude, increase the output frequency of the High-Frequency signal generator until the display is reduced to 3.5 divisions.

e. CHECK—Output frequency of the High-Frequency signal generator must be at least 200 megahertz.

f. Move the test signal to the CH 2 input and set the VERT MODE switch to CH 2.

g. Repeat the bandwidth check procedure, step 34-c through 34-e.

h. Disconnect the test setup.

35. Check Cascaded Bandwidth

a. Set both AC-GND-DC switches to DC, both VOLTS/DIV switches to 5 mV, the A TIME/DIV switch to 1 ms, and the VERT MODE switch to CH 1.

b. Connect the CH 2 VERT SIGNAL OUT (on the rear panel) to the CH 1 input via a 42-inch 50 Ω BNC cable and a 50 Ω BNC termination.

c. Connect the output of the Medium-Frequency Constant-Amplitude Signal Generator (Type 191) to the CH 2 input via a GR-to-BNC adapter, 42-inch 50 Ω BNC cable, X10 BNC attenuator, and a 50 Ω BNC termination.

d. Adjust the Medium-Frequency signal generator for a five division display of a 50 kHz signal.

e. Without changing the output amplitude of the Medium-Frequency signal generator, increase the output frequency until the display is reduced to 3.5 divisions.

f. CHECK—Output frequency of the Medium-Frequency signal generator must be at least 50 megahertz.

g. Disconnect the test setup from the CH 2 VERT SIGNAL OUT to the CH 1 input connector.

36. Check Vertical Channel Isolation

a. Set the VERT MODE switch to CH 2, the CH 2 VOLTS/DIV switch to 0.2 V, and the CH 1 AC-GND-DC switch to GND.

b. Connect the output of the Medium-Frequency Constant-Amplitude Signal Generator (Type 191) to the CH 1 & 2 inputs via a GR-to-BNC adapter, 42-inch 50 Ω BNC cable, X10 BNC attenuator, 50 Ω BNC termination, and a dual input coupler.

c. Adjust the Medium-Frequency signal generator for a 4 division display of a 50 MHz signal.

d. Set both VOLTS/DIV switches to 20 mV and the VERT MODE switch to CH 1.

e. CHECK—CRT display for no more than 0.2 division of deflection.

f. Set the CH 2 AC-GND-DC switch to GND, the CH 1 AC-GND-DC switch to DC, and the CH 1 VOLTS/DIV switch to 0.2 V.

g. Adjust the Medium-Frequency signal generator for a 4 division display of a 50 MHz signal.

h. Set the VERT MODE switch to CH 2.

i. CHECK—CRT display for no more than 0.2 division of deflection.

j. Disconnect the test setup.

37. Check Bandwidth Limit Operation

a. Pull the 20 MHz BW/TRIG VIEW button to BW and set the CH 1 AC-GND-DC switch to DC.

b. Connect the Medium-Frequency Constant-Amplitude Signal Generator (Type 191) to the CH 1 input via a 42-inch 50 Ω BNC cable and a 50 Ω BNC termination.

c. Adjust the Medium-Frequency signal generator for a six division display of a 50 kilohertz signal.

d. Increase the output frequency of the signal generator until the display is reduced to 4.2 divisions.

e. CHECK—Output frequency of the signal generator is between 15 and 25 megahertz.

f. Disconnect the test setup.

TRIGGER SYSTEM CALIBRATION

Equipment Required	
1. Standard Amplitude Calibrator (067-0502-01).	8. GR-to-BNC Female Adapter.
2. High-Frequency Constant-Amplitude Signal Generator (067-0532-01).	9. 42-inch 50 Ω BNC Cable.
3. Medium-Frequency Constant-Amplitude Signal Generator (Type 191).	10. 18-inch 50 Ω BNC Cable (two).
4. Low-Frequency Sine-Wave Generator (General Radio 1310-A).	11. X10 BNC Attenuator
5. Time-Mark Generator (Type 2901).	12. X2 BNC Attenuator
6. 50 Ω Signal Pickoff Unit (Type CT-3).	13. BNC-T Connector
7. 50 Ω 5 nanosecond GR Cable.	14. 50 Ω BNC Termination (two).
	15. Dual Input Coupler (two).
	16. Three-inch Screwdriver.

Control Settings

Preset instrument controls to the settings given under Preliminary Control Settings except as follows:

CH 1 VOLTS/DIV	10 mV
A SOURCE	EXT
A COUPLING	AC
A LEVEL	0

38. Adjust A Trigger Sensitivity

a. Connect the output of the Medium-Frequency Constant-Amplitude Signal Generator (Type 191) to the A and B External Trigger inputs via a 50 Ω 5 ns GR cable, 50 Ω Signal Pickoff Unit (Type CT-3) thru output, GR-to-BNC adapter, X10 BNC attenuator, 50 Ω BNC termination, and a dual input coupler.

b. Connect the 10% BNC output connector of the Signal Pickoff Unit to the CH 1 and CH 2 inputs via an 18-inch 50 Ω BNC cable, a 50 Ω BNC termination, and a dual input coupler.

c. Adjust the Medium-Frequency signal generator output for a 3 division display of a 350 kHz signal.

d. Turn the CH 1 VOLTS/DIV switch to 0.1 V.

e. CHECK—That a stable display can be obtained by rotating the A LEVEL control.

f. Adjust the Medium-Frequency signal generator to increase the CRT display to 0.35 division.

g. ADJUST—A Trigger Sensitivity adjustment, R565, (see Fig. 5-20) so that a stable display can just be obtained by rotating the A LEVEL control.

39. Adjust B Trigger Sensitivity

a. Set the HORIZ DISPLAY to B DLY'D, the B COUPLING switch to AC, the B SOURCE switch to EXT, and the B SLOPE switch to +.

b. Adjust the Medium-Frequency signal generator for a 0.3 division display.

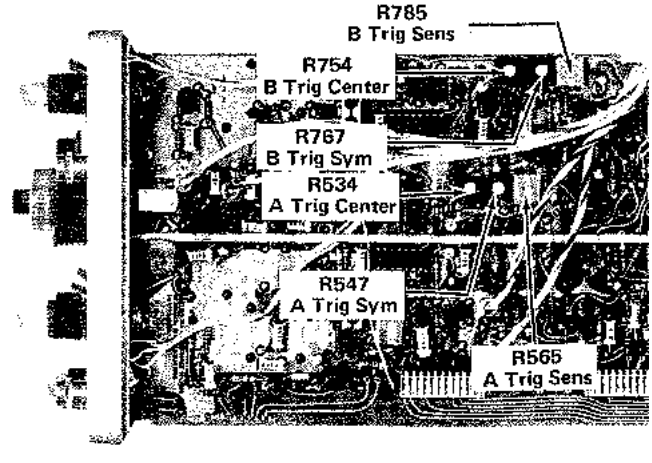


Fig. 5-20. Location of Trigger Sensitivity, Symmetry, and Centering adjustments.

c. CHECK—That a stable display can just be obtained by rotating the B LEVEL control.

d. Adjust the Medium-Frequency signal generator to increase the CRT display to 0.35 division.

e. ADJUST—B Trigger Sensitivity adjustment, R785 (see Fig. 5-20) so that a stable display can just be obtained by rotating the B LEVEL control.

40. Adjust B Trigger Centering and Symmetry

a. Set both TIME/DIV switches to 10 μs, both LEVEL controls to 0, the CH 1 VOLTS/DIV switch to 50 mV, and the B SOURCE switch to NORM.

b. Adjust the Medium-Frequency signal generator for a 2 division display of a 350 kilohertz signal.

c. Vertically center the display about the center horizontal graticule line.

d. CHECK—CRT display begins at the same vertical point in both slopes of the displayed waveform.

e. ADJUST—B Trigger Symmetry adjustment, R767 (see Fig. 5-20), so that the trace begins at the same point in both slopes of the displayed waveform.

f. ADJUST—B Trigger Centering adjustment, R754 (see Fig. 5-20), for the trigger point of the display to be at the graticule center.

g. CAL AID—A gap equal to 35 mV should exist between the + and — trigger points.

41. Adjust A Trigger Centering and Symmetry

a. Set the HORIZ DISPLAY switch to A and the A SOURCE switch to NORM.

b. CHECK—CRT display begins at the same vertical point in both slopes of the displayed waveform.

c. ADJUST—A Trigger Symmetry adjustment, R547 (see Fig. 5-20), so that the trace begins at the same point in both slopes of the displayed waveform.

d. ADJUST—A Trigger Centering adjustment, R534 (see Fig. 5-20), for the trigger point of the display to be at the graticule center.

e. CAL AID—A gap equal to 35 mV should exist between the + and — trigger points.

42. Adjust Trigger DC Balance

a. Set the A COUPLING switch to DC, the A SOURCE switch to NORM, and the A LEVEL control to 0.

b. Adjust the Medium-Frequency signal generator for a 0.3 division display.

c. Position the display to the vertical center of the graticule viewing area.

d. CHECK—That a stable display can be obtained on both slopes of the displayed waveform.

e. ADJUST—Normal Trigger DC Balance adjustment, R425 (see Fig. 5-21), so that the display begins at the same DC level when switching the A COUPLING switch from DC to AC.

f. Set the A SOURCE switch to CH 1.

g. CHECK—That a stable display can be obtained on both slopes of the displayed waveform.

h. ADJUST—CH 1 Trigger DC Balance adjustment, R403 (see Fig. 5-21), so that the display begins at the same DC level when switching the A COUPLING switch from DC to AC.

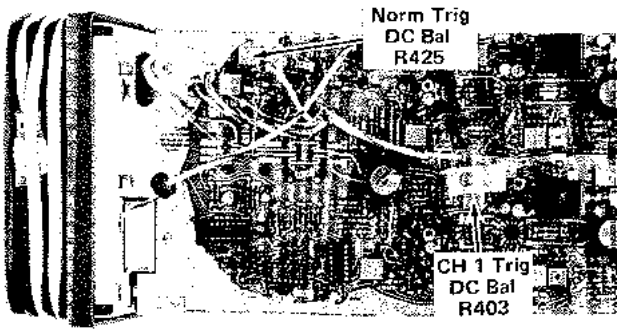


Fig. 5-21. Location of Normal Trigger DC Balance and CH 1 Trigger DC Balance adjustments.

i. Set the VERT MODE switch to CH 2.

j. Adjust the CH 2 VOLTS/DIV switch to obtain a 0.3 division display.

k. Position the display to the vertical center of the graticule viewing area.

l. Set the A SOURCE switch to CH 2.

m. CHECK—That a stable display can be obtained on both slopes of the displayed waveform.

43. Check B Trigger DC Balance

a. Set the HORIZ DISPLAY switch to B DLY'D, the B LEVEL control to 0, the B SOURCE switch to NORM, and the B COUPLING switch to DC.

b. CHECK—That a stable display can be obtained on both slopes of the displayed waveform in the NORM and CH 2 positions of the B SOURCE switch.

c. Set the VERT MODE switch to CH 1.

d. Adjust the CH 1 VOLTS/DIV switch to obtain a 0.3 division display.

e. Position the display to the vertical center of the graticule viewing area.

f. CHECK—That a stable display can be obtained on both slopes of the displayed waveform in the NORM and CH 1 positions of the B SOURCE switch.

44. Check B Internal 40 Megahertz Triggering

a. Set the DELAY TIME POSITION dial fully counter-clockwise, both TIME/DIV switches to 0.5 μs, both VOLTS/DIV switches to 10 mV, and both SOURCE switches to NORM.

b. Adjust the Medium-Frequency Constant-Amplitude Signal Generator (Type 191) to maintain a 0.3 division display of a 40 megahertz signal throughout this step.

c. CHECK—A stable display can be obtained on both slopes of the displayed waveform in the AC, LF REJ, and DC positions of the B COUPLING switch by adjusting the B LEVEL control.

d. Set the B SOURCE switch to CH 1.

e. CHECK—Repeat step 44-c.

f. Set the VERT MODE switch to CH 2.

g. CHECK—That a stable display cannot be obtained with the B SOURCE switch set to CH 1.

h. Set the B SOURCE switch to CH 2.

i. CHECK—A stable display can be obtained on both slopes of the displayed waveform in the AC, LF REJ, and DC positions of the B COUPLING switch by adjusting the B LEVEL control.

j. Set the B SOURCE switch to NORM.

k. CHECK—Repeat step 44-i.

45. Check A Internal 40 Megahertz Triggering

a. Set the HORIZ DISPLAY switch to A.

b. Adjust the Medium-Frequency signal generator to maintain a 0.3 division display of a 40 megahertz signal throughout this step.

c. CHECK—A stable display can be obtained on both slopes of the displayed waveform in the AC, LF REJ, and DC positions of the A COUPLING switch by adjusting the A LEVEL control.

d. Set the A SOURCE switch to CH 2.

e. CHECK—Repeat step 45-c.

f. Set the VERT MODE switch to CH 1.

g. CHECK—That a stable display cannot be obtained with the A SOURCE switch set to CH 2.

h. Set the A SOURCE switch to CH 1.

i. CHECK–A stable display can be obtained on both slopes of the displayed waveform in the AC, LF REJ, and DC positions of the A COUPLING switch by adjusting the A LEVEL control.

j. Set the A SOURCE switch to NORM.

k. CHECK–Repeat step 45-i.

46. Check A External 40 Megahertz Triggering

a. Set the HORIZ DISPLAY switch to A, the A SOURCE switch to EXT, the B SOURCE switch to NORM, and the CH 1 VOLTS/DIV switch to 20 mV.

b. Adjust the Medium-Frequency signal generator for a five division display of a 40 megahertz signal.

c. Add a X2 BNC attenuator to the External Trigger signal test setup between the X10 BNC attenuator and the 50 Ω BNC termination.

d. CHECK–A stable display can be obtained, by adjusting the A LEVEL control, on both slopes of the displayed waveform in the AC and DC positions of the A COUPLING switch.

e. Remove the X2 BNC attenuator from the External Trigger signal test setup.

f. CHECK–A stable display can be obtained, by adjusting the A LEVEL control, on both slopes of the displayed waveform in the LF REJ position of the A COUPLING switch.

g. Set the A SOURCE switch to EXT ÷ 10.

h. Remove the X10 BNC attenuator from the test setup.

i. CHECK–Repeat step 46-f.

j. Replace the X2 BNC attenuator to the test setup.

k. CHECK–Repeat step 46-d.

l. Replace the X10 BNC attenuator to the test setup.

47. Check B External 40 Megahertz Triggering

a. Set the HORIZ DISPLAY switch to B DLY'D, the B SOURCE switch to EXT, and the A SOURCE switch to NORM.

b. Adjust the Medium-Frequency signal generator for a five division display.

c. CHECK–A stable display can be obtained, by adjusting the LEVEL controls, on both slopes of the displayed waveform in the AC and DC positions of the B COUPLING switch.

d. Remove the X2 BNC attenuator from the test setup.

e. CHECK–A stable display can be obtained, by adjusting the LEVEL controls, on both slopes of the displayed waveform in the LF REJ position of the B COUPLING switch.

f. Disconnect the test setup.

48. Check External 200 Megahertz Triggering

a. Set the TIME/DIV switch to 10 µs, the TRIG MODE switch to AUTO, the X10 MAG button in, both VOLTS/DIV switches to 1 V, the VERT MODE switch to CH 1, and the A SOURCE switch to EXT.

b. Connect the High-Frequency Constant-Amplitude Signal Generator (067-0532-01) to the A and B External Trigger inputs via a 50 Ω Signal Pickoff Unit (Type CT-3), GR-to-BNC adapter, X10 BNC attenuator, X2 BNC attenuator, 50 Ω BNC termination, and a dual-input coupler.

c. Connect the 10% BNC output connector of the Signal Pickoff Unit to the CH 1 and CH 2 inputs via an 18-inch 50 Ω BNC cable, a 50 Ω BNC termination, and a dual input coupler.

d. Adjust the High-Frequency signal generator for a five division display of a 3 megahertz signal.

e. Set the TIME/DIV switch to 0.1 µs.

f. Adjust the High-Frequency signal generator for a 200 megahertz output frequency.

g. CHECK—That a stable display, with no more than 0.2 division of jitter, can be obtained on both slopes of the displayed waveform, by adjusting the A LEVEL control, in the AC and DC positions of the A COUPLING switch.

h. Remove the X2 BNC attenuator from the test setup.

i. CHECK—That a stable display, with no more than 0.2 division of jitter, can be obtained on both slopes of the displayed waveform, by adjusting the A LEVEL control, in the LF REJ position of the A COUPLING switch.

j. Remove the X10 BNC attenuator and replace the X2 BNC attenuator to the test setup.

k. Set the A SOURCE switch to EXT ÷ 10.

l. CHECK—Repeat step 48-g.

m. Replace the X10 BNC attenuator to the test setup.

n. Set the HORIZ DISPLAY switch to B DLY'D, the B SOURCE switch to EXT, and the A SOURCE switch to NORM.

o. CHECK—That a stable display, with no more than 0.2 division of jitter, can be obtained on both slopes of the displayed waveform, by adjusting both LEVEL controls, in the AC and DC positions of the B COUPLING switch.

p. Remove the X2 BNC attenuator from the test setup.

q. CHECK—That a stable display, with no more than 0.2 division of jitter, can be obtained on the slopes of the displayed waveform, by adjusting both LEVEL controls, in the LF REJ position of the B COUPLING switch.

49. Check B Internal 200 Megahertz Triggering

a. Set the B SOURCE switch to NORM and both VOLTS/DIV switches to 10 mV.

b. Adjust the High-Frequency Constant-Amplitude Signal Generator (067-0532-01) for a 1.5 division display of a 200 megahertz signal.

c. CHECK—That a stable display, with no more than 0.2 division of jitter, can be obtained on both slopes of the displayed waveform, by adjusting both LEVEL controls, in the AC, LF REJ, and DC positions of the B COUPLING switch.

d. Set the B SOURCE switch to CH 1.

e. CHECK—Repeat step 49-c.

f. Set the B SOURCE switch to CH 2.

g. CHECK—That a stable display cannot be obtained in any position of the B COUPLING switch.

h. Set the VERT MODE switch to CH 2.

i. CHECK—Repeat step 49-c.

j. Set the B SOURCE switch to NORM.

k. CHECK—Repeat step 49-c.

l. Set the B SOURCE switch to CH 1.

m. CHECK—Repeat step 49-g.

50. Check A Internal 200 Megahertz Triggering

a. Set the HORIZ DISPLAY switch to A.

b. CHECK—That a stable display, with no more than 0.2 division of jitter, can be obtained on both slopes of the displayed waveform, by adjusting the A LEVEL control, in the AC, LF REJ, and DC positions of the A COUPLING switch.

c. Set the A SOURCE switch to CH 2.

d. CHECK—Repeat step 50-b.

e. Set the A SOURCE switch to CH 1.

f. CHECK—That a stable display cannot be obtained in any position of the A COUPLING switch.

g. Set the VERT MODE switch to CH 1.

h. CHECK—Repeat step 50-b.

i. Set the A SOURCE switch to NORM.

j. CHECK—Repeat step 50-b.

k. Set the A SOURCE switch to CH 2.

l. CHECK—Repeat step 50-f.

m. Disconnect the test setup.

51. Check HF REJ Triggering

a. Set the HORIZ DISPLAY switch to A, the TIME/DIV switches to 2 μs, the TRIG MODE switch to AUTO, both COUPLING switches to HF REJ, and both SOURCE switches to NORM.

b. Connect the output of the Medium-Frequency Constant-Amplitude Signal Generator (Type 191) to the CH 1 input via a 50 Ω 5 ns GR cable, a 50 Ω Signal Pickoff Unit (Type CT-3), a GR-to-BNC adapter, and an 18-inch 50 Ω BNC cable.

c. Connect the 10% output of the Signal Pickoff Unit to the A External Trigger input via an 18-inch 50 Ω BNC cable and a 50 Ω BNC termination.

d. Adjust the Medium-Frequency signal generator for a 0.5 volt, 50 kilohertz, output signal.

e. Adjust the CH 1 VOLTS/DIV switch for a 0.3 division display.

f. CHECK—That a stable display can be obtained on both slopes of the displayed waveform in all positions of the A COUPLING switch, by adjusting the A LEVEL control.

g. Increase the output of the Medium-Frequency signal generator to 1 megahertz.

h. CHECK—That a stable display cannot be obtained in the HF REJ position of the A COUPLING switch.

i. Set the A SOURCE switch to EXT.

j. CHECK—That a stable display cannot be obtained in the HF REJ position of the A COUPLING switch.

k. Reduce the Medium-Frequency signal generator output frequency to 50 kilohertz.

l. CHECK—That a stable display can be obtained on both slopes of the displayed waveform, in all positions of the A COUPLING switch, by adjusting the A LEVEL control.

m. Move the external Trigger signal to the B External Trigger input.

n. Set the HORIZ DISPLAY switch to B DLY'D.

o. CHECK—That a stable display can be obtained on both slopes of the displayed waveform, in all positions of the B COUPLING switch, by adjusting the LEVEL controls.

p. Increase the output of the Medium-Frequency signal generator to 1 megahertz.

q. CHECK—That a stable display cannot be obtained in the HF REJ position of the B COUPLING switch.

r. Set the B SOURCE switch to EXT.

s. CHECK—That a stable display cannot be obtained in the HF REJ position of the B COUPLING switch.

t. Reduce the Medium-Frequency signal generator output frequency to 50 kilohertz.

u. CHECK—That a stable display can be obtained on both slopes of the displayed waveform, in all positions of the B COUPLING switch, by adjusting the LEVEL controls.

v. Disconnect the test setup.

52. Check B 60 Hertz and LF REJ Triggering

a. Set the B TIME/DIV switch to 5 ms, the HORIZ DISPLAY switch to B DLY'D, both SOURCE switches to NORM, and both VOLTS/DIV switches to 0.1 V.

b. Connect the Low-Frequency Sine-Wave Generator (General Radio 1310-A) to the CH 1 input via a 42-inch 50 Ω BNC cable, a BNC-T connector, an 18-inch 50 Ω BNC cable, and a 50 Ω BNC termination.

c. Connect the other side of the BNC-T connector to the B External Trigger input via a X10 BNC attenuator and a 50 Ω BNC termination.

d. Adjust the Low-Frequency generator for a 0.3 division display of a 60 hertz signal.

e. CHECK—That a stable display can be obtained on both slopes of the displayed waveform in the AC, HF REJ, and DC positions of the B COUPLING switch, by adjusting the LEVEL controls.

f. CHECK—That a stable display cannot be obtained in the LF REJ position of the B COUPLING switch.

g. Set the B SOURCE switch to CH 1.

h. CHECK—Repeat step 52-e.

i. CHECK—Repeat step 52-f.

j. Set the B SOURCE switch to CH 2.

k. CHECK—That a stable display cannot be obtained in any position of the B COUPLING switch.

l. Move the test signal from the CH 1 input to the CH 2 input.

m. Set the VERT MODE switch to CH 2.

n. Adjust the Low-Frequency generator for a 0.3 division display of a 60 hertz signal.

o. CHECK—Repeat step 52-e.

p. CHECK—Repeat step 52-f.

q. Set the B SOURCE switch to EXT.

r. CHECK—Repeat step 52-e.

s. CHECK—Repeat step 52-f.

53. Check A 60 Hertz and LF REJ Triggering

a. Set the HORIZ DISPLAY switch to A.

b. Move the signal from the B External Trigger input to the A External Trigger input.

c. CHECK—That a stable display can be obtained on both slopes of the displayed waveform, in the AC, HF REJ, and DC positions of the A COUPLING switch, by adjusting the A LEVEL control.

d. CHECK—That a stable display cannot be obtained in the LF REJ position of the A COUPLING switch.

e. Set the A SOURCE switch to CH 2.

f. CHECK—Repeat step 53-c.

g. CHECK—Repeat step 53-d.

h. Set the A SOURCE switch to CH 1.

i. CHECK—That a stable display cannot be obtained in any position of the A COUPLING switch.

j. Move the test signal from the CH 2 input to the CH 1 input.

k. Set the VERT MODE switch to CH 1.

l. Adjust the Low-Frequency generator for a 0.3 division display of a 60 hertz signal.

m. CHECK—Repeat step 53-c.

n. CHECK–Repeat step 53-d.

o. Set the A SOURCE switch to EXT.

p. CHECK–Repeat step 53-c.

q. CHECK–Repeat step 53-d.

r. Disconnect the test setup.

54. Check A LEVEL Control External Range

a. Set both SOURCE switches to EXT, the CH 1 VOLTS/DIV switch to 1 V, the A SLOPE switch to +, and the A COUPLING switch to AC.

b. Connect the output of the Low-Frequency Sine-Wave Generator (General Radio 1310-A) to the CH 1 input and the A External Trigger input through a BNC-T connector and two 18-inch 50 Ω BNC cables.

c. Adjust the Low-Frequency generator for a four division display of a 1 kilohertz signal.

d. CHECK–That the display can be triggered at any point along the positive slope of the waveform when rotating the A LEVEL control throughout its range.

e. CHECK–CRT display is not triggered at either extreme of the A LEVEL control.

f. Set the A SLOPE switch to –.

g. CHECK–That the display can be triggered at any point along the negative slope of the displayed waveform when rotating the A LEVEL control throughout its range.

h. CHECK–Repeat step 54-e.

i. Set the CH 1 VOLTS/DIV switch to 10 V and the A SOURCE switch to EXT ÷ 10.

j. Adjust the Low-Frequency generator for a four division display of a 1 kilohertz signal.

k. CHECK–That the display can be triggered at any point along the negative slope of the displayed waveform, in the AC, HF REJ, and DC positions of the A COUPLING switch, when rotating the A LEVEL control throughout its range.

l. CHECK–Repeat step 54-e.

m. Set the A SLOPE switch to +.

n. CHECK–That the display can be triggered at any point along the positive slope of the displayed waveform, in the AC, HF REJ, and DC positions of the A COUPLING switch, when rotating the A LEVEL control throughout its range.

o. CHECK–Repeat step 54-e.

55. Check B LEVEL Control External Range

a. Set the HORIZ DISPLAY switch to B DLY'D, the A SOURCE switch to NORM, the B SLOPE switch to +, and the CH 1 VOLTS/DIV switch to 1 V.

b. Move the External Trigger signal to the B External Trigger input.

c. Adjust the Low-Frequency generator for a four-division display of a 1 kilohertz signal.

d. CHECK–That the display can be triggered at any point along the positive slope of the displayed waveform when rotating the B LEVEL control throughout its range.

e. CHECK–CRT display is not triggered at either extreme of the B LEVEL control.

f. Set the B SLOPE switch to –.

g. CHECK–That the display can be triggered at any point along the negative slope of the displayed waveform when rotating the B LEVEL control throughout its range.

h. CHECK–Repeat step 55-e.

56. Check Single Sweep Operation

a. Set the HORIZ DISPLAY switch to A and the A COUPLING switch to AC.

b. Adjust the Low-Frequency Sine-Wave Generator (General Radio 1310-A) for a 50 kilohertz signal output.

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

d. Disconnect the test signal from the CH 1 input.

e. Press the SINGL SWP button of the TRIG MODE switch.

f. CHECK—READY light turns on when SINGL SWP button is pressed and remains on until the test signal is re-applied.

g. Reconnect the test signal to the CH 1 input.

h. CHECK—READY light is extinguished.

i. Press the SINGL SWP button.

j. CHECK—That a single-sweep display (one sweep only) is presented.

57. Check Normal Mode Operation

a. Set the A SOURCE switch to NORM and the TRIG MODE switch to AUTO.

b. Adjust the Low-Frequency Sine-Wave Generator (General Radio 1310-A) for a 50 kilohertz signal.

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

d. Switch the TRIG MODE switch to NORM.

e. CHECK—For a stable display.

f. Remove the test signal from the CH 1 input.

g. CHECK—For no trace in the absence of an adequate trigger signal.

58. Check LINE Triggering

a. Set the HORIZ DISPLAY switch to A, the TRIG MODE switch to AUTO, the A SOURCE switch to LINE, the A COUPLING switch to AC, and the A SLOPE switch to +.

b. Push the TRIG VIEW button and hold it in.

c. CHECK—CRT display is triggerable on the positive slope by rotating the A LEVEL control.

d. Release the TRIG VIEW button.

59. Check Automatic Recovery Time

a. Set the A TIME/DIV switch to 50 ms, the A SLOPE switch to +, and the A SOURCE switch to NORM.

b. Connect the Time-Mark Generator (Type 2901) to the CH 1 input via a 42-inch 50 Ω BNC cable and a 50 Ω BNC termination.

c. Select 50 ms time marks from the Time-Mark Generator.

d. CHECK—That a stable display can be obtained by adjusting the A LEVEL control. Time marker must be at the start of the sweep.

e. Disconnect the test setup.

60. Adjust Trigger View Centering

a. Set the CH 1 AC-GND-DC switch to DC, the CH 1 VOLTS/DIV switch to 10 mV, the A COUPLING switch to DC, the A SOURCE switch to EXT, the A SLOPE switch to +, and the A LEVEL control to 0.

b. Push the TRIG VIEW button and hold it in.

c. CHECK—That the trace is within 1 division of the center horizontal graticule line.

d. ADJUST—Trigger View Centering adjustment, R673 (see Fig. 5-22), so that the trace is at the center horizontal line.

e. Release the TRIG VIEW button.

f. Disconnect the test setup.

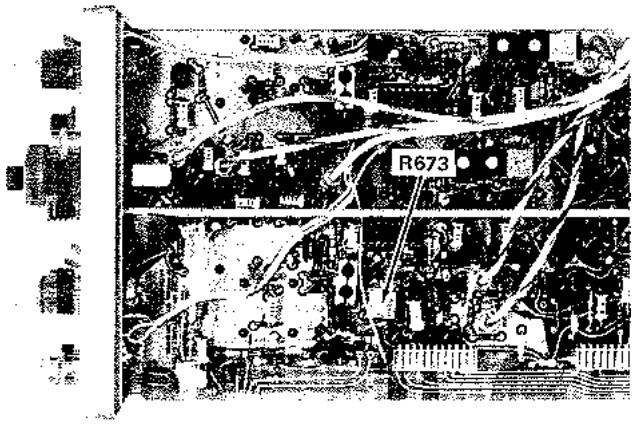


Fig. 5-22. Location of Trigger View Centering adjustment.

61. Check Trigger View Deflection Factor

a. Connect the output of the Standard Amplitude Calibrator to the A External Trigger input via a 42-inch 50 Ω BNC cable.

b. Adjust the Standard Amplitude Calibrator for a 200 mV output.

c. Push the TRIG VIEW button and hold it in.

d. CHECK–For 3.2 to 4.8 divisions of display.

e. Release the TRIG VIEW button.

f. Disconnect the test setup.

HORIZONTAL SYSTEM CALIBRATION

Equipment Required	
1. Standard Amplitude Calibrator (067-0502-01)	6. P6022 Current Probe
2. Medium-Frequency Constant-Amplitude Signal Generator (Type 191)	7. 42-inch 50 Ω BNC Cable (two)
	8. 50 Ω BNC Termination (two)
3. Time-Mark Generator (Type 2901)	9. Dual Input Coupler
4. Test Oscilloscope	10. Three-inch Screwdriver
5. X10 Probe	11. Low-Capacitance Screwdriver

Control Settings

Preset instrument controls to the settings given under Preliminary Control Settings except as follows:

A TIME/DIV	1 ms
B TIME/DIV	1 μs
HORIZ DISPLAY	A INTEN
B SOURCE	STARTS AFTER DELAY
DELAY TIME POSITION	1.00

62. Adjust Delay Start and Delay Stop

a. Connect 1 ms time marks to the CH 1 input from the Time-Mark Generator (Type 2901) via a 42-inch 50 Ω BNC cable and a 50 Ω BNC termination.

b. CHECK–Intensified portion of the sweep begins at the second time marker.

c. ADJUST–Delay Start adjustment, R938 (see Fig. 5-23), so the left side of the intensified zone starts on the leading edge of the second time marker.

d. Set the DELAY TIME POSITION dial to 9.00.

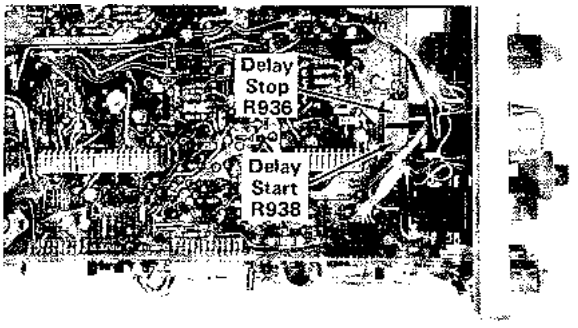


Fig. 5-23. Location of Delay Start and Delay Stop adjustments.

e. CHECK—Intensified portion of the sweep begins at the tenth time marker.

f. ADJUST—Delay Stop adjustment, R936 (see Fig. 5-23), so the left side of the intensified zone starts on the leading edge of the tenth time marker.

g. Set the HORIZ DISPLAY switch to B DLY'D.

h. Set the DELAY TIME POSITION dial to 1.00.

i. CHECK—Displayed pulse starts at the beginning of the sweep.

j. ADJUST—Delay Start adjustment, R938, so the displayed pulse starts at the beginning of the sweep.

k. Set the DELAY TIME POSITION dial to 9.00.

l. CHECK—Displayed pulse starts at the beginning of the sweep.

m. ADJUST—Delay Stop adjustment, R936, so the displayed pulse starts at the beginning of the sweep.

n. INTERACTION—Between Delay Start and Delay Stop adjustments. Repeat both for no visible interaction.

63. Check Differential Time Accuracy

a. Set the DELAY TIME POSITION dial to position the tenth time marker to the beginning of the sweep.

b. Note the reading on the DELAY TIME POSITION dial.

c. Adjust the DELAY TIME POSITION dial so the ninth time marker is at the beginning of the sweep.

d. CHECK—DELAY TIME POSITION dial for a reading one division less, within 0.01 division from +15°C to +35°C (one division less, within 0.02 division from −15°C to +55°C) than the reading noted in step 63-b.

e. Rotate the DELAY TIME POSITION dial to position each successive time marker to the beginning of the sweep.

f. CHECK—DELAY TIME POSITION dial for a reading of one division less, within 0.01 division from +15°C to +35°C (one division less, within 0.02 division from −15°C to +55°C), than the adjacent time marker.

64. Adjust Horizontal Amplifier Gain

a. Set the HORIZ DISPLAY switch to A, both TIME/DIV switches to 1 ms, and the VERT MODE switch to CH 1.

b. Select 1 ms time marks from the Time-Mark Generator.

NOTE

Unless otherwise stated, timing checks are made over the entire 10 divisions.

c. CHECK—CRT display for 1 time marker/division, within 1% from +20°C to +30°C; for 1 time marker/division, within 3% from −15°C to +55°C.

d. ADJUST—Horizontal Gain adjustment, R1155 (see Fig. 5-24), for 1 time marker/division.

NOTE

Effective range of R1155 is determined by the selected value of R1154. R1154 may be 100 Ω, 124 Ω, or 150 Ω, 1/8 watt, 1% resistor.

e. Select 0.1 ms time marks from the Time-Mark Generator.

f. Push the X10 MAG button.

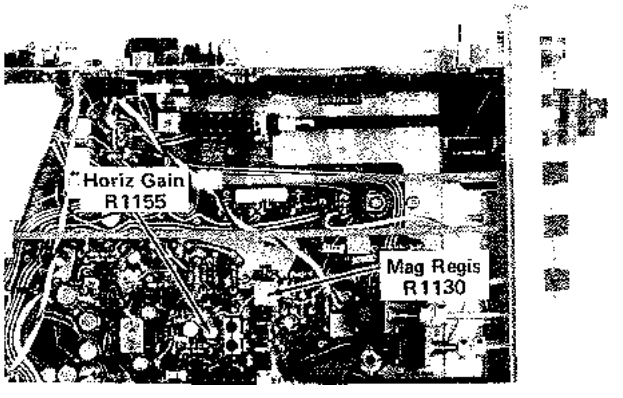


Fig. 5-24. Location of Horizontal Gain and Magnifier Registration adjustments.

g. CHECK–X10 MAG light is on when the X10 MAG button is in.

h. CHECK–CRT display for 1 time marker/division, within 2% from +20°C to +30°C; for 1 time marker/division, within 4% from –15°C to +55°C.

65. Adjust Magnifier Registration

a. Select 5 ms time marks from the Time-Mark Generator.

b. Position the second time marker to the center vertical graticule line.

c. Release the X10 MAG.

d. CHECK–Second time marker is within 0.4 division of the center vertical graticule line.

e. ADJUST–Magnifier Registration adjustment, R1130 (see Fig. 5-24), to position the second time marker to the center vertical graticule line.

f. CAL AID–Repeat the above procedure until no shift occurs between the positions of the X10 MAG switch.

66. Check VAR TIME/DIV Range

a. Set the A TIME/DIV switch to 2 ms and the HORIZ DISPLAY switch to A.

b. Select 5 ms time marks from the Time-Mark Generator.

c. CHECK–At least 1 time marker/division can be obtained by rotating the VAR TIME/DIV control.

d. CHECK–That the UNCAL light comes on when the VAR TIME/DIV control is out of the detent position.

e. Return the VAR TIME/DIV control to the detent position.

67. Check Horizontal POSITION Control Range

a. Set the Horizontal FINE control to midrange and the A TIME/DIV switch to 2 ms.

b. Turn the horizontal POSITION control fully clockwise.

c. CHECK–Start of sweep is to the right of the center vertical graticule line.

d. Turn the horizontal POSITION control fully counterclockwise.

e. CHECK–End of sweep is to the left of the center vertical graticule line.

f. Rotate the horizontal FINE control.

g. CHECK–That the FINE control will position the sweep between one and two divisions.

68. Adjust 10 Microsecond Timing

a. Set the DELAY TIME POSITION dial to 0.00, the B SOURCE switch to STARTS AFTER DELAY, and both TIME/DIV switches to 10 μs.

b. Select 10 μs time marks from the Time-Mark Generator.

c. CHECK–CRT display for 1 time marker/division, within 1% from +20°C to +30°C; 1 time marker/division, within 3% from –15°C to +55°C.

d. ADJUST–C1064 (see Fig. 5-25) with a low-capacitance screwdriver, for 1 time marker/division.

e. Set the HORIZ DISPLAY switch to A INTEN, and the B TIME/DIV switch to 0.1 μs.

f. CHECK–CRT display for 1 time marker/division, within 1% from +20°C to +30°C; 1 time/marker/division, within 3% from –15°C to +55°C.

g. ADJUST–C1023 (see Fig. 5-25) with a low-capacitance screwdriver, for 1 time marker/division.

h. Set the HORIZ DISPLAY switch to B DLY'D and the DELAY TIME POSITION dial to 1.00.

i. Adjust the DELAY TIME POSITION dial to position the time marker to the center vertical graticule line.

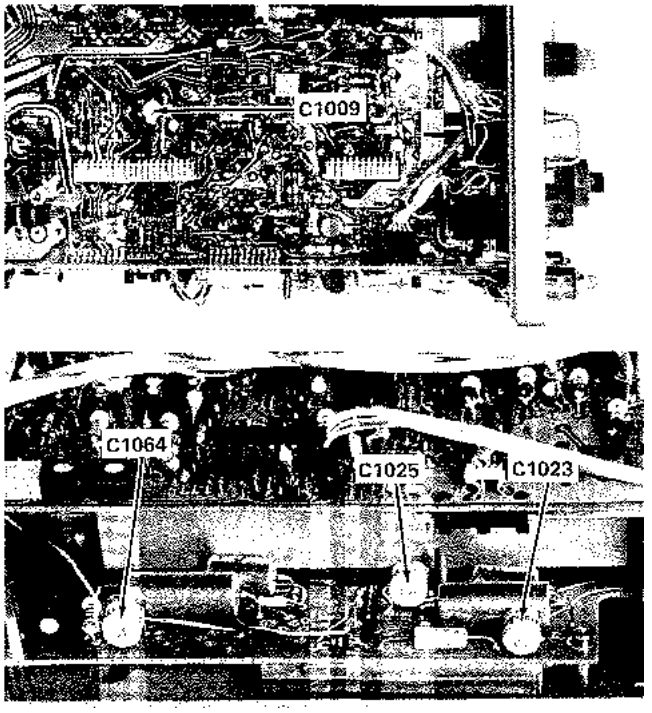


Fig. 5-25. Location of A and B Sweep timing adjustments.

j. Note the reading on the DELAY TIME POSITION dial for use in step 68-k.

k. Turn the DELAY TIME POSITION dial 8 divisions higher than the reading in step 68-j.

l. CHECK—Time marker is at center vertical graticule line.

m. ADJUST—C1023 to position the time marker to the center vertical graticule line.

n. CAL AID—Repeat the above procedure for optimum timing response at +1.00 and +8.00 settings of the DELAY TIME POSITION dial.

69. Adjust 0.1 Microsecond Timing

a. Set the DELAY TIME POSITION dial to 1.00, the HORIZ DISPLAY switch to A INTEN, and the B TIME/DIV switch to 0.1 μs.

b. Select 0.1 μs time marks from the Time-Mark Generator.

c. CHECK—CRT display for 1 time marker/division, within 2% from +20°C to +30°C; 1 time marker/division, within 3% from −15°C to +55°C.

d. ADJUST—C1025 (see Fig. 5-25) with a low-capacitance screwdriver, for 1 time marker/division.

e. Set the HORIZ DISPLAY switch to B DLY'D and the B TIME/DIV switch to 0.01 μs.

f. Adjust the DELAY TIME POSITION dial to position the time marker to the center vertical graticule line.

g. Note the reading of the DELAY TIME POSITION dial for use in step 69-h.

h. Turn the DELAY TIME POSITION dial 8 divisions higher than the reading in step 69-g.

i. CHECK—Time marker is at center vertical graticule line.

j. ADJUST—C1025 to position the time marker to the center vertical graticule line.

k. CAL AID—Repeat the above procedure for optimum timing response at +1.00 and +8.00 settings of the DELAY TIME POSITION dial.

l. Set the HORIZ DISPLAY switch to A and both TIME/DIV switches to 0.1 μs.

m. CHECK—CRT display for 1 time marker/division, within 1% from +20°C to +30°C; 1 time marker/division, within 3% from −15°C to +55°C.

n. ADJUST—C1009 (see Fig. 5-25) with a low-capacitance screwdriver for 1 time marker/division.

o. Disconnect the test setup.

70. Adjust Horizontal Output Centering

a. Set the A TIME/DIV switch to X-Y, the HORIZ DISPLAY switch to A, and the VERT MODE switch to CH 1.

b. Adjust the CH 1 POSITION control to horizontally center the dot.

c. Set the Test Oscilloscope: TIME/DIV switch to 1 ms, VOLTS/DIV switch to 0.5 V, and AC-GND-DC switch to DC.

d. Connect a X10 probe from the Test Oscilloscope to the +50 V test point on the 475 (see Fig. 5-26).

e. Position the trace on the Test Oscilloscope to the center vertical graticule line.

f. Disconnect the probe from the +50 V test point.

g. Alternately check the voltage on the collectors of Q1214 and Q1204 (see Fig. 5-26).

h. CHECK—That the voltage at the collectors of Q1214 and Q1204 is equal.

i. Adjust the 475 CH 1 POSITION control until the voltage at the collector of Q1214 equals that on the collector of Q1204.

j. ADJUST—Horizontal Output Centering adjustment, R1256 (see Fig. 5-26), for +50 V on the collector of Q1214 and Q1204.

k. Disconnect the test setup.

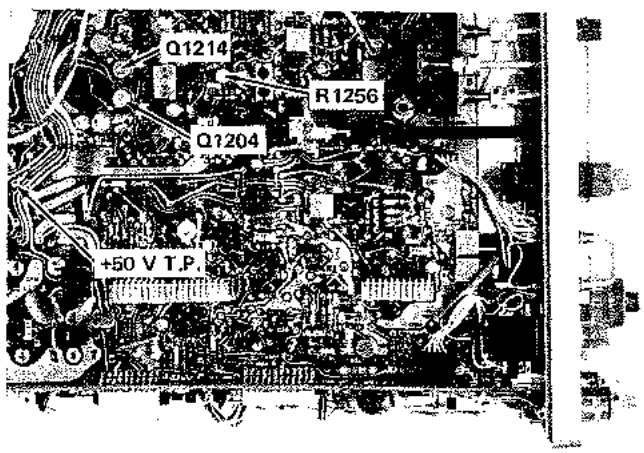


Fig. 5-26. Location of Q1204, Q1214, +50 V TP, and Horizontal Output Centering adjustment.

71. Adjust High-Speed Timing—Visual Method

NOTE

This step is intended only as a "touch up" of the timing adjustments. If the adjustments are greatly misadjusted, or major portions of the circuitry have been replaced, proceed with step 72.

a. Set the A TIME/DIV switch to 0.05 μs, the X10 MAG button in, the A SOURCE switch to EXT, and the A COUPLING switch to LF REJ.

b. Connect the output of the Time-Mark Generator (Type 2901) to the CH 1 input via a 42-inch 50 Ω BNC cable and a 50 Ω BNC termination.

c. Connect the TRIGGER OUT of the Time-Mark Generator to the A External Trigger input via a 42-inch 50 Ω BNC cable and a 50 Ω BNC termination.

d. Select 5 ns time marks and 0.1 μs triggers from the Time-Mark Generator.

e. CHECK—CRT display for 1 cycle/division, within 2% from +20°C to +30°C; 1 cycle/division, within 4% from −15°C to +55°C.

f. ADJUST—C1233 and C1253 (see Fig. 5-27), with a low-capacitance screwdriver, in approximately equal amounts to achieve 1 cycle/division.

g. Set the A TIME/DIV switch to 0.02 μs.

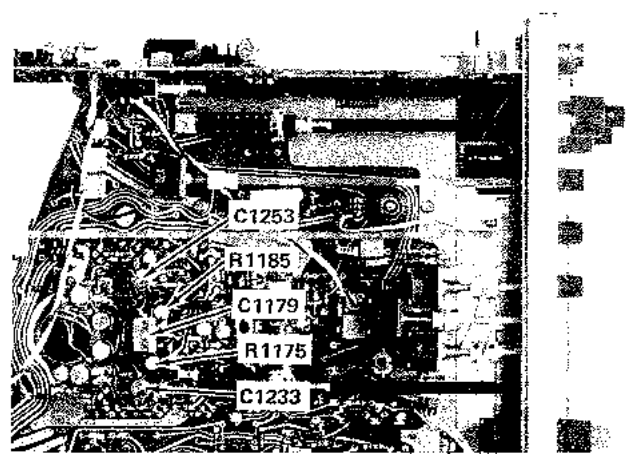


Fig. 5-27. Location of high-speed timing adjustments (except R1075).

h. Select 2 ns time marks from the Time-Mark Generator.

i. CHECK—CRT display for 1 cycle/division, within 2% from +20°C to +30°C; 1 cycle/division, within 4% from −15°C to +55°C.

j. ADJUST—C1179 (see Fig. 5-27) with a low-capacitance screwdriver, for 1 cycle/division.

k. Set the A TIME/DIV switch to 0.01 μs.

l. CHECK—CRT display for 1 cycle/2 divisions, within 2% from +20°C to +30°C; 1 cycle/2 divisions, within 4% from −15°C to +55°C.

m. ADJUST—R1075 (see Fig. 5-28) with a low-capacitance screwdriver, for 1 cycle/2 divisions.

n. CAL AID—If the 2 ns timing is long and the 5 ns timing is short, decrease C1179 and increase C1233 or C1253.

NOTE

If timing cannot be adjusted to within 2% accuracy from +20°C to +30°C, or 4% accuracy from −15°C to +55°C, proceed to step 72. If timing is within the given accuracy, proceed with step 73.

72. Adjust High-Speed Timing—Current Probe Method

NOTE

The signal amplitudes given in this step are only approximations and should only be used as guides. It is desirable to obtain as flat and wide a current waveform as possible.

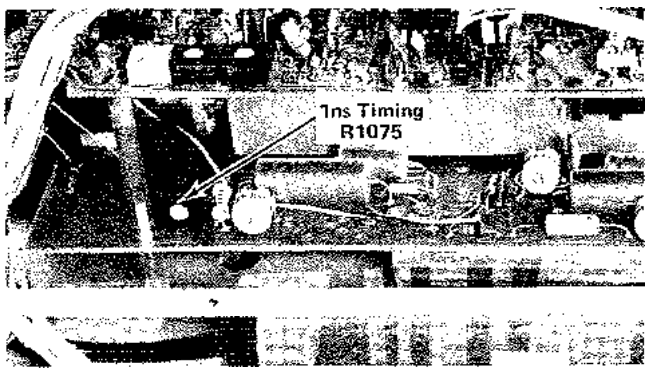


Fig. 5-28. Location of 1 nanosecond timing adjustment.

a. Set the A TIME/DIV switch to 0.05 μs and push the X10 MAG button in.

b. Select 5 ns time marks and 0.1 μs triggers from the Time-Mark Generator.

c. Connect a P6022 current probe with passive termination from the Test Oscilloscope.

d. Hook the current probe around the crossed horizontal deflection leads on the 475 (see Fig. 5-29).

e. Horizontally center the trace with the horizontal POSITION control.

f. Set the Test Oscilloscope: VOLTS/DIV switch to 5 mV, TIME/DIV switch to 0.5 μs, and the X10 MAG switch engaged.

g. CHECK—Test Oscilloscope for current waveform with approximately 16 mA amplitude.

h. ADJUST—(See Fig. 5-27), R1175 to midrange, R1185 to midrange, C1233 and C1253 half-closed, and C1179 one turn from fully clockwise.

i. ADJUST—R1175 and R1185 (see Fig. 5-27) for a symmetrical waveform similar to that in Fig. 5-30.

j. CAL AID—The small ringing is from the Time-Mark Generator. The top should be as flat and wide as possible. Since R1175 and R1185 have a greater effect on the 1 ns and 2 ns ranges, they will be adjusted again later in the step.

k. ADJUST—C1233 and C1253 (see Fig. 5-27) equally for 1 time marker/division.

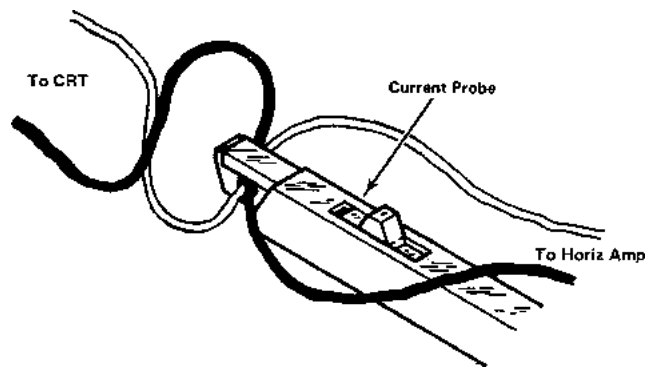


Fig. 5-29. Proper connection of current probe to horizontal deflection leads for high-speed timing calibration.

NOTE

C1253 may need to be closed more than C1233 to make the top of the waveform flatter on the 2 ns range.

l. Set the A TIME/DIV switch to 0.02 μs and select 2 ns time marks from the Time-Mark Generator.

m. Set the Test Oscilloscope TIME/DIV switch to 0.2 μs, and the VOLTS/DIV switch to 10 mV.

n. ADJUST—C1179 (see Fig. 5-27) for 1 time marker/division.

o. CHECK—Test Oscilloscope for a current waveform approximately 40 mA in amplitude.

p. Set the 475 A TIME/DIV switch to 0.01 μs.

q. Set the Test Oscilloscope TIME/DIV switch to 0.1 μs, and the VOLTS/DIV switch to 20 mV.

r. ADJUST—R1075 for 1 time marker/2 divisions.

s. CHECK—Test Oscilloscope for a current waveform approximately 80 mA in amplitude.

t. ADJUST—R1175 and R1185 for a symmetrical waveform with a flat top.

NOTE

Q1234 affects the flatness of the top of the waveform and should be changed if it is difficult to obtain a flat-top waveform.

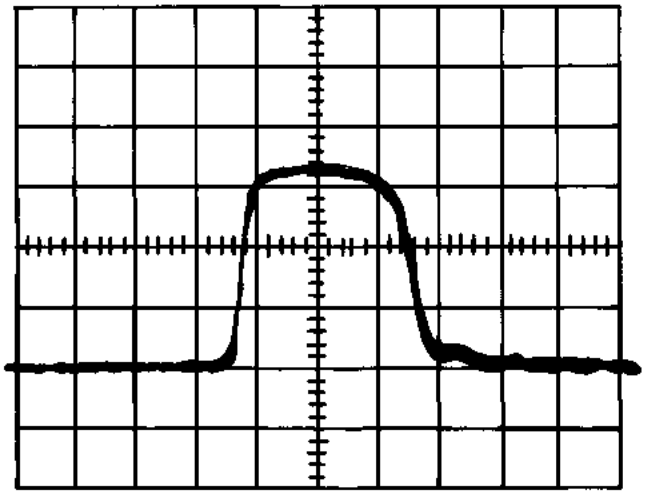


Fig. 5-30. Typical CRT display with high-speed timing adjustments preset.

v. CHECK—Timing error at 2 ns and 5 ns ranges.

NOTE

If 2 ns timing is long and 5 ns timing is short, decrease C1179 and increase C1233 and/or C1253.

w. INTERACTION—R1175 and R1185 should be readjusted for best symmetry and flatness on the 1 ns and 2 ns ranges if C1179, C1233, C1253, or R1075 is readjusted.

x. Remove the current probe, being sure not to spread the CRT horizontal deflection leads.

73. Check TIME/DIV Accuracy

a. CHECK—Using the A TIME/DIV switch and the Time-Mark Generator settings given in Table 5-7, check that A SWEEP timing is within the given tolerance.

TABLE 5-7

Timing Accuracy

A TIME/DIV Switch Setting	Time-Mark Generator Output	CRT Display (markers/division)	Accuracy	
			+20°C to +30°C	−15°C to +55°C
0.01 μs	10 ns	1	1%	3%
0.02 μs	10 ns	2	1%	3%
0.05 μs	50 ns	1	1%	3%
0.1 μs	0.1 μs	1	1%	3%
0.2 μs	0.1 μs	2	1%	3%
0.5 μs	0.5 μs	1	1%	3%
1 μs	1 μs	1	1%	3%
2 μs	1 μs	2	1%	3%
5 μs	5 μs	1	1%	3%
10 μs	10 μs	1	1%	3%
20 μs	10 μs	2	1%	3%
50 μs	50 μs	1	1%	3%
0.1 ms	0.1 ms	1	1%	3%
0.2 ms	0.1 ms	2	1%	3%
0.5 ms	0.5 ms	1	1%	3%
1 ms	1 ms	1	1%	3%
2 ms	1 ms	2	1%	3%
5 ms	5 ms	1	1%	3%
10 ms	10 ms	1	2%	3%
20 ms	10 ms	2	2%	3%
50 ms	50 ms	1	2%	3%
0.1 s	0.1 s	1	2%	3%
0.2 s	0.1 s	2	2%	3%
0.5 s	0.5 s	1	2%	3%

74. Check A INTEN Timing Accuracy

a. Set the HORIZ DISPLAY switch to A INTEN.

b. CHECK—Using the A TIME/DIV switch and Time-Mark Generator settings given in Table 5-8, check that A INTEN timing is within the given tolerance.

TABLE 5-8

A Intensified Timing Accuracy

A TIME/DIV Switch Setting	Time-Mark Generator Output	CRT Display (markers/division)	Accuracy	
			+20°C to +30°C	+15°C to +55°C
0.05 μs	50 ns	1	2%	3%
0.1 μs	0.1 μs	1	2%	3%
0.2 μs	0.1 μs	2	2%	3%
0.5 μs	0.5 μs	1	2%	3%
1 μs	1 μs	1	2%	3%
2 μs	1 μs	2	2%	3%
5 μs	5 μs	1	2%	3%
10 μs	10 μs	1	2%	3%
20 μs	10 μs	2	2%	3%
50 μs	50 μs	1	2%	3%
0.1 ms	0.1 ms	1	2%	3%
0.2 ms	0.2 ms	2	2%	3%
0.5 ms	0.5 ms	1	2%	3%
1 ms	1 ms	1	2%	3%
2 ms	1 ms	1	2%	3%
5 ms	5 ms	1	2%	3%
10 ms	10 ms	1	2%	3%
20 ms	10 ms	2	2%	3%
50 ms	50 ms	1	2%	3%
0.1 s	0.1 s	1	2%	3%
0.2 s	0.1 s	2	2%	3%
0.5 s	0.5 s	1	2%	3%

75. Check Magnified Timing Accuracy

a. CHECK—Using the A TIME/DIV switch and the Time-Mark Generator settings given in Table 5-10, check that A magnified sweep timing is within the given tolerance. Note the portions of the total magnified sweep length to be excluded from the measurement.

76. Check Delay Time Accuracy

a. Set the HORIZ DISPLAY switch to B DLY'D, the A TIME/DIV switch to 0.05 μs, the B TIME/DIV switch to 0.01 μs and the B SOURCE switch to STARTS AFTER DELAY.

b. CHECK—Using the A TIME/DIV switch, the B TIME/DIV switch and the Time-Mark Generator settings given in Table 5-9, check that delayed sweep accuracy is within the given tolerance. First set the DELAY TIME POSITION dial to 1.00 and rotate the dial until the sweep starts at the top of the second time marker. Note the control setting, then set the dial to 2.00 and rotate it slightly until the sweep starts at the top of the third time marker. The error for intervals less then 1 dial division cannot exceed 0.01 dial division. Continue to rotate the DELAY TIME POSITION dial to check between the 1.00 and 9.00 settings for all A sweep speeds from 0.05 μs to 0.5 s. The difference between any two time markers greater than 1 dial division apart cannot exceed 1%.

NOTE

Sweep will start at the top of the third time marker at 1.00 and at the top of the nineteenth time marker at 9.00 for sweep rates which are multiples of 2 (e.g., 2 μs, 20 μs, 0.2 ms, etc.). If in doubt as to the correct setting of the DELAY TIME POSITION dial, set the HORIZ DISPLAY switch to A INTEN and check which time marker is intensified.

TABLE 5-9

Delayed Sweep Accuracy

A TIME/DIV Switch Setting	B TIME/DIV Switch Setting	Time-Mark Generator Output
0.05 μs	0.01 μs	0.05 μs
0.1 μs	0.01 μs	0.1 μs
0.2 μs	0.05 μs	0.1 μs
0.5 μs	0.05 μs	0.5 μs
1 μs	0.1 μs	1 μs
2 μs	0.1 μs	1 μs
5 μs	0.1 μs	5 μs
10 μs	1 μs	10 μs
20 μs	1 μs	10 μs
50 μs	1 μs	50 μs
0.1 ms	10 μs	0.1 ms
0.2 ms	10 μs	0.1 ms
0.5 ms	10 μs	0.5 ms
1 ms	0.1 ms	1 ms
2 ms	0.1 ms	1 ms
5 ms	0.1 ms	5 ms
10 ms	1 ms	10 ms
20 ms	1 ms	10 ms
50 ms	1 ms	50 ms
0.1 s	10 ms	0.1 s
0.2 s	10 ms	0.1 s
0.5 s	10 ms	0.5 s

TABLE 5-10

A and B Magnified Timing Accuracy

A TIME/DIV Switch Setting	Time-Mark Generator Output	CRT Display (Markers/ Division)	Portions of total magnified sweep length to exclude from measurement	Accuracy	
				+20°C to +30°C	−15°C to +55°C
0.01 μs	2 ns	2	First 25 ns and all beyond the 100th magnified division.	2%	4%
0.02 μs	2 ns	1		2%	4%
0.05 μs	5 ns	1		2%	4%
0.1 μs	10 ns	1		2%	4%
0.2 μs	10 ns	2		2%	4%
0.5 μs	50 ns	1		2%	4%
1 μs	0.1 μs	1		2%	4%
2 μs	0.1 μs	2		2%	4%
5 μs	0.5 μs	1		2%	4%
10 μs	1 μs	1		2%	4%
20 μs	1 μs	2		2%	4%
50 μs	5 μs	1		2%	4%
0.1 ms	10 μs	1		2%	4%
0.2 ms	10 μs	2		2%	4%
0.5 ms	50 μs	1		2%	4%
1 ms	0.1 ms	1		2%	4%
2 ms	0.1 ms	2		2%	4%
5 ms	0.5 ms	1		2%	4%
10 ms	1 ms	1		3%	4%
20 ms	1 ms	2		3%	4%
50 ms	5 ms	1		3%	4%

77. Check Delay Time Jitter

a. Set the DELAY TIME POSITION dial to 1.00, the HORIZ DISPLAY switch to B DLY'D, the A TIME/DIV switch to 1 ms, and the B TIME/DIV switch to 0.2 μs.

b. Position the time marker near the center of the display area with the DELAY TIME POSITION dial.

c. CHECK—Jitter on the leading edge of the time marker does not exceed 1 division.

d. Turn the DELAY TIME POSITION dial to 9.00 and adjust it so the time marker is displayed near the center of the display area.

e. CHECK—Jitter on the leading edge of the time marker does not exceed 1 division.

78. Check Mixed Sweep Timing Accuracy

a. Set the A TIME/DIV switch to 1 ms, the B TIME/DIV switch to 0.5 ms, the HORIZ DISPLAY switch to MIX, the B SOURCE switch to STARTS AFTER DELAY, and the DELAY TIME POSITION dial fully clockwise.

b. Select 1 ms time marks from the Time-Mark Generator.

c. CHECK—The timing between first and eleventh time markers is within ±0.3 division.

NOTE

Exclude the first 0.5 division of sweep after the display start and the first 0.2 division, or 0.1 μs (whichever is greater) after the transition of A to B.

d. Disconnect the test setup.

79. Adjust X Gain

a. Set the A TIME/DIV switch to X-Y, the VERT MODE switch to CH 2, both VOLTS/DIV switches to 5 mV, and the CH 1 AC-GND-DC switch to DC.

b. Apply a 20 mV square wave from the Standard Amplitude Calibrator to the CH 1 or X input through a 42-inch 50 Ω BNC cable.

c. CHECK—CRT display for 4 divisions of deflection between the two displayed dots, within 3%.

d. ADJUST—X-Gain adjustment, R1102 (see Fig. 5-31) for exactly four divisions of deflection between the two dots displayed on the CRT.

e. Disconnect the test setup.

80. Adjust X-Y Phasing and Bandwidth

a. Set both VOLTS/DIV switches to 5 mV and both AC-GND-DC switches to AC.

b. Connect the output of the Medium-Frequency Constant-Amplitude Signal Generator (Type 191) to the CH 1 and CH 2 inputs through a GR-to-BNC adapter, a 42-inch 50 Ω BNC cable, 50 Ω BNC termination, and a dual input coupler.

c. Adjust the Medium-Frequency signal generator for an eight division horizontal display of 50 kilohertz signal.

d. Center the display vertically and horizontally with the CH 1 and CH 2 POSITION controls.

e. CHECK—CRT display for an opening at the center horizontal line of 0.14 division or less.

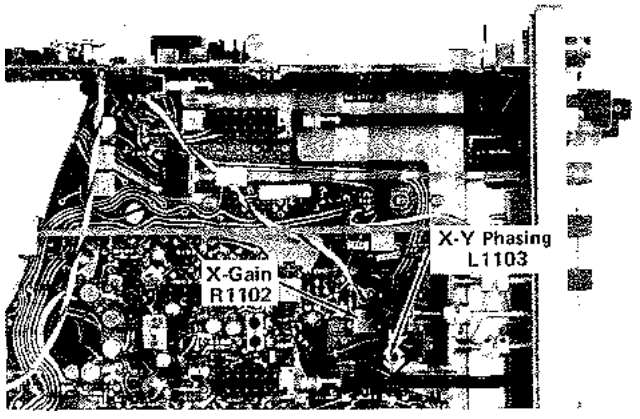


Fig. 5-31. Location of X Gain and X-Y Phasing adjustments.

f. Increase the output frequency of the Medium-Frequency signal generator to 2 megahertz.

g. CHECK—CRT display for an opening at the center horizontal line of 0.42 division or less.

h. ADJUST—L1103 (see Fig. 5-31), for maximum closing of the display.

i. Remove the dual input coupler from the test setup.

j. Reconnect the test signal to the CH 1 input.

k. Adjust the signal generator for a 4 division horizontal display of 50 kilohertz signal.

l. Increase the output frequency of the signal generator until the display is reduced to 2.8 divisions.

m. CHECK—Output frequency of the signal generator is at least 3 megahertz.

n. Disconnect the test setup.

81. Check B ENDS A Operation

a. Set the HORIZ DISPLAY switch to A INTEN, the A TIME/DIV switch to 1 ms, the B TIME/DIV switch to 0.1 ms, and the A TRIG HOLDOFF control to B ENDS A.

b. Adjust the INTENSITY control so that the A sweep is visible.

c. Rotate the DELAY TIME POSITION dial through its range.

d. CHECK—A Sweep ends after the intensified portion at all settings of the DELAY TIME POSITION dial settings.

82. Check A TRIG HOLDOFF Operation

a. Set the HORIZ DISPLAY switch to A, the A TIME/DIV switch to 50 μs, and the A TRIG HOLDOFF control fully counterclockwise.

b. Connect the +A GATE output signal to the Test Oscilloscope via a 42-inch 50 Ω BNC cable.

c. Set the Test Oscilloscope TIME/DIV switch so that the bottom portion of the waveform (holdoff time of the +A GATE) is slightly less than one division.

d. Rotate the A TRIG HOLDOFF control clockwise (not into the B ENDS A detent).

e. CHECK—For at least nine times increase in the holdoff time of the +A GATE.

f. Set the A TRIG HOLDOFF control fully counterclockwise.

CALIBRATOR, + GATES, AND EXT Z-AXIS CALIBRATOR

Equipment Required	
1. Medium-Frequency Constant-Amplitude Signal Generator (Type 191)	4. BNC-T Connector
2. Precision DC Voltmeter	5. 42-inch 50 Ω BNC Cable (two)
3. GR-to-BNC Female Adapter	6. Three-inch Screwdriver

Control Settings

Preset instrument controls to the settings given under Preliminary Control Settings.

83. Adjust CALIBRATOR Amplitude

a. Connect the Precision DC Voltmeter between the CALIBRATOR current loop and ground.

b. Short the emitter and base of Q1504 together (see Fig. 5-32).

c. CHECK—For a meter reading of +0.3 volt, within 3 mV.

d. ADJUST—Calibrator Amplitude adjustment, R1515 (see Fig. 5-32) for +0.3 volt, within 1% from 0°C to +40°C; for +0.3 volt, within 1.5% from −15°C to +55°C.

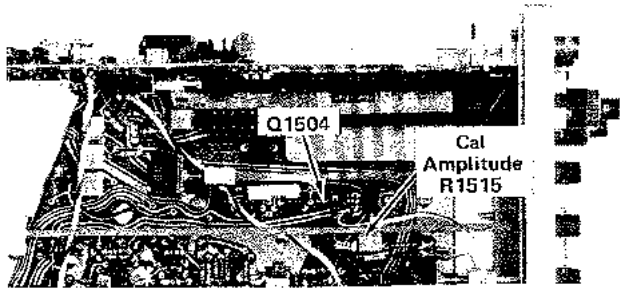


Fig. 5-32. Location of Q1504 and Calibrator amplitude adjustment.

e. Remove the Precision DC Voltmeter connections and the short between emitter and base of Q1504.

84. Check A and B + GATE Outputs

a. Set the DELAY TIME POSITION dial fully counterclockwise, the HORIZ DISPLAY switch to B DLY'D, the B SOURCE switch to STARTS AFTER DELAY, the B TIME/DIV switch to 50 μs, and the TRIG MODE to AUTO.

b. Connect the B + GATE output signal to the Test Oscilloscope via a 42-inch 50 Ω BNC cable.

c. CHECK—Test Oscilloscope for a positive-going pulse +5.5 volts in amplitude (within 0.5 V).

d. Remove the B + GATE output signal and connect the A + GATE output signal to the Test Oscilloscope.

e. CHECK—Repeat step 84-c.

f. Disconnect the test setup.

85. Check EXT Z-AXIS Operation

a. Set the HORIZ DISPLAY switch to A, the A TIME/DIV switch to 0.2 ms, and the A SOURCE switch to NORM.

b. Set the INTENSITY control for a normal viewing level.

c. Connect the Medium-Frequency Constant-Amplitude Signal Generator (Type 191) to the CH 1 input and the EXT Z-AXIS input (on the rear panel) via a GR-to-BNC adapter, a BNC-T connector, and two 42-inch 50 Ω BNC cables.

d. Adjust the Medium-Frequency signal generator for a 5 volt (peak-to-peak) 50 kilohertz signal.

e. CHECK—CRT display for noticeable intensity modulation of the positive peaks.

f. Disconnect the test setup.

ELECTRICAL PARTS LIST

Replacement parts should be ordered from the Tektronix Field Office or Representative in your area. Changes to Tektronix products give you the benefit of improved circuits and components. Please include the instrument type number and serial number with each order for parts or service.

ABBREVIATIONS AND REFERENCE DESIGNATORS

A	Assembly, separable or repairable	FL	Filter	PTM	paper or plastic, tubular molded
AT	Attenuator, fixed or variable	H	Heat dissipating device (heat sink, etc.)	R	Resistor, fixed or variable
B	Motor	HR	Heater	RT	Thermistor
BT	Battery	J	Connector, stationary portion	S	Switch
C	Capacitor, fixed or variable	K	Relay	T	Transformer
Cer	Ceramic	L	Inductor, fixed or variable	TP	Test point
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	U	Assembly, inseparable or non-repairable
CRT	cathode-ray tube	M	Meter	V	Electron tube
DL	Delay line	Q	Transistor or silicon-controlled rectifier	Var	Variable
DS	Indicating device (lamp)	P	Connector, movable portion	VR	Voltage regulator (zener diode, etc.)
Elect.	Electrolytic	PMC	Paper, metal cased	WW	wire-wound
EMC	electrolytic, metal cased	PT	paper, tubular	Y	Crystal
EMT	electrolytic, metal tubular				
F	Fuse				

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLIES				
A1	670-2100-00			CH 1 ATTEN Circuit Board Assembly
A2	670-2100-00			CH 2 ATTEN Circuit Board Assembly
A3	670-2240-00			VERT PREAMP. Circuit Board Assembly
A4	670-2243-00			GAIN SW Circuit Board Assembly
A5	670-2242-00			VERT OUTPUT Circuit Board Assembly
A6	670-2245-00			FAN MOTOR Circuit Board Assembly
A7	670-2244-00			TIMING Circuit Board Assembly
A8	670-2241-00			TRIGGER GEN & Z AXIS LOGIC Circuit Board Assembly
A9	670-2239-00			MAIN Circuit Board Assembly
A10	670-2279-00			GRATICULE ILLUM Circuit Board Assembly
MOTOR				
B1690	147-0035-00			Motor, 10-5VDC, 145 mA
CAPACITORS				
C10	281-0064-00			0.25-1.5 pF, Var, Tub., 600 V
C11	283-0000-00			0.001 uF, Cer, 500 V, +100%-10%
C12	285-0816-01			0.019 uF, Plastic, 600 V, 10%
C13	283-0000-00			0.001 uF, Cer, 500 V, +100%-10%
C30, C31 2	307-1014-01			Attenuator strip, 100X
C32, C33 2	307-1013-01			Attenuator strip, 10X
C34, C35 2	307-1011-00			Attenuator strip, 10X
C36, C37 2	307-1010-01			Attenuator strip, 2X

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
CAPACITORS (cont)				
C41	283-0156-00			1000 pF, Cer, 200 V, +100%-0%
C50	281-0064-00			0.25-1.5 pF, Var, Tub., 600 V
C51	283-0000-00			0.001 uF, Cer, 500 V, +100%-0%
C52	285-0816-01			0.019 uF, Plastic, 600 V, 10%
C53	283-0000-00			0.001 uF, Cer, 500 V, +100%-0%
C61	283-0156-00			1000 pF, Cer, 200 V, +100%-0%
C104	281-0619-00	B010100	B010309	1.2 pF, Cer, 200 V, ±0.1 pF
C104	281-0064-00	B010310		0.25-1.5 pF, Var, Tub., 600 V
C105	283-0080-00			0.022 uF, Cer, 25 V, +80%-20%
C107	283-0111-00			0.1 uF, Cer, 50 V
C109	283-0238-00	B010100	B049999	0.01 uF, Cer, 50 V, 10%
C109	283-0238-00	B050000		0.01 uF, (nominal value), selected
C112	281-0123-00			5-25 pF, Var, Cer
C113	283-0156-00			0.001 uF, Cer, 200 V, +100%-0%
C119	283-0191-00			0.022 uF, Cer, 50 V, 20%
C123	283-0080-00	XB050000		0.022 uF, Cer, 25 V, +80%-20%
C127	283-0080-00	XB050000		0.022 uF, Cer, 25 V, +80%-20%
C133	281-0123-00			5-25 pF, Var, Cer
C136	283-0213-00			300 pF, Cer, 100 V, 5%
C137	283-0178-00			0.1 uF, Cer, 100 V, +80%-20%
C138	283-0177-00			1 uF, Cer, 25 V, +80%-20%
C139, C142[1]	283-0268-00			0.015 uF, Cer, 50 V, 10%
C144, C147[1], C151[1], C152[1]	290-0534-00			1 uF, Elect., 35 V, 20%
C153	283-0186-00	B010100	B029999	27 pF, Cer, 50 V, 5%
C153	281-0504-00	B030000		10 pF, (nominal value), selected
C157	290-0534-00			1 uF, Elect., 35 V, 20%
C158	283-0156-00	XB030000		0.001 uF, Cer, 200 V, +100%-0%
C172	283-0103-00			180 pF, Cer, 500 V, 5%
C175	281-0123-00			5-25 pF, Var, Cer
C182	283-0103-00			180 pF, Cer, 500 V, 5%
C204	281-0619-00	B010100	B010309	1.2 pF, Cer, 200 V, ±0.1 pF
C204	281-0064-00	B010310		0.25-1.5 pF, Var, Tub., 600 V
C205	283-0080-00			0.022 uF, Cer, 25 V, +80%-20%
C207	283-0111-00			0.1 uF, Cer, 50 V
C209	283-0238-00	B010100	B049999	0.01 uF, Cer, 50 V, 10%
C209	283-0238-00	B050000		0.01 uF, (nominal value), selected
C212	281-0123-00			5-25 pF, Var, Cer
C213	283-0156-00			0.001 uF, Cer, 200 V, +100%-0%
C219	283-0191-00			0.022 uF, Cer, 50 V, 20%
C223	283-0080-00	XB050000		0.022 uF, Cer, 25 V, +80%-20%
C227	283-0080-00	XB050000		0.022 uF, Cer, 25 V, +80%-20%

[1]Part of Circuit Board.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
CAPACITORS (cont)				
C233	281-0123-00			5-25 pF, Var, Cer
C236	283-0213-00			300 pF, Cer, 100 V, 5%
C237	283-0178-00			0.1 uF, Cer, 100 V, +80%-20%
C238	283-0177-00			1 uF, Cer, 25 V, +80%-20%
C239	283-0268-00			0.015 uF, Cer, 50 V, 10%
C242[1]				
C244	290-0534-00			1 uF, Elect., 35 V, 20%
C247[1]				
C251[1]				
C252[1]				
C253	283-0186-00	B010100	B029999	27 pF, Cer, 50 V, 5%
C253	281-0578-00	B030000		18 pF, (nominal value), selected
C257	290-0534-00			1 uF, Elect., 35 V, 20%
C258	283-0156-00	XB050000		1000 pF, Cer, 200 V, +100%-0%
C272	283-0103-00			180 pF, Cer, 500 V, 5%
C275	281-0123-00			5-25 pF, Var, Cer
C282	283-0103-00			180 pF, Cer, 500 V, 5%
C291	290-0525-00			4.7 uF, Elect., 50 V, 20%
C292	290-0523-00			2.2 uF, Elect., 20 V, 20%
C297	290-0523-00			2.2 uF, Elect., 20 V, 20%
C310	283-0000-00			0.001 uF, Cer, 500 V, +100%-0%
C320	283-0000-00			0.001 uF, Cer, 500 V, +100%-0%
C329	283-0024-00	XB030000		0.1 uF, Cer, 30 V, +80%-20%
C335	283-0632-00	B010100	B010274	87 pF, Mica, 100 V, 1%
C335	283-0677-00	B010275		82 pF, Mica, 500 V, 1%
C336	283-0632-00	B010100	B010274	87 pF, Mica, 100 V, 1%
C336	283-0677-00	B010275		82 pF, Mica, 500 V, 1%
C343	281-0549-00			68 pF, Cer, 500 V, 10%
C346	281-0543-00			270 pF, Cer, 500 V, 10%
C375	281-0544-00			5.6 pF, Cer, 500 V, 10%
C376	281-0589-00			170 pF, Cer, 500 V, 5%
C393	281-0610-00	B010100	B010309	2.2 pF, Cer, 200 V, ±0.1 pF
C393	281-0659-00	B010310		4.3 pF, Cer, 500 V, ±0.25 pF
C396	290-0534-00			1 uF, Elect., 35 V, 20%
C398	281-0518-00	B010100	B010309	47 pF, Cer, 500 V, 20%
C398	281-0511-00	B010310		22 pF, Cer, 500 V, 10%
C399	281-0508-00			12 pF, Cer, 500 V, 10%
C403	290-0534-00			1 uF, Elect., 35 V, 20%
C420	281-0544-00			5.6 pF, Cer, 500 V, 10%
C430	290-0534-00			1 uF, Elect., 35 V, 20%
C436	283-0080-00			0.022 uF, Cer, 25 V, +80%-20%
C437	283-0080-00			0.022 uF, Cer, 25 V, +80%-20%
C438	290-0534-00			1 uF, Elect., 35 V, 20%
C439	290-0534-00			1 uF, Elect., 35 V, 20%
C441[1]				

[1]Part of Circuit Board.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
CAPACITORS (cont)				
C445[1]				
C450	281-0122-00			2.5-9 pF, Var, Cer, 100 V
C454	283-0058-00			0.027 uF, Cer, 100 V, 10%
C455	283-0180-00			5600 pF, Cer, 200 V, 20%
C460	283-0111-00			0.1 uF, Cer, 50 V
C466	281-0122-00			2.5-9 pF, Var, Cer, 100 V
C470	281-0122-00			2.5-9 pF, Var, Cer, 100 V
C471	281-0097-00			9-35 pF, Var, Cer
C475	283-0116-00			820 pF, Cer, 500 V, 5%
C476	283-0139-00			150 pF, Cer, 50 V, 20%
C477	281-0122-00			2.5-9 pF, Var, Cer, 100 V
C485	283-0111-00			0.1 uF, Cer, 50 V
C486	281-0523-00			100 pF, Cer, 350 V, 20%
C491	283-0067-00			0.001 uF, Cer, 200 V, 10%
C494	283-0198-00			0.22 uF, Cer, 50 V, 20%
C498	283-0111-00			0.1 uF, Cer, 50 V
C499	283-0111-00			0.1 uF, Cer, 50 V
C500	281-0508-00			12 pF, Cer, 500 V, 20%
C504	290-0524-00			4.7 uF, Elect., 10 V, 20%
C506	283-0081-00			0.1 uF, Cer, 25 V, +80%-20%
C507	281-0546-00			330 pF, Cer, 500 V, 10%
C508	283-0081-00			0.1 uF, Cer, 25 V, +80%-20%
C509	281-0508-00			12 pF, Cer, 500 V, 20%
C510	281-0505-00			12 pF, Cer, 500 V, 10%
C511[2]	281-0572-00			6.8 pF, cer, 500 V, ±0.5 pF
C513[2]				
C515	281-0523-00			100 pF, Cer, 350 V, 20%
C516	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C517	281-0579-00			21 pF, Cer, 500 V, 5%
C519	290-0524-00			4.7 uF, Elect., 10 V, 20%
C520	281-0508-00			12 pF, Cer, 500 V, 20%
C521	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C524	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C525	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C526	281-0601-00			7.5 pF, Cer, 500 V
C543	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C546	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C554	281-0508-00			12 pF, Cer, 500 V, 20%
C555	290-0524-00			4.7 uF, Elect., 10 V, 20%
C556	281-0662-00	B010100	B029999	10 pF, Cer, 500 V, ±0.5 pF
C556	281-0523-00	B030000		100 pF, Cer, 350 V, 20%
C557	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C562	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C565	290-0524-00			4.7 uF, Elect., 10 V, 20%
C571	290-0524-00			4.7 uF, Elect., 10 V, 20%

[1]Part of Circuit Board.
[2]Short adjustable wire.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
CAPACITORS (cont)				
C572	281-0509-00	XB030000	B049999X	15 pF, Cer, 500 V, 10%
C575	281-0509-00	XB030000	B049999X	15 pF, Cer, 500 V, 10%
C583	281-0523-00	XB050000		100 pF, Cer, 350 V, 20%
C584	281-0617-00	XB030000		15 pF, Cer, 200 V, 10%
C593	281-0524-00			150 pF, Cer, 500 V, 20%
C596	290-0524-00			4.7 uF, Elect., 10 V, 20%
C599	281-0519-00	XB030000		47 pF, Cer, 500 V, 10%
C600	290-0524-00			4.7 uF, Elect., 10 V, 20%
C606	290-0526-00			6.8 uF, Elect., 20%
C607	290-0535-00	XB010310		33 uF, Elect., 10 V, 20%
C608	290-0524-00			4.7 uF, Elect., 10 V, 20%
C609	290-0534-00			1 uF, Elect., 35 V, 20%
C610	290-0535-00	XB010310		33 uF, Elect., 10 V, 20%
C611	281-0592-00			4.7 pF, Cer, 500 V, ±0.5 pF
C622	290-0524-00			4.7 uF, Elect., 10 V, 20%
C627	283-0000-00			0.001 uF, Cer, 500 V, +100%-0%
C644	283-0003-00	XB020000		0.01 uF, Cer, 150 V, +80%-20%
C647	281-0523-00			100 pF, Cer, 350 V, 20%
C668	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C669	Selected	XB030000		
C670	283-0000-00			0.001 uF, Cer, 500 V, +100%-0%
C673	281-0632-00			35 pF, Cer, 500 V, 1%
C675	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C679	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C683	281-0629-00			33 pF, Cer, 600 V, 5%
C684	281-0519-00			47 pF, Cer, 500 V, 10%
C693	281-0528-00			82 pF, Cer, 500 V, 10%
C695	281-0503-00			8 pF, Cer, 500 V, ±0.5 pF
C698	290-0523-00			2.2 uF, Elect., 20 V, 20%
C708	281-0579-00			21 pF, Cer, 500 V, 5%
C711	290-0524-00			4.7 uF, Elect., 10 V, 20%
C712	290-0524-00			4.7 uF, Elect., 10 V, 20%
C713	290-0524-00			4.7 uF, Elect., 10 V, 20%
C714	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C715	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C717	281-0509-00			15 pF, Cer, 500 V, 10%
C718	281-0509-00			15 pF, Cer, 500 V, 10%
C719	281-0509-00			15 pF, Cer, 500 V, 10%
C721	281-0505-00			12 pF, Cer, 500 V, 10%
C722	281-0572-00			6.8 pF, Cer, 500 V, ±0.5 pF
C729	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C735	281-0523-00			100 pF, Cer, 350 V, 20%
C736	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C739	290-0524-00			4.7 uF, Elect., 10 V, 20%
C741	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
CAPACITORS (cont)				
C744	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C745	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C746	281-0601-00			7.5 pF, Cer, 500 V
C752	290-0524-00			4.7 uF, Elect., 10 V, 20%
C763	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C764	290-0524-00			4.7 uF, Elect., 10 V, 20%
C766	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C771	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C774	281-0508-00			12 pF, Cer, 500 V, 20%
C775	290-0524-00			4.7 uF, Elect., 10 V, 20%
C776	281-0662-00	B010100	B029999	10 pF, Cer, 500 V, ±0.5 pF
C776	281-0523-00	B030000		100 pF, Cer, 350 V, 20%
C777	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C783	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C785	290-0524-00			4.7 uF, Elect., 10 V, 20%
C795	283-0001-00			0.005 uF, Cer, 500 V
C798	290-0523-00			2.2 uF, Elect., 20 V, 20%
C799	283-0000-00			0.001 uF, Cer, 500 V, +100%-0%
C803	290-0523-00			2.2 uF, Elect., 20 V, 20%
C811	281-0509-00	XB050000		15 pF, Cer, 500 V, 10%
C813	281-0509-00	XB030000	B049999X	15 pF, Cer, 500 V, 10%
C819	290-0524-00			4.7 uF, Elect., 10 V, 20%
C823	281-0523-00	XB050000		100 pF, Cer, 350 V, 20%
C824	281-0617-00	XB030000		15 pF, Cer, 200 V, 10%
C825	290-0524-00			4.7 uF, Elect., 10 V, 20%
C826	290-0523-00			2.2 uF, Elect., 20 V, 20%
C905	290-0523-00			2.2 uF, Elect., 20 V, 20%
C913	290-0527-00			15 uF, Elect., 20 V, 20%
C917	281-0525-00			470 pF, Cer, 500 V, 20%
C922	281-0509-00			15 pF, Cer, 500 V, 10%
C923	283-0024-00			0.1 uF, Cer, 30 V, +80%-20%
C933	290-0523-00			2.2 uF, Elect., 20 V, 20%
C947	283-0000-00			0.001 uF, Cer, 500 V, +100%-0%
C961	290-0523-00			2.2 uF, Elect., 20 V, 20%
C963	290-0523-00			2.2 uF, Elect., 20 V, 20%
C965	290-0523-00			2.2 uF, Elect., 20 V, 20%
C967	290-0524-00			4.7 uF, Elect., 10 V, 20%
C969	290-0523-00			2.2 uF, Elect., 20 V, 20%
C976	281-0579-00			21 pF, Cer, 500 V, 5%
C984	281-0503-00			8 pF, Cer, 500 V, ±0.5 pF
C1007	283-0000-00			0.001 uF, Cer, 500 V, +100%-0%
C1008	283-0157-00			7 pF, Cer, 500 V, 5%
C1009	281-0168-00			1.3-5.4 pF, Var, Air
C1010	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C1023	281-0096-00			5.5-18 pF, Var, Air

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
CAPACITORS (cont)				
C1025	281-0096-00			5.5-18 pF, Var, Air
C1033	281-0549-00			68 pF, Cer, 500 V, 10%
C1045	283-0000-00			0.001 uF, Cer, 500 V, +100%-0%
C1050	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C1052	281-0589-00			170 pF, Cer, 500 V, 5%
C1054	290-0525-00			4.7 uF, Cer, 50 V, 20%
C1056	283-0187-00	B010100	B049999	0.047 uF, Cer, 400 V, 10%
C1056	283-0341-00	B050000		0.047 uF, Cer, 100 V, 10%
C1058	281-0543-00			270 pF, Cer, 500 V, 10%
C1059	290-0392-00			3.6 uF, Elect., 125 V, 10%
C1064	281-0096-00			5.5-18 pF, Var, Air
C1071				10 uF,
C1072 [1]	295-0163-00			0.1 uF, Matched capacitors
C1073				0.001 uF,
C1075	283-0144-00			33 pF, Cer, 500 V, 1%
C1081	281-0523-00			100 pF, Cer, 350 V, 20%
C1082				10 uF,
C1083 [1]	295-0163-00			0.1 uF, Matched capacitors
C1085				0.001 uF,
C1091	290-0523-00			2.2 uF, Cer, 350 V, 20%
C1093	290-0523-00			2.2 uF, Cer, 350 V, 20%
C1103	283-0670-00			375 pF, Mica, 500 V, 1%
C1112	283-0010-00			0.05 uF, Cer, 50 V
C1116	283-0000-00			0.001 uF, Cer, 500 V, +100%-0%
C1124	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C1134	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C1140	283-0010-00			0.05 uF, Cer, 50 V
C1152	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C1162	283-0003-00			0.01 uF, Cer, 150 V, +80%-20%
C1171	281-0564-00			24 pF, Cer, 500 V, 5%
C1178	283-0631-00			95 pF, (nominal value), selected
C1179	281-0118-00			8-90 pF, Var, Mica
C1187	283-0010-00			0.05 uF, Cer, 50 V
C1201	283-0005-00			0.01 uF, Cer, 250 v, +100%-0%
C1205	283-0005-00			0.01 uF, Cer, 250 V, +100%-0%
C1211	283-0005-00			0.01 uF, Cer, 250 V, +100%-0%
C1212	283-0005-00			0.01 uF, Cer, 250 V, +100%-0%
C1216	283-0010-00			0.05 uF, Cer, 50 V
C1231	283-0638-00			130 pF, Mica, 100 V, 1%
C1233 [2]	281-0153-00			1.7-10 pF, Var, Air, 250 V
C1235 [2]				
C1251	283-0638-00			130 pF, Mica, 100 V, 1%
C1253 [2]	281-0153-00			1.7-10 pF, Var, Air, 250 V
C1255 [2]				
C1261	290-0523-00			2.2 uF, Elect., 20 V, 20%

[1] C1071, C1072, C1073, C1082, C1083, and C1085 furnished as a unit. Individual timing capacitors in this assembly must be ordered by the 9 digit part number, letter suffix and tolerance printed on the timing capacitor to be replaced.

285-XXXX-XX F-

The letter suffix and the tolerance should be the same for all of the timing capacitors in the assembly.

[2] Part of the Circuit Board.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
CAPACITORS (cont)				
C1263	290-0524-00			4.7 uF, Elect., 10 V, 20%
C1265	290-0523-00			2.2 uF, Elect., 20 V, 20%
C1267	283-0092-00			0.03 uF, Cer, 200 V, +80%-20%
C1302	290-0534-00			1 uF, Elect., 35 V, 20%
C1304	290-0573-00			2.7 uF, Elect., 50 V, 20%
C1305	290-0572-00			0.1 uF, Elect., 50 V, 20%
C1316	290-0534-00			1 uF, Elect., 35 V, 20%
C1317	290-0536-00			10 uF, Elect., 25 V, 20%
C1318	290-0312-00			47 uF, Elect., 35 V, 10%
C1320	283-0011-00			0.01 uF, Cer, 2000 V
C1322	283-0071-00			0.0068 uF, Cer, 5000 V, +80%-30%
C1323	283-0071-00			0.0068 uF, Cer, 5000 V, +80%-30%
C1326	281-0518-00			47 pF, Cer, 500 V, 20%
C1328	283-0071-00			0.0068 uF, Cer, 5000 V, +80%-30%
C1330	290-0524-00			4.7 uF, Elect., 10 V, 20%
C1335	283-0078-00			0.001 uF, Cer, 500 V, 20%
C1336	283-0078-00			0.001 uF, Cer, 500 V, 20%
C1346	283-0002-00			0.01 uF, Cer, 500 V
C1348	283-0005-00			0.01 uF, Cer, 250 V, +100%-0%
C1352	281-0064-00			0.25-1.5 pF, Var, Cer, 600 V
C1354	283-0005-00			0.01 uF, Cer, 250 V, +100%-0%
C1358	283-0057-00			0.1 uF, Cer, 200 V, +80%-20%
C1363	283-0057-00			0.1 uF, Cer, 200 V, +80%-20%
C1366	281-0627-00			1 pF, Cer, 600 V
C1371	285-1040-00			0.0012 uF, Plastic, 4000 V, 10%
C1372	285-1040-00			0.0012 uF, Plastic, 4000 V, 10%
C1373	283-0178-00			0.1 uF, Cer, 100 V, +80%-20%
C1374	290-0164-00			1 uF, Elect., 150 V
C1380	285-1040-00			0.0012 uF, Plastic, 4000 V, 10%
C1381	283-0002-00			0.01 uF, Cer, 500 V
C1387	290-0523-00			2.2 uF, Elect., 20 V, 20%
C1388	290-0523-00			2.2 uF, Elect., 20 V, 20%
C1390	283-0001-00			0.005 uF, Cer, 500 V
C1394	283-0001-00	B010100	B029999X	0.005 uF, Cer, 500 V
C1394	283-0001-00	XB050000		0.005 uF, Cer, 500 V
C1397	283-0001-00			0.005 uF, Cer, 500 V
C1399	283-0111-00			0.1 uF, Cer, 50 V
C1412	290-0585-00			350 uF, Elect., 75 V, +75%-10%
C1414	290-0586-00			1000 uF, Elect., 75 V, +75%-10%
C1416	283-0004-00			0.02 uF, Cer, 150 V
C1428	290-0525-00			4.7 uF, Elect., 50 V, 20%
C1431	281-0546-00			330 pF, Cer, 500 V, 10%
C1442	290-0584-00			5500 uF, Elect., 30 V, +100%-10%
C1448	290-0536-00			10 uF, Elect., 25 V, 20%
C1452	290-0571-00			5000 uF, Elect., 25 V, +100%-10%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
CAPACITORS (cont)				
C1458	290-0535-00			33 uF, Elect., 10 V, 20%
C1462	290-0584-00			5500 uF, Elect., 30 V, +100%-10%
C1468	290-0535-00			33 uF, Elect., 10 V, 20%
C1472	290-0583-00			3000 uF, Elect., 35 V, +100%-10%
C1478	290-0536-00			10 uF, Elect., 25 V, 20%
C1486	281-0523-00			100 pF, Cer, 350 V, 20%
C1489	283-0092-00			0.03 uF, Cer, 200 V, +80%-20%
C1492	290-0523-00			2.2 uF, Elect., 20 V, 20%
C1505	285-0686-00			0.068 uF, PTM, 100 V, 10%
C1511	290-0532-00			150 uF, Elect., 6 V, 20%
C1512	281-0523-00			100 pF, Cer, 350 V, 20%
C1698	290-0536-00			10 uF, Elect., 25 V, 20%
DIODES				
CR104	152-0323-00			Silicon, SE365
CR105	152-0323-00			Silicon, SE365
CR107	152-0141-02			Silicon, 1N4152
CR170	152-0422-00			Silicon, VVC, 7 pF, 4 V, PG1084
CR174	152-0422-00			Silicon, VVC, 7 pF, 4 V, PG1084
CR204	152-0323-00			Silicon, SE365
CR205	152-0323-00			Silicon, SE365
CR207	152-0141-02			Silicon, 1N4152
CR270	152-0422-00			Silicon, VVC, 7 pF, 4 V, PG1084
CR274	152-0422-00			Silicon, VVC, 7 pF, 4 V, PG1084
CR290	152-0141-02			Silicon, 1N4152
CR301	152-0141-02			Silicon, 1N4152
CR306	152-0141-02			Silicon, 1N4152
CR312	152-0141-02			Silicon, 1N4152
CR322	152-0141-02			Silicon, 1N4152
CR336	152-0141-02			Silicon, 1N4152
CR351	152-0141-02			Silicon, 1N4152
CR352	152-0141-02			Silicon, 1N4152
CR359	152-0141-02			Silicon, 1N4152
CR361	152-0141-02			Silicon, 1N4152
CR368	152-0141-02			Silicon, 1N4152
CR369	152-0141-02			Silicon, 1N4152
CR422	152-0141-02			Silicon, 1N4152
CR519	152-0246-00			Silicon, CD12676 or FD3375
CR556	152-0386-00			Tunnel, 10 mA, 25 pF, selected from 1N3718
CR566	152-0386-00			Tunnel, 10 mA, 25 pF, selected from 1N3718
CR582	152-0141-02			Silicon, 1N4152
CR584	152-0141-02			Silicon, 1N4152
CR592	152-0141-02			Silicon, 1N4152
CR601	152-0141-02			Silicon, 1N4152
CR604	152-0141-02			Silicon, 1N4152

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
DIODES (cont)				
CR605	152-0141-02			Silicon, 1N4152
CR680	152-0141-02			Silicon, 1N4152
CR681	152-0141-02			Silicon, 1N4152
CR682	152-0141-02			Silicon, 1N4152
CR683	152-0141-02			Silicon, 1N4152
CR685	152-0141-02			Silicon, 1N4152
CR689	152-0141-02			Silicon, 1N4152
CR691	152-0141-02			Silicon, 1N4152
CR692	152-0141-02			Silicon, 1N4152
CR693	152-0141-02			Silicon, 1N4152
CR694	152-0141-02			Silicon, 1N4152
CR699	152-0141-02			Silicon, 1N4152
CR701	152-0141-02			Silicon, 1N4152
CR703	152-0141-02			Silicon, 1N4152
CR705	152-0141-02			Silicon, 1N4152
CR739	152-0246-00			Silicon, CD12676 or FD3375
CR776	152-0386-00			Tunnel, 10 mA, 25 pF, selected from 1N3718
CR786	152-0386-00			Tunnel, 10 mA, 25 pF, selected from 1N3718
CR787	152-0141-02			Silicon, 1N4152
CR788	152-0141-02			Silicon, 1N4152
CR792	152-0141-02			Silicon, 1N4152
CR793	152-0141-02			Silicon, 1N4152
CR794	152-0141-02			Silicon, 1N4152
CR795	152-0141-02			Silicon, 1N4152
CR796	152-0141-02			Silicon, 1N4152
CR797	152-0141-02			Silicon, 1N4152
CR799	152-0141-02			Silicon, 1N4152
CR801	152-0141-02			Silicon, 1N4152
CR802	152-0141-02			Silicon, 1N4152
CR806	152-0141-02			Silicon, 1N4152
CR811	152-0141-02			Silicon, 1N4152
CR812	152-0141-02			Silicon, 1N4152
CR814	152-0141-02			Silicon, 1N4152
CR822	152-0141-02			Silicon, 1N4152
CR824	152-0141-02			Silicon, 1N4152
CR903	152-0141-02			Silicon, 1N41552
CR907	152-0141-02			Silicon, 1N4152
CR914	152-0501-00			Silicon, MSD6150
CR922	152-0141-02			Silicon, 1N4152
CR926	152-0322-00			Silicon, A1108
CR927	152-0322-00			Silicon, A1108
CR940	152-0141-02			Silicon, 1N4152
CR943	152-0141-02			Silicon, 1N4152
CR944	152-0141-02			Silicon, 1N4152
CR945	152-0141-02			Silicon, 1N4152

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
DIODES (cont)				
CR952	152-0141-02			Silicon, 1N4152
CR955	152-0141-02			Silicon, 1N4152
CR956	152-0141-02			Silicon, 1N4152
CR971	152-0141-02			Silicon, 1N4152
CR976	152-0141-02			Silicon, 1N4152
CR985	152-0141-02			Silicon, 1N4152
CR987	152-0141-02			Silicon, 1N4152
CR988	152-0141-02			Silicon, 1N4152
CR996	152-0141-02			Silicon, 1N4152
CR1001	152-0141-02			Silicon, 1N4152
CR1006	152-0141-02			Silicon, 1N4152
CR1015	152-0141-02			Silicon, 1N4152
CR1017	152-0141-02			Silicon, 1N4152
CR1018	152-0141-02			Silicon, 1N4152
CR1023	152-0141-02			Silicon, 1N4152
CR1026	152-0141-02			Silicon, 1N4152
CR1028	152-0141-02			Silicon, 1N4152
CR1029	152-0141-02			Silicon, 1N4152
CR1034	152-0141-02			Silicon, 1N4152
CR1036	152-0141-02			Silicon, 1N4152
CR1037	152-0141-02			Silicon, 1N4152
CR1044	152-0141-02			Silicon, 1N4152
CR1046	151-0141-02			Silicon, 1N4152
CR1049	152-0141-02			Silicon, 1N4152
CR1052	152-0141-02			Silicon, 1N4152
CR1054	152-0141-02	B010100	B049999	Silicon, 1N4152
CR1054	152-0061-00	B050000		Silicon, CD8393 or FDH2161
CR1056	152-0141-02	B010100	B049999	Silicon, 1N4152
CR1056	152-0061-00	B050000		Silicon, CD8393 or FDH2161
CR1058	152-0141-02	B010100	B049999	Silicon, 1N4152
CR1058	152-0061-00	B050000		Silicon, CD8393 or FDH2161
CR1060	152-0141-02			Silicon, 1N4152
CR1061	152-0141-02			Silicon, 1N4152
CR1062	152-0141-02			Silicon, 1N4152
CR1075	152-0141-02	XB010316		Silicon, 1N4152
CR1097	152-0141-02	XB010316		Silicon, 1N4152
CR1102	152-0141-02			Silicon, 1N4152
CR1103	152-0141-02			Silicon, 1N4152
CR1104	152-0141-02			Silicon, 1N4152
CR1111	152-0141-02			Silicon, 1N4152
CR1121	152-0322-00			Silicon, A1108
CR1122	152-0322-00			Silicon, A1108
CR1140	152-0141-02			Silicon, 1N4152
CR1164	152-0141-02			Silicon, 1N4152
CR1173	152-0322-00			Silicon, A1108

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
DIODES (cont)				
CR1183	152-0322-00			Silicon, A1108
CR1237	152-0141-02			Silicon, 1N4152
CR1304	152-0333-00			Silicon, FDH6012
CR1310	152-0141-02			Silicon, 1N4152
CR1312	152-0141-02			Silicon, 1N4152
CR1314	152-0141-02			Silicon, 1N4152
CR1316	152-0333-00			Silicon, FDH6012
CR1317	152-0141-02			Silicon, 1N4152
CR1320	152-0429-00			Silicon, VG-5X
CR1321	152-0429-00			Silicon, VG-5X
CR1331	152-0153-00			Silicon, FD7003 or CD5574
CR1337	152-0141-02			Silicon, 1N4152
CR1341	152-0153-00			Silicon, FD7003 or CD5574
CR1342	152-0141-02			Silicon, 1N4152
CR1343	152-0153-00			Silicon, FD7003 or CD5574
CR1344	152-0141-02			Silicon, 1N4152
CR1345	152-0141-02			Silicon, 1N4152
CR1352	152-0141-02			Silicon, 1N4152
CR1353	152-0061-00			Silicon, CD8393 or FDH2161
CR1354	152-0141-02			Silicon, 1N4152
CR1358	152-0141-02			Silicon, 1N4152
CR1360	152-0107-00			Silicon, TI60 or 1N647
CR1366	152-0141-02			Silicon, 1N4152
CR1367	152-0107-00			Silicon, TI60 or 1N647
CR1371	152-0061-00			Silicon, CD8393 or FDH2161
CR1373	152-0061-00			Silicon, CD8393 or FDH2161
CR1377	152-0242-00			Silicon, selected from 1N486A
CR1379	152-0242-00			Silicon, selected from 1N486A
CR1412	152-0488-00			Silicon, full wave bridge, 1.5A, 200 V
CR1415	152-0107-00			Silicon, TI60 or 1N647
CR1421	152-0141-02			Silicon, 1N4152
CR1422	152-0061-00			Silicon, CD8393 or FDH2161
CR1424	152-0141-02			Silicon, 1N4152
CR1426	152-0066-00			Silicon, diffused, selected from 1N3194
CR1428	152-0066-00			Silicon, diffused, selected from 1N3194
CR1432	152-0141-02			Silicon, 1N4152
CR1442	152-0462-00			Silicon, MDA960-3
CR1448	152-0066-00			Silicon, diffused, selected from 1N3194
CR1452	152-0488-00			Silicon, full wave bridge, 1.5A, 200 V
CR1456	152-0141-02			Silicon, 1N4152
CR1458	152-0066-00			Silicon, diffused, selected from 1N3194
CR1462	152-0488-00			Silicon, full wave bridge, 1.5A, 200 V
CR1466	152-0141-02			Silicon, 1N4152
CR1468	152-0066-00			Silicon, diffused, selected from 1N3194
CR1472	152-0488-00			Silicon, full wave bridge, 1.5A, 200 V

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
DIODES (cont)				
CR1478	152-0066-00			Silicon, diffused, selected from 1N3194
CR1489	152-0061-00			Silicon, CD8393 or FDH2161
CR1691	152-0141-02			Silicon, 1N4152
CR1692	152-0141-02			Silicon, 1N4152
CR1694	152-0141-02			Silicon, 1N4152
CR1696	152-0141-02			Silicon, 1N4152
CR1698	152-0141-02			Silicon, 1N4152
DELAY LINE				
DL380	119-0388-00			Delay line assembly
BULBS				
DS128	150-0111-00			Neon, AICT, 125VAC, 1.2 mA
DS228	150-0111-00			Neon, AICT, 125VAC, 1.2 mA
DS312	150-0130-00			Incandescent, 5 V, 60 mA
DS314	150-0130-00			Incandescent, 5 V, 60 mA
DS322	150-0130-00			Incandescent, 5 V, 60 mA
DS324	150-0130-00			Incandescent, 5 V, 60 mA
DS608	150-0130-00			Incandescent, 5 V, 60 mA
DS610	150-0130-00			Incandescent, 5 V, 60 mA
DS1091	150-0111-00			Neon, AICT, 125VAC, 1.2 mA
DS1110	150-0111-00			Neon, AICT, 125VAC, 1.2 mA
DS1382	150-0002-00			Neon, NE2
DS1383	150-0002-00			Neon, NE2
DS1482	150-0129-00			Incandescent 2112, 6.3 V, 200 mA
DS1483	150-0129-00			Incandescent 2112, 6.3 V, 200 mA
DS1492	150-0130-00			Incandescent, 5 V, 60 mA
FUSES				
F1318	159-0016-00			Cartridge, 1.5A, 3AG, fast-blo
F1401	159-0016-00			Cartridge, 1.5A, 3AG, fast-blo
CONNECTORS				
J10	131-0679-00			Receptacle, electrical, 3 contact, BNC
J50	131-0679-00			Receptacle, electrical, 3 contact, BNC
J349	131-1003-00			Receptacle, electrical, coaxial cable
J379	131-1003-00			Receptacle, electrical, coaxial cable
J380	131-1003-00			Receptacle, electrical, coaxial cable
J385	131-1003-00			Receptacle, electrical, coaxial cable
J400	131-1003-00			Receptacle, electrical, coaxial cable
J405	131-1003-00			Receptacle, electrical, coaxial cable
J410	131-1003-00			Receptacle, electrical, coaxial cable
J430	131-1003-00			Receptacle, electrical, coaxial cable
J435	131-0955-00			Receptacle, electrical, BNC
J510	131-0955-00			Receptacle, electrical, BNC
J584	131-1003-00			Receptacle, electrical, coaxial cable
J589	131-0955-00			Receptacle, electrical, BNC

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
CONNECTORS (cont)				
J664	131-1003-00			Receptacle, electrical, coaxial cable
J674	131-1003-00			Receptacle, electrical, coaxial cable
J694	131-1003-00			Receptacle, electrical, coaxial cable
J702	131-1003-00			Receptacle, electrical, coaxial cable
J704	131-1003-00			Receptacle, electrical, coaxial cable
J706	131-1003-00			Receptacle, electrical, coaxial cable
J720	131-0955-00			Receptacle, electrical, BNC
J824	131-1003-00			Receptacle, electrical, coaxial cable
J829	131-0955-00			Receptacle, electrical, BNC
J1101	131-1003-00			Receptacle, electrical, coaxial cable
J1302	131-1003-00			Receptacle, electrical, coaxial cable
J1330	131-0955-00			Receptacle, electrical, BNC
J1333	131-1003-00			Receptacle, electrical, coaxial cable
J1334	131-1003-00			Receptacle, electrical, coaxial cable
J1478	131-0771-00			Receptacle, electrical, 4 contact
J1479	131-0771-00			Receptacle, electrical, 4 contact
RELAY				
K1103	148-0076-00			Mag reed
INDUCTORS				
L141[1]				
L142[1]				
L147[1]				
L148[1]				
L151	108-0743-00			52 nH
L152	108-0743-00			52 nH
L170	108-0440-00			8 uH
L171	276-0528-00	B010100	B029999	Core, ferramic suppressor
L171	276-0507-00	B030000		Core, ferramic suppressor, selected
L172	276-0507-00			Core, ferramic suppressor
L174	276-0528-00	B010100	B029999	Core, ferramic suppressor
L174	276-0507-00	B030000		Core, ferramic suppressor, selected
L180	108-0440-00			8 uH
L182[1]	276-0507-00			Core, ferramic suppressor
L241[1]				
L242[1]				
L247[1]				
L248[1]				
L251	108-0743-00			52 nH
L252	108-0743-00			52 nH
L270	108-0440-00			8 uH
L271	276-0528-00	B010100	B029999	Core, ferramic suppressor
L271	276-0507-00	B030000		Core, ferramic suppressor, selected
L272	276-0507-00			Core, ferramic suppressor

[1]Part of Circuit Board.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
INDUCTORS (cont)				
L274	276-0528-00	B010100	B029999	Core, ferramic suppressor
L274	276-0507-00	B030000		Core, ferramic suppressor, selected
L280	108-0440-00			8 uH
L282	276-0507-00			Core, ferramic suppressor
L291	108-0440-00			8 uH
L292	108-0440-00			8 uH
L297	108-0440-00			8 uH
L375	108-0182-00			0.3 uH
L376	108-0182-00			0.3 uH
L435	276-0588-00			Core, ferrite
L439[1]	108-0440-00			8 uH
L441[1]				
L442[1]				
L444[1]				
L445[1]				
L498	108-0440-00			8 uH
L499	108-0440-00			8 uH
L546	108-0433-00			0.09 uH
L551	108-0433-00			0.09 uH
L552	276-0528-00			Core, ferramic suppressor
L562	276-0528-00			Core, ferramic suppressor
L572	276-0507-00			Core, ferramic suppressor
L574	276-0507-00			Core, ferramic suppressor
L584	276-0507-00	B010100	B029999X	Core, ferramic suppressor
L588	276-0507-00	XB030000		Core, ferramic suppressor
L600	120-0402-00	XB020000		Toroid, 3 turns, single
L771	108-0433-00			0.09 uH
L772	276-0528-00			Core, ferramic suppressor
L781	108-0433-00			0.09 uH
L782	276-0528-00			Core, ferramic suppressor
L794	276-0507-00			Core, ferramic suppressor
L802	276-0507-00	XB050000		Core, ferramic suppressor
L804	276-0507-00	XB050000		Core, ferramic suppressor
L826	276-0507-00	XB050000		Core, ferramic suppressor
L917	108-0750-00			9.3 uH
L922	276-0507-00			Core, ferramic suppressor
L984	276-0507-00			Core, ferramic suppressor
L1018	120-0407-00			Toroid, 5 turns, single
L1091	276-0507-00			Core, ferramic suppressor
L1093	276-0507-00			Core, ferramic suppressor
L1102	108-0538-00			2.7 uH
L1103	114-0278-00			4.6-16.7 uH, Var, Core 276-0568-00
L1209	108-0245-00			3.9 uH
L1231	276-0507-00			Core, ferramic suppressor
L1232	276-0507-00			Core, ferramic suppressor

[1]Part of Circuit Board.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
INDUCTORS (cont)				
L1251	276-0507-00			Core, ferramic suppressor
L1261	108-0245-00			3.9 uH
L1263	108-0245-00			3.9 uH
L1265	108-0245-00			3.9 uH
L1318	108-0422-00			80 uH
L1330	108-0440-00			8 uH
L1385	108-0714-00			Y axis alignment
L1386	108-0713-00			Trace rotator
L1387	108-0245-00			3.9 uH
L1388	108-0245-00			3.9 uH
L1394	276-0541-00	XB030000		Core, ferrite
L1511	108-0245-00			3.9 uH
LR496	108-0685-00			80 nH
LR497	108-0685-00			80 nH
LR1335	108-0537-00	XB050000		200 uH
LR1336	108-0537-00	XB050000		200 uH
TRANSISTORS				
Q172	151-0271-00			Silicon, PNP, SAB4113
Q178	151-0271-00			Silicon, PNP, SAB4113
Q182	151-0271-00			Silicon, PNP, SAB4113
Q184	151-0188-00			Silicon, PNP, 2N3906
Q188	151-0271-00			Silicon, PNP, SAB4113
Q272	151-0271-00			Silicon, PNP, SAB4113
Q278	151-0271-00			Silicon, PNP, SAB4113
Q282	151-0271-00			Silicon, PNP, SAB4113
Q284	151-0188-00			Silicon, PNP, 2N3906
Q288	151-0271-00			Silicon, PNP, SAB4113
Q312	151-0301-00			Silicon, PNP, 2N2907
Q314	151-0301-00			Silicon, PNP, 2N2907
Q322	151-0301-00			Silicon, PNP, 2N2907
Q324	151-0301-00			Silicon, PNP, 2N2907
Q338	151-0301-00			Silicon, PNP, 2N2907
Q348	151-0301-00			Silicon, PNP, 2N2907
Q390	151-0367-00			Silicon, NPN, SKA6516
Q396	151-0271-00			Silicon, PNP, SAB4113
Q420	151-0367-00	B010100	B010309	Silicon, NPN, SKA6516
Q420	151-0223-00	B010310		Silicon, NPN, 2N4275
Q430	151-0188-00			Silicon, PNP, 2N3906
Q444	151-0301-00			Silicon, PNP, 2N2907
Q502	151-0367-00			Silicon, NPN, SKA6516
Q504	151-0367-00			Silicon, NPN, SKA6516
Q506	151-0367-00			Silicon, NPN, SKA6516
Q522, Q524	151-1042-00			Silicon, FET, N channel, selected from 2N5245, matched pair
Q526	151-0221-00			Silicon, PNP, 2N4258

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
TRANSISTORS (cont)				
Q532	151-0188-00			Silicon, PNP, 2N3906
Q552	151-0369-00			Silicon, PNP, replaceable by 151-0271-00
Q556	151-0221-00			Silicon, PNP, 2N4258
Q562	151-0369-00			Silicon, PNP, replaceable by 151-0271-00
Q566	151-0221-00			Silicon, PNP, 2N4258
Q572	151-0199-00			Silicon, PNP, MPS3640
Q574	151-0199-00			Silicon, PNP, MPS3640
Q584	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q588	151-0199-00			Silicon, PNP, MPS3640
Q594	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q596	151-0188-00			Silicon, PNP, 2N3906
Q612	151-0223-00			Silicon, NPN, 2N4275
Q628	151-0223-00			Silicon, NPN, 2N4275
Q644	151-0350-00			Silicon, PNP, 2N5401
Q662	151-0221-00			Silicon, PNP, 2N4258
Q664	151-0367-00			Silicon, NPN, SKA6516
Q672	151-0221-00			Silicon, PNP, 2N4258
Q674	151-0367-00			Silicon, NPN, SKA6516
Q680	151-0188-00			Silicon, PNP, 2N3906
Q688	151-0223-00	B010100	B010161	Silicon, NPN, 2N4275
Q688	151-0367-00	B010162		Silicon, NPN, SKA6516
Q698	151-0223-00	B010100	B010161	Silicon, NPN, 2N4275
Q698	151-0367-00	B010162		Silicon, NPN, SKA6516
Q712	151-0367-00			Silicon, NPN, SKA6516
Q714	151-0367-00			Silicon, NPN, SKA6516
Q716	151-0367-00			Silicon, NPN, SKA6516
Q742, Q744	151-1042-00			Silicon, FET, N channel, selected from 2N5245, matched pair
Q746	151-0221-00			Silicon, PNP, 2N4258
Q752	151-0188-00			Silicon, PNP, 2N3906
Q772	151-0271-00			Silicon, PNP, SAB4113
Q776	151-0221-00			Silicon, PNP, 2N4258
Q782	151-0271-00			Silicon, PNP, SAB4113
Q786	151-0221-00			Silicon, PNP, 2N4258
Q788	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q790	151-0223-00			Silicon, NPN, 2N4275
Q792	151-0223-00			Silicon, NPN, 2N4275
Q794	151-0188-00			Silicon, PNP, 2N3906
Q796	151-0188-00			Silicon, PNP, 2N3906
Q798	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q802	151-0199-00			Silicon, PNP, MPS3640
Q804	151-0199-00			Silicon, PNP, MPS3640
Q824	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q826	151-0199-00			Silicon, PNP, MPS3640
Q902	151-0199-00			Silicon, PNP, MPS3640

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
TRANSISTORS (cont)				
Q904	151-0190-01			Silicon, NPN, 2N3904 or TE3904
Q914	151-0261-00			Silicon, PNP, NS7406
Q920	151-1025-00			Silicon, JFET, N channel, similar to KE4416
Q922	151-0127-00			Silicon, NPN, selected from 2N2369
Q926A,B	151-1036-00			Silicon, JFET, N channel, 2N4393, dual
Q928	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q938	151-0261-00			Silicon, PNP, NS7406
Q940	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q944	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q946	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q956	151-0188-00			Silicon, PNP, 2N3906
Q972	151-0188-00			Silicon, PNP, 2N3906
Q974	151-0190-01			Silicon, NPN, 2N3904 or TE3904
Q980	151-1025-00			Silicon, JFET, N channel, similar to KE4416
Q984	151-0127-00			Silicon, NPN, selected from 2N2369
Q988	151-0188-00			Silicon, PNP, 2N3906
Q992	151-0188-00			Silicon, PNP, 2N3906
Q996	151-0199-00			Silicon, PNP, MPS3640
Q1002	151-0347-00			Silicon, NPN, 2N5551
Q1004	151-0367-00			Silicon, NPN, SKA6516
Q1008	151-0347-00			Silicon, NPN, 2N5551
Q1010	151-1025-00			Silicon, JFET, N channel, similar to KE4416
Q1014	151-0127-00			Silicon, NPN, selected from 2N2369
Q1018	151-0188-00			Silicon, PNP, 2N3906
Q1022	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q1026	151-0188-00			Silicon, PNP, 2N3906
Q1034	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q1044	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q1052	151-0350-00			Silicon, PNP, 2N5401
Q1054	151-0350-00			Silicon, PNP, 2N5401
Q1056	151-0350-00			Silicon, PNP, 2N5401
Q1058	151-0350-00			Silicon, PNP, 2N5401
Q1086	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q1114	151-0302-00			Silicon, NPN, 2N2222A
Q1124	151-0367-00			Silicon, NPN, SKA6516
Q1134	151-0367-00			Silicon, NPN, SKA6516
Q1140	151-0302-00			Silicon, NPN, 2N2222A
Q1152	151-0325-00			Silicon, PNP, 2N4258
Q1162	151-0325-00			Silicon, PNP, 2N4258
Q1164	151-0188-00			Silicon, PNP, 2N3906
Q1172	151-0325-00			Silicon, PNP, 2N4258
Q1174	151-0325-00			Silicon, PNP, 2N4258

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
TRANSISTORS (cont)				
Q1182	151-0367-00			Silicon, NPN, SKA6516
Q1184	151-0367-00	B010100	B010274	Silicon, NPN, SKA6516
Q1184	151-0127-00	B010275		Silicon, NPN, selected from 2N2369
Q1188	151-0302-00			Silicon, NPN, 2N2222A
Q1202	151-0270-00			Silicon, PNP, selected from 2N3495
Q1204	151-0124-00			Silicon, NPN, selected from 2N3501
Q1212	151-0270-00			Silicon, PNP, selected from 2N3495
Q1214	151-0124-00			Silicon, NPN, selected from 2N3501
Q1234	151-0188-00			Silicon, PNP, 2N3906
Q1254	151-0188-00			Silicon, PNP, 2N3906
Q1306	151-0126-00			Silicon, NPN, 2N2484
Q1308	151-0301-00			Silicon, PNP, 2N2907
Q1310	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q1312	151-0188-00			Silicon, PNP, 2N3906
Q1316	151-0136-00			Silicon, NPN, 2N3053
Q1318	151-0140-00			Silicon, NPN, selected from 2N3055
Q1332	151-0199-00			Silicon, PNP, MPS3640
Q1338	151-0367-00			Silicon, NPN, SKA6516
Q1344	151-0188-00			Silicon, PNP, 2N3906
Q1352	151-0124-00			Silicon, NPN, selected from 2N3501
Q1354	151-0270-00			Silicon, PNP, selected from 2N3495
Q1358	151-0199-00			Silicon, PNP, MPS3640
Q1362	151-0188-00			Silicon, PNP, 2N3906
Q1424	151-0347-00			Silicon, NPN, 2N5551
Q1426	151-0349-00			Silicon, NPN, SJE924
Q1432	151-0347-00			Silicon, NPN, 2N5551
Q1444	151-0302-00			Silicon, NPN, 2N2222A
Q1446	151-0302-00			Silicon, NPN, 2N2222A
Q1448	151-0349-00			Silicon, NPN, SJE924
Q1454	151-0302-00			Silicon, NPN, 2N2222A
Q1456	151-0390-00			Silicon, NPN, MPSU45
Q1464	151-0302-00			Silicon, NPN, 2N2222A
Q1466	151-0302-00			Silicon, NPN, 2N2222A
Q1468	151-0349-00			Silicon, NPN, replaceable by MJE2801
Q1474	151-0302-00			Silicon, NPN, 2N2222A
Q1478	151-0260-02			Silicon, NPN, 2N5189 or 2N5859
Q1482	151-0390-00			Silicon, NPN, MPSU45
Q1490	151-0190-00			Silicon, NPN, 2N3904 or TE3904
Q1492	151-0302-00			Silicon, NPN, 2N2222A
Q1494	151-0347-00			Silicon, NPN, 2N5551
Q1496	151-0350-00			Silicon, PNP, 2N5401
Q1498	151-0302-00			Silicon, NPN, 2N2222A
Q1502	151-0342-00			Silicon, PNP, 2N4249
Q1504	151-0342-00			Silicon, PNP, 2N4249
Q1512	151-0164-00			Silicon, PNP, 2N5447 or 2N3702
Q1698	151-0301-00			Silicon, PNP, 2N2907

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS				
R10	315-0430-00			43 ohm, ¼ W, 5%
R13	316-0101-00			100 ohm, ¼ W, 10%
R22(2)	316-0105-00			1M ohm, ¼ W, 10%
R24(2)	315-0510-00			51 ohm, ½ W, 5%
R32(2)	317-0047-00			4.7 ohm, 1/8 W, 5%
R33(2)	315-0360-00			36 ohm, ½ W, 5%
R34(2)	317-0120-00	B010100	B010309	12 ohm, 1/8 W, 5%
R34(2)	317-0100-00	B010310		10 ohm, 1/8 W, 5%
R35(2)	317-0390-00	XB010310		39 ohm, 1/8 W, 5%
R36(2)	317-0120-00			12 ohm, 1/8 W, 5%
R39(2)	321-0481-00			1M ohm, 1/8 W, 1%
R41	317-0474-00			470K ohm, 1/8 W, 5%
R42	315-0300-00			30 ohm, ½ W, 5%
R50	315-0430-00			43 ohm, ¼ W, 5%
R53	316-0101-00			100 ohm, ¼ W, 10%
R61	317-0474-00			470K ohm, 1/8 W, 5%
R62	315-0300-00			30 ohm, ½ W, 5%
R104	317-0391-00			390 ohm, 1/8 W, 5%
R105	315-0470-00			47 ohm, ¼ W, 5%
R109	317-0332-00	B010100	B049999	3.3K ohm, 1/8 W, 5%
R109	317-0332-00	B050000		3.3K ohm, (nominal value), selected
R110	311-1228-00			10K ohm, Var
R111	315-0103-00			10K ohm, ½ W, 5%
R112	311-1259-00			100 ohm, Var
R113	317-0102-00			1K ohm, 1/8 W, 5%
R114	315-0151-00			150 ohm, ¼ W, 5%
R119	315-0300-00			30 ohm, ½ W, 5%
R120	315-0104-00			100K ohm, ½ W, 5%
R122	321-0239-00			3.01K ohm, 1/8 W, 1%
R123	315-0470-00	B010100	B049999	47 ohm, ¼ W, 5%
R123	316-0101-00	B050000		100 ohm, ¼ W, 10%
R124	321-0307-00			15.4K ohm, 1/8 W, 1%
R125	311-1226-00	B010100	B029999	2.5K ohm, Var
R125	315-0222-00	B030000		2.2K ohm, ¼ W, 5%
R126	321-0277-00			7.5K ohm, 1/8 W, 1%
R127	315-0470-00	B010100	B049999	47 ohm, ¼ W, 5%
R127	316-0101-00	B050000		100 ohm, ¼ W, 10%
R128[1]	311-1403-00			5K ohm, Var
R129	316-0105-00			1M ohm, ¼ W, 10%
R130	321-0133-00			237 ohm, 1/8 W, 1%
R131	321-0133-00			237 ohm, 1/8 W, 1%
R132	317-0101-00			100 ohm, 1/8 W, 5%
R133	311-1259-00			100 ohm, Var
R134	317-0101-00			100 ohm, 1/8 W, 5%

[1]Furnished as a unit with S128.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R135	311-1222-00			100 ohm, Var
R136	317-0101-00			100 ohm, 1/8 W, 5%
R137	317-0152-00	B010100	B010309	1.5K ohm, 1/8 W, 1%
R137	317-0132-00	B010310		1.3K ohm, 1/8 W, 5%
R138	317-0242-00			2.4K ohm, 1/8 W, 5%
R139	311-0635-00			1K ohm, Var
R142	321-0072-00			54.9 ohm, 1/8 W, 1%
R143	321-0072-00			54.9 ohm, 1/8 W, 1%
R145	315-0470-00			47 ohm, ¼ W, 5%
R149	321-0260-00			4.99K ohm, 1/8 W, 1%
RT149	307-0124-00			5K ohm, Thermal
R151	321-0076-00			60.4 ohm, 1/8 W, 1%
R152	321-0076-00			60.4 ohm, 1/8 W, 1%
R154	321-0076-00			60.4 ohm, 1/8 W, 1%
R155	321-0076-00			60.4 ohm, 1/8 W, 1%
R156	321-0081-00			68.1 ohm, 1/8 W, 1%
R157	321-0024-00			17.4 ohm, 1/8 W, 1%
R161	315-0511-00			510 ohm, ¼ W, 5%
R162	321-0172-00			604 ohm, 1/8 W, 1%
R163	321-0211-00			1.54K ohm, 1/8 W, 1%
R164	321-0147-00			332 ohm, 1/8 W, 1%
R165	311-1225-00			1K ohm, Var
R168	315-0222-00			2.2K ohm, ¼ W, 5%
R170	315-0152-00	B010100	B029999	1.5K ohm, ¼ W, 5%
R170	315-0122-00	B030000		1.2K ohm, (nominal value), selected
RT170	307-0181-00			100K ohm, Thermal
R171	315-0100-00			100 ohm, ¼ W, 5%
R172	315-0471-00	B010100	B010244	470 ohm, ¼ W, 5%
R172	315-0331-00	B010245		330 ohm, ¼ W, 5%
R173	321-0018-00			15 ohm, 1/8 W, 1%
R174	315-0154-00			150K ohm, ¼ W, 5%
R175	311-1260-00			250 ohm, Var
R176	311-1223-00	B010100	B010244	250 ohm, Var
R176	311-1226-00	B010245		2.5K ohm, Var
R177	317-0201-00			200 ohm, 1.8 W, 5%
R178	315-0391-00			390 ohm, ¼ W, 5%
R179	321-0152-00	B010100	B010244	374 ohm, 1/8 W, 1%
R179	321-0164-00	B010245		499 ohm, 1/8 W, 1%
R180	315-0152-00	B010100	B029999	1.5K ohm, ¼ W, 5%
R180	315-0122-00	B030000		1.2K ohm, (nominal value), selected
R181	315-0101-00			100 ohm, ¼ W, 5%
R182	315-0471-00	B010100	B010244	470 ohm, ¼ W, 5%
R182	315-0331-00	B010245		330 ohm, ¼ W, 5%
R183	321-0018-00			15 ohm, 1/8 W, 1%
R184	321-0067-00	B010100	B010244	48.7 ohm, 1/8 W, 1%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R184	321-0051-00	B010245		33.2 ohm, 1/8 W, 1%
R185	311-1397-00			2 x 5K ohm, Var
R186	321-0152-00	B010100	B010244	374 ohm, 1/8 W, 1%
R186	321-0148-00	B010245		340 ohm, 1/8 W, 1%
R187	321-0231-00			2.49K ohm, 1/8 W, 1%
R188	315-0391-00			390 ohm, ¼ W, 5%
R189	321-0152-00	B010100	B010244	374 ohm, 1/8 W, 1%
R189	321-0164-00	B010245		499 ohm, 1/8 W, 1%
R193	321-0097-00	XB030000		100 ohm, 1/8 W, 1%
R194	321-0097-00	XB030000		100 ohm, 1/8 W, 1%
R195	311-1266-00	XB030000		2.5K ohm, Var
R196	315-0182-00	XB010245		1.8K ohm, ¼ W, 5%
R198	315-0182-00	XB010245		1.8K ohm, ¼ W, 5%
R204	317-0391-00			390 ohm, 1/8 W, 5%
R205	315-0470-00			47 ohm, ¼ W, 5%
R209	317-0332-00	B010100	B049999	3.3K ohm, 1/8 W, 5%
R209	317-0332-00	B050000		3.3K ohm, (nominal value), selected
R210	311-1228-00			10K ohm, Var
R211	315-0103-00			10K ohm, ¼ W, 5%
R212	311-1259-00			100 ohm, Var
R213	317-0102-00			1K ohm, 1/8 W, 5%
R214	315-0151-00			150 ohm, ¼ W, 5%
R215	311-1268-00			10K ohm, Var
R216	315-0103-00			10K ohm, ¼ W, 5%
R217	321-0277-00			7.5K ohm, 1/8 W, 1%
R218	321-0277-00			7.5K ohm, 1/8 W, 1%
R219	315-0300-00			30 ohm, ¼ W, 5%
R220	315-0104-00			100K ohm, ¼ W, 5%
R221	321-0307-00			15.4K ohm, 1/8 W, 1%
R222	321-0253-00			4.22K ohm, 1/8 W, 1%
R223	315-0470-00	B010100	B049999	47 ohm, ¼ W, 5%
R223	316-0101-00	B050000		100 ohm, ¼ W, 10%
R224	321-0307-00			15.4K ohm, 1/8 W, 1%
R225	311-1226-00	B010100	B029999	2.5K ohm, Var
R225	315-0222-00	B030000		2.2K ohm, ¼ W, 5%
R226	321-0253-00			4.22K ohm, 1/8 W, 1%
R227	315-0470-00	B010100	B049999	47 ohm, ¼ W, 5%
R227[1]	316-0101-00	B050000		100 ohm, ¼ W, 10%
R228[1]	311-1403-00			5K ohm, Var
R229	316-0105-00			1M ohm, ¼ W, 10%
R230	321-0133-00			237 ohm, 1/8 W, 1%
R231	321-0133-00			237 ohm, 1/8 W, 1%
R232	317-0101-00			100 ohm, 1/8 W, 5%
R233	311-1259-00			100 ohm, Var
R234	317-0101-00			100 ohm, 1/8 W, 5%

[1]Furnished as a unit with S228.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R235	311-1222-00			100 ohm, Var
R236	317-0101-00			100 ohm, 1/8 W, 5%
R237	317-0152-00	B010100	B010309	1.5K ohm, 1/8 W, 5%
R237	317-0132-00	B010310		1.3K ohm, 1/8 W, 5%
R238	317-0242-00			2.4K ohm, 1/8 W, 5%
R239	311-0635-00			1K ohm, Var
R242	321-0072-00			54.9 ohm, 1/8 W, 1%
R243	321-0072-00			54.9 ohm, 1/8 W, 1%
R245	315-0470-00			47 ohm, ¼ W, 5%
R249	321-0260-00			4.99K ohm, 1/8 W, 1%
RT249	307-0124-00			5K ohm, Thermal
R251	321-0076-00			60.4 ohm, 1/8 W, 1%
R252	321-0076-00			60.4 ohm, 1/8 W, 1%
R254	321-0076-00			60.4 ohm, 1/8 W, 1%
R255	321-0076-00			60.4 ohm, 1/8 W, 1%
R256	321-0081-00			68.1 ohm, 1/8 W, 5%
R257	321-0024-00			17.4 ohm, 1/8 W, 1%
R261	315-0511-00			510 ohm, ½ W, 5%
R262	321-0172-00			604 ohm, 1/8 W, 1%
R263	321-0211-00			1.54K ohm, 1/8 W, 1%
R264	321-0147-00			332 ohm, 1/8 W, 1%
R265	311-1225-00			1K ohm, Var
R268	315-0222-00			2.2K ohm, ¼W, 5%
R270	315-0152-00	B010100	B029999	1.5K ohm, ¼ W, 5%
R270	315-0122-00	B030000		1.2K ohm, (nominal value), selected
RT270	307-0181-00			100K ohm, Thermal
R271	315-0100-00			100 ohm, ¼ W, 5%
R272	315-0471-00	B010100	B010244	470 ohm, ¼ W, 5%
R272	315-0331-00	B010245		330 ohm, ¼ W, 5%
R273	321-0018-00			15 ohm, 1/8 W, 1%
R274	315-0154-00			150K ohm, ¼ W, 5%
R275	311-1260-00			250 ohm, Var
R276	311-1223-00	B010100	B010244	250 ohm, Var
R276	311-1226-00	B010245		2.5K ohm, Var
R277	317-0201-00			200 ohm, 1/8 W, 5%
R278	315-0391-00			390 ohm, ¼ W, 5%
R279	321-0152-00	B010100	B010244	374 ohm, 1/8 W, 1%
R279	321-0164-00	B010245		499 ohm, 1/8 W, 1%
R280	315-0152-00	B010100	B029999	1.5K ohm, ¼ W, 5%
R280	315-0122-00	B030000		1.2K ohm, (nominal value), selected
R281	315-0101-00			100 ohm, ¼ W, 5%
R282	315-0471-00	B010100	B010244	470 ohm, ¼ W, 5%
R282	315-0331-00	B010245		330 ohm, ¼ W, 5%
R283	321-0018-00			15 ohm, 1/8 W, 1%
R284	321-0067-00	B010100	B010244	48.7 ohm, 1/8 W, 1%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R284	321-0051-00	B010245		33.2 ohm, 1/8 W, 1%
R285	311-1397-00			2 x 5K ohm, Var
R286	321-0152-00	B010100	B010244	374 ohm, 1/8 W, 1%
R286	321-0148-00	B010245		340 ohm, 1/8 W, 1%
R287	321-0231-00			2.49K ohm, 1/8 W, 1%
R288	315-0391-00			390 ohm, ¼ W, 5%
R289	321-0152-00	B010100	B010244	374 ohm, 1/8 W, 1%
R289	321-0164-00	B010245		499 ohm, 1/8 W, 1%
R291	307-0106-00			4.7 ohm, ¼ W, 5%
R292	307-0106-00			4.7 ohm, ¼ W, 5%
R293	321-0097-00	XB030000		100 ohm, 1/8 W, 1%
R294	321-0097-00	XB030000		100 ohm, 1/8 W, 1%
R295	311-1266-00	XB030000		2.5K ohm, Var
R296	315-0182-00	XB010245		1.8K ohm, ¼ W, 5%
R297	307-0106-00			4.7 ohm, ¼ W, 5%
R298	315-0182-00	XB010245		1.8K ohm, ¼ W, 5%
R301	321-0164-00			499 ohm, 1/8 W, 1%
R302	321-0131-00			226 ohm, 1/8 W, 1%
R304	315-0102-00			1K ohm, ¼ W, 5%
R306	315-0121-00			120 ohm, ¼ W, 5%
R310	315-0101-00			100 ohm, ¼ W, 5%
R311	315-0152-00			1.5K ohm, ¼ W, 5%
R312	315-0120-00			12 ohm, ¼ W, 5%
R313	315-0222-00			2.2K ohm, ¼ W, 5%
R314	316-0822-00			8.2K ohm, ½ W, 10%
R316	315-0223-00			22K ohm, ¼ W, 5%
R320	315-0101-00			100 ohm, ¼ W, 5%
R321	315-0152-00			1.5K ohm, ¼ W, 5%
R322	315-0120-00			12 ohm, ¼ W, 5%
R323	315-0222-00			2.2K ohm, ¼ W, 5%
R324	316-0822-00			8.2K ohm, ½ W, 10%
R326	315-0223-00			22K ohm, ¼ W, 5%
R331	315-0102-00			1K ohm, ¼ W, 5%
R332	315-0123-00			12K ohm, ¼ W, 5%
R333	315-0182-00			1.8K ohm, ¼ W, 5%
R335	315-0123-00			12K ohm, ¼ W, 5%
R336	315-0182-00			1.8K ohm, ¼ W, 5%
R338	315-0203-00			20K ohm, ¼ W, 5%
R339	315-0222-00			2.2K ohm, ¼ W, 5%
R341	315-0102-00			1K ohm, ¼ W, 5%
R342	315-0132-00			1.3K ohm, ¼ W, 5%
R343	315-0511-00			510 ohm, ¼ W, 5%
R346	315-0102-00			1K ohm, ¼ W, 5%
R347	315-0102-00			1K ohm, ¼ W, 5%
R348	315-0391-00			390 ohm, ¼ W, 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R351	315-0202-00			2K ohm, ¼ W, 5%
R353	321-0152-00			374 ohm, 1/8 W, 1%
R354	321-0114-00			150 ohm, 1/8 W, 1%
R355	321-0174-00			634 ohm, 1/8 W, 1%
R356	321-0114-00			150 ohm, 1/8 W, 1%
R357	321-0174-00			634 ohm, 1/8 W, 1%
R358	321-0152-00			374 ohm, 1/8 W, 1%
R359	315-0202-00			2K ohm, ¼ W, 5%
R361	315-0202-00			2K ohm, ¼ W, 5%
R363	321-0152-00			374 ohm, 1/8 W, 1%
R364	321-0114-00			150 ohm, 1/8 W, 1%
R365	321-0174-00			634 ohm, 1/8 W, 1%
R366	321-0114-00			150 ohm, 1/8 W, 1%
R367	321-0174-00			634 ohm, 1/8 W, 1%
R368	321-0152-00			374 ohm, 1/8 W, 1%
R369	315-0202-00			2K ohm, ¼ W, 5%
R371	315-0470-00			47 ohm, ¼ W, 5%
R372	315-0470-00			47 ohm, ¼ W, 5%
R373	315-0470-00			47 ohm, ¼ W, 5%
R374	315-0470-00			47 ohm, ¼ W, 5%
R380	321-0078-00			63.4 ohm, 1/8 W, 1%
R381	321-0078-00			63.4 ohm, 1/8 W, 1%
R382	323-0130-00			221 ohm, ½ W, 1%
R383	323-0130-00			221 ohm, ½ W, 1%
R384	322-0107-00			127 ohm, ¼ W, 1%
R385	311-1221-00			50 ohm, Var
R388	315-0270-00			27 ohm, ¼ W, 5%
R391	321-0154-00			392 ohm, 1/8 W, 1%
R392	321-0124-00	B010100	B010309	191 ohm, 1/8 W, 1%
R392	321-0122-00	B010310		182 ohm, 1/8 W, 1%
R393	315-0200-00	B010100	B010309	20 ohm, ¼ W, 5%
R393	315-0271-00	B010310		270 ohm, ¼ W, 5%
R394	321-0143-00	B010100	B010309	301 ohm, 1/8 W, 1%
R394	321-0146-00	B010310		324 ohm, 1/8 W, 1%
R395	322-0156-00			412 ohm, 1/8 W, 1%
R396	315-0100-00			10 ohm, ¼ W, 5%
R398	315-0620-00			62 ohm, ¼ W, 5%
R399	315-0390-00			39 ohm, ¼ W, 5%
R401	321-0132-00			232 ohm, 1/8 W, 1%
R402	321-0078-00			63.4 ohm, 1/8 W, 1%
R403	311-1221-00			50 ohm, Var
R404	321-0132-00			232 ohm, 1/8 W, 1%
R405	321-0078-00			63.4 ohm, 1/8 W, 1%
R411	321-0132-00			232 ohm, 1/8 W, 1%
R412	321-0078-00			63.4 ohm, 1/8 W, 1%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R414	321-0132-00			232 ohm, 1/8 W, 1%
R415	321-0078-00			63.4 ohm, 1/8 W, 1%
R419	321-0068-00			49.9 ohm, 1/8 W, 1%
R420	315-0200-00			20 ohm, ¼ W, 5%
R421	321-0151-00			365 ohm, 1/8 W, 1%
R422	321-0210-00			1.5K ohm, 1/8 W, 1%
R423	321-0070-00			52.3 ohm, 1/8 W, 1%
R425	311-1223-00			250 ohm, Var
R426	322-0161-00			464 ohm, ½ W, 1%
R427	315-0271-00			270 ohm, ¼ W, 5%
R430	315-0471-00			470 ohm, ¼ W, 5%
R431	321-0071-00			53.6 ohm, 1/8 W, 1%
R432	321-0184-00			806 ohm, 1/8 W, 1%
R436	315-0100-00			10 ohm, ¼ W, 5%
R437	315-0100-00			10 ohm, ¼ W, 5%
R438	307-0106-00			4.7 ohm, ½ W, 5%
R441	321-0068-00			49.9 ohm, 1/8 W, 1%
R445	321-0068-00			49.9 ohm, 1/8 W, 1%
R446	321-0136-00			255 ohm, 1/8 W, 1%
R447	321-0249-00	B010100	B049999	3.83K ohm, 1/8 W, 1%
R447	321-0239-00	B050000		3.01K ohm, 1/8 W, 1%
R448	321-0193-00			1K ohm, 1/8 W, 1%
R449	311-1238-00			5K ohm, Var
R450	311-1260-00			250 ohm, Var
R451	317-0101-00			100 ohm, 1/8 W, 1%
R452	317-0200-00			20 ohm, 1/8 W, 5%
RT452	307-0127-00			1K ohm, Thermal
R453	317-0200-00			20 ohm, 1/8 W, 5%
R454	317-0681-00			680 ohm, 1/8 W, 5%
R455	317-0102-00			1K ohm, 1/8 W, 5%
R457	321-0163-00			487 ohm, 1/8 W, 1%
R458	321-0163-00			487 ohm, 1/8 W, 1%
R459	315-0751-00			750 ohm, ¼ W, 5%
R460	315-0270-00			27 ohm, ¼ W, 5%
R461	321-0198-00			1.13K ohm, 1/8 W, 1%
R462	323-0147-00			332 ohm, ½ W, 1%
R463	315-0561-00			560 ohm, ¼ W, 5%
R464	323-0147-00			332 ohm, ½ W, 1%
R465	315-0561-00			560 ohm, ¼ W, 5%
R466	311-1279-00			500 ohm, Var
R467	317-0150-00			15 ohm, 1/8 W, 5%
R468	321-0055-00			36.5 ohm, 1/8 W, 1%
R469	321-0055-00			36.5 ohm, 1/8 W, 1%
R470	311-1278-00			250 ohm, Var
R471	315-0102-00			1K ohm, ½ W, 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R472	315-0200-00			20 ohm, ¼ W, 5%
R473	315-0200-00			20 ohm, ¼ W, 5%
R474	317-0150-00			15 ohm, 1/8 W, 5%
R475	311-1245-00			10K ohm, Var
R476	317-0182-00			1.8K ohm, 1/8 W, 5%
R477	315-0102-00			1K ohm, ¼ W, 5%
R478	321-0164-00			499 ohm, 1/8 W, 1%
R479	321-0164-00			499 ohm, 1/8 W, 1%
R480	315-0330-00			33 ohm, ¼ W, 5%
R481	321-0039-00			24.9 ohm, 1/8 W, 1%
R482	321-0039-00			24.9 ohm, 1/8 w, 1%
R483	322-0157-00			422 ohm, ½ W, 1%
R484	322-0157-00			422 ohm, ½ W, 1%
R485	315-0560-00			56 ohm, ¼ W, 5%
R486	315-0100-00			10 ohm, ¼ W, 5%
R487	315-0301-00			300 ohm, ¼ W, 5%
R488	311-1236-00			250 ohm, Var
R489	315-0911-00			910 ohm, ¼ W, 5%
R491	301-0100-00			10 ohm, ½ W, 5%
R492	323-0134-00			243 ohm, ½ W, 1%
R493	323-0134-00			243 ohm, ½ W, 1%
R494	317-0621-00			620 ohm, 1/8 W, 5%
R495	323-0134-00			243 ohm, ½ W, 1%
R496	323-0134-00			243 ohm, ½ W, 1%
R497	307-0292-00			Thick film
R498	307-0106-00			4.7 ohm, ¼ W, 5%
R499	307-0106-00			4.7 ohm, ¼ W, 5%
R500	315-0560-00			56 ohm, ¼ W, 5%
R501	316-0221-00			220 ohm, ½ W, 10%
R502	316-0152-00			1.5K ohm, ¼ W, 10%
R503	316-0221-00			220 ohm, ¼ W, 10%
R504	316-0152-00			1.5K ohm, ¼ W, 10%
R505	316-0470-00			47 ohm, ½ W, 10%
R506	316-0152-00			1.5K ohm, ¼ W, 10%
R507	316-0103-00			10K ohm, ¼ W, 10%
R508	316-0274-00			270K ohm, ¼ W, 10%
R509	315-0560-00			56 ohm, ¼ W, 5%
R510	316-0330-00			33 ohm, ¼ W, 10%
R511	315-0914-00			910 ohm, ½ W, 5%
R512	315-0434-00			430K ohm, ¼ W, 5%
R513	315-0475-00			4.7M ohm, ¼ W, 5%
R514	315-0154-00			150K ohm, ¼ W, 5%
R515	316-0104-00			100K ohm, ¼ W, 10%
R516	316-0563-00			56K ohm, ¼ W, 10%
R517	315-0105-00			1M ohm, ¼ W, 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R518	316-0100-00			10 ohm, ½ W, 10%
R519	316-0101-00			100 ohm, ½ W, 10%
R520	315-0560-00			56 ohm, ¼ W, 5%
R521	316-0101-00			100 ohm, ½ W, 10%
R522	316-0150-00			15 ohm, ½ W, 10%
R523	316-0150-00			15 ohm, ½ W, 10%
R524	316-0101-00			100 ohm, ½ W, 10%
R525	316-0821-00			820 ohm, ½ W, 10%
R526	315-0220-00			22 ohm, ¼ W, 5%
R527	322-0178-00			698 ohm, ½ W, 1%
R528	315-0220-00			22 ohm, ¼ W, 5%
R529	316-0103-00			10K ohm, ½ W, 10%
R530[1]	311-1192-00			10K ohm, Var
R532	315-0122-00			1.2K ohm, ½ W, 5%
R533	316-0821-00			820 ohm, ½ W, 10%
R534	311-1230-00			20K ohm, Var
R535	315-0302-00			3K ohm, ½ W, 5%
R536	316-0101-00			100 ohm, ½ W, 10%
R537	316-0152-00			1.5K ohm, ½ W, 10%
R538	316-0332-00			3.3K ohm, ½ W, 10%
R541	316-0682-00			6.8K ohm, ½ W, 10%
R542	316-0392-00			3.9K ohm, ½ W, 10%
R543	316-0221-00			220 ohm, ½ W, 10%
R544	315-0302-00			3K ohm, ¼ W, 5%
R545	315-0242-00			2.4K ohm, ¼ W, 5%
R546	316-0470-00			47 ohm, ½ W, 10%
R547	311-1230-00			20K ohm, Var
R551	321-0082-00			69.8 ohm, 1/8 W, 1%
R552	322-0283-00			8.66K ohm, ¼ W, 1%
R553	321-0082-00			69.8 ohm, 1/8 W, 1%
R554	321-0059-00			40.2 ohm, 1/8 W, 1%
R555	321-0185-00			825 ohm, 1/8 W, 1%
R556	321-0047-00			30.1 ohm, 1/8 W, 1%
R557	321-0224-00			2.1K ohm, 1/8 W, 1%
R558	321-0044-00			28 ohm, 1/8 W, 1%
R559	321-0259-00			4.87K ohm, 1/8 W, 1%
RT559	307-0124-00			5K ohm, Thermal
R561	321-0082-00			69.8 ohm, 1/8 W, 1%
R562	322-0283-00			8.66K ohm, ¼ W, 1%
R563	321-0082-00			69.8 ohm, 1/8 W, 1%
R564	315-0242-00			2.4K ohm, ¼ W, 5%
R565	311-1228-00			10K ohm, Var
R566	321-0044-00			28 ohm, 1/8 W, 1%
R567	321-0224-00			2.1K ohm, 1/8 W, 1%
R568	316-0470-00	B010100	B029999	47 ohm, ½ W, 10%

[1]Furnished as a unit with S530.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R568	316-0101-00	B030000		100 ohm, ¼ W, 10%
R569	321-0279-00			7.87K ohm, 1/8 W, 1%
R570	301-0181-00			180 ohm, ½ W, 5%
R571	315-0100-00			10 ohm, ½ W, 5%
R572	321-0187-00			866 ohm, 1/8 W, 1%
R574	315-0432-00			4.3K ohm, ¼ W, 5%
R575	315-0151-00			150 ohm, ¼ W, 5%
R577	321-0246-00			3.57K ohm, 1/8 W, 1%
R578	321-0164-00			499 ohm, 1/8 W, 1%
R579	301-0201-00			200 ohm, ½ W, 5%
R580	316-0220-00	XB030000		22 ohm, ¼ W, 10%
R581	315-0101-00			100 ohm, ¼ W, 5%
R582	315-0471-00			470 ohm, ¼ W, 5%
R583	315-0331-00			330 ohm, ¼ W, 5%
R588	301-0121-00			120 ohm, ½ W, 5%
R590	315-0102-00			1K ohm, ¼ W, 5%
R591	321-0242-00			3.24K ohm, 1/8 W, 1%
R592	321-0222-00			2K ohm, 1/8 W, 1%
R593	316-0103-00			10K ohm, ¼ W, 10%
R594	315-0162-00			1.6K ohm, ¼ W, 5%
R595	315-0102-00			1K ohm, ¼ W, 5%
R596	307-0106-00			4.7 ohm, ½ W, 5%
R597	315-0221-00			220 ohm, ¼ W,5%
R598	315-0221-00			220 ohm, ¼ W, 5%
R599	321-0318-00			20K ohm, 1/8 W, 1%
R600	307-0106-00			4.7 ohm, ½ W, 5%
R601	315-0472-00			4.7K ohm, ¼ W, 5%
R602	315-0472-00			4.7K ohm, ¼ W, 5%
R603	315-0241-00			240 ohm, ¼ W, 5%
R604	316-0393-00			39K ohm, ¼ W, 10%
R607	315-0101-00			100 ohm, ¼ W, 5%
R608	307-0103-00	XB010310		2.7 ohm, ½ W, 5%
R609	315-0104-00			100K ohm, ¼ W, 5%
R610	307-0103-00	XB010310		2.7 ohm, ½ W, 5%
R611	321-0174-00			634 ohm, 1/8 W, 1%
R612	321-0190-00			931 ohm, 1/8 W, 1%
R613	315-0101-00			100 ohm, ¼ W, 5%
R622	307-0103-00			2.7 ohm, ½ W, 5%
R626	315-0201-00			200 ohm, ¼ W, 5%
R627	315-0101-00			100 ohm, ¼ W, 5%
R628	321-0184-00			806 ohm, 1/8 W, 1%
R629	321-0205-00			1.33K ohm, 1/8 W, 1%
R641	321-0222-00			2K ohm, 1/8 W, 1%
R642[1]	321-0275-00			7.15K ohm, 1/8 W, 1%
R644[1]	311-1401-00			100K ohm, Var

[1]Furnished as a unit with S644.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R647	315-0473-00			47K ohm, ¼ W, 5%
R661	315-0430-00			43 ohm, ¼ W, 5%
R662	315-0150-00			15 ohm, ¼ W, 5%
R663	322-0207-00			1.4K ohm, ½ W, 1%
R664	315-0510-00			51 ohm, ¼ W, 5%
R665	316-0103-00			10K ohm, ¼ W, 10%
R666	315-0102-00			1K ohm, ¼ W,5%
R667	315-0510-00			51 ohm, ¼ W, 5%
R668	321-0178-00			698 ohm, 1/8 W, 1%
R669	315-0150-00			15 ohm, ¼ W, 5%
R670	316-0470-00			47 ohm, ¼ W, 10%
R671	315-0430-00			43 ohm, ¼ W, 5%
R672	315-0150-00			15 ohm, ¼ W, 5%
R673	311-1223-00			250 ohm, Var
R674	315-0510-00			51 ohm, ¼ W, 5%
R675	321-0155-00			402 ohm, 1/8 W, 1%
R676	315-0102-00			1K ohm, ¼ W, 5%
R677	315-0510-00			51 ohm, ¼ W, 5%
R678	321-0178-00			698 ohm, 1/8 W, 1%
R679	316-0220-00			22 ohm, ¼ W, 10%
R680	321-0225-00			2.15K ohm, 1/8 W, 1%
R681	321-0209-00			1.47K ohm, 1/8 W, 1%
R682	315-0102-00			1K ohm, ¼ W, 5%
R683	315-0202-00			2K ohm, ¼ W, 5%
R684	321-0248-00			3.74K ohm, 1/8 W, 1%
R685	321-0248-00			3.74K ohm, 1/8 W, 1%
R686	321-0210-00			1.5K ohm, 1/8 W, 1%
R687	321-0209-00			1.47K ohm, 1/8 W, 1%
R688	321-0141-00			287 ohm, 1/8 W, 1%
R689	315-0432-00			4.3K ohm, ¼ W, 5%
R692	315-0472-00			4.7K ohm, ¼ W, 5%
R693	315-0181-00	B010100	B039999	180 ohm, ¼ W, 5%
R693	315-0471-00	B040000		470 ohm, ¼ W, 5%
R694	315-0470-00			47 ohm, ¼ W, 5%
R695	321-0204-00			1.3K ohm, 1/8 W, 1%
R696	321-0222-00			2K ohm, 1/8 W, 1%
R697	321-0178-00			698 ohm, 1/8 W, 1%
R698	315-0100-00			10 ohm, ¼ W, 5%
R699	315-0472-00			4.7K ohm, ¼ W, 5%
R701	315-0152-00			1.5K ohm, ¼ W, 5%
R702	315-0162-00			1.6K ohm, ¼ W, 5%
R703	315-0152-00			1.5K ohm, ¼ W, 5%
R704	315-0162-00			1.6K ohm, ¼ W, 5%
R705	315-0152-00			1.5K ohm, ¼ W, 5%
R706	315-0162-00			1.6K ohm, ¼ W, 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R711	316-0152-00			1.5K ohm, ½ W, 10%
R712	316-0221-00			220 ohm, ½ W, 10%
R713	316-0152-00			1.5K ohm, ½ W, 10%
R714	316-0221-00			220 ohm, ½ W, 10%
R715	316-0151-00			150 ohm, ½ W, 10%
R716	316-0152-00			1.5K ohm, ½ W, 10%
R717	315-0620-00			62 ohm, ¼ W, 5%
R718	315-0620-00			62 ohm, ¼ W, 5%
R719	315-0620-00			62 ohm, ¼ W, 5%
R721	316-0330-00			33 ohm, ½ W, 10%
R722	315-0754-00			750K ohm, ½ W, 5%
R723	315-0334-00			330K ohm, ½ W, 5%
R729	316-0101-00			100 ohm, ½ W, 10%
R731	316-0332-00			3.3K ohm, ½ W, 10%
R735	316-0104-00			100K ohm, ½ W, 10%
R736	316-0563-00			56K ohm, ½ W, 10%
R737	315-0105-00			1M ohm, ½ W, 5%
R738	316-0100-00			10 ohm, ½ W, 10%
R739	316-0101-00			100 ohm, ¼ W, 10%
R741	316-0101-00			100 ohm, ½ W, 10%
R742	316-0150-00			15 ohm, ¼ W, 10%
R743	316-0150-00			15 ohm, ½ W, 10%
R744	316-0101-00			100 ohm, ½ W, 10%
R745	316-0821-00			820 ohm, ½ W, 10%
R746	315-0220-00			22 ohm, ½ W, 5%
R747	322-0178-00			698 ohm, ¼ W, 1%
R748	315-0220-00			22 ohm, ¼ W, 5%
R750[1]	311-1192-00			10K ohm, Var
R752	315-0122-00			1.2K ohm, ½ W, 5%
R753	316-0821-00			820 ohm, ¼ W, 10%
R754	311-1230-00			20K ohm, Var
R755	315-0302-00			3K ohm, ½ W, 5%
R756	315-0101-00			100 ohm, ½ W, 5%
R758	316-0152-00			1.5K ohm, ½ W, 10%
R759	321-0259-00			4.87K ohm, 1/8 W, 1%
RT759	307-0124-00			5K ohm, Thermal
R761	316-0682-00			6.8K ohm, ¼ W, 10%
R762	316-0392-00			3.9K ohm, ¼ W, 10%
R763	316-0221-00			220 ohm, ½ W, 10%
R764	315-0302-00			3K ohm, ¼ W, 5%
R765	315-0242-00			2.4K ohm, ¼ W, 5%
R766	316-0470-00			47 ohm, ¼ W, 10%
R767	311-1230-00			20K ohm, Var
R769	321-0279-00			7.87K ohm, 1/8 W, 1%
R771	321-0082-00			69.8 ohm, 1/8 W, 1%

[1]Furnished as a unit with S750.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R772	322-0283-00			8.66K ohm, ¼ W, 1%
R773	321-0082-00			69.8 ohm, 1/8 W, 1%
R774	321-0059-00			40.2 ohm, 1/8 W, 1%
R775	321-0185-00			825 ohm, 1/8 W, 1%
R776	321-0047-00			30.1 ohm, 1/8 W, 1%
R777	321-0224-00			2.1K ohm, 1/8 W, 1%
R778	321-0044-00			28 ohm, 1/8 W, 1%
R781	321-0082-00			69.8 ohm, 1/8 W, 1%
R782	322-0283-00			8.66K ohm, ¼ W, 1%
R783	321-0082-00			69.8 ohm, 1/8 W, 1%
R784	315-0242-00			2.4K ohm, ¼ W, 5%
R785	311-1228-00			10K ohm, Var
R786	321-0044-00			28 ohm, 1/8 W, 1%
R787	321-0224-00			2.1K ohm, 1/8 W, 1%
R788	315-0472-00			4.7K ohm, ¼ W, 5%
R789	316-0221-00			220 ohm, ¼ W, 10%
R793	321-0289-00			10K ohm, 1/8 W, 1%
R794	321-0260-00			4.99K ohm, 1/8 W, 1%
R795	321-0225-00			2.15K ohm, 1/8 W, 1%
R796	321-0227-00			2.26K ohm, 1/8 W, 1%
R797	315-0101-00			100 ohm, ½ W, 5%
R798	321-0249-00			3.83K ohm, 1/8 W, 1%
R799	316-0102-00	XB010205		1K ohm, ¼ W, 10%
R801	315-0332-00			3.3K ohm, ¼ W, 5%
R802	315-0471-00	B010100	B010204	470 ohm, ½ W, 5%
R802	315-0221-00	B010205		220 ohm, ½ W, 5%
R803	307-0103-00			2.7 ohm, ½ W, 5%
R804	321-0166-00			523 ohm, 1/8 W, 1%
R805	321-0193-00			1K ohm, 1/8 W, 1%
R806	321-0177-00			681 ohm, 1/8 W, 1%
R807	321-0254-00			4.32K ohm, 1/8 W, 1%
R808	321-0250-00			3.92K ohm, 1/8 W, 1%
R809	315-0101-00			100 ohm, ¼ W, 5%
R810	315-0201-00			200 ohm, ¼ W, 5%
R811	315-0202-00			2K ohm, ¼ W, 5%
R812	315-0332-00			3.3K ohm, ¼ W, 5%
R813	315-0151-00			150 ohm, ½ W, 5%
R814	315-0102-00			1K ohm, ¼ W, 5%
R815	321-0232-00			2.55K ohm, 1/8 W, 1%
R816	321-0155-00			402 ohm, 1/8 W, 1%
R817	315-0221-00			200 ohm, ½ W, 5%
R818	321-0187-00			866 ohm, 1/8 W, 1%
R819	316-0100-00			10 ohm, ¼ W, 10%
R821	315-0101-00			100 ohm, ½ W, 5%
R822	315-0471-00			470 ohm, ¼ W, 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R823	315-0331-00			330 ohm, ¼ W, 5%
R825	307-0106-00			4.7 ohm, ¼ W, 5%
R826	307-0106-00			4.7 ohm, ¼ W, 5%
R900	321-0225-00			2.15K ohm, 1/8 W, 1%
R902	321-0155-00			402 ohm, 1/8 W, 1%
R903	315-0221-00			220 ohm, ¼ W, 5%
R904	321-0168-00			549 ohm, 1/8 W, 1%
R905	307-0106-00			4.7 ohm, ¼ W, 5%
R906	321-0268-00			6.04K ohm, 1/8 W, 1%
R907	321-0289-00			10K ohm, 1/8 W, 1%
R908	321-0294-00			11.3K ohm, 1/8 W, 1%
R911	321-0164-00			499 ohm, 1/8 W, 1%
R912	321-0274-00			6.98K ohm, 1/8 W, 1%
R913	316-0100-00			10 ohm, ¼ W, 10%
R916	323-0227-00			2.26K ohm, ½ W, 1%
R917	315-0471-00			470 ohm, ½ W, 5%
R918	316-0220-00			22 ohm, ½ W, 10%
R921	315-0182-00			1.8K ohm, ½ W, 5%
R922	315-0821-00			820 ohm, ½ W, 5%
R923	316-0100-00			10 ohm, ¼ W, 10%
R924	301-0682-00			6.8K ohm, ½ W, 5%
R925	321-0218-00			1.82K ohm, 1/8 W, 1%
R926	321-0193-00			1K ohm, 1/8 W, 1%
R927	321-0238-00			2.94K ohm, 1/8 W, 1%
R928	321-0193-00			1K ohm, 1/8 W, 1%
R929	316-0123-00			12K ohm, ¼ W, 10%
R930	311-1458-00			50K ohm, Var
R931	316-0392-00			3.9K ohm, ½ W, 10%
R932	316-0102-00			1K ohm, ¼ W, 10%
R933	321-0338-00			32.4K ohm, 1/8 W, 1%
R934	321-0193-00			1K ohm, 1/8 W, 1%
R935	321-0274-00			6.98K ohm, 1/8 W, 1%
R936	311-1226-00			2.5K ohm, Var
R937	321-0196-00			1.07K ohm, 1/8 W, 1%
R938	311-1225-00			1K ohm, Var
R939	321-0258-00			4.75K ohm, 1/8 W, 1%
R940	315-0153-00			15K ohm, ½ W, 5%
R941	321-0193-00			1K ohm, 1/8 W, 1%
R942	321-0145-00			316 ohm, 1/8 W, 1%
R943	321-0152-00			374 ohm, 1/8 W, 1%
R944	321-0231-00			2.49K ohm, 1/8 W, 1%
R946	321-0216-00			1.74K ohm, 1/8 W, 1%
R947	315-0220-00			22 ohm, ½ W, 5%
R948	321-0239-00			3.01K ohm, 1/8 W, 1%
R949	321-0260-00			4.99K ohm, 1/8 W, 1%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R950	311-1222-00			100 ohm, Var
R951	321-0183-00			787 ohm, 1/8 W, 1%
R952	321-0199-00			1.15K ohm, 1/8 W, 1%
R955	315-0272-00			2.7K ohm, ¼ W, 5%
R956	315-0103-00			10K ohm, ¼ W, 5%
R961	315-0100-00			10 ohm, ¼ W, 5%
R963	315-0100-00			10 ohm, ¼ W, 5%
R965	315-0100-00			10 ohm, ¼ W, 5%
R967	307-0106-00			4.7 ohm, ½ W, 5%
R969	307-0106-00			4.7 ohm, ½ W, 5%
R971	315-0472-00			4.7K ohm, ¼ W, 5%
R972	321-0287-00			9.53K ohm, 1/8 W, 1%
R973	315-0391-00			390 ohm, ¼ W, 5%
R974	321-0268-00			6.04K ohm, 1/8 W, 1%
R975	321-0354-00			47.5K ohm, 1/8 W, 1%
R976	315-0562-00			5.6K ohm, ¼ W, 5%
R981	315-0182-00			1.8K ohm, ¼ W, %
R982	316-0101-00			100 ohm, ½ W, 10%
R985	301-0682-00			6.8K ohm, ½ W, 5%
R986	316-0103-00			10K ohm, ¼ W, 10%
R987	316-0332-00			3.3K ohm, ¼ W, 10%
R988	315-0680-00			68 ohm, ¼ W, 5%
R994	321-0225-00			2.15K ohm, 1/8 W, 1%
R995	321-0155-00			402 ohm, 1/8 W, 1%
R996	315-0221-00			220 ohm, ¼ W, 5%
R1001	315-0392-00			3.9K ohm, ¼ W, 5%
R1002	315-0332-00			3.3K ohm, ¼ W, 5%
R1004	321-0268-00			6.04K ohm, 1/8 W, 1%
R1005	321-0354-00			47.5K ohm, 1/8 W, 1%
R1006	321-0287-00			9.53K ohm, 1/8 W, 1%
R1007	315-0220-00			22 ohm, ¼ W, 5%
R1010	321-0414-00			200K ohm, 1/8 W, 1%
R1011	315-0182-00			1.8K ohm, ½ W, 5%
R1012	Selected			
R1015	301-0682-00			6.8K ohm, ½ W, 5%
R1016	316-0103-00			10K ohm, ¼ W, 10%
R1017	316-0332-00			3.3K ohm, ¼ W, 10%
R1018	315-0330-00			33 ohm, ¼ W, 5%
R1022	315-0153-00			15K ohm, ¼ W, 5%
R1023	321-0185-00			825 ohm, 1/8 W, 1%
R1024	321-0197-00			1.1K ohm, 1/8 W, 1%
R1028	315-0103-00			10K ohm, ¼ W, 5%
R1029	315-0272-00			2.7K ohm, ¼ W, 5%
R1031	321-0193-00			1K ohm, 1/8 W, 1%
R1032	321-0145-00			316 ohm, 1/8 W, 1%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R1033	321-0149-00			348 ohm, 1/8 W, 1%
R1036	321-0222-00			2K ohm, 1/8 W, 1%
R1042	321-0208-00			1.43K ohm, 1/8 W, 1%
R1045	315-0220-00			22 ohm, ¼ W, 5%
R1046	321-0239-00			3.01K ohm, 1/8 W, 1%
R1047	321-0260-00			4.99K ohm, 1/8 W, 1%
R1049	315-0102-00			1K ohm, ½ W, 5%
R1050	316-0220-00			22 ohm, ¼ W, 10%
R1051	315-0101-00			100 ohm, ½ W, 5%
R1052	315-0563-00			56K ohm, ½ W, 5%
R1053	315-0202-00	B010100	B010179	2K ohm, ½ W, 5%
R1053	315-0432-00	B010180		4.3K ohm, ½ W, 5%
R1056	321-0352-00			45.3K ohm, 1/8 W, 1%
R1057	315-0204-00			200K ohm, ¼ W, 5%
R1058	315-0105-00			1M ohm, ½ W, 5%
R1059	316-0103-00			10K ohm, ¼ W, 10%
R1060[1]	315-0331-00			330 ohm, ½ W, 5%
R1070[1]	311-1402-00			20K ohm, Var
R1071	321-0472-04			806K ohm, 1/8 W, 1/10%
R1072	321-0481-04			1M ohm, 1/8 W, 1/10%
R1073	321-0976-04			602K ohm, 1/8 W, 1/10%
R1074	321-0431-04			301K ohm, 1/8 W, 1/10%
R1075	311-1246-00			50K ohm, Var
R1076	321-0973-04			60.2K ohm, 1/8 W, 1/10%
R1077	321-0977-04			120.4K ohm, 1/8 W, 1/10%
R1078	321-0973-04			60.2K ohm, 1/8 W, 1/10%
R1079	321-0973-04			60.2K ohm, 1/8 W, 1/10%
R1080	311-1246-00	XB010316		1M ohm, Var
R1081	316-0101-00			100 ohm, ¼ W, 10%
R1082	321-0973-04			60.2K ohm, 1/8 W, 1/10%
R1083	321-0472-04			806K ohm, 1/8 W, 1/10%
R1084	321-0481-04			1M ohm, 1/8 W, 1/10%
R1085	321-0976-04			602K ohm, 1/8 W, 1/10%
R1086	321-0431-04			301K ohm, 1/8 W, 1/10%
R1087	321-0975-04			180.6K ohm, 1/8 W, 1/10%
R1088	321-0973-04			60.2K ohm, 1/8 W,1/10%
R1089	321-0973-04			60.2K ohm, 1/8 W, 1/10%
R1091	316-0105-00			1M ohm, ¼ W, 10%
R1092	316-0104-00			100K ohm, ⅛ W, 10%
R1093	316-0101-00			100 ohm, ⅛ W, 10%
R1094	321-0164-00			499 ohm, 1/8 W, 1%
R1095	321-0274-00			6.98K ohm, 1/8 W, 1%
R1096	316-0220-00			22 ohm, ¼ W, 10%
R1097	316-0105-00	XB010316		1M ohm, ¼ W, 10%
R1101	321-0068-00			49.9 ohm, 1/8 W, 1%

[1] Furnished as a unit with S1070A,B.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R1102	311-1223-00			250 ohm, Var
R1104	315-0103-00			10K ohm, ½ W, 5%
R1106	321-0118-04			165 ohm, 1/8 W, 1/10%
R1107	321-0738-04			1.485K ohm, 1/8 W, 1/10%
R1108	321-0118-04			165 ohm, 1/8 W, 1/10%
R1109	316-0104-00			100K ohm, ¼ W, 10%
R1110	316-0105-00			1M ohm, ¼ W, 10%
R1111	315-0201-00			200 ohm, ½ W, 5%
R1112	321-0258-00			4.75K ohm, 1/8 W, 1%
R1113	321-0243-00			3.32K ohm, 1/8 W, 1%
R1114	321-0141-00			287 ohm, 1/8 W, 1%
R1115	315-0470-00			47 ohm, ½ W, 5%
R1116	315-0561-00			560 ohm, ½ W, 5%
R1117	315-0622-00			6.2K ohm, ½ W, 5%
R1119A,B	311-1411-00			1K ohm x 10K ohm, Var
R1121	315-0560-00			56 ohm, ½ W, 5%
R1122	315-0201-00			200 ohm, ½ W, 5%
RT1123	307-0124-00			5K ohm, Thermal
R1124	315-0201-00			200 ohm, ½ W, 5%
R1125	321-0134-00			243 ohm, 1/8 W, 1%
R1126	321-0108-00			130 ohm, 1/8 W, 1%
R1128	321-0056-00			37.4 ohm, 1/8 W, 1%
R1130	311-1230-00			20K ohm, Var
R1131	315-0273-00			27K ohm, ½ W, 5%
R1132	315-0151-00			150 ohm, ½ W, 5%
R1134	315-0271-00			270 ohm, ½ W, 5%
R1135	321-0134-00			243 ohm, 1/8 W, 1%
R1138	321-0056-00			37.4 ohm, 1/8 W, 1%
R1140	321-0097-00			100 ohm, 1/8 W, 1%
R1141	321-0195-00			1.05K ohm, 1/8 W, 1%
R1142	321-0164-00			499 ohm, 1/8 W, 1%
R1152	315-0121-00			120 ohm, ½ W, 5%
R1153	321-0147-00			332 ohm, 1/8 W, 1%
R1154	321-0106-00			124 ohm, 1/8 W, 1%
R1155	311-1258-00			50 ohm, Var
R1156	321-0159-00			442 ohm, 1/8 W, 1%
R1159	321-0159-00			442 ohm, 1/8 W, 1%
R1162	315-0121-00			120 ohm, ¼ W, 5%
R1163	321-0147-00			332 ohm, 1/8 W, 1%
R1164	315-0223-00			22K ohm, ½ W, 5%
R1165	321-0193-00			1K ohm, 1/8 W, 1%
R1166	315-0513-00			51K ohm, ½ W, 5%
R1167	321-0193-00			1K ohm, 1/8 W, 1%
R1168	315-0821-00			820 ohm, ½ W, 5%
R1169	315-0161-00			160 ohm, ½ W, 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R1171	131-0566-00			Link, terminal connecting
R1172	321-0157-00			422 ohm, 1/8 W, 1%
R1173	321-0157-00			422 ohm, 1/8 W, 1%
R1174	315-0751-00			750 ohm, ¼ W, 5%
R1175	311-1258-00			50 ohm, Var
R1182	321-0145-00			316 ohm, 1/8 W, 1%
R1183	321-0131-00			226 ohm, 1/8 W, 1%
R1184	315-0751-00			750 ohm, ¼ W, 5%
R1185	311-1258-00			50 ohm, Var
R1186	321-0182-00			768 ohm, 1/8 W, 1%
R1187	321-0162-00			475 ohm, 1/8 W, 1%
R1188	321-0114-00			150 ohm, 1/8 W, 1%
R1189	315-0102-00			1K ohm, ¼ W, 5%
R1201	315-0102-00			1K ohm, ¼ W, 5%
R1202	321-0218-00			1.82K ohm, 1/8 W, 1%
R1203	321-0234-00			2.67K ohm, 1/8 W, 1%
R1204	321-0213-00			1.62K ohm, 1/8 W, 1%
R1205	311-1007-00	B010100	B010274X	20 ohm, Var
R1209	321-0121-00			178 ohm, 1/8 W, 1%
R1211	315-0102-00			1K ohm, ¼ W, 5%
R1212	321-0218-00			1.82K ohm, 1/8 W, 1%
R1216	321-0153-00			383 ohm, 1/8 W, 1%
R1233	321-0260-00			4.99K ohm, 1/8 W, 1%
R1234	315-0101-00			100 ohm, ¼ W, 5%
R1235	321-0385-00			100K ohm, 1/8 W, 1%
R1237	321-0193-00			1K ohm, 1/8 W, 1%
R1239	321-0365-00			61.9K ohm, 1/8 W, 1%
R1253	321-0260-00			4.99K ohm, 1/8 W, 1%
R1254	315-0100-00			10 ohm, ¼ W, 5%
R1255	321-0385-00			100K ohm, 1/8 W, 1%
R1256	311-1230-00			20K ohm, Var
R1257	321-0385-00			100K ohm, 1/8 W, 1%
R1258	321-0202-00			1.24K ohm, 1/8 W, 1%
R1259	321-0291-00			10.5K ohm, 1/8 W, 1%
R1267	315-0101-00			100 ohm, ¼ W, 5%
R1268	315-0473-00			47K ohm, ¼ W, 5%
R1302	315-0203-00			20K ohm, ¼ W, 5%
R1303A				24.5M ohm,
R1303B				500K ohm,
R1303C	307-0290-03			23.4M ohm, Thick film
R1303D				6.57M ohm,
R1304	315-0244-00			240K ohm, ¼ W, 5%
R1305	315-0822-00			8.2K ohm, ¼ W, 5%
R1306	315-0123-00			12K ohm, ¼ W, 5%
R1307	315-0683-00			68K ohm, ¼ W, 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R1308	315-0102-00			1K ohm, ¼ W, 5%
R1310	316-0392-00			3.9K ohm, ¼ W, 10%
R1312	315-0242-00			2.4K ohm, ¼ W, 5%
R1313	321-0327-00			24.9K ohm, 1/8 W, 1%
R1314	316-0103-00			10K ohm, ¼ W, 10%
R1315	316-0473-00			47K ohm, ¼ W, 10%
R1316	316-0472-00			4.7K ohm, ¼ W, 10%
R1317	321-0329-00			26.1K ohm, 1/8 W, 1%
R1322	316-0103-00			10K ohm, ¼ W, 10%
R1326	315-0394-00			390K ohm, ¼ W, 5%
R1328	321-0157-00			422 ohm, 1/8 W, 1%
R1331	301-0153-00			15K ohm, ½ W, 5%
R1332	315-0220-00	B010100	B010161	22 ohm, ¼ W, 5%
R1332	331-0566-00	B010162		Zero ohm strap
R1333	315-0221-00			220 ohm, ¼ W, 5%
R1335	311-1373-00			5K ohm, Var
R1336	321-0206-00			1.37K ohm, 1/8 W, 1%
R1337	321-0206-00			1.37K ohm, 1/8 W, 1%
R1339	321-0174-00			634 ohm, 1/8 W, 1%
R1340	321-0120-00			174 ohm, 1/8 W, 1%
R1341	322-0197-00			1.1K ohm, ¼ W, 1%
R1342	315-0331-00			330 ohm, ¼ W, 5%
R1343	321-0322-00			22.1K ohm, 1/8 W, 1%
R1344	316-0102-00			1K ohm, ¼ W, 10%
R1345	315-0390-00	B010100	B039999	39 ohm, ¼ W, 5%
R1345	315-0201-00	B040000		200 ohm, ¼ W, 5%
R1346	315-0682-00			6.8K ohm, ¼ W, 5%
R1349	315-0682-00			6.8K ohm, ¼ W, 5%
R1352	315-0911-00	XB040000		910 ohm, ¼ W, 5%
R1354	301-0752-00			7.5K ohm, ½ W, 5%
R1355	302-0273-00			27K ohm, ½ W, 10%
R1356	301-0752-00			7.5K ohm, ½ W, 5%
R1358	315-0241-00			240 ohm, ¼ W, 5%
R1362	315-0332-00			3.3K ohm, ¼ W, 5%
R1363	315-0332-00			3.3K ohm, ¼ W, 5%
R1364	315-0470-00			47 ohm, ¼ W, 5%
R1368	315-0201-00	B010100	B039999	200 ohm, ¼ W, 5%
R1368	315-0271-00	B040000		270 ohm, ¼ W, 5%
R1369	323-0307-00			15.4K ohm, ½ W, 1%
R1371	316-0471-00			470 ohm, ¼ W, 10%
R1372	316-0471-00			470 ohm, ¼ W, 10%
R1373	316-0471-00			470 ohm, ¼ W, 10%
R1375	311-1231-00			25K ohm, Var
R1376	316-0103-00			10K ohm, ¼ W, 10%
R1378	315-0226-00			22M ohm, ¼ W, 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R1379	316-0103-00			10K ohm, ¼ W, 10%
R1380	311-0075-00			5M ohm, Var
R1384	302-0121-00			120 ohm, ½ W, 10%
R1385	311-1227-00			5K ohm, Var
R1386	311-1373-00			5K ohm, Var
R1390	311-1235-00			100K ohm, Var
R1391	316-0470-00			47 ohm, ¼ W, 10%
R1393	321-0231-00			2.49K ohm, 1/8 W, 1%
R1394	321-0248-00			3.74K ohm, 1/8 W, 1%
R1395	311-1226-00			2.5K ohm, Var
R1396	316-0100-00			10 ohm, ¼ W, 10%
R1397	311-1372-00			100K ohm, Var
R1398	316-0100-00			10 ohm, ¼ W, 10%
R1399	316-0470-00			47 ohm, ¼ W, 10%
R1416	323-0265-00			5.62K ohm, ½ W, 1%
R1417	321-0282-00			8.45K ohm, 1/8 W, 1%
R1422	315-0682-00			6.8K ohm, ¼ W, 5%
R1423	303-0822-00			8.2K ohm, 1 W, 5%
R1424	315-0122-00			1.2K ohm, ¼ W, 5%
R1425	315-0563-00			56K ohm, ¼ W, 5%
R1426	307-0052-00			3 ohm, ½ W, 5%
R1430	311-1226-00			2.5K ohm, Var
R1431	321-0351-00			44.2K ohm, 1/8 W, 1%
R1432	321-0284-00			8.87K ohm, 1/8 W, 1%
R1444	321-0761-03			35K ohm, 1/8 W, ½%
R1445	321-0684-00			15K ohm, 1/8 W, ½%
R1446	315-0471-00			470 ohm, ¼ W, 5%
R1447	315-0622-00			6.2K ohm, ¼ W, 5%
R1448	308-0245-00			0.6 ohm, 2 W, WW, 5%
R1454	321-0775-03			45K ohm, 1/8 W, ½%
R1455	321-0816-03			5K ohm, 1/8 W, ½%
R1456	315-0331-00			330 ohm, ¼ W, 5%
R1457	315-0302-00			3K ohm, ¼ W, 5%
R1458	308-0245-00			0.6 ohm, 2 W, WW, 5%
R1463	321-0273-00			6.81K ohm, 1/8 W, 1%
R1464	321-0756-03			50K ohm, 1/8 W, ½%
R1465	321-0962-03			8K ohm, 1/8 W, ½%
R1466	315-0561-00			560 ohm, ¼ W, 5%
R1467	315-0432-00			4.3K ohm, ¼ W, 5%
R1468	308-0245-00			0.6 ohm, 2 W, WW, 5%
R1473	321-0287-00			9.53K ohm, 1/8 W, 1%
R1474	321-0756-03			50K ohm, 1/8 W, ½%
R1475	321-0684-00			15K ohm, 1/8 W, ½%
R1476	315-0331-00			330 ohm, ¼ W, 5%
R1477	315-0472-00			4.7K ohm, ¼ W, 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R1478	307-0052-00			3 ohm, ½ W, 5%
R1480	311-1373-00			5K ohm, Var
R1481	315-0392-00			3.9K ohm, ¼ W, 5%
R1483	315-0202-00			2K ohm, ¼ W, 5%
R1484	315-0433-00			43K ohm, ¼ W, 5%
R1485	315-0473-00			47K ohm, ¼ W, 5%
R1486	321-0364-00			60.4K ohm, 1/8 W, 1%
R1487	321-0356-00			49.9K ohm, 1/8 W, 1%
R1488	305-0242-00			2.4K ohm, 2 W, 5%
R1493	315-0104-00			100K ohm, ¼ W, 5%
R1494	315-0104-00			100K ohm, ¼ W, 5%
R1496	321-0356-00			49.9K ohm, 1/8 W, 1%
R1497	321-0280-00			8.06K ohm, 1/8 W, 1%
R1498	315-0153-00			15K ohm, ¼ W, 5%
R1499	315-0102-00			1K ohm, ¼ W, 5%
R1501	315-0912-00			9.1K ohm, ½ W, 5%
R1502	315-0433-00			43K ohm, ¼ W, 5%
R1503	315-0822-00			8.2K ohm, ¼ W, 5%
R1504	315-0473-00			47K ohm, ¼ W, 5%
R1506	315-0512-00			5.1K ohm, ¼ W, 5%
R1515	311-1221-00			50 ohm, Var
R1516	321-0107-00			127 ohm, 1/8 W, 1%
R1517	321-0001-00			10 ohm, 1/8 W, 1%
R1691	303-0150-00			15 ohm, 1 W, 5%
R1692	321-0062-00			43.2 ohm, 1/8 W, 1%
R1693	323-0140-00			280 ohm, ½ W, 1%
R1694	323-0140-00			280 ohm, ½ W, 1%
R1695	321-0228-00			2.32K ohm, 1/8 W, 1%
RT1696	307-0124-00			5K ohm, Thermal
R1697	321-0201-00			1.21K ohm, 1/8 W, 1%
R1698	315-0363-00			36K ohm, ¼ W, 5%
SWITCHES				
S20A(2)	105-0282-00			Actuator assembly, Cam, AC/GND/DC
S20B(2)	105-0343-00			Actuator assembly, Cam, VOLTS/DIV
S128[1]				
S225	260-1208-00			Push, INVERT
S228[2]				
S300	260-1424-00			Pushbutton, VERT MODE
S375A	105-0423-00			Actuator assembly, slide, 20 MHz BW
S375B,C	105-0421-00			Actuator assembly, slide, TRIG VIEW
S450	260-1310-01			Push, BEAM FIND
S505	105-0400-00			Actuator assembly, slide, A TRIGGER SOURCE
S508	105-0399-00			Actuator assembly, slide, A TRIGGER COUPLING
S530[3]				A TRIGGER SLOPE

[1]Furnished as a unit with R128.
[2]Furnished as a unit with R228.
[3]Furnished as a unit with R530.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
SWITCHES (cont)				
S600[1]	260-1422-00			Pushbutton, TRIG MODE
S644[1]				B ENDS A
S705	105-0401-00			Actuator assembly, slide, B (DLY'D) TRIGGER SOURCE
S708[2]	105-0399-00			Actuator assembly, slide, B (DLY'D) COUPLING
S750[2]				B DLY'D TRIGGER SLOPE
S1050A,B	105-0363-00			Actuator assembly, A & B TIME/DIV & DELAY TIME
S1070A,B[3]				
S1090	260-1423-00			Pushbutton, HORIZ DISPLAY
S1110	260-1209-00			Push, X10 MAG
S1401	260-0834-00			Toggle, POWER
S1402	260-0638-00			Thermostatic, open 75 deg. C, close 55 deg. C
S1403	260-1300-01			Slide
TRANSFORMERS				
T178	120-0469-00			Toroid, 3 turns, bifilar
T278	120-0469-00			Toroid, 3 turns, bifilar
T1320[4]	120-0815-00			HV Power (varnished)
T1320[4]	120-0815-01			HV Power (molded)
T1400	120-0799-00			LV Power
INTEGRATED CIRCUITS				
U120	155-0085-00			Hybrid, dual FET input & amplifier
U140	155-0078-00			Monolithic, vertical amplifier
U220	155-0085-00			Hybrid, dual FET input & amplifier
U240	155-0078-00			Monolithic, vertical amplifier
U330	156-0030-00			Quad 2-input positive nand gate, SN7400N
U340	156-0030-00			Quad 2-input positive nand gate, SN7400N
U350	156-0041-00			Dual 15 MHz D-type pos.-edge-trig, flip-flop, SN7474N
U370	155-0091-00			Monolithic, channel switch
U450	155-0078-01			Monolithic, vert amp., selected
U470	155-0082-00			Hybrid, vert output amp.
U520	155-0032-01			MOnolithic, input pre-amplifier, selected
U600	155-0049-00			Monolithic, sweep control
U720	155-0032-01			Monolithic, input pre-amplifier, selected
U930	156-0158-00			Dual operational amplifier, N5558V
U1418	156-0158-00			Dual operational amplifier, N5558V
U1454	156-0158-00			Dual operational amplifier, N5558V
U1464	156-0158-00			Dual operational amplifier, N5558V
U1690	156-0281-00			4 transistor array, Motorola MPQ2221
VOLTAGE MULTIPLIER				
U1321	152-0552-00			Voltage multiplier

[1]Furnished as a unit with R644.
[2]Furnished as a unit with R750.
[3]Furnished as a unit with R1070.
[4]Either of these transformers may be used.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ELECTRON TUBE				
V1380	154-0677-00			CRT
DIODES, ZENER				
VR144	152-0195-00			Selected from 1N751A, 0.4 W, 5.1 V, 5%
VR161	152-0166-00			Selected from 1N753A, 0.4 W, 6.2 V, 5%
VR244	152-0195-00			Selected from 1N751A, 0.4 W, 5.1 V, 5%
VR261	152-0166-00			Selected from 1N753A, 0.4 W, 6.2 V, 5%
VR290	152-0280-00			1N753A, 0.4 W, 6.2 V, 5%
VR396	152-0280-00			1N753A, 0.4 W, 6.2 V, 5%
VR462	152-0195-00			Selected from 1N751A, 0.4 W, 5.1 V, 5%
VR464	152-0195-00			Selected from 1N751A, 0.4 W, 5.1 V, 5%
VR482	152-0195-00			Selected from 1N751A, 0.4 W, 5.1 V, 5%
VR570	152-0217-00			Selected from 1N756A, 0.4 W, 8.2 V, 5%
VR608	152-0278-00			1N4372A, 0.4 W, 3 V, 5%
VR647	152-0195-00			Selected from 1N751A, 0.4 W, 5.1 V, 5%
VR796	152-0226-00			Selected from 1N751A, 0.4 W, 5.1 V, 5%
VR798	152-0278-00			1N4372A, 0.4 W, 3 V, 5%
VR930	152-0265-00			1N970B, 0.4 W, 24 V, 5%
VR938	152-0304-00			1N968B, 0.4 W, 20 V, 5%
VR956	152-0278-00			1N4372A, 0.4 W, 3 V, 5%
VR1026	152-0278-00			1N4372A, 0.4 W, 3 V, 5%
VR1216	152-0055-00			1N962B, 0.4 W, 11 V, 5%
VR1267	152-0166-00			Selected from 1N753A, 0.4 W, 6.2 V, 5%
VR1362	152-0166-00			Selected from 1N753A, 0.4 W, 6.2 V, 5%
VR1374	152-0357-00			1N983B, 0.4 W, 82 V, 5%
VR1381	152-0247-00			1N989B, 0.4 W, 150 V, 5%
VR1416	152-0411-00			1N937, 0.25 W, 9 V, 5%
VR1418	152-0022-00			Selected from 1N3029, 1 W, 25 V, 5%
VR1422	152-0283-00			1N976B, 0.4 W, 43 V, 5%
VR1423	152-0304-00			1N968B, 0.4 W, 20 V, 5%

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

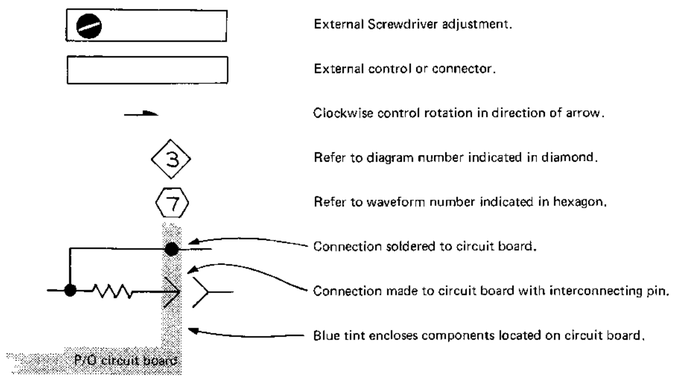
Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).
Resistors = Ohms (Ω)

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

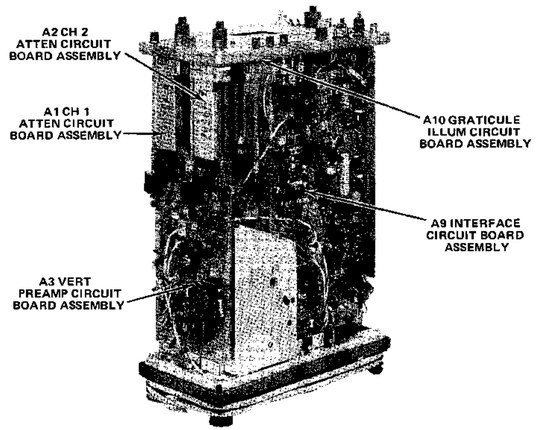
Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:



The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)
AT	Attenuator, fixed or variable
B	Motor
BT	Battery
C	Capacitor, fixed or variable
CR	Diode, signal or rectifier
DL	Delay line
DS	Indicating device (lamp)
F	Fuse
FL	Filter
H	Heat dissipating device (heat sink, heat radiator, etc.)
HR	Heater
J	Connector, stationary portion
K	Relay
L	Inductor, fixed or variable
LR	Inductor/resistor combination
M	Meter
Q	Transistor or silicon-controlled rectifier
P	Connector, movable portion
R	Resistor, fixed or variable
RT	Thermistor
S	Switch
T	Transformer
TP	Test point
U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
V	Electron tube
VR	Voltage regulator (zener diode, etc.)
Y	Crystal



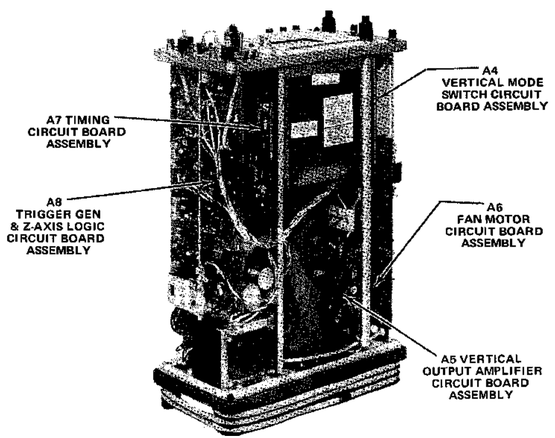


Fig. 7-1. Location of circuit boards in the 475 Oscilloscope.

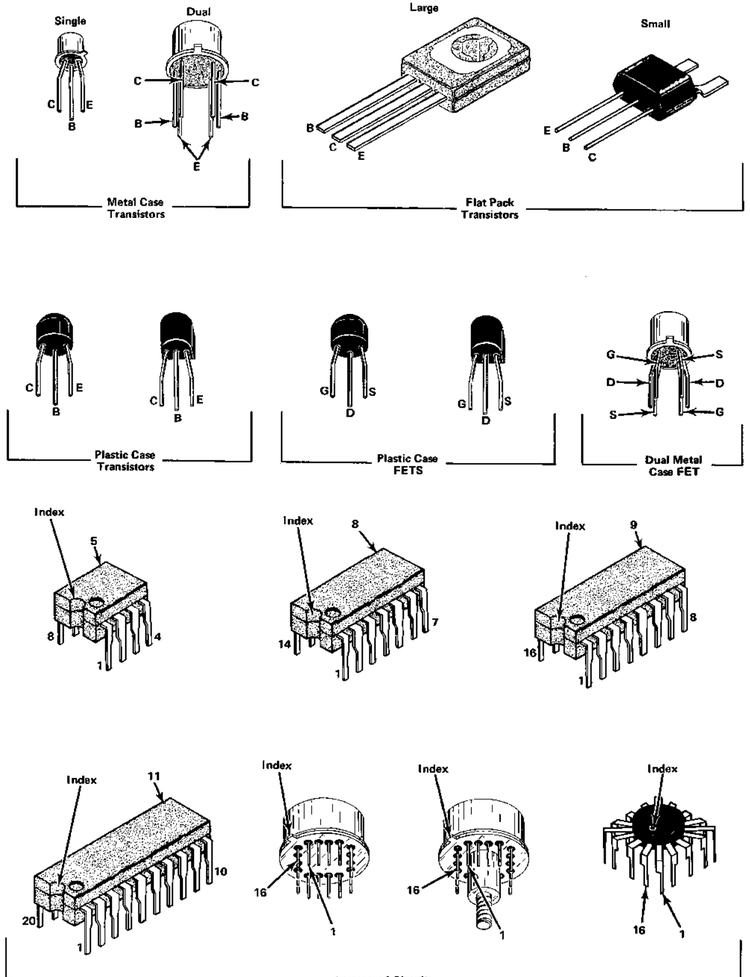
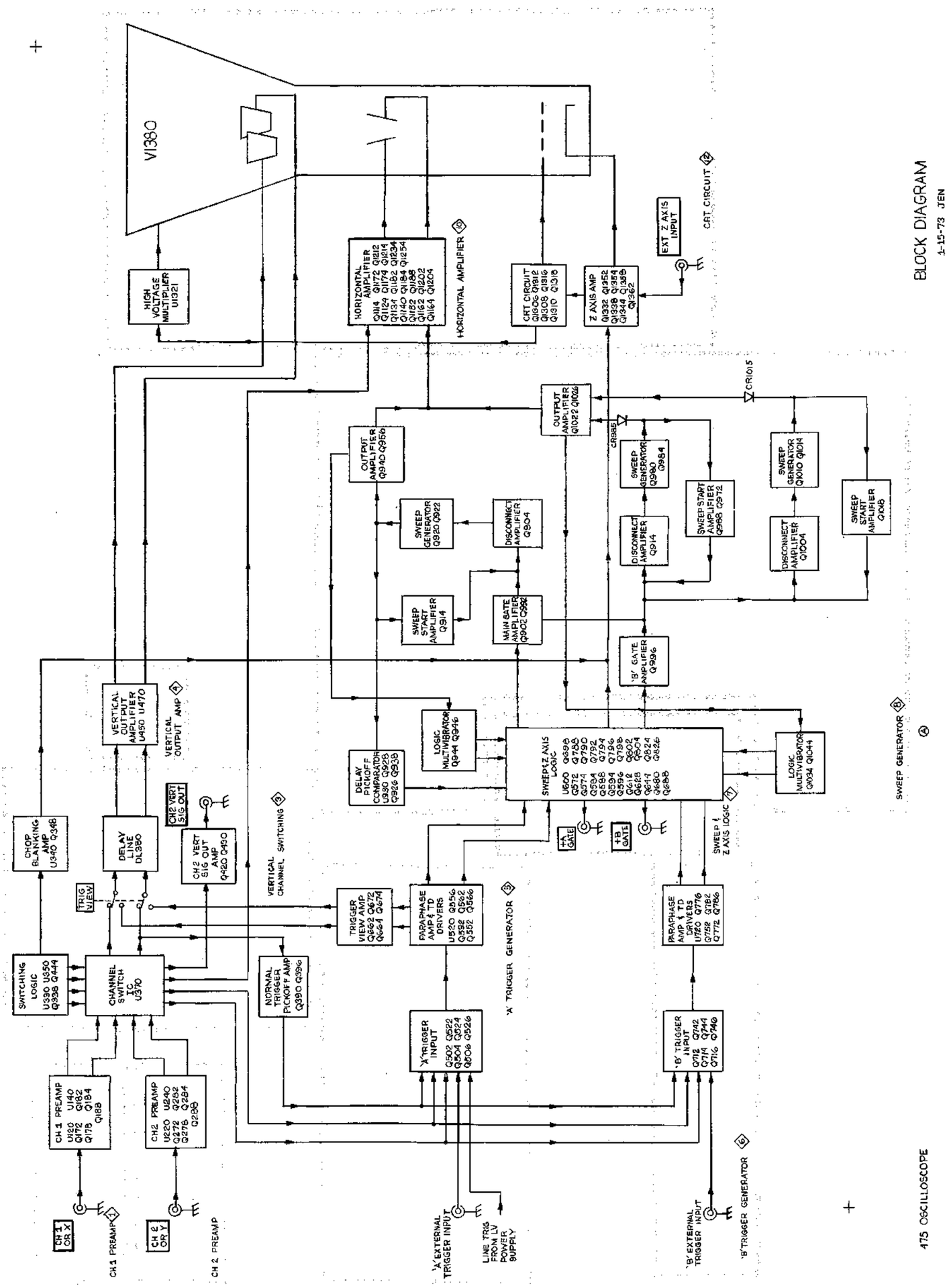


Fig. 7-2. Lead configurations for semiconductors used in this instrument.


V1380
HIGH VOLTAGE MULTIPLIER U1321
HORIZONTAL AMPLIFIER Q114 Q172 Q1212 Q1124 Q1174 Q1214 Q1132 Q1182 Q1234 Q1142 Q1184 Q1254 Q1152 Q1192 Q1202 Q1162 Q1202 Q1204 Q1164 Q1204
CRT CIRCUIT Q1302 Q1312 Q1308 Q1316 Q1310 Q1318
Z AXIS AMP Q1332 Q1352 Q1338 Q1354 Q1344 Q1356 Q1362
EXT Z AXIS INPUT
CRT CIRCUIT
OUTPUT AMPLIFIER Q1022 Q1006
CR1015
OUTPUT AMPLIFIER Q940 Q956
SWEEP GENERATOR Q820 Q922
DISCONNECT AMPLIFIER Q904
SWEEP START AMPLIFIER Q914
MAIN GATE AMPLIFIER Q902 Q932
SWEEP GENERATOR Q980 Q984
DISCONNECT AMPLIFIER Q914
SWEEP START AMPLIFIER Q972
SWEEP GENERATOR Q1010 Q1034
DISCONNECT AMPLIFIER Q1004
SWEEP START AMPLIFIER Q1016
'B' GATE AMPLIFIER Q996
VERTICAL OUTPUT AMPLIFIER U450 U470
VERTICAL OUTPUT AMP
CHOP BLANKING AMP U340 Q348
DELAY LINE DL380
CH2 VERT SIG OUT
CH2 VERT SIG OUT AMP Q420 Q490
TRIG VIEW
VERTICAL CHANNEL SWITCHING
DELAY PICKOFF COMPARATOR U930 Q926 Q938
LOGIC MULTIVIBRATOR Q944 Q946
SWEEP Z AXIS LOGIC U600 Q698 Q572 Q788 Q574 Q790 Q584 Q792 Q586 Q794 Q594 Q796 Q596 Q798 Q612 Q802 Q614 Q804 Q624 Q826 Q680 Q828
LOGIC MULTIVIBRATOR Q1034 Q1044
SWEEP GENERATOR
+A GATE
+B GATE
SWEEP I Z AXIS LOGIC
SWITCHING LOGIC U330 U350 Q338 Q444
CHANNEL SWITCH IC U370
NORMAL TRIGGER PICKOFF AMP Q390 Q396
TRIGGER VIEW AMP Q662 Q672 Q664 Q674
PARAPHASE AMP & TD DRIVERS U520 Q550 Q552 Q562 Q554 Q566
PARAPHASE AMP & TD DRIVERS U720 Q716 Q752 Q782 Q772 Q786
'A' TRIGGER GENERATOR
'A' TRIGGER INPUT Q502 Q522 Q504 Q524 Q506 Q526
'B' TRIGGER INPUT Q712 Q742 Q714 Q744 Q716 Q746
CH 1 PREAMP U120 U140 Q112 Q182 Q178 Q184 Q188
CH 2 PREAMP U220 U240 Q272 Q282 Q276 Q284 Q288
CH 1 OR X
CH 2 OR Y
CH 1 PREAMP
CH 2 PREAMP
'A' EXTERNAL TRIGGER INPUT
LINE TRIG FROM LV POWER SUPPLY
'B' EXTERNAL TRIGGER INPUT
'B' TRIGGER GENERATOR
BLOCK DIAGRAM
1-15-73 JEN
475 OSCILLOSCOPE

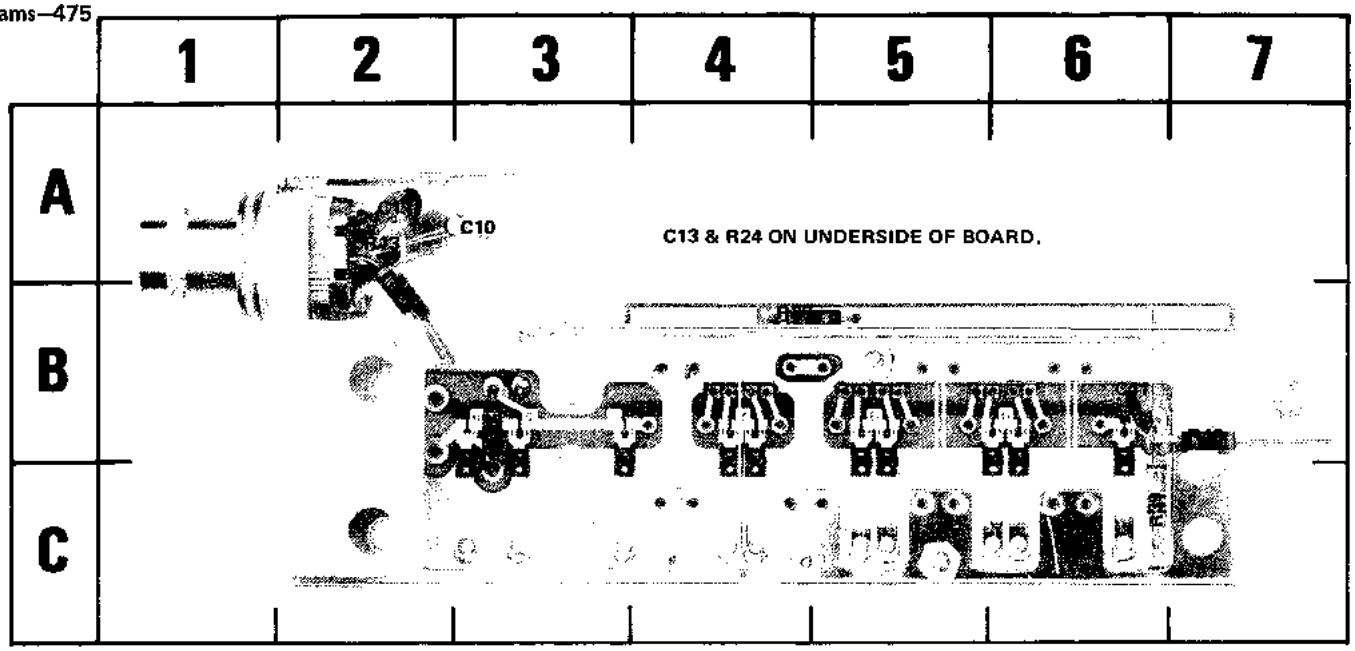


Fig. 7-3. A1 Channel 1 Attenuator circuit board.

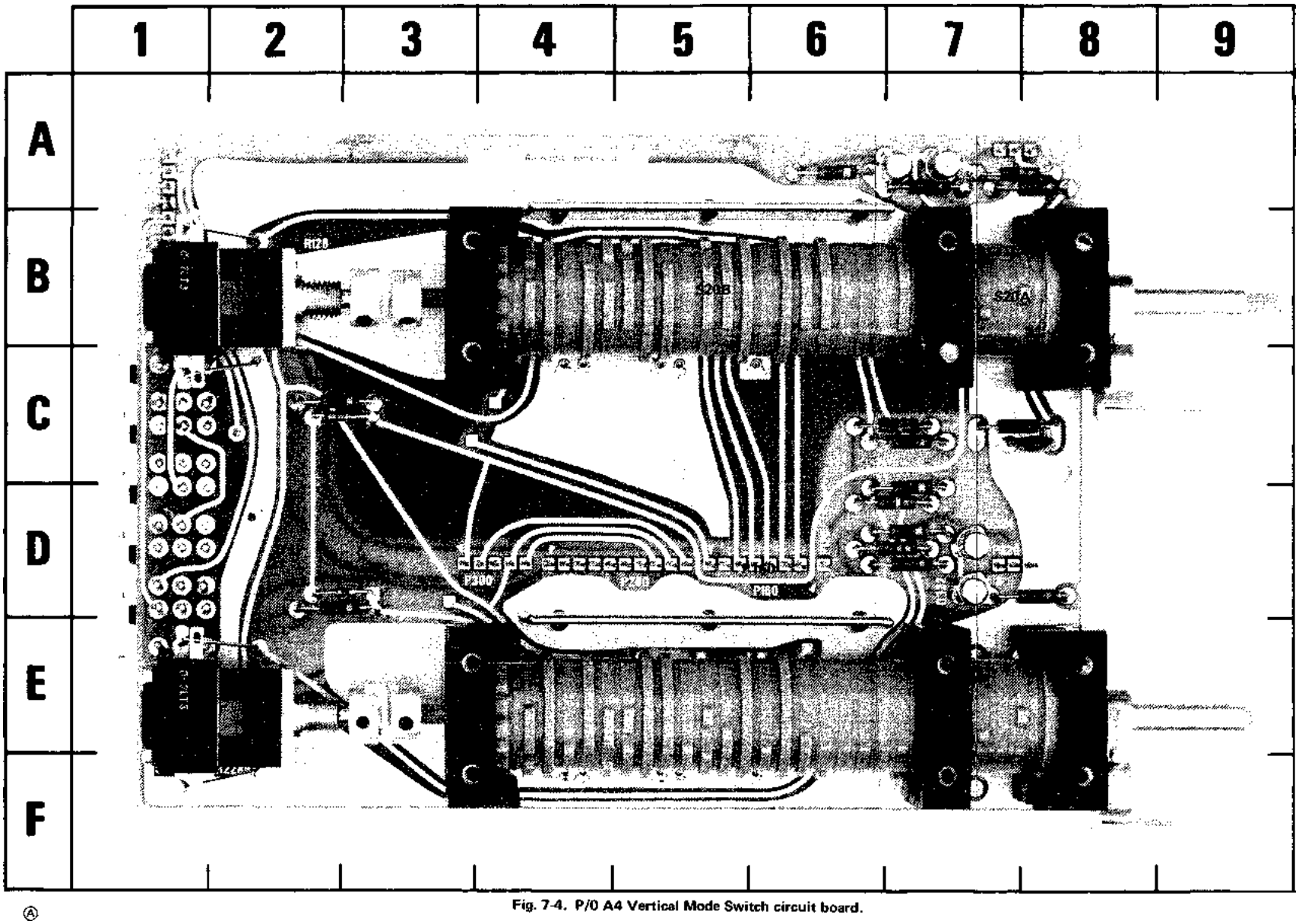


Fig. 7-4. P/0 A4 Vertical Mode Switch circuit board.

GRID LOCATOR

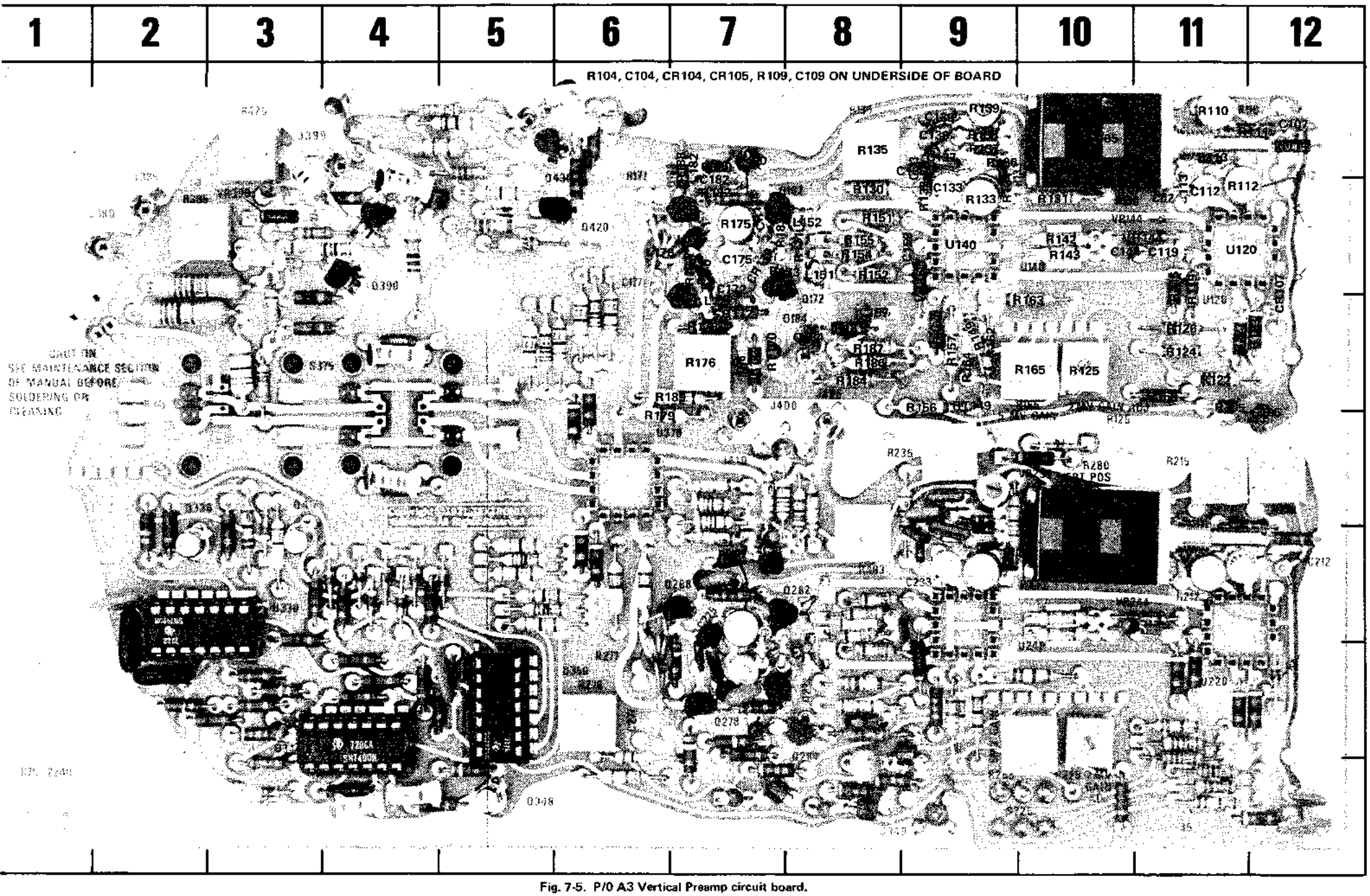


Fig. 7-5. P/0 A3 Vertical Preamp circuit board.

Fig. 7-3. A1 Channel 1 Attenuator circuit board.

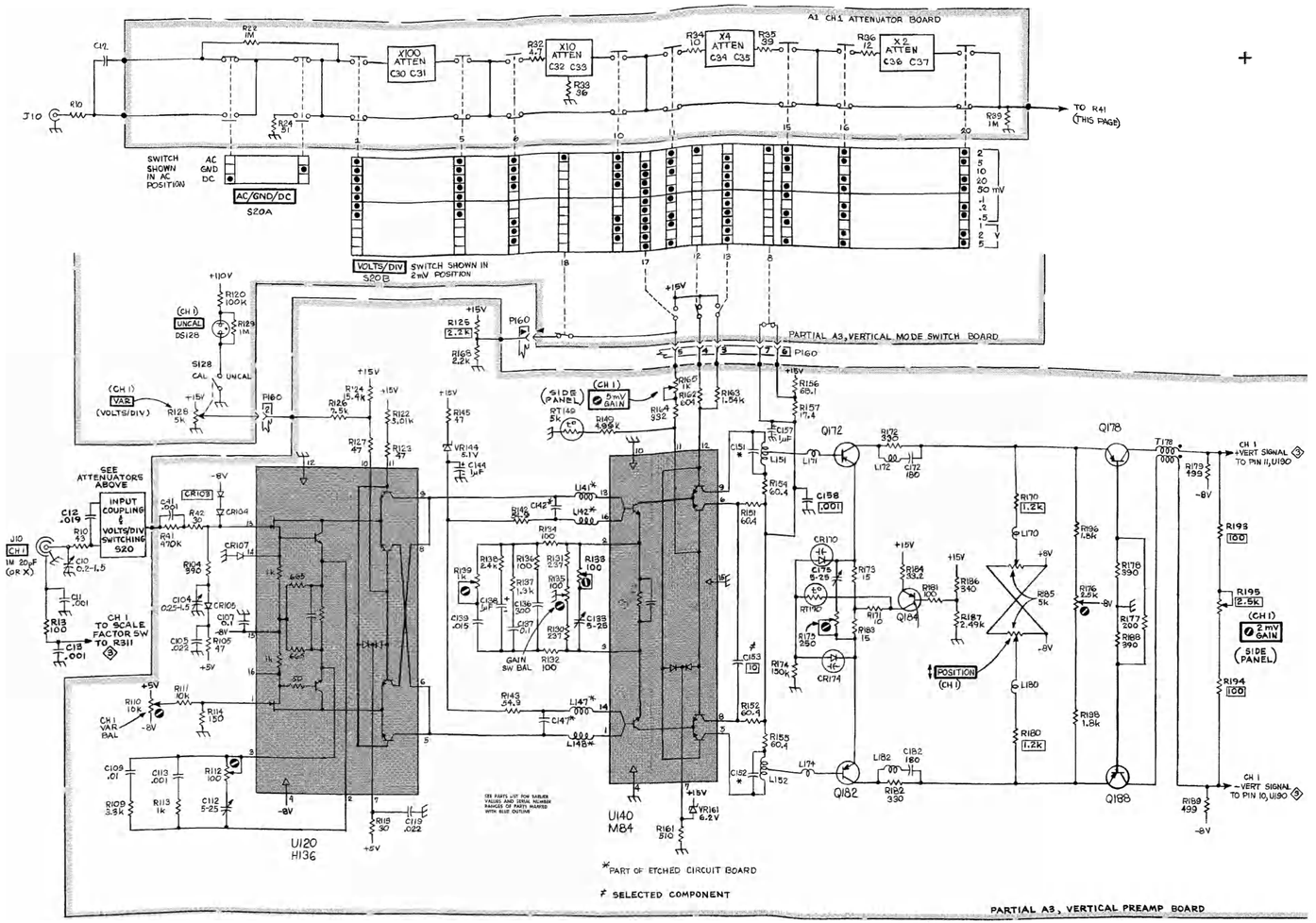
CKT NO	GRID LOC	CKT NO	GRID LOC
C10	3A	R22	3B
C11	2A	R33	4B
C41	6B	R39	6C
R10	2B	R41	6B
R13	2A	R42	7B

Fig. 7-4. A4 Vertical Mode Switch circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC
P160	5D	R129	7C
R120	7C	S20A	7B
R128	2B	S20B	5B

Fig. 7-5. A3 Vertical Preamp circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C105	12C	C172	7B	L180	7A	R113	11A	R134	9B	R155	8B	R174	7C	R187	8C
C107	12A	C175	7B	L182	7B	R114	12A	R135	8A	R156	9C	R175	7B	R188	7B
C112	11B	C182	7B			R119	11C	R136	9A	R157	9C	R176	7C	R189	6C
C113	11B			Q172	7B	R122	11C	R137	9A	R161	9C	R177	7B		
C119	11B	CR107	12C	Q178	7C	R123	12C	R138	9A	R162	9C	R178	7C	RT170	7C
C133	9B	CR170	7B	Q182	7B	R124	11C	R139	9A	R163	9C	R179	6D		
C136	9A	CR174	7B	Q184	8C	R125	10C	R142	10B	R164	9C	R180	7A	U120	11B
C137	9A			Q188	7B	R126	11C	R143	10B	R165	10C	R181	8C	U140	9B
C138	9A	L151	8B			R127	11C	R145	11C	R168	11C	R182	7B		
C139	9A	L152	8B	R105	11C	R130	8B	R149	9C	R170	7B	R183	7B	VR144	10B
C144	10B	L172	7C	R110	11A	R131	10B	R151	8B	R171	8B	R184	8C	VR161	9C
C153	9B	L170	7B	R111	11A	R132	9B	R152	8B	R172	7C	R185	10A		
C157	8C	L178	6B	R112	11B	R133	9B	R154	8B	R173	7B	R186	8C		



475 OSCILLOSCOPE

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CH 1 VERTICAL PREAMP ◇

JEN 1272

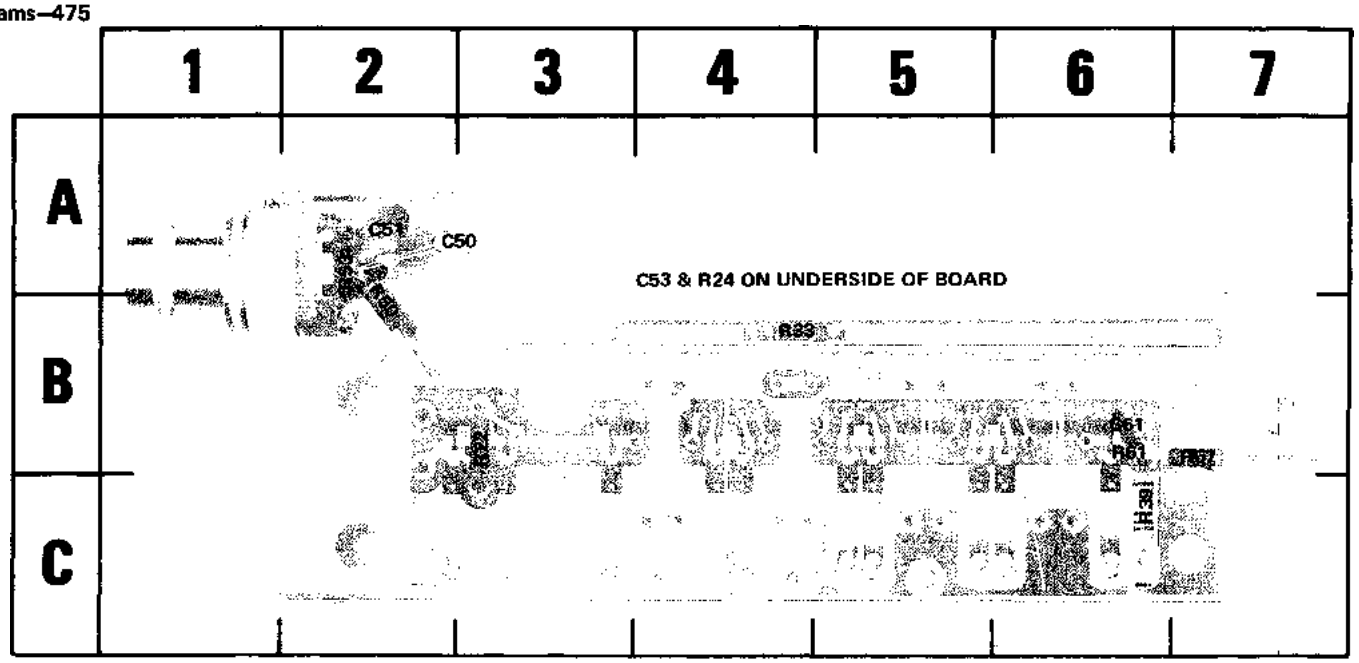


Fig. 7-6. A2 Channel 2 Attenuator circuit board.

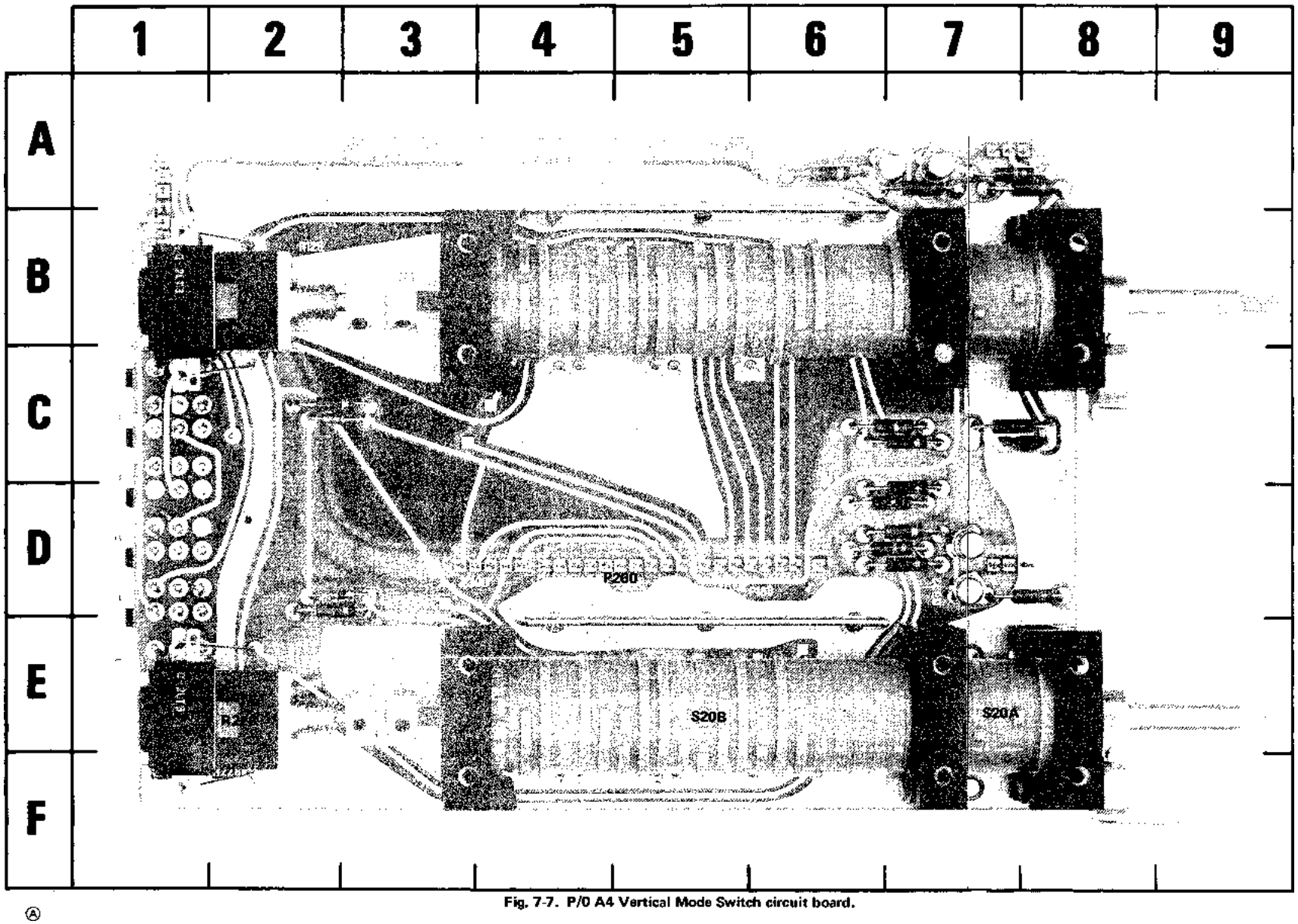


Fig. 7-7. P/0 A4 Vertical Mode Switch circuit board.

GRID LOCATOR

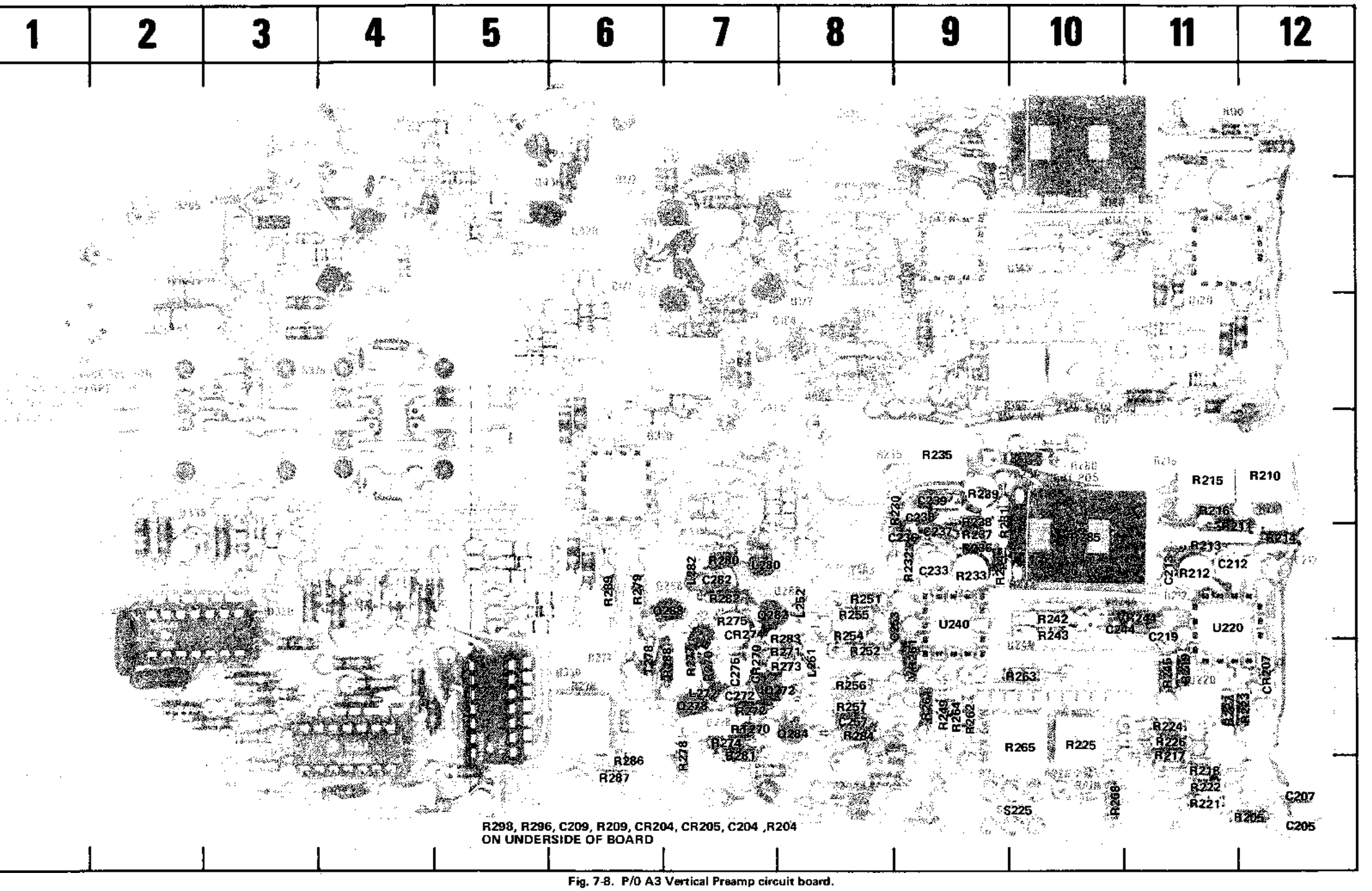


Fig. 7-8. P/0 A3 Vertical Preamp circuit board.

Fig. 7-6. A2 Channel 2 Attenuator circuit board.

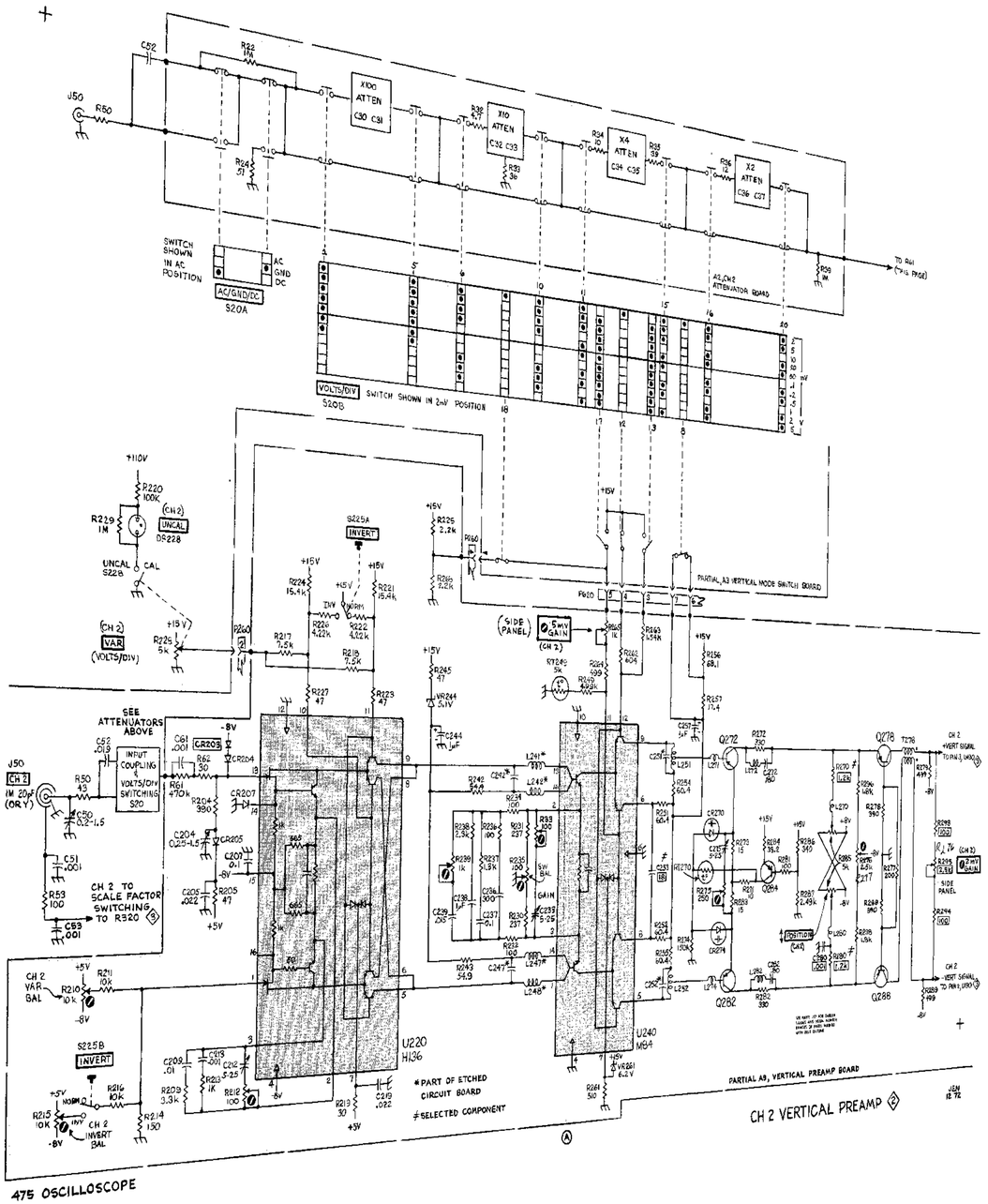
CKT NO	GRID LOC	CKT NO	GRID LOC
C50	2A	R39	6C
C51	2A	R50	2A
C61	6B	R53	2A
		R61	6B
R22	3B	R67	7B
R33	4B		

Fig. 7-7. A4 Vertical Mode Switch circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC
P260	4D	R229	7D
R220	7D	S20A	7E
R228	2E	S20B	5E

Fig. 7-8. A3 Vertical Preamp circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C205	12G	C275	7F	Q282	7E	R219	11F	R236	9E	R261	9F	R279	6E	S225	10G
C207	12G	C282	7E	Q284	8F	R221	11G	R237	9E	R262	9F	R280	7E		
C212	11E	CR207	12F	Q288	6E	R222	11G	R238	9D	R263	10F	R281	7F	T278	6F
C213	11E	CR270	7F			R223	12F	R239	9D	R264	9F	R282	7E		
C219	11E	CR274	7E	R205	11G	R224	11F	R242	10E	R265	10F	R283	8E	U220	11E
C233	9E			R210	12D	R225	10F	R243	10E	R268	10G	R284	8F	U240	9E
C236	8E	L251	8F	R211	11E	R226	11F	R245	11F	R270	7F	R285	10E		
C237	9E	L252	8E	R212	11E	R227	11F	R249	9F	R271	7F	R286	6G	VR244	10E
C238	9D	L272	7F	R213	11E	R230	9D	R251	8E	R272	7F	R287	6G	VR261	9F
C239	9D	L280	7E	R214	12E	R231	9E	R252	8F	R273	7F	R288	7F		
C244	10E	L282	7E	R215	11D	R232	9E	R254	8E	R274	7F	R289	6E		
C253	9E			R216	11D	R233	9E	R255	8E	R275	7E				
C257	8F	Q272	7F	R217	11F	R234	9E	R256	8F	R277	7F	RT270	7F		
C272	7F	Q278	7F	R218	11G	R235	9D	R257	8F	R278	7G				



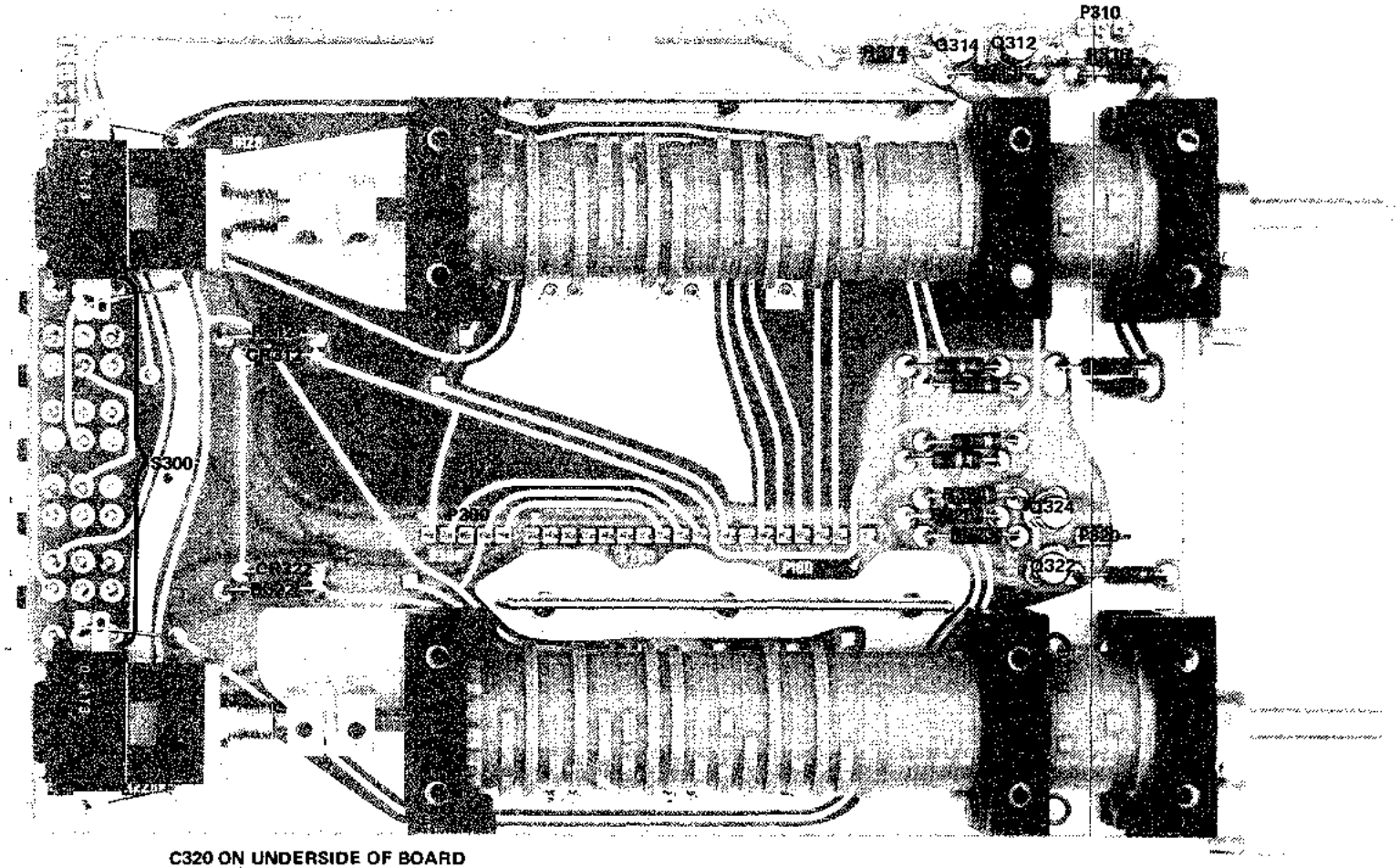


Fig. 7-9. P/0 A4 Vertical Mode Switch circuit board.

GRID LOCATOR

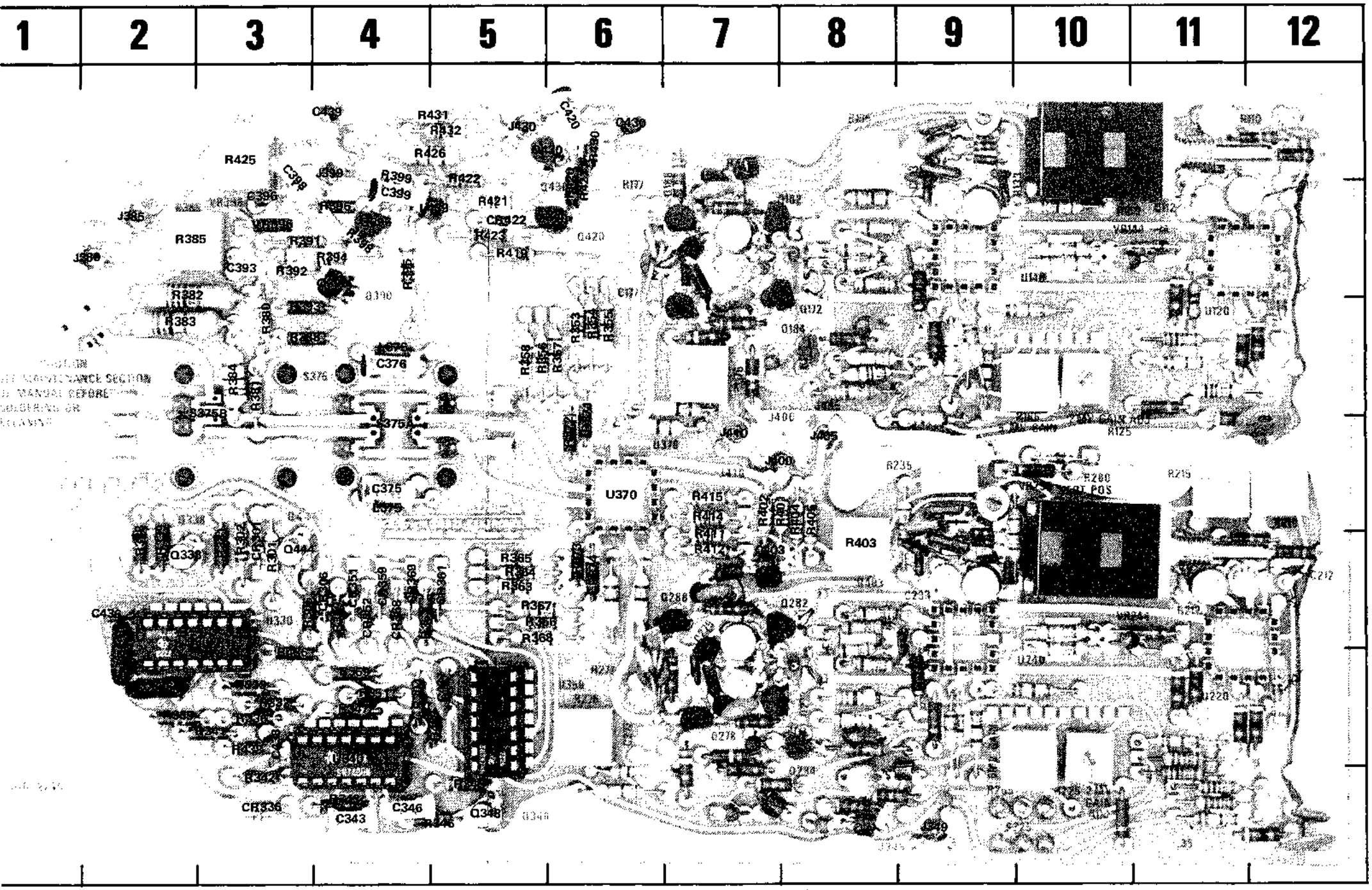


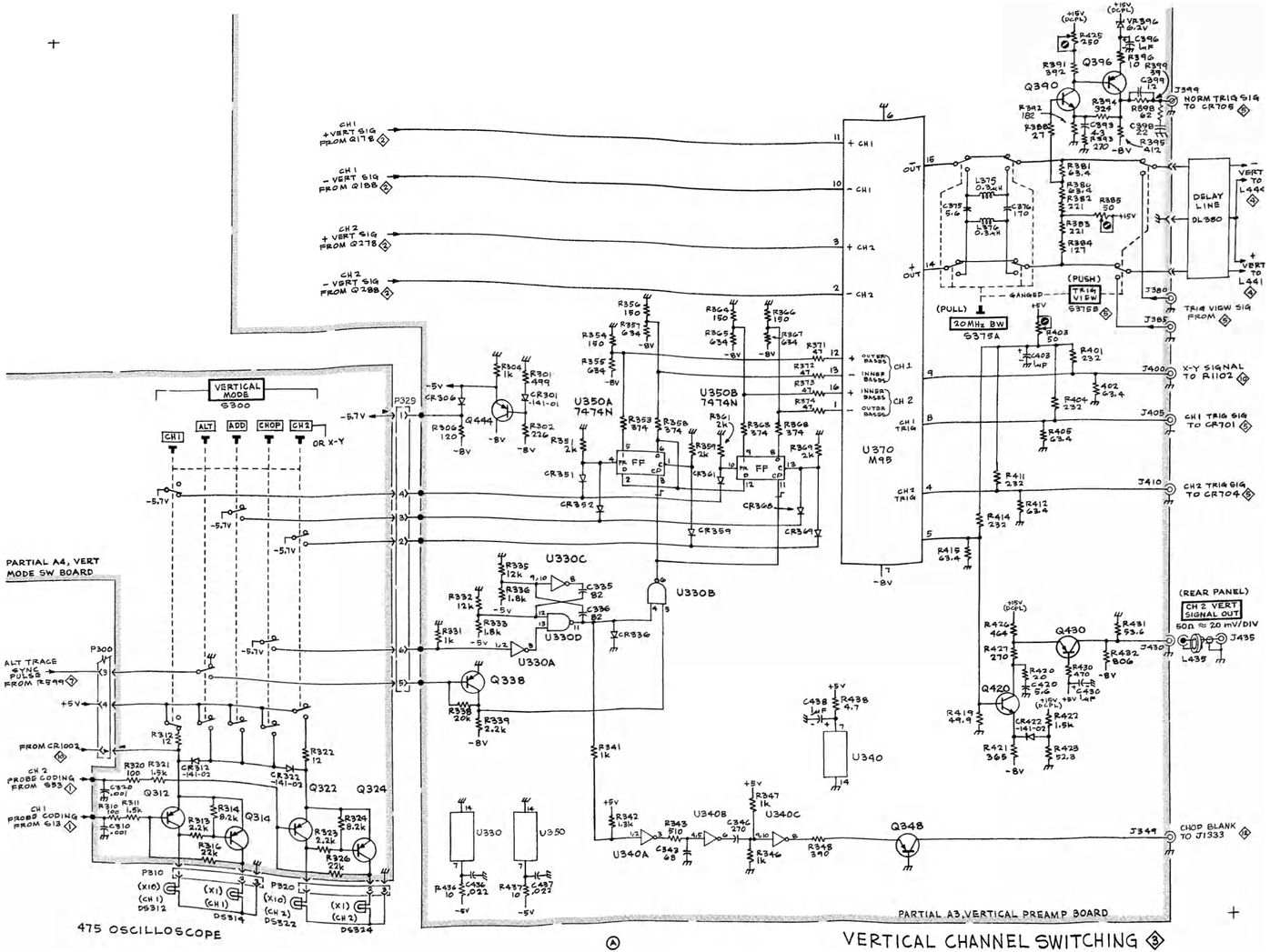
Fig. 7-10. P/0 A3 Vertical Preamp circuit board.

Fig. 7-9. A4 Vertical Mode Switch circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C310	7C	Q312	7A	R312	2C	R324	6D
		Q314	6A	R313	7A	R326	6D
CR312	2C	Q322	7D	R314	6A		
CR322	2D	Q324	7D	R316	7A	S300	2D
		Q348	5G	R320	7E		
P300	4D			R321	7D		
P310	7A	R310	7C	R322	2D		
P320	7D	R311	7A	R323	6D		

Fig. 7-10. A3 Vertical Preamp circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C335	2F	CR301	3E	J410	7D	R332	3F	R357	6C	R382	2B	R405	8D	R437	5F
C336	2F	CR306	4E	J430	5A	R333	3F	R358	6C	R383	2C	R411	7D		
C343	4G	CR336	3G			R335	2F	R359	4E	R384	3C	R412	7E	S375A	4D
C346	4G	CR351	4E	L375	4D	R336	2F	R361	5E	R385	2B	R414	7D	S375B	3C
C347	5F	CR352	4E	L376	4C	R338	2E	R363	5E	R388	3C	R415	7D		
C375	4D	CR359	4E	L439	4B	R339	2E	R364	5E	R391	3B	R419	5B	U330	2E
C376	4C	CR361	5E			R341	2F	R365	5E	R392	3B	R420	6B	U340	4F
C393	3B	CR368	4E	Q338	2E	R342	2G	R366	5E	R393	3C	R421	5B	U350	5F
C396	3B	CR369	4E	Q390	4B	R343	4G	R367	5E	R394	4B	R422	5A	U370	6D
C398	3A	CR422	5B	Q396	4B	R346	5G	R368	5E	R395	4B	R423	5B		
C399	4B			Q430	5A	R347	4F	R369	4F	R396	4B	R425	3A	VR396	3B
C403	7E	J349	9G	Q444	3E	R348	5G	R371	6D	R398	4B	R426	4A		
C420	6A	J380	2B			R351	4F	R372	6D	R399	4A	R427	6B		
C430	6A	J385	2B	R302	3E	R353	6C	R373	6E	R401	8D	R430	6A		
C436	2E	J399	4A	R304	4F	R354	6C	R374	6E	R402	7D	R431	4A		
C438	3F	J400	7D	R306	3E	R355	6C	R380	3C	R403	8E	R432	5A		
C439	4A	J405	8D	R331	3E	R356	6C	R381	3C	R404	8D	R436	3F		



GRID LOCATOR

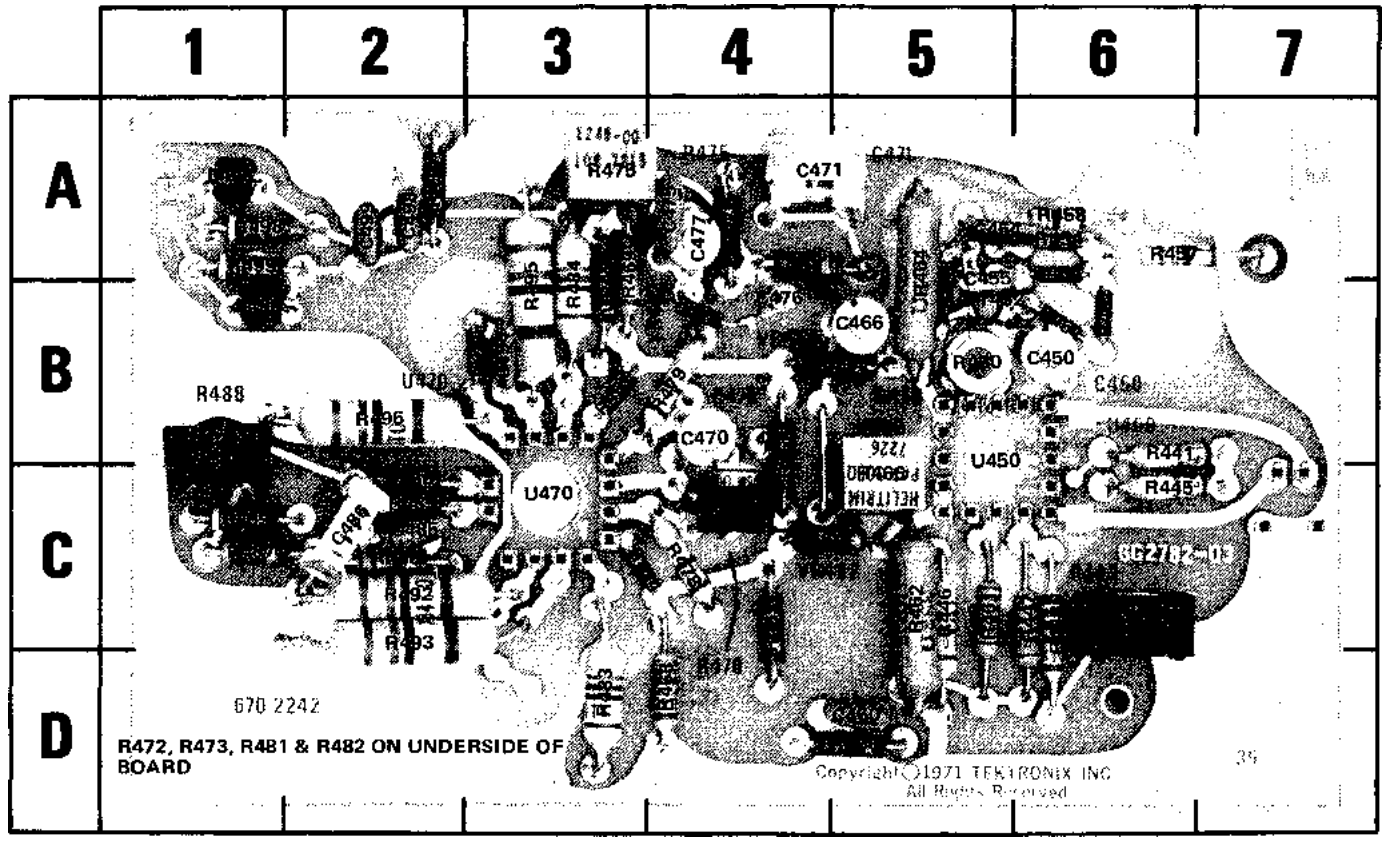
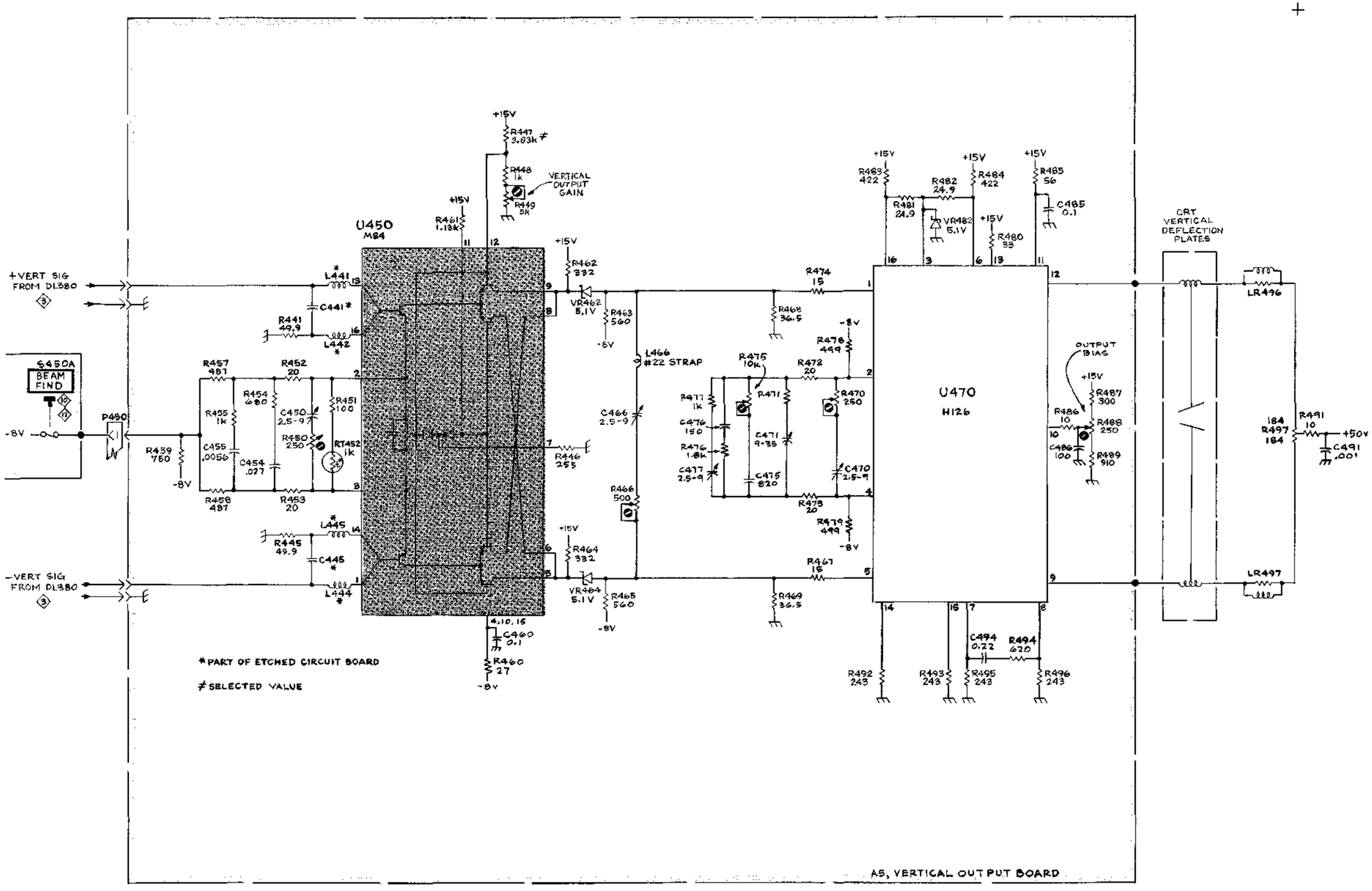


Fig. 7-11. A5 Vertical Output circuit board.

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Fig. 7-11. A5 Vertical Output circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C450	6B	C485	2C	R445	6C	R455	6A	R466	5C	R478	4C	R492	2C	U450	5B
C454	5A	C486	2C	R446	5C	R457	6A	R467	3B	R479	4B	R493	2C	U470	3C
C455	5A	C494	3B	R447	6C	R458	6A	R468	4D	R480	2C	R494	3B		
C460	5D	C498	2A	R448	6C	R459	2A	R469	3B	R483	3D	R495	3B	VR462	4C
C466	5B	C499	2A	R449	6C	R460	5D	R470	4C	R484	3B	R496	2B	VR464	4B
C470	4B			R450	5B	R461	5C	R471	4A	R485	2C	R498	1A	VR482	3B
C471	4A	L498	1A	R451	6B	R462	5C	R474	3C	R486	2C	R499	1A		
C475	4A	L499	1B	R452	6B	R463	4C	R475	3A	R487	1C				
C476	4B			R453	5B	R464	5B	R476	4B	R488	1B	RT452	5B		
C477	4A	R441	6B	R454	6A	R465	4C	R477	4A	R489	1C				


+VERT SIG FROM DL380
-VERT SIG FROM DL380
S450A BEAM FIND
P490
U450 M84
U470 H126
L441*
L442*
L444*
L445*
C441*
C445*
R441 49.9
R445 49.9
R447 3.83k ≠
R448 1k
R449 5k
VERTICAL OUTPUT GAIN
R461 1.18k
R462 332
R464 332
VR462 5.1V
VR464 5.1V
R463 560
R465 560
R457 487
R458 487
R452 20
R453 20
R454 680
R455 1k
R456 750
C450 2.5-9
C455 .0056
C454 .027
R450 250
R451 100
RT452 1k
R459 750
R446 255
L466 #22 STRAP
C466 2.5-9
R466 500
C460 0.1
R460 27
R474 15
R468 36.5
R475 10k
R471
R472 20
R470 250
R477 1k
C476 150
R476 1.8k
C477 2.5-9
C471 9-35
C475 820
C470 2.5-9
R473 20
R479 499
R478 499
R467 15
R469 36.5
R463 422
R482 24.9
R484 422
R485 56
R481 24.9
VR482 5.1V
R480 33
C485 0.1
OUTPUT BIAS
R487 300
R486 10
R488 250
C486 100
R489 910
CRT VERTICAL DEFLECTION PLATES
LR496
LR497
184
R497 184
R491 10
+50V
C491 .001
C494 0.22
R494 620
R492 243
R493 243
R495 243
R496 243
+15V
-8V
4,10,15
*PART OF ETCHED CIRCUIT BOARD
≠SELECTED VALUE
A5, VERTICAL OUTPUT BOARD

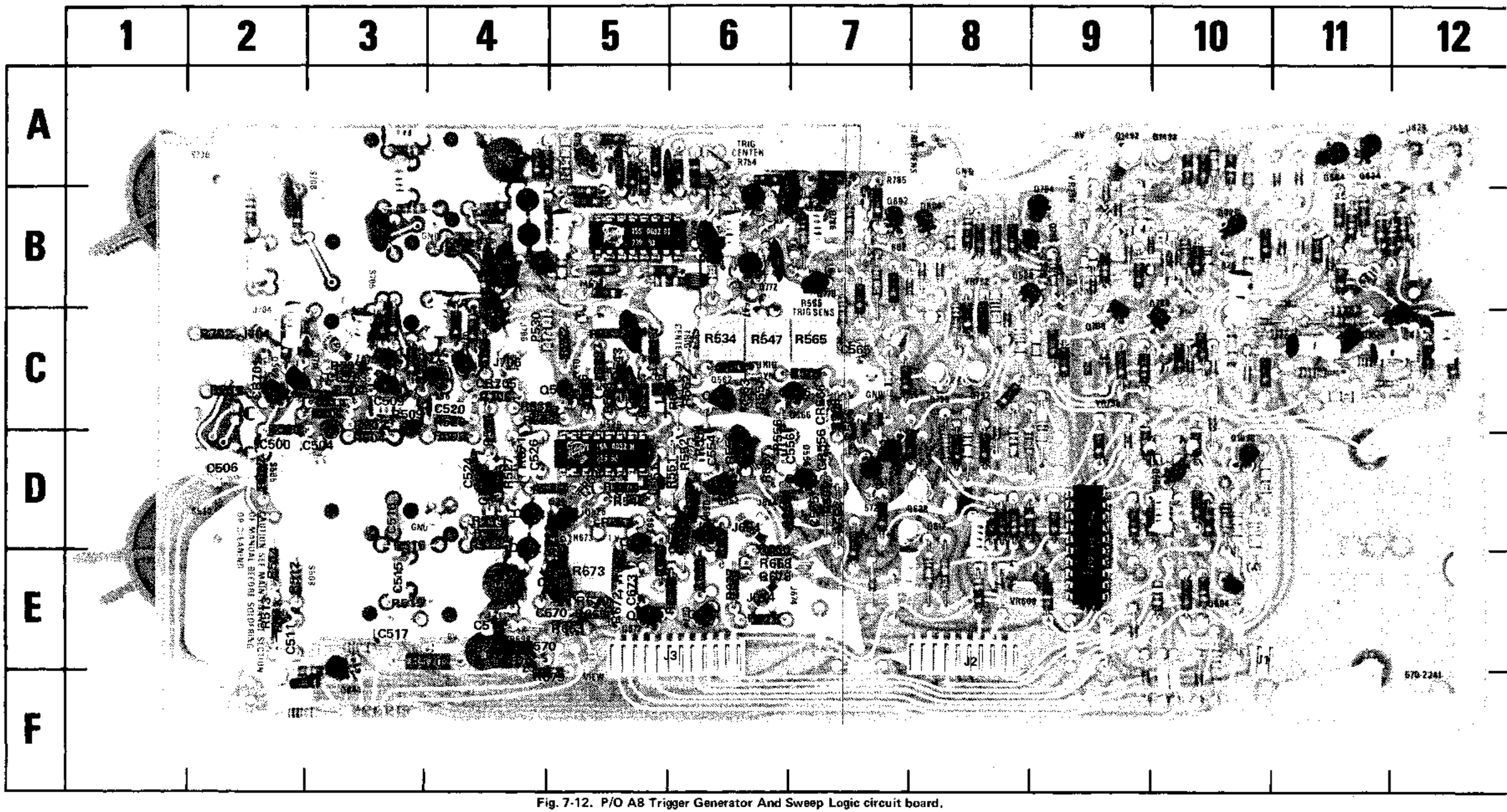
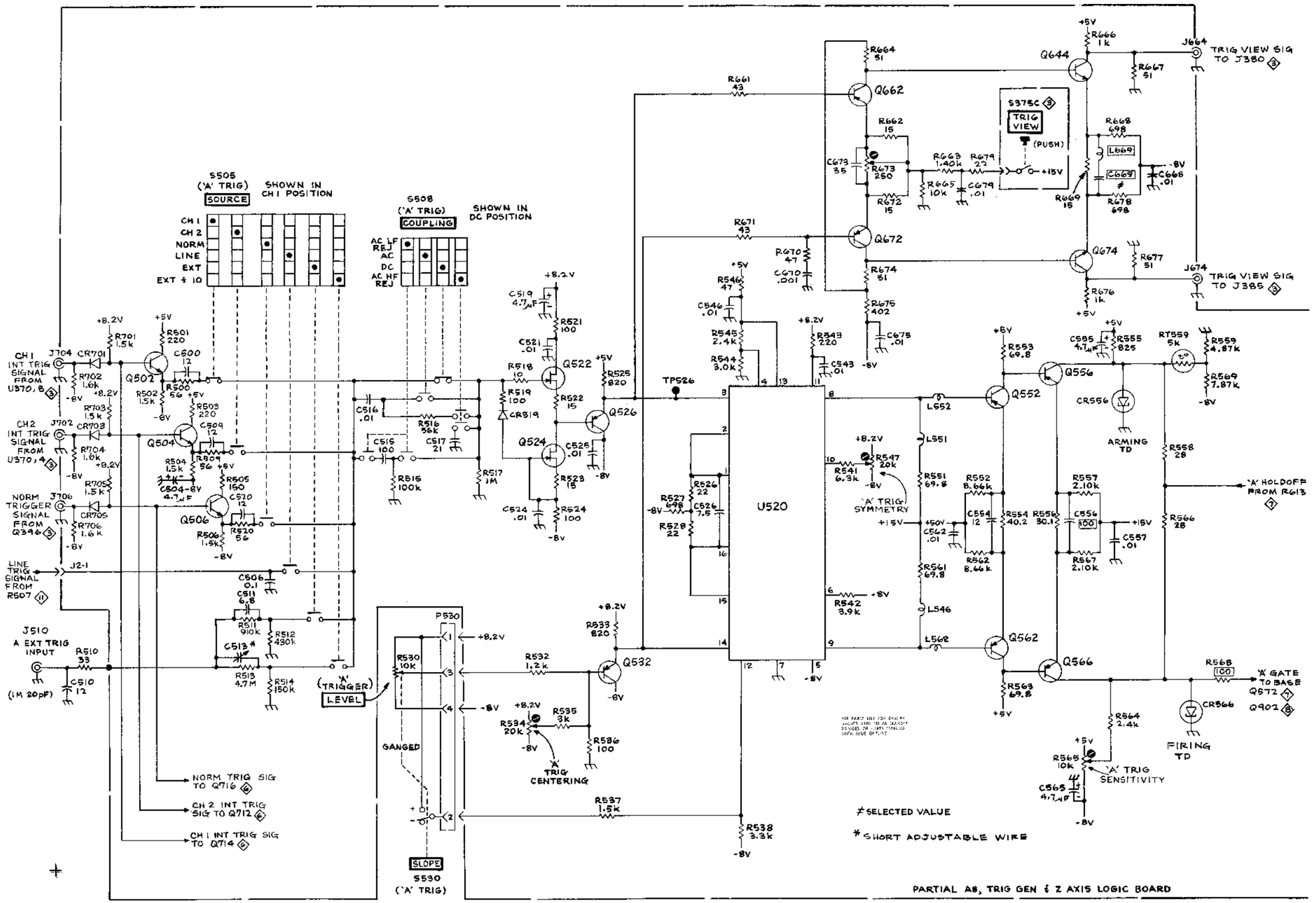


Fig. 7-12. P/O A8 Trigger Generator And Sweep Logic circuit board.

Fig. 7-12. A8 Trigger Generator and Sweep Logic circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C500	2D	C557	6D	J674	6E	Q566	7D	R516	3D	R538	5C	R564	7C	R673	5E
C504	3D	C562	6D	J704	2C	Q662	5D	R517	4D	R541	6C	R565	7C	R674	6E
C506	2D	C565	7C	J706	2C	Q664	6D	R518	4D	R542	5D	R566	7D	R675	6E
C509	3C	C668	6D			Q672	5E	R519	4D	R543	5C	R567	6D	R676	6E
C511	2E	C673	5E	L546	5C	Q674	6E	R520	4C	R544	5D	R568	7C	R677	6E
C515	3E	C675	6E	L551	5D			R521	4E	R545	5C	R570	3E	R678	6E
C516	3D	C679	4E			R500	2C	R522	5E	R546	5C	R579	4E	R679	4F
C517	3E			P530	4C	R501	3C	R523	4D	R547	6C	R661	5D	R701	2C
C519	4E	CR519	4D			R502	2D	R524	4D	R551	6D	R662	5E	R702	2C
C520	4C	CR556	7D	Q502	2C	R503	3C	R525	5E	R552	6D	R663	5E	R703	3C
C521	4E	CR566	7C	Q504	3C	R504	3D	R526	4D	R553	6D	R664	5E	R704	3C
C524	4D	CR701	2C	Q506	4C	R505	3C	R527	4D	R554	6D	R665	5E	R705	4C
C525	4E	CR703	3C	Q522	4D	R506	4D	R528	4C	R555	7D	R666	6D	R706	4C
C526	4D	CR705	4C	Q524	4D	R509	3C	R532	5C	R556	6D	R667	6E		
C543	5C			Q526	5D	R511	2E	R533	4C	R557	6C	R668	6E	TP526	5D
C546	5C	J1	10E	Q532	4C	R512	2E	R534	6C	R558	7D	R669	6E		
C554	6D	J2	8E	Q552	6D	R513	2E	R535	5C	R561	6C	R670	5E	U520	5D
C555	7D	J3	6E	Q556	6C	R514	2E	R536	5C	R562	6C	R671	4D		
C556	7D	J664	6D	Q562	6C	R515	3E	R537	5C	R563	6C	R672	5E	VR570	4E


S505 ('A' TRIG) SOURCE
SHOWN IN CH 1 POSITION
CH 1
CH 2
NORM
LINE
EXT
EXT ÷ 10
S508 ('A' TRIG) COUPLING
SHOWN IN DC POSITION
AC LF REJ
AC
DC
AC HF REJ
CH 1 INT TRIG SIGNAL FROM U370, 8
CH 2 INT TRIG SIGNAL FROM U370, 4
NORM TRIGGER SIGNAL FROM Q396
LINE TRIG SIGNAL FROM R507
J510 A EXT TRIG INPUT
(1M 20pF)
'A' TRIGGER LEVEL
GANGED
SLOPE
S530 ('A' TRIG)
NORM TRIG SIG TO Q716
CH 2 INT TRIG SIG TO Q712
CH 1 INT TRIG SIG TO Q714
TP526
U520
'A' TRIG SYMMETRY
'A' TRIG CENTERING
'A' TRIG SENSITIVITY
S375C TRIG VIEW (PUSH)
TRIG VIEW SIG TO J380
TRIG VIEW SIG TO J385
ARMING TD
FIRING TD
'A' HOLDOFF FROM R613
'A' GATE TO BASE Q572 Q902
SELECTED VALUE
* SHORT ADJUSTABLE WIRE
PARTIAL A8, TRIG GEN & Z AXIS LOGIC BOARD

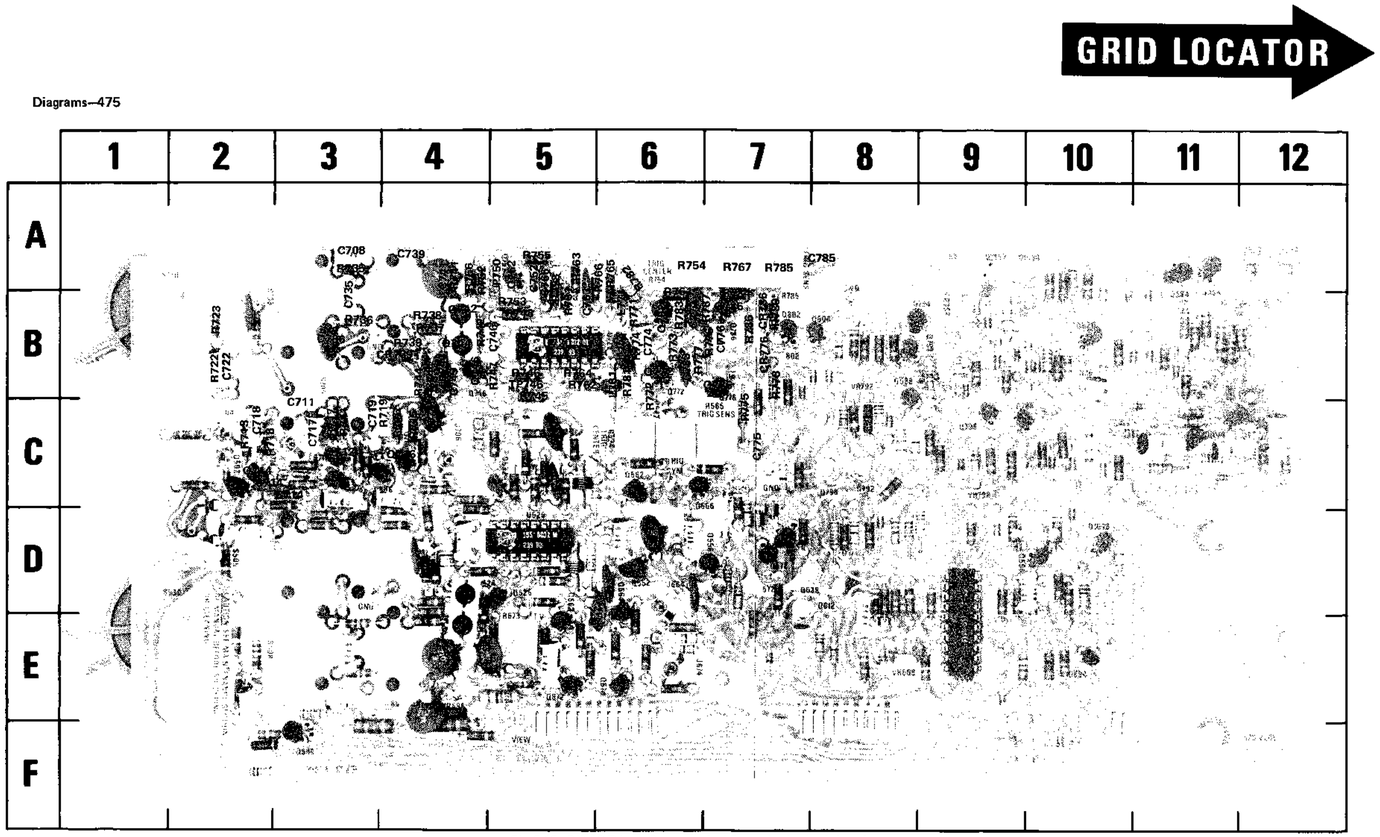
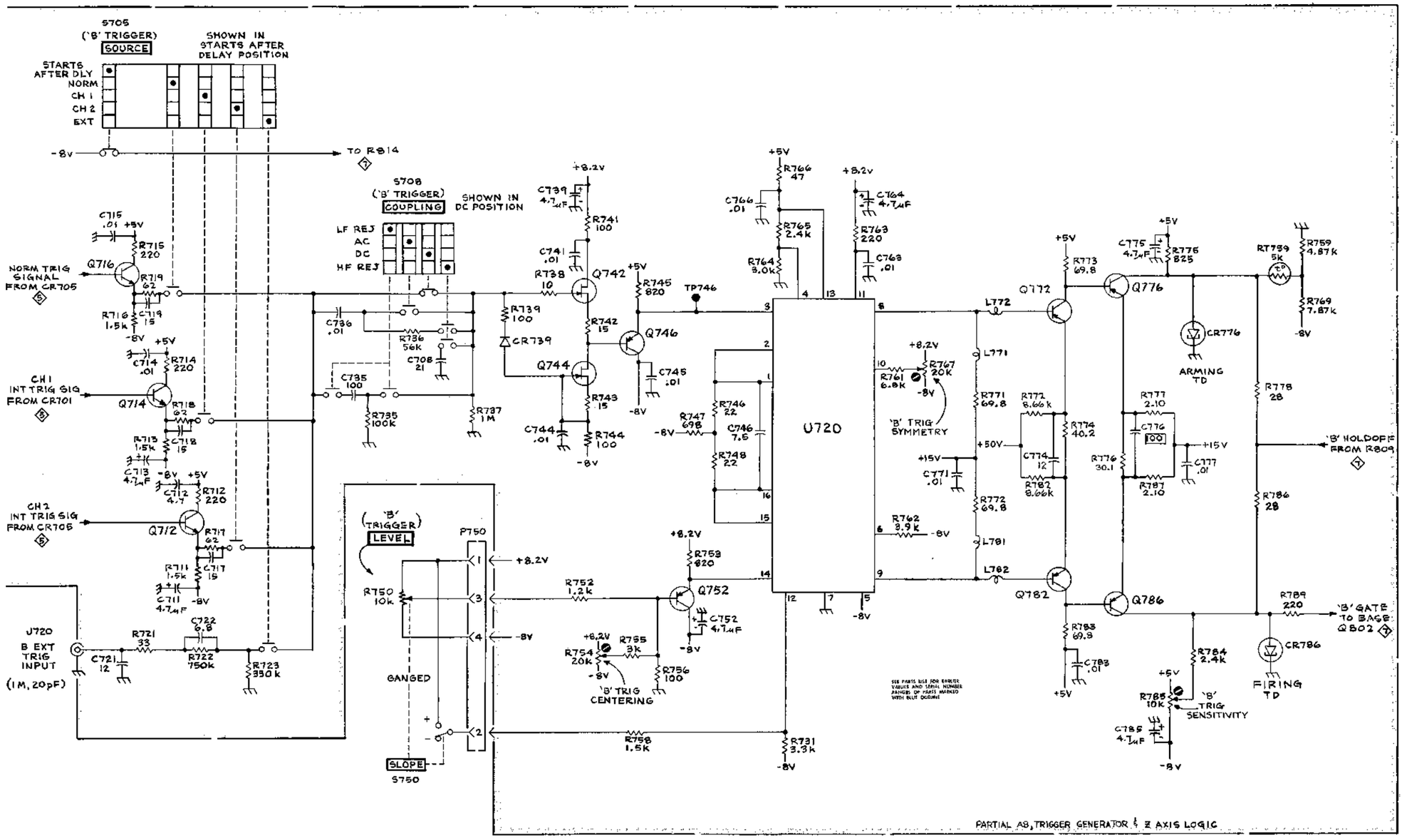


Fig. 7-13. P/O A8 Trigger Generator And Sweep Logic circuit board.

Fig. 7-13. A8 Trigger Generator and Sweep Logic circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C708	3A	C745	4B	CR739	4B	Q744	4B	R717	3C	R743	4B	R763	5A	R781	6B
C711	3C	C746	5B	CR776	7B	Q746	4B	R718	2C	R744	4B	R764	5B	R782	6A
C714	2C	C752	5A	CR786	7B	Q752	5A	R719	4C	R745	5B	R765	6A	R783	6B
C715	4C	C763	5B			Q772	6B	R722	2B	R746	5B	R766	6A	R784	7B
C717	3C	C766	5A	L771	6B	Q776	7B	R723	2B	R748	5B	R767	7A	R785	7A
C718	2C	C771	6B	L781	6B	Q782	6B	R731	5B	R752	4A	R771	6B	R786	7B
C719	3C	C774	6B			Q786	7B	R735	3A	R753	5B	R772	6C	R787	7B
C722	2B	C775	7C	P750	5A			R736	3B	R754	6A	R773	6B	R789	7B
C735	3B	C776	7B			R711	3C	R737	4B	R755	5A	R774	6B		
C736	3B	C777	6B	Q712	3C	R713	2C	R738	4B	R756	4A	R775	7C	TP746	5B
C739	4A	C783	6B	Q714	2C	R714	3C	R739	4B	R758	5B	R776	7B		
C741	4A	C785	7A	Q716	4C	R715	4C	R741	4A	R761	5B	R777	6B	U720	5B
C744	4B			Q742	4B	R716	4C	R742	4B	R762	5B	R778	7B		


S705
('B' TRIGGER)
SOURCE
SHOWN IN STARTS AFTER DELAY POSITION
STARTS AFTER DLY
NORM
CH 1
CH 2
EXT
-8V
TO R814
S708
('B' TRIGGER)
COUPLING
SHOWN IN DC POSITION
LF REJ
AC
DC
HF REJ
NORM TRIG SIGNAL FROM CR705
CH1 INT TRIG SIG FROM CR701
CH2 INT TRIG SIG FROM CR705
J720
B EXT TRIG INPUT
(1M, 20pF)
Q716
Q714
Q712
Q742
Q744
Q746
Q752
Q772
Q776
Q782
Q786
CR739
CR776
CR786
TP746
U720
'B' TRIG SYMMETRY
ARMING TD
FIRING TD
'B' TRIG CENTERING
'B' TRIG SENSITIVITY
'B' HOLDOFF FROM R809
'B' GATE TO BASE Q802
'B' TRIGGER LEVEL
GANGED
SLOPE
S750
P750
+8.2V
+5V
-8V
+15V
+50V
PARTIAL A8, TRIGGER GENERATOR & Z AXIS LOGIC

GRID LOCATOR

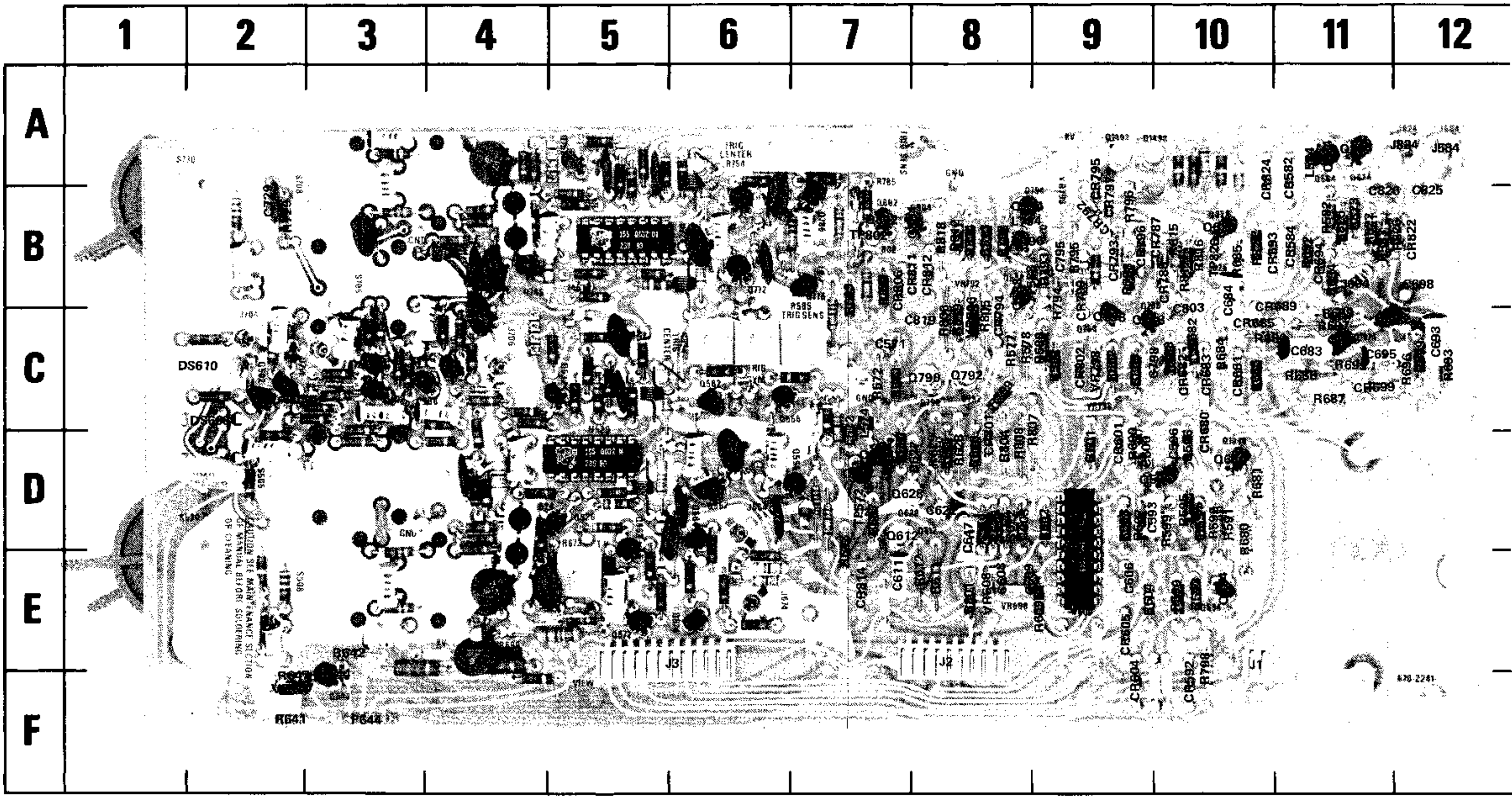


Fig. 7-14. P/0 A8 Trigger Generator And Sweep Logic circuit board.

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Fig. 7-14. A8 Trigger Generator and Sweep Logic circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C571	7C	CR592	10F	CR811	8B	Q584	11A	R577	8C	R613	7E	R698	10C	R815	10B
C593	9D	CR601	9D	CR812	8B	Q588	8B	R578	8C	R622	8D	R699	12C	R816	10B
C600	9D	CR604	9F	CR814	7E	Q594	10E	R581	9C	R626	8D	R729	2B	R817	10B
C606	9E	CR605	9E	CR822	12B	Q596	9D	R582	11B	R627	8D	R788	9B	R818	8B
C608	8E	CR680	10D	CR824	10B	Q612	7D	R583	11B	R628	8D	R793	9B	R819	8C
C609	8E	CR681	10C			Q628	7D	R588	9C	R629	8D	R794	9C	R821	10B
C611	7E	CR682	10C	DS608	2C	Q644	3F	R590	10E	R641	2F	R795	9B	R822	11B
C622	8D	CR683	10C	DS610	2C	Q680	10D	R591	10D	R642	3E	R796	9B	R823	11B
C627	8D	CR685	10C			Q688	11C	R592	10D	R647	2F	R797	8B	R825	11B
C647	8D	CR689	10B	J1	10E	Q698	11C	R593	10E	R680	10D	R798	10F	R826	12B
C683	11C	CR693	10B	J2	8E	Q788	9C	R594	10D	R681	10D	R799	8C		
C684	10C	CR694	11B	J3	5E	Q790	8C	R595	10D	R682	10C	R801	8E	TP572	7D
C693	12C	CR699	11C	J584	12A	Q792	8C	R596	10D	R683	11C	R802	9C	TP588	8B
C695	11C	CR787	10B	J694	11B	Q794	8A	R597	9D	R684	10C	R803	9C	TP802	7B
C698	12B	CR788	10B	J824	12A	Q796	8A	R598	9D	R685	10B	R804	8D	TP826	10B
C729	2B	CR792	9B			Q798	9C	R599	10D	R686	10C	R805	8C		
C795	9B	CR793	9B	L572	7D	Q802	7A	R600	9D	R687	11C	R806	8C	U600	9D
C798	9C	CR794	8C	L574	7D	Q804	8A	R601	9D	R688	11C	R807	8D		
C803	10B	CR795	9B	L584	11A	Q824	11A	R602	9D	R689	11C	R808	8D	VR647	2F
C819	7C	CR796	9B	L794	8B	Q826	10B	R603	8D	R692	11B	R809	7C	VR608	8E
C825	12B	CR797	9B					R604	9E	R693	12C	R810	8D	VR796	8C
C826	11B	CR799	9C	P644	3F	R571	7C	R607	7D	R694	11B	R811	7B	VR798	9C
		CR801	8B			R572	7C	R609	9E	R695	11C	R812	8B		
CR582	11B	CR802	9C	Q572	7D	R574	8D	R611	8E	R696	12C	R813	8B		
CR584	11B	CR806	7B	Q574	7D	R575	8D	R612	8E	R697	11C	R814	2B		

PARTIAL A9, INTERFACE BOARD
PARTIAL A7, TIMING BOARD
S1090 A
P6-5
J3-8
DLY'D GATE FROM R789 6
TP802
Q802
Q804
+5V (DCPL1)
R818 866
R812 9.3k
R813 150
CR814
R814 1k
R816 2.55k
Q826
R816 402
R817 220
-8V (DCPL1)
TP826
J3-1
TO BASE Q996 6
STARTS AFTER DELAY S705 6
CR812
R811 2k
R729 100
C729 .01
-8V
FROM COLL Q1034 8
J3-3
Q788
CR788
R788 4.7k
R793 10k
CR787
FROM COLL Q938 8
J3-12
R806 681
CR806
CR811
R805 1k
R807 4.32k
R808 3.92k
Q792
Q790
R809 100
'B' HOLD OFF TO R778 & R779 6
-8V(DCPL1)
R810 200
-8V(DCPL2)
R799 1k
TO BASE Q1002 6
R801 3.3k
CR801
Q796
R797 100
R794 4.99k
R795 2.15k
C795 .008
L794
Q794
CR794
Q798
VR798 3V
C798 2.2μF
CR802
R802 220
-8V (DCPL1)
CR795
CR796
CR797
CR792
CR793
CR799
R796 2.26k
VR796 5.1V
R804 523
-8V (DCPL1)
B ENDS A
P644
S644B
OPEN IN CW OF R644
R798 3.83k
C799 .001
CR592
MAIN GATE FROM R568 5
TP572
L572
L574
Q572
Q574
R571 10
R572 866
C571 4.7μF
R574 4.3k
R575 150
R577 3.57k
R578 499
L588
Q588
TP588
R581 100
R583 2k
C583 33
CR683
CR681
CR682
R588 120
-8V (DCPL1)
R607 100
R600 4.7
C600 4.7μF
L600
R599 20k
C599 47
R596 4.7
C596 4.7μF
Q596
R592 2k
R594 1.6k
R595 1k
Q594
R591 3.24k
R590 1k
R593 10k
C593 150
R597 220
R598 220
-8V
HOLDOFF START FROM CR446, CR1037 6
J9-2
ALT TRACE SYNC PULSE TO S900 6
-8V (DCPL1)
FROM COLL Q946 6
J3-4
Q680
CR680
R680 2.15k
R681 1.47k
R682 1k
-8V (DCPL1)
U600 M79
+TD IN
+TD OUT
-TD IN
-TD OUT
HO START
LOCKOUT IN
AUTO
AUTO RC
RESET TIMING
RESET START
SWP DISABLE
GRAT SWP
TRIG'D
READY
H-O
Vcc
Vbb
R602 4.7k
R603 240
R609 100k
C609 1μF
C611 4.7
R611 634
R612 931
Q612
Q628
R613 100
R627 100
R628 806
R629 1.33k
R626 200
C627 .001
R608 2.7
C607 33μF
TRIG'D DS608
R622 2.7
C622 4.7μF
-8V
'A' HOLDOFF TO R558 & R556 5
R647 47k
C647 100
Q644
VR647 5.1V
C644 .01
+50V
R642 7.15k
R641 2k
VR608 3V
C608 4.7μF
-8V
R610 2.7
C610 33μF
READY DS610
S1050 TIME/DIV (A) 7
NORM
AUTO
S600 TRIG MODE
SINGL SWP PUSH TO RESET
P6-2
P6-9
P6-11
P6-10
J3-9
J3-11
J3-10
CR601
CR604
CR605
R601 4.7k
R604 39k
C606 .68μF
FROM CR1060 9
P4-10
PARTIAL A7, TIMING BOARD
PARTIAL A9, INTERFACE BRD
P644
S644A
B ENDS A
OPEN IN CW POS OF R644
R644 100k
A TRIG HOLDOFF
475 OSCILLOSCOPE
PARTIAL A8, TRIGGER GENERATOR & Z AXIS LOGIC
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE
(REAR PANEL) B+GATE 500Ω 5.5V⎍
J824
J829
Q824
C824 15
R821 100
R822 470
CR822
CR824
R823 330
(REAR PANEL) A+GATE 500Ω 5.5V⎍
J584
J589
Q584
C584 15
R582 470
CR582
CR584
R583 330
-8V (DCPL2)
HORIZ DISPLAY
MIX
A INT
B PLY'D
TO R985 8
S1090
P4-4
P4-3
CR691
CR692
A9, Z AXIS UNBLANK
R692 4.7k
CR693
CR694
J2-5
J694
TO J1334 12
C684 47
R685 3.74k
CR685
R686 1.80k
R688 287
Q688
R695 1.30k
C695 8
Q698
C693 82
R693 470
R694 47
R684 3.74k
R687 1.47k
CR689
CR699
R689 4.3k
R699 4.7k
R696 2k
R697 698
R698 10
C698 2.2μF
-8V
J2-7
P5-2
TIME/DIV (A) S1050 7
J2-6
P4-7
P/O A7, TIMING BD
PARTIAL A9, INTERFACE BOARD
A
SWEEP & Z AXIS LOGIC 7
GAB 8-22-72

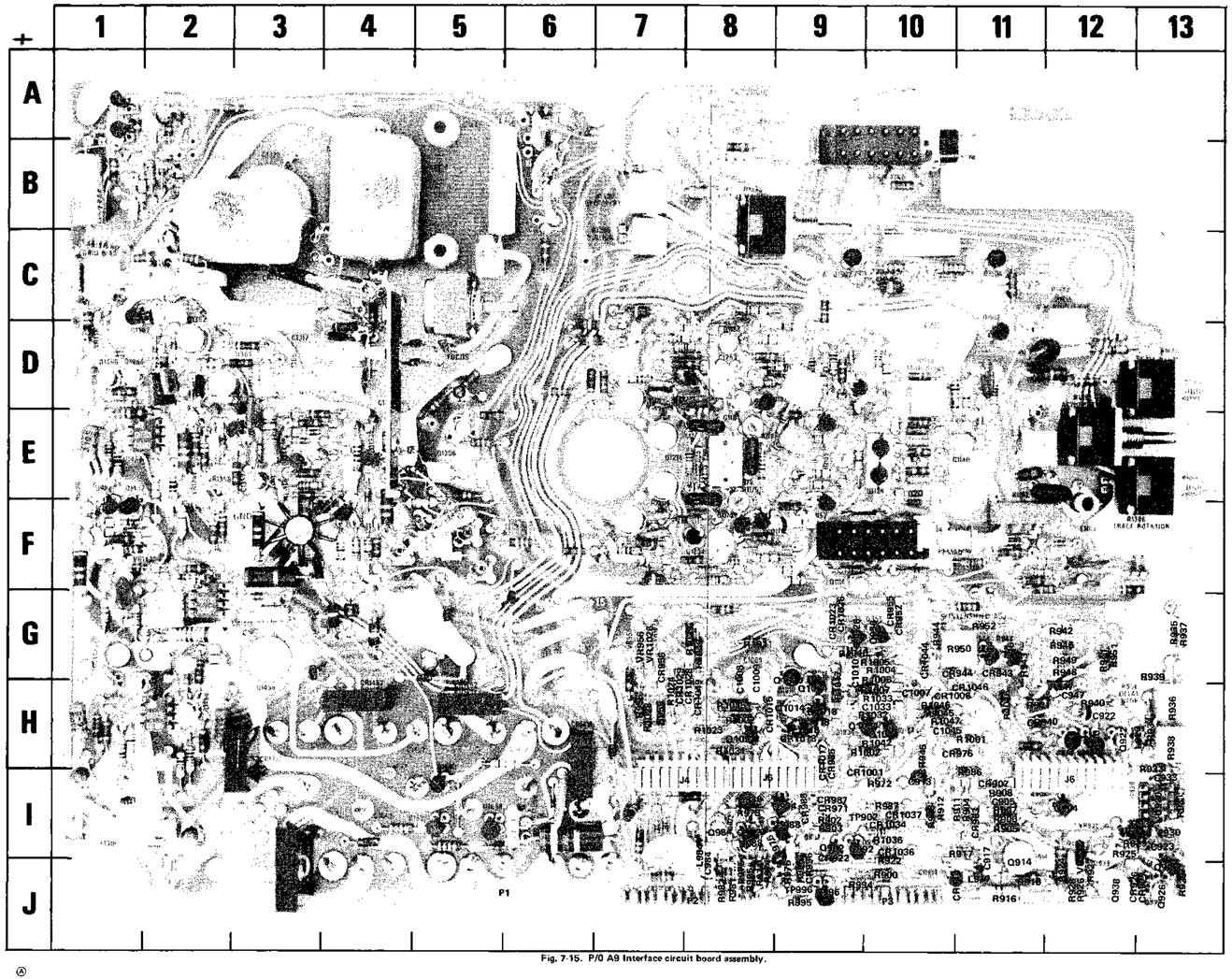
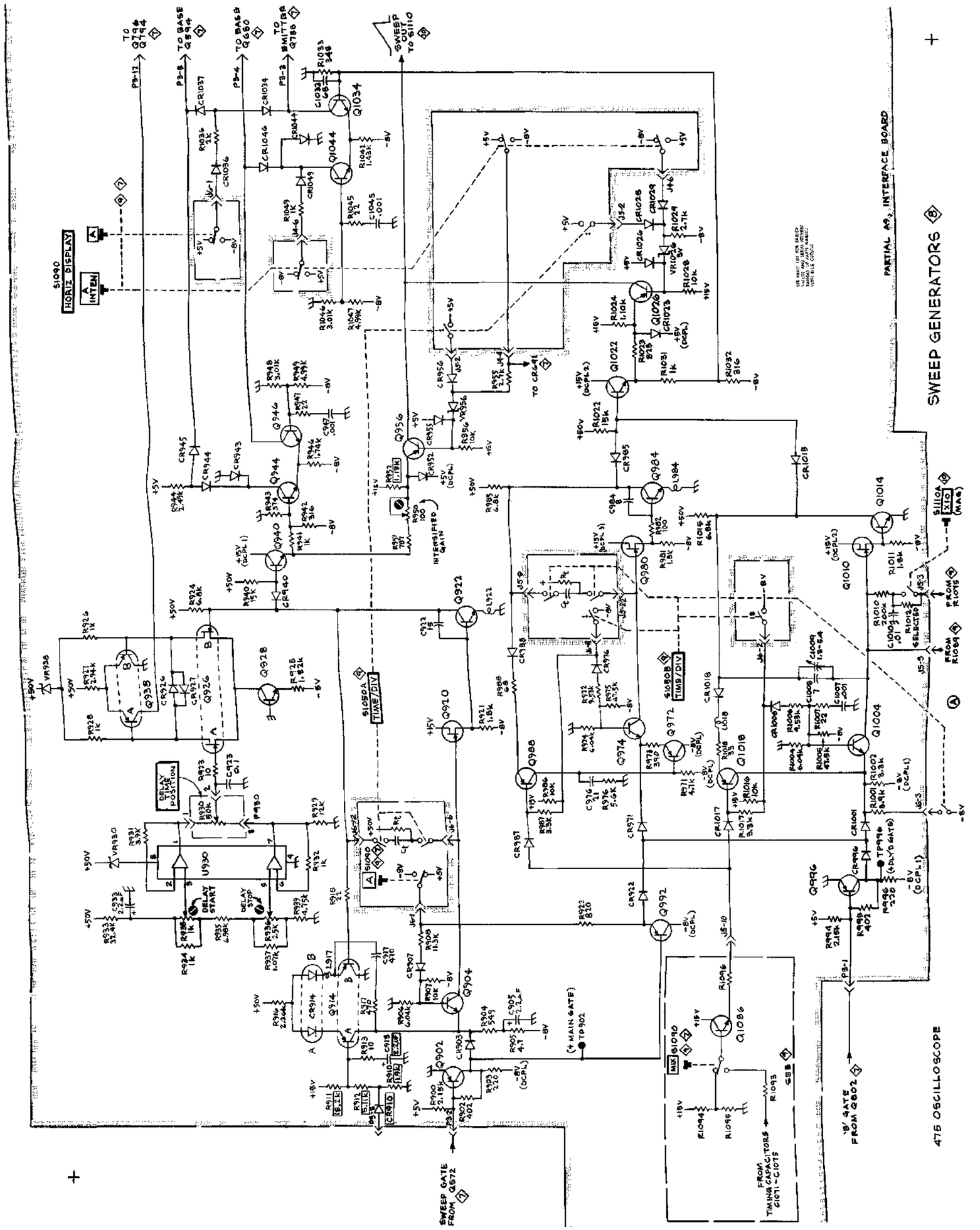


Fig. 7-15. P/O A9 Interface circuit board assembly.

Fig. 7-15. A9 Interface circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C905	11I	CR945	10H	J4	7I	Q970	12H	R911	11I	R941	12G	R994	9J	R1046	10H
C913	10I	CR952	10G	J5	8I	Q972	8I	R912	10I	R942	12G	R995	9J	R1047	10H
C917	11J	CR955	10G	J6	12I	Q974	9I	R913	10I	R943	11G	R996	9J	R1049	10H
C922	12H	CR956	7G			Q980	8I	R916	11J	R944	10G	R1001	11H		
C923	13I	CR971	9I	L917	11J	Q984	8I	R917	10I	R946	12G	R1002	9H	S1110	9F
C933	13I	CR976	10H	L922	13H	Q988	9I	R918	11J	R947	12H	R1004	9G		
C947	12H	CR985	9I	L984	8J	Q992	9I	R921	11H	R948	12G	R1005	10G	TP902	9I
C976	9I	CR987	9I	L1018	9H	Q996	9J	R922	10I	R949	12G	R1006	10G	TP996	9J
C1007	10H	CR988	9I			Q1004	9H	R923	13J	R950	10G	R1007	10H		
C1008	8H	CR996	9J	P1	5J	Q1010	9G	R924	12J	R951	12G	R1010	9G	U930	13I
C1009	8H	CR1001	9I	P2	8J	Q1014	9H	R925	12I	R953	11G	R1011	8G		
C1010	9H	CR1006	10H	P3	10J	Q1018	9H	R926	12J	R955	7H	R1015	8H	VR930	12I
C1033	10H	CR1015	8H	P930	13I	Q1022	8H	R927	12J	R956	7H	R1016	11H	VR938	12J
C1045	10H	CR1017	9I			Q1026	9G	R928	12J	R971	8J	R1017	9H	VR956	7G
		CR1018	9H	Q902	9I	Q1034	9H	R929	12I	R972	10I	R1018	9H	VR1026	7G
CR903	11I	CR1023	9G	Q904	12I	Q1044	10H	R931	13I	R973	8I	R1022	8H		
CR907	11I	CR1026	9G	Q914	11I			R932	12I	R974	8J	R1023	8H		
CR914	11I	CR1028	8H	Q922	12H	R900	10J	R933	13H	R975	8J	R1024	7H		
CR922	9I	CR1029	7H	Q926	13J	R902	9I	R934	13H	R976	9J	R1028	7H		
CR926	12J	CR1034	10I	Q928	13J	R903	9I	R935	13G	R981	8J	R1029	8G		
CR927	13J	CR1036	10I	Q938	12J	R904	11I	R936	13H	R982	8J	R1031	8H		
CR940	11H	CR1037	10I	Q940	12H	R905	11I	R937	13G	R985	8J	R1032	10H		
CR943	11G	CR1044	10G	Q944	11G	R906	11I	R938	13H	R986	11H	R1033	10H		
CR944	10G	CR1046	11H	Q946	11G	R907	11I	R939	13G	R987	10I	R1042	10H		
		CR1049	8H	Q956	10G	R908	11I	R940	12H	R988	8I	R1045	10H		


SWEEP GENERATORS 8
PARTIAL A9 INTERFACE BOARD
475 OSCILLOSCOPE
S1090 HORIZ DISPLAY
INTEN
TO Q794 Q794
TO BASE Q844
TO BASE Q660
TO EMITTER Q786
SWEEP OUT TO S1110
TIME/DIV
DELAY POSITION
DELAY START
DELAY STOP
INTENSIFIED GAIN
SWEEP GATE FROM Q672
+ MAIN GATE
'B' GATE FROM Q802
FROM TIMING CAPACITORS C1071-C1075
FROM R1089
FROM R1015
S1110A
X10 (MAG)
U930
Q1034
Q1044
Q1022
Q1026
Q956
Q946
Q944
Q940
Q984
Q980
Q922
Q928
Q926
Q938
Q910
Q988
Q914
Q972
Q974
Q1018
Q1010
Q1014
Q1004
Q992
Q996
Q904
Q902
Q1086

GRID LOCATOR

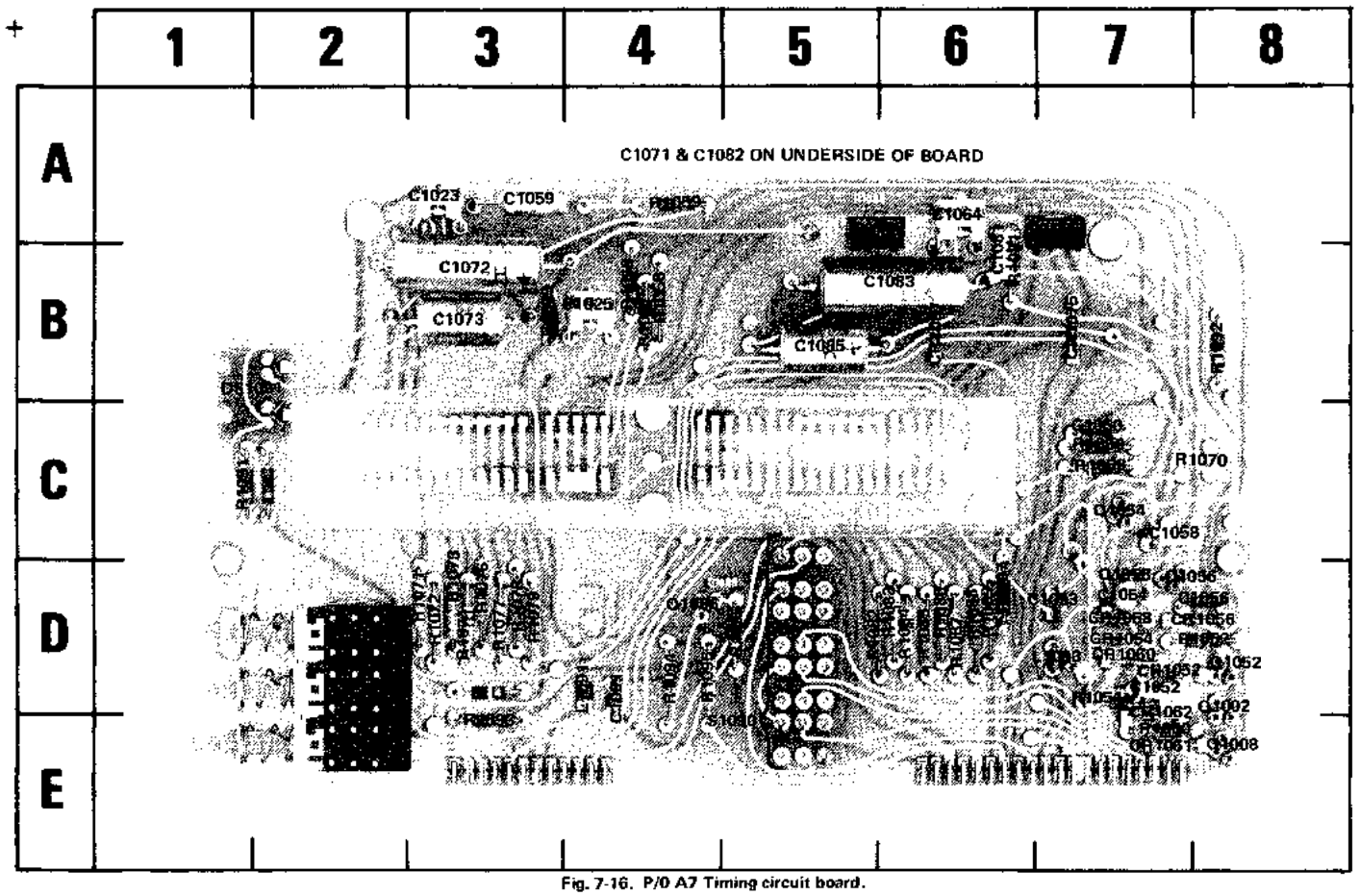


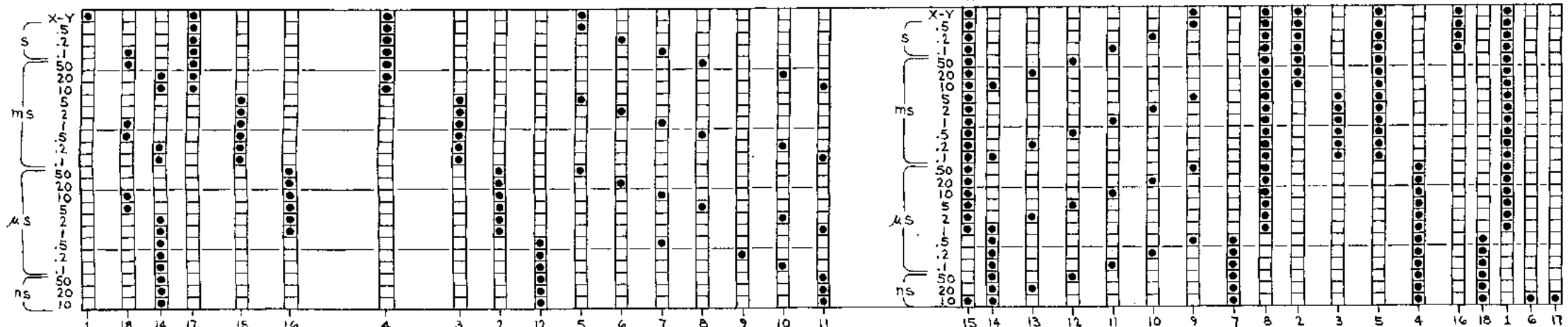
Fig. 7-16. P/O A7 Timing circuit board.

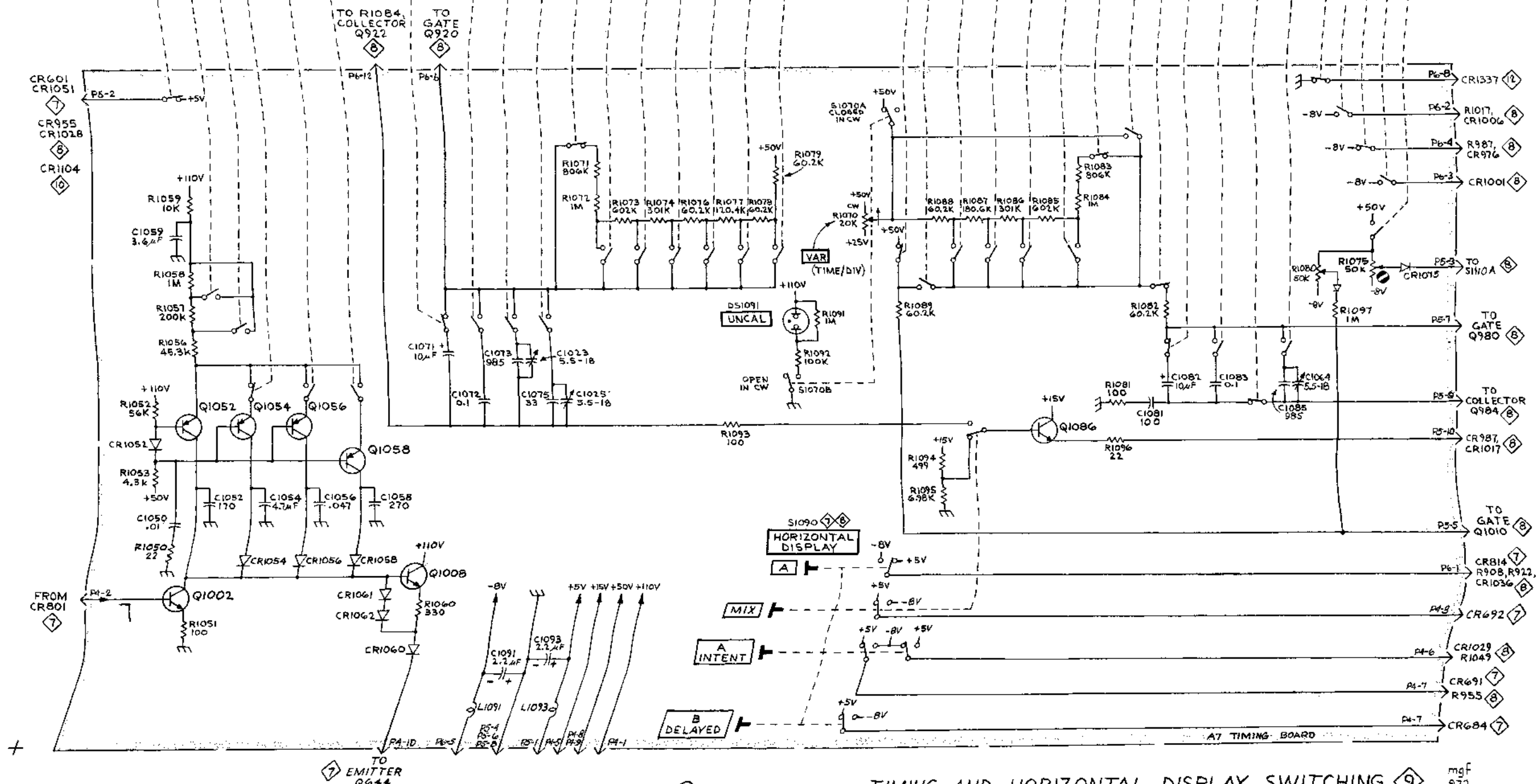
Fig. 7-16. A7 Timing circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C1023	3A	C1073	3B	CR1056	7D	L1091	4D	R1050	7C	R1071	3D	R1081	6B	R1092	8B
C1025	4B	C1075	3B	CR1058	7D	L1093	7E	R1051	7D	R1072	3D	R1082	5D	R1093	4D
C1050	7C	C1081	6B	CR1060	7D			R1052	7D	R1073	3D	R1083	6D	R1094	4D
C1052	7D	C1083	5B	CR1061	7E	Q1002	8D	R1053	7C	R1074	3D	R1084	6D	R1095	4D
C1054	7D	C1085	5B	CR1062	7D	Q1008	8E	R1056	4B	R1075	7A	R1085	6D	R1096	5D
C1056	7D	C1091	4D	CR1075	7B	Q1052	8D	R1057	4B	R1076	3D	R1086	6D	R1097	6D
C1058	7C	C1093	7D	CR1097	6B	Q1054	7C	R1058	4B	R1077	3D	R1087	6D		
C1059	3A					Q1056	7D	R1059	4A	R1078	3D	R1088	6D	S1090	5E
C1064	6A	CR1052	7D	DS1091	1B	Q1058	7D	R1060	7D	R1079	3D	R1089	6D		
C1072	3B	CR1054	7D			Q1086	4D	R1070	7C	R1080	5A	R1091	1C		

S1050 TIME/DIV DELAY TIME A — B

SWITCH SHOWN IN X-Y POSITION





475 OSCILLOSCOPE

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TIMING AND HORIZONTAL DISPLAY SWITCHING ⑨ mgf 972

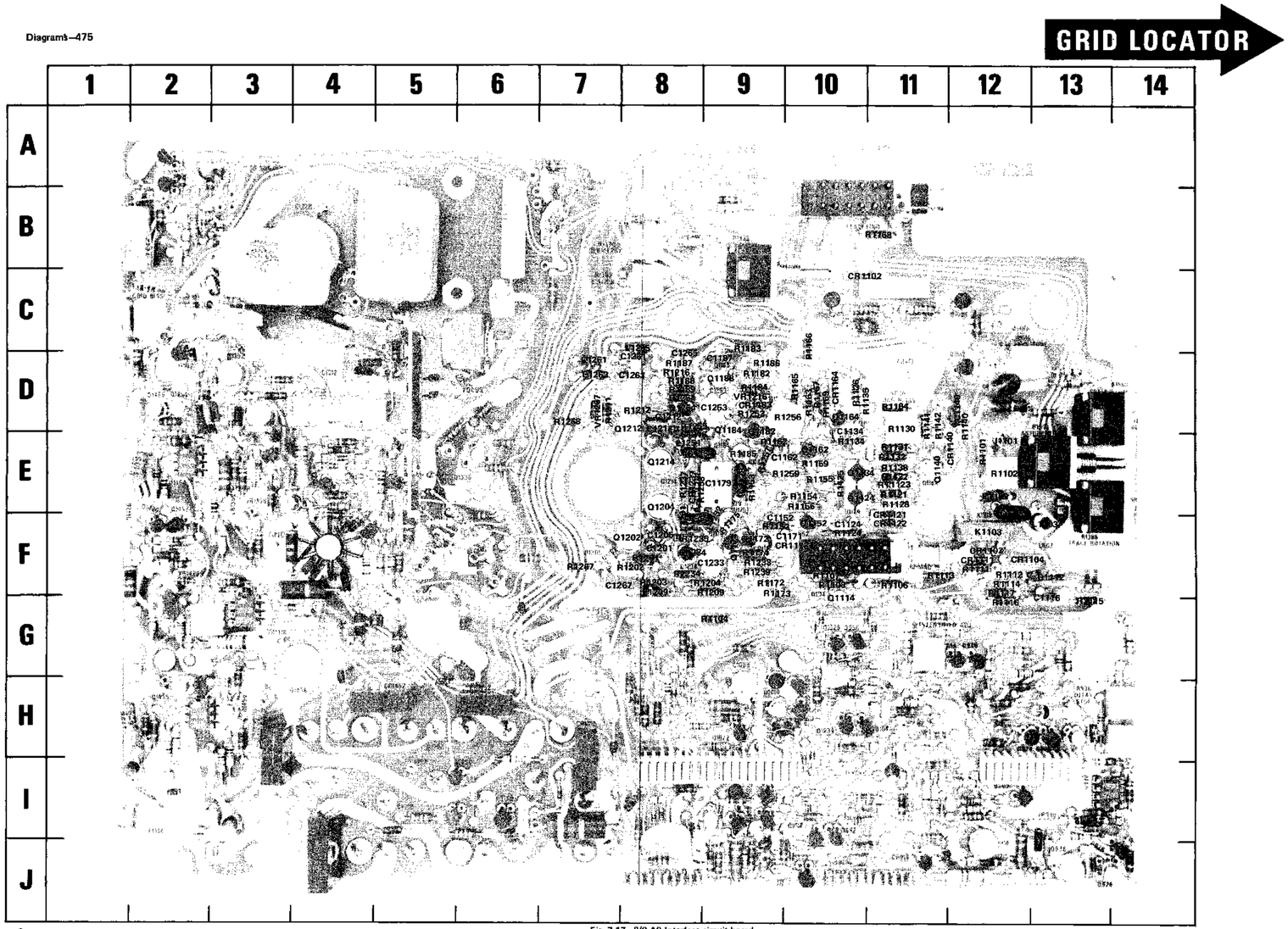
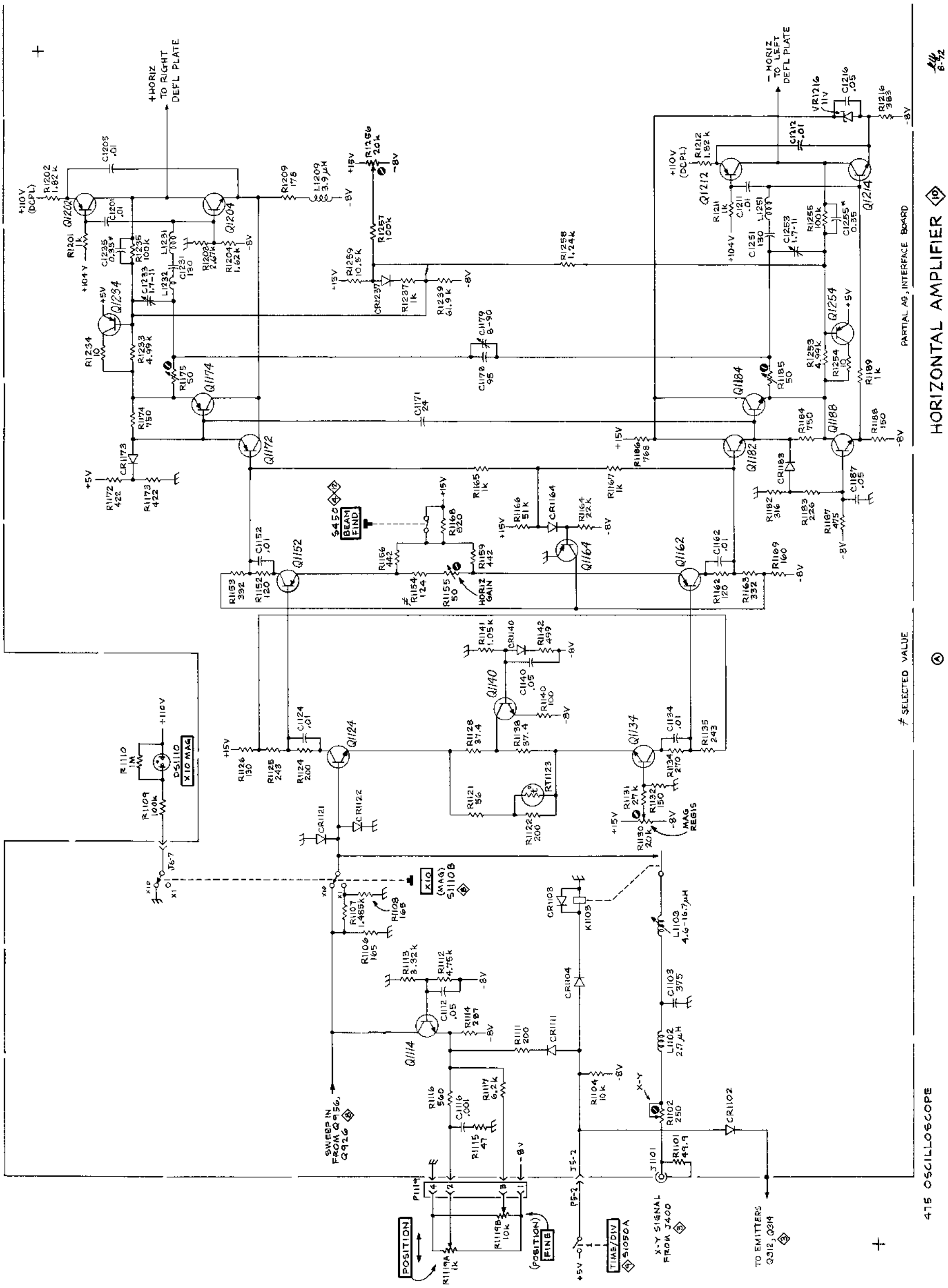


Fig. 7-17. P/O A9 Interface circuit board.

Fig. 7-17. A9 Interface circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C1103	12E	C1253	9D	K1103	12F	Q1172	9F	R1111	12F	R1138	11E	R1173	9F	R1234	8F
C1112	13F	C1261	8D			Q1174	9F	R1112	12F	R1140	12E	R1174	9F	R1235	8F
C1116	13F	C1263	8D	L1102	12E	Q1182	9D	R1113	11F	R1141	11E	R1182	9D	R1239	9F
C1124	10F	C1265	8D	L1103	13F	Q1184	9D	R1114	12F	R1142	11E	R1183	9C	R1253	9D
C1134	10D	C1267	7F	L1209	8F	Q1188	9D	R1115	13G	R1152	9F	R1184	9D	R1254	8D
C1140	12D			L1231	8F	Q1202	7F	R1116	12G	R1153	9E	R1185	9E	R1255	8D
C1152	9F	CR1102	10C	L1232	9F	Q1204	8E	R1117	12F	R1154	10E	R1186	9D	R1256	9D
C1162	9E	CR1103	12F	L1251	8E	Q1212	8D	R1121	11E	R1155	10E	R1187	8D	R1257	9E
C1171	9F	CR1104	12F	L1261	7D	Q1214	8E	R1122	11E	R1156	10E	R1188	8D	R1258	8E
C1178	9E	CR1111	12F	L1263	7D	Q1233	8F	R1124	10F	R1159	10E	R1189	8D	R1259	9E
C1179	9E	CR1121	11E	L1265	8C	Q1234	8F	R1125	10E	R1162	9E	R1201	8F	R1267	7F
C1187	9D	CR1122	11F			Q1254	8D	R1126	10D	R1163	10D	R1202	7F	R1268	7D
C1201	8F	CR1140	12E	Q1114	10F			R1128	11E	R1164	11D	R1203	8F		
C1205	8F	CR1164	10D	Q1124	10E	R1101	12E	R1130	11D	R1165	10D	R1204	8F	RT1123	11E
C1211	8D	CR1164	10D	Q1134	10E	R1102	12E	R1131	11E	R1166	10D	R1209	8F		
C1212	8D	CR1183	9D	Q1140	11E	R1104	9G	R1132	11E	R1167	10D	R1211	7D	S1110	10F
C1216	8E	CR1237	8E	Q1152	10F	R1106	11F	R1134	10E	R1168	11B	R1212	8D		
C1231	8F			Q1162	10E	R1107	10F	R1135	10D	R1169	10D	R1216	8D	VR1216	9D
C1251	8E	J1101	12E	Q1164	10D	R1108	10F	R1137	8E	R1172	9F	R1233	9F	VR1267	7D

HORIZONTAL AMPLIFIER 10



GRID LOCATOR

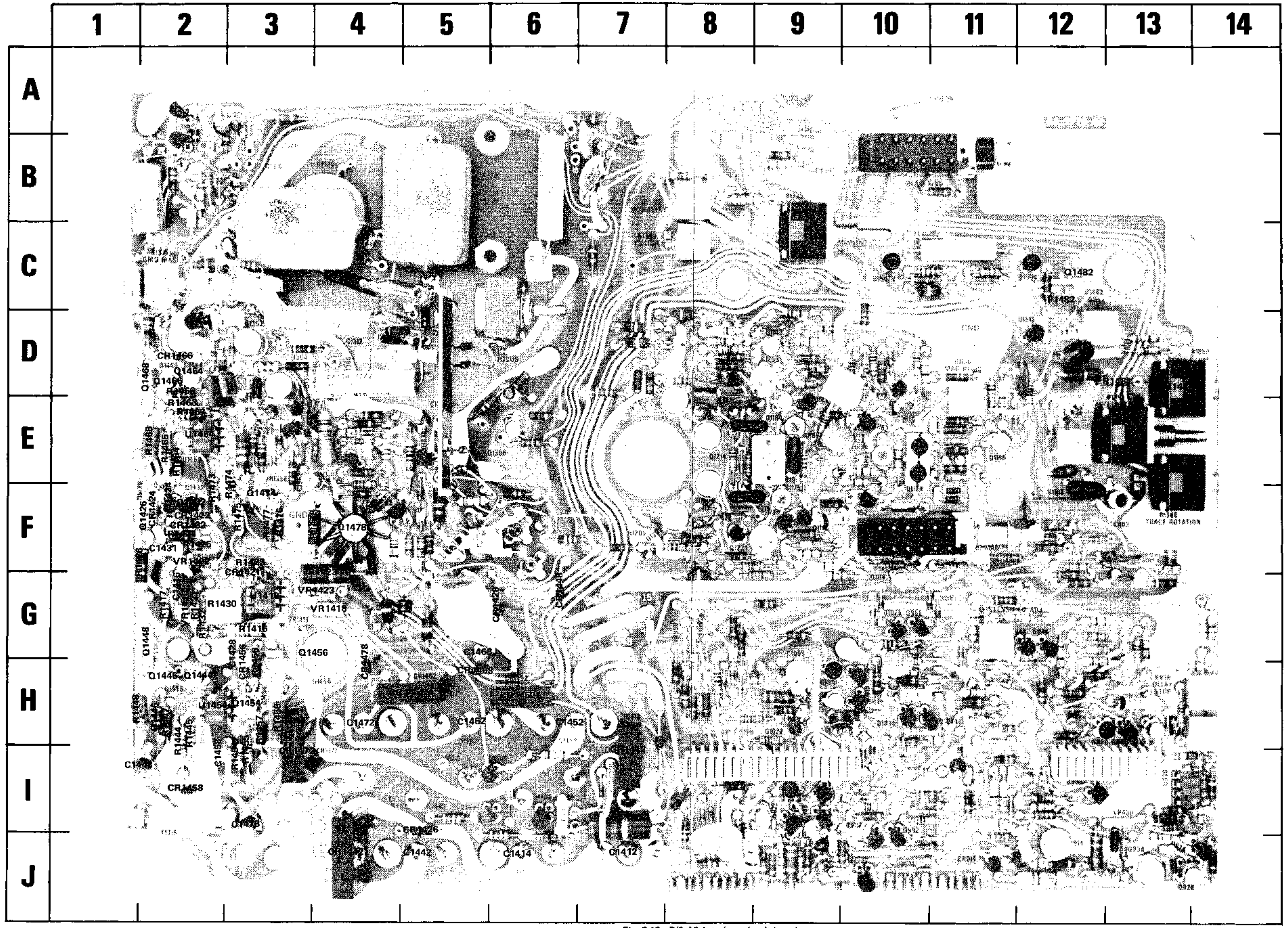
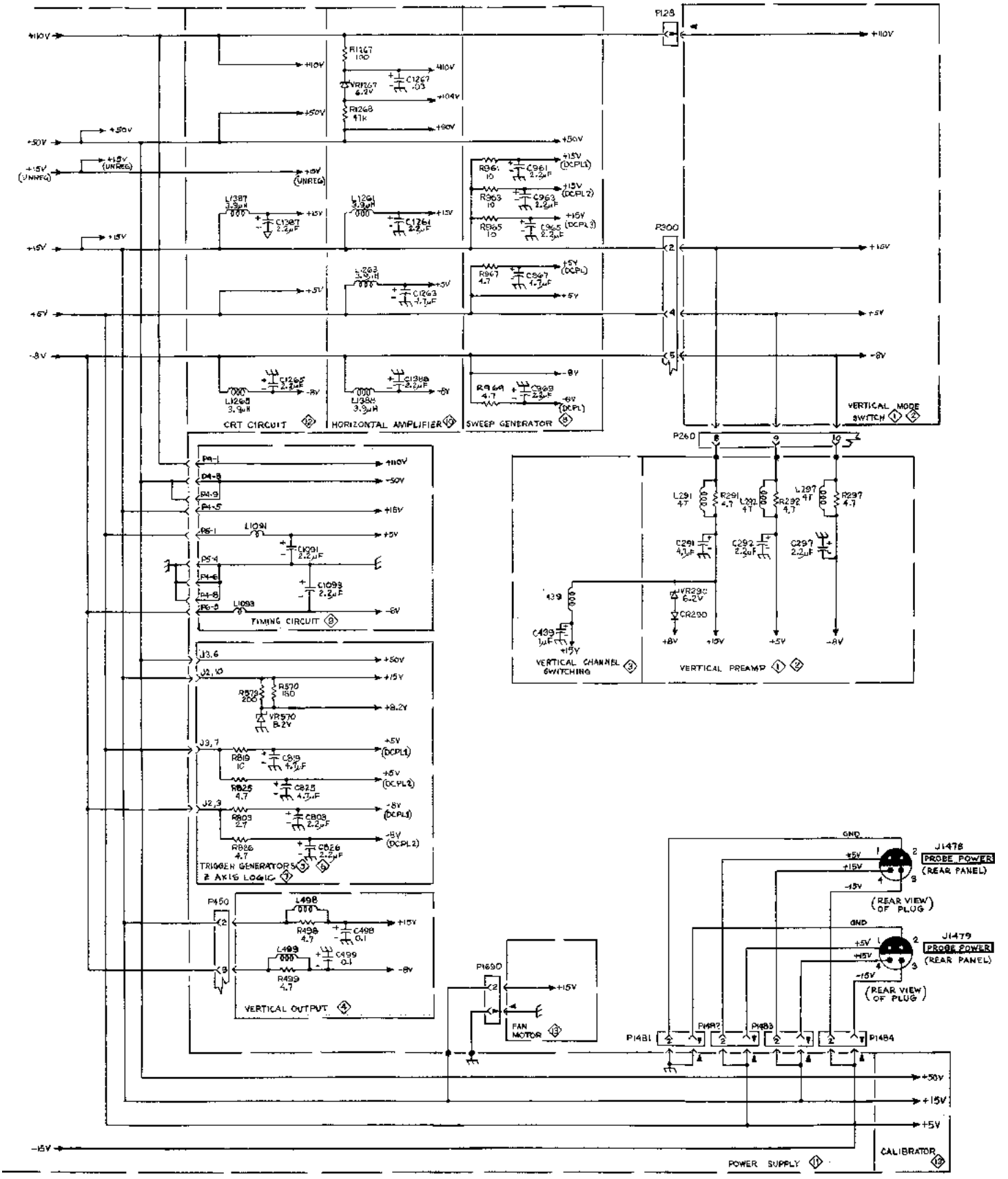


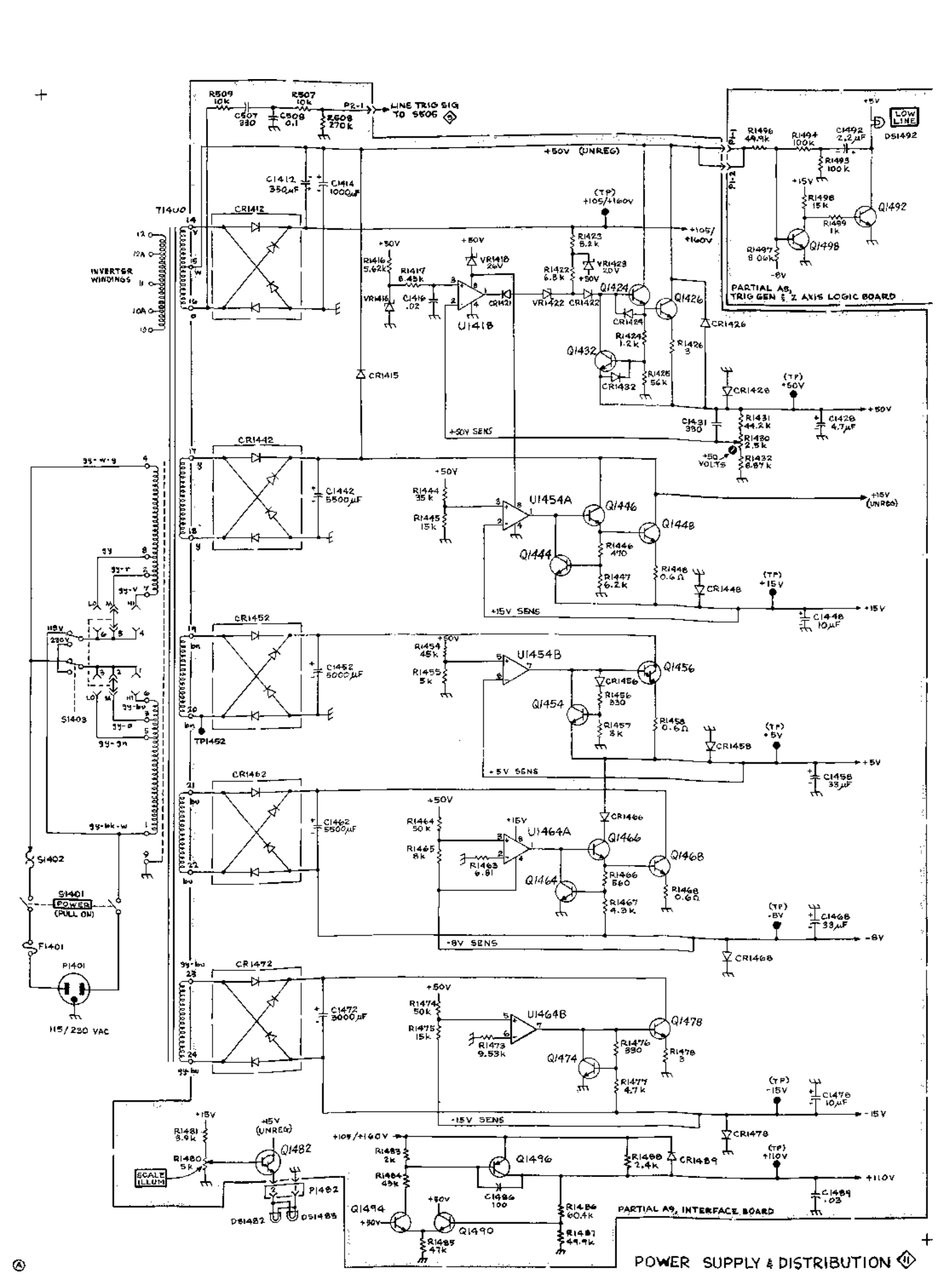
Fig. 7-18. P/O A9 Interface circuit board.

Fig. 7-18. A9 Interface circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C1412	7J	CR1412	7I	CR1466	2D	Q1454	3H	R1424	2F	R1458	3H	R1480	13D
C1414	6J	CR1421	3G	CR1468	5H	Q1456	3G	R1425	2F	R1463	2E	R1481	12D
C1416	2G	CR1422	2F	CR1472	3I	Q1464	2D	R1426	2G	R1464	2E		
C1428	3H	CR1424	2F	CR1478	4H	Q1466	2D	R1430	2G	R1465	2E	U1418	3G
C1431	2F	CR1426	5I			Q1468	2D	R1431	2G	R1466	2D	U1454	2H
C1442	5J	CR1428	6G	P1482	12C	Q1474	3F	R1432	2G	R1467	2E	U1464	2E
C1448	1I	CR1432	2F			Q1478	4F	R1445	2H	R1468	2E		
C1452	6H	CR1442	4J	Q1424	2F	Q1482	12C	R1446	2H	R1473	2F	VR1416	2G
C1458	2I	CR1448	6G	Q1426	2F			R1447	2H	R1474	3F	VR1418	4G
C1462	5H	CR1452	6H	Q1432	2F	R1416	3G	R1448	1H	R1475	3F	VR1422	2F
C1468	5G	CR1456	3H	Q1444	2H	R1417	2G	R1454	3I	R1476	3F	VR1423	3G
C1472	5H	CR1458	2I	Q1446	2H	R1422	3F	R1455	3I	R1477	3F		
C1478	3I	CR1462	4H	Q1448	2G	R1423	3G	R1456	3H	R1478	3F		
								R1457	3H				

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+110V
+50V
+15V (UNREG)
+15V
+5V
-8V
P128
P300
P260
CRT CIRCUIT
HORIZONTAL AMPLIFIER
SWEEP GENERATOR
VERTICAL MODE SWITCH
TIMING CIRCUIT
TRIGGER GENERATOR & Z AXIS LOGIC
VERTICAL OUTPUT
VERTICAL CHANNEL SWITCHING
VERTICAL PREAMP
FAN MOTOR
P1690
P1480
P1481
P1482
P1483
P1484
J1478
PROBE POWER
(REAR PANEL)
J1479
PROBE POWER
(REAR PANEL)
(REAR VIEW OF PLUG)
GND
POWER SUPPLY
CALIBRATOR



POWER SUPPLY & DISTRIBUTION 11

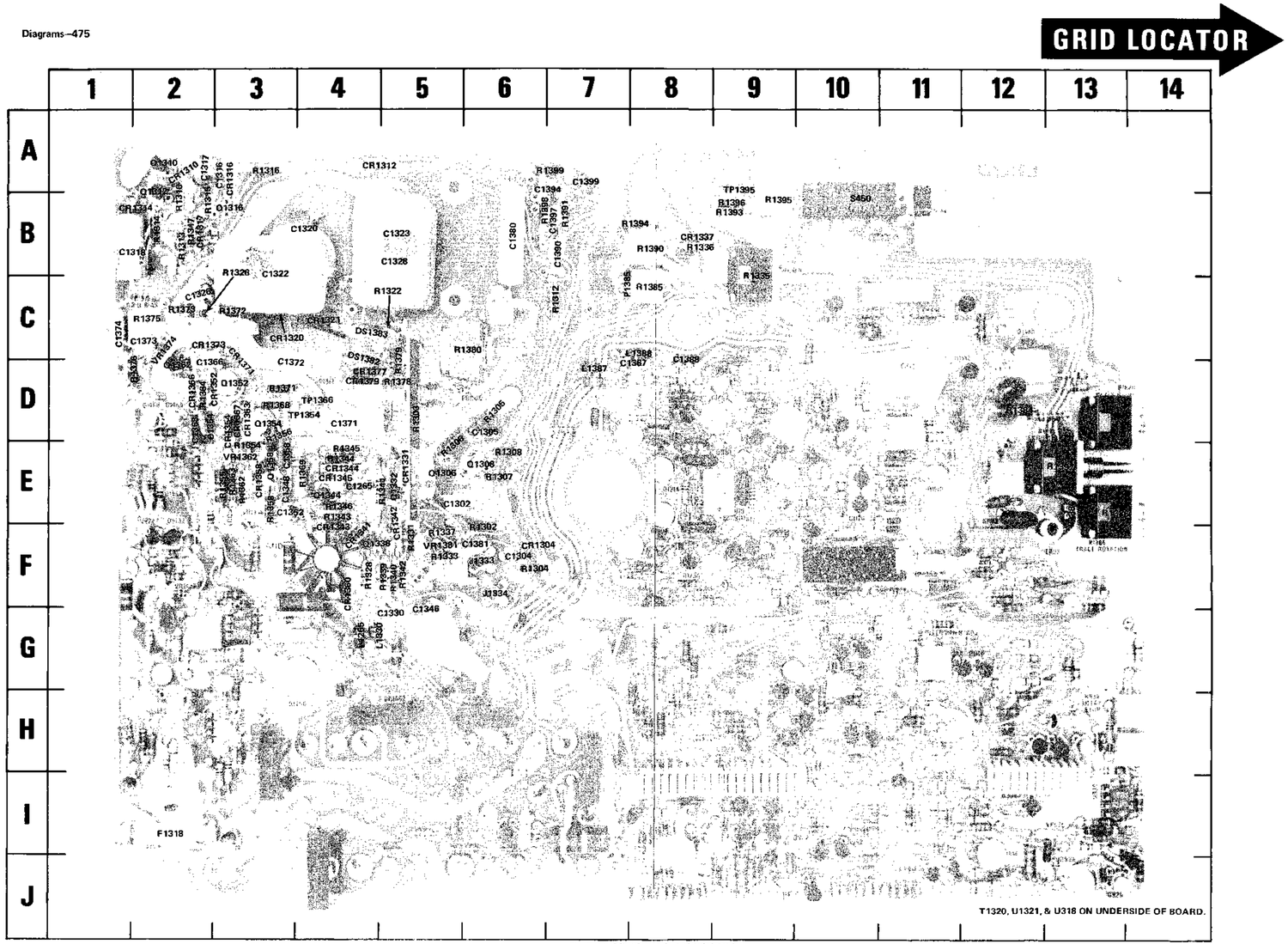
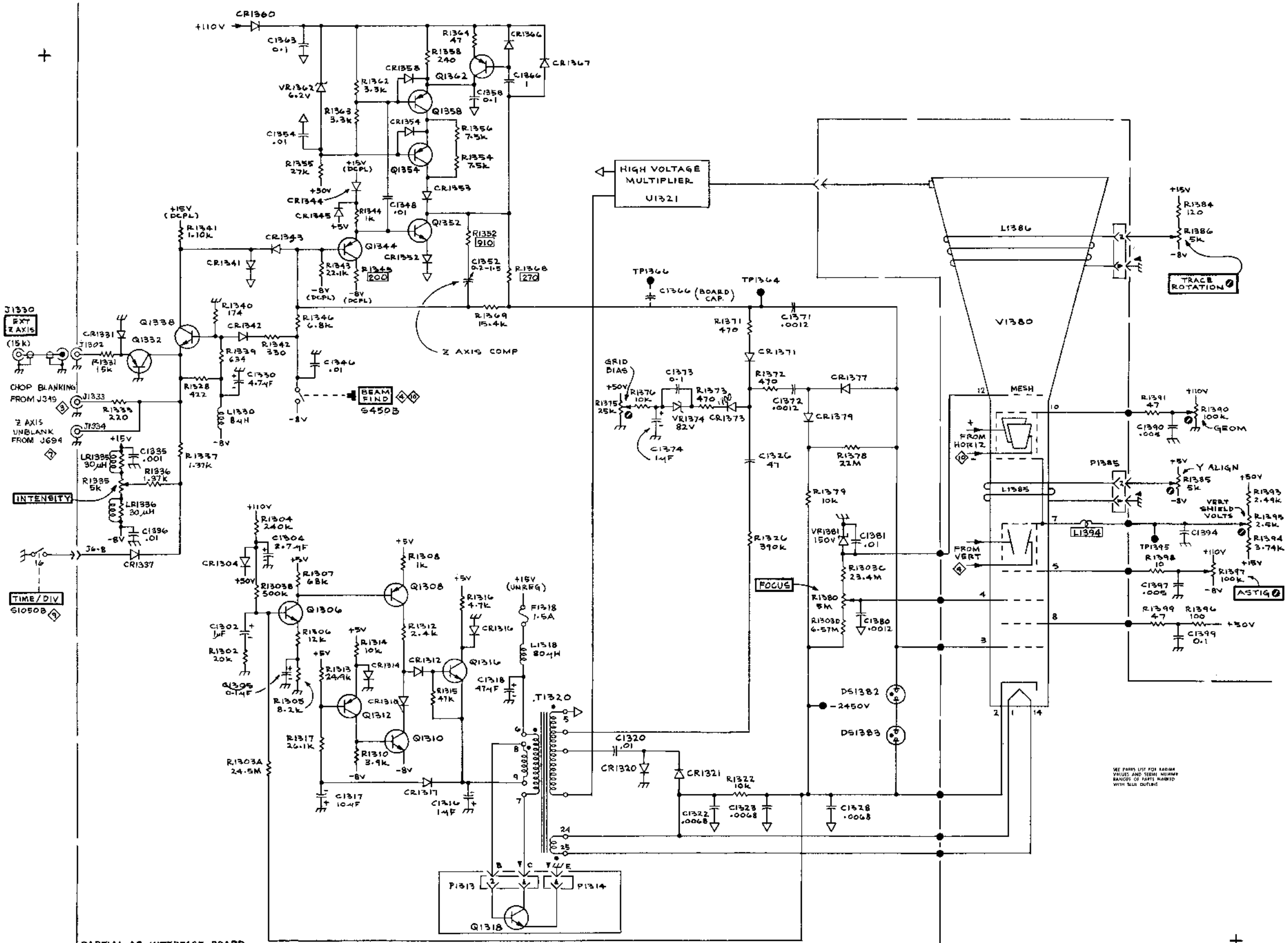


Fig. 7-19. P/O A9 interface circuit board.

Fig. 7-19. Interface circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C1265	4E	C1371	4D	CR1321	4C	DS1382	4C	Q1316	3B	R1315	2B	R1355	3E	R1391	7B
C1302	5E	C1372	3D	CR1331	5E	DS1383	4C	Q1322	5E	R1316	3A	R1356	3D	R1393	9B
C1304	6F	C1373	2C	CR1337	8B			Q1338	4F	R1317	2B	R1358	3E	R1394	7B
C1305	6D	C1374	1C	CR1341	4F	F1318	1I	Q1344	4E	R1322	4C	R1362	3E	R1395	9B
C1316	3A	C1380	6B	CR1342	5F			Q1352	3D	R1326	3B	R1363	3E	R1396	9B
C1317	2A	C1381	6F	CR1343	4F	J1333	6F	Q1354	3D	R1328	4F	R1364	2D	R1397	13E
C1318	1B	C1387	7D	CR1344	4E	J1334	6F	Q1358	3E	R1331	5F	R1368	3D	R1398	6B
C1320	3B	C1388	8C	CR1345	4E			Q1362	2D	R1332	5F	R1369	4E	R1399	6A
C1322	3B	C1390	7B	CR1352	2D	L1265	4G			R1335	9C	R1371	3D		
C1323	5B	C1394	6A	CR1353	3D	L1330	4G	R1302	6F	R1336	8B	R1372	3C	S450	10B
C1326	2C	C1397	7B	CR1354	3E	L1387	7D	R1303	5D	R1337	5F	R1373	2C		
C1328	5B	C1399	7A	CR1358	3E	L1388	7C	R1304	6F	R1339	5F	R1375	2C	TP1354	4D
C1330	5G			CR1360	4F			R1305	6D	R1340	5F	R1376	2D	TP1366	4D
C1346	5G	CR1304	6F	CR1366	2D	P1385	7C	R1306	5E	R1341	5E	R1378	5D	TP1395	9A
C1348	3E	CR1310	2A	CR1367	3D	P1386	13C	R1307	6E	R1342	5F	R1379	5D		
C1352	3E	CR1312	4A	CR1371	3C			R1308	6E	R1343	4E	R1380	5C	VR1362	3E
C1354	2D	CR1314	1B	CR1377	4D	Q1306	5E	R1310	2B	R1344	4E	R1384	12D	VR1374	2C
C1358	3E	CR1316	3A	CR1379	4D	Q1308	6E	R1312	7C	R1345	4E	R1385	8C	VR1381	5F
C1363	2D	CR1317	2B			Q1310	2A	R1313	2B	R1346	4E	R1386	13E		
C1366	2D	CR1320	3C			Q1312	2A	R1314	2B	R1354	3E	R1390	8B		


CR1360
+110V
C1363 0.1
R1364 47
R1358 240
CR1366
CR1367
C1366 1
Q1362
CR1358
C1358 0.1
VR1362 6.2V
R1362 3.3k
Q1358
R1363 3.3k
C1354 .01
CR1354
R1356 7.5k
R1354 7.5k
Q1354
R1355 27k
+15V (DCPL)
+50V
CR1344
CR1345
+5V
R1344 1k
C1348 .01
CR1353
Q1352
R1352 910
Q1344
CR1343
CR1352
C1352 0.2-1.5
R1368 270
R1343 22.1k
R1345 200
-8V (DCPL)
-8V (DCPL)
R1369 15.4k
Z AXIS COMP
HIGH VOLTAGE MULTIPLIER U1321
TP1366
TP1364
C1366 (BOARD CAP.)
R1371 470
C1371 .0012
CR1371
GRID BIAS
+50V
R1376 10K
R1375 25K
C1373 0.1
R1373 470
VR1374 82V
CR1373
C1374 1uF
R1372 470
CR1377
C1372 .0012
CR1379
C1326 47
R1378 22M
R1379 10k
R1326 390k
VR1381 150V
C1381 .01
R1303C 23.4M
R1380 5M
R1303D 6.57M
C1380 .0012
FOCUS
DS1382
-2450V
DS1383
L1386
V1380
+15V
R1384 12.0
R1386 5K
-8V
TRACE ROTATION
12
MESH
10
R1391 47
+110V
R1390 100K
GROM
C1390 .005
FROM HORIZ
P1385
+5V
Y ALIGN
R1385 5K
-8V
L1385
+50V
R1393 2.49K
VERT SHIELD VOLTS
R1395 2.5K
7
L1394
R1394 3.74K
TP1395
C1394
+110V
R1398 10
C1397 .005
5
R1397 100K
+15V
-8V
ASTIG
4
8
R1399 4.7
R1396 100
+50V
C1399 0.1
3
FROM VERT
2
1
14
J1330 EXT Z AXIS (15k)
CR1331
Q1338
Q1332
J1302
R1331 15k
R1340 174
CR1342
R1342 330
R1339 634
C1330 4.7pF
L1330 84uH
R1328 422
C1346 .01
BEAM FIND
S450B
CHOP BLANKING FROM J349
J1333
R1333 220
Z AXIS UNBLANK FROM J694
J1334
+15V
LR1335 30uH
C1335 .001
R1337 1.37K
R1335 5k
R1336 1.37K
LR1336 30uH
C1336 .01
CR1337
-8V
INTENSITY
J6-8
16
TIME/DIV S10508
+110V
R1304 240K
C1304 2.7pF
CR1304
+50V
R1303B 500K
Q1306
R1307 68k
+5V
R1306 12k
C1302 1uF
R1302 20k
Q1305 0.1uF
R1305 8.2k
R1308 1k
Q1308
R1312 2.4k
R1314 10k
CR1314
R1313 24.9k
CR1312
Q1312
CR1310
Q1310
R1310 3.9k
R1317 26.1k
R1303A 24.5M
C1317 10uF
CR1317
C1316 1uF
R1316 4.7k
CR1316
Q1316
R1315 47k
C1318 47pF
+15V (UNREG)
F1318 1.5A
L1318 80uH
T1320
C1320 .01
CR1320
CR1321
R1322 10k
C1322 .0068
C1323 .0068
C1328 .0068
P1313
P1314
Q1318
B
C
E
PARTIAL A9, INTERFACE BOARD
PARTIAL A9 INTERFACE BOARD
SEE PARTS LIST FOR RATING VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

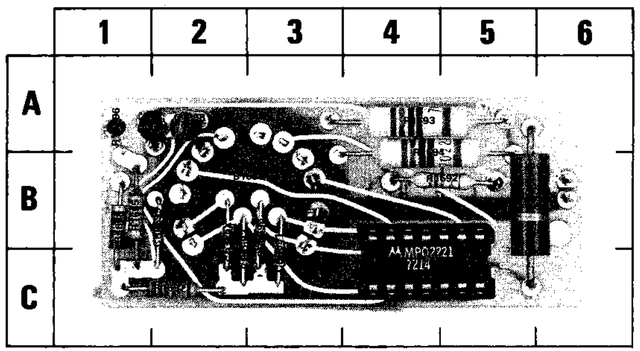


Fig. 7-20. A6 Fan Motor circuit board.

GRID LOCATOR

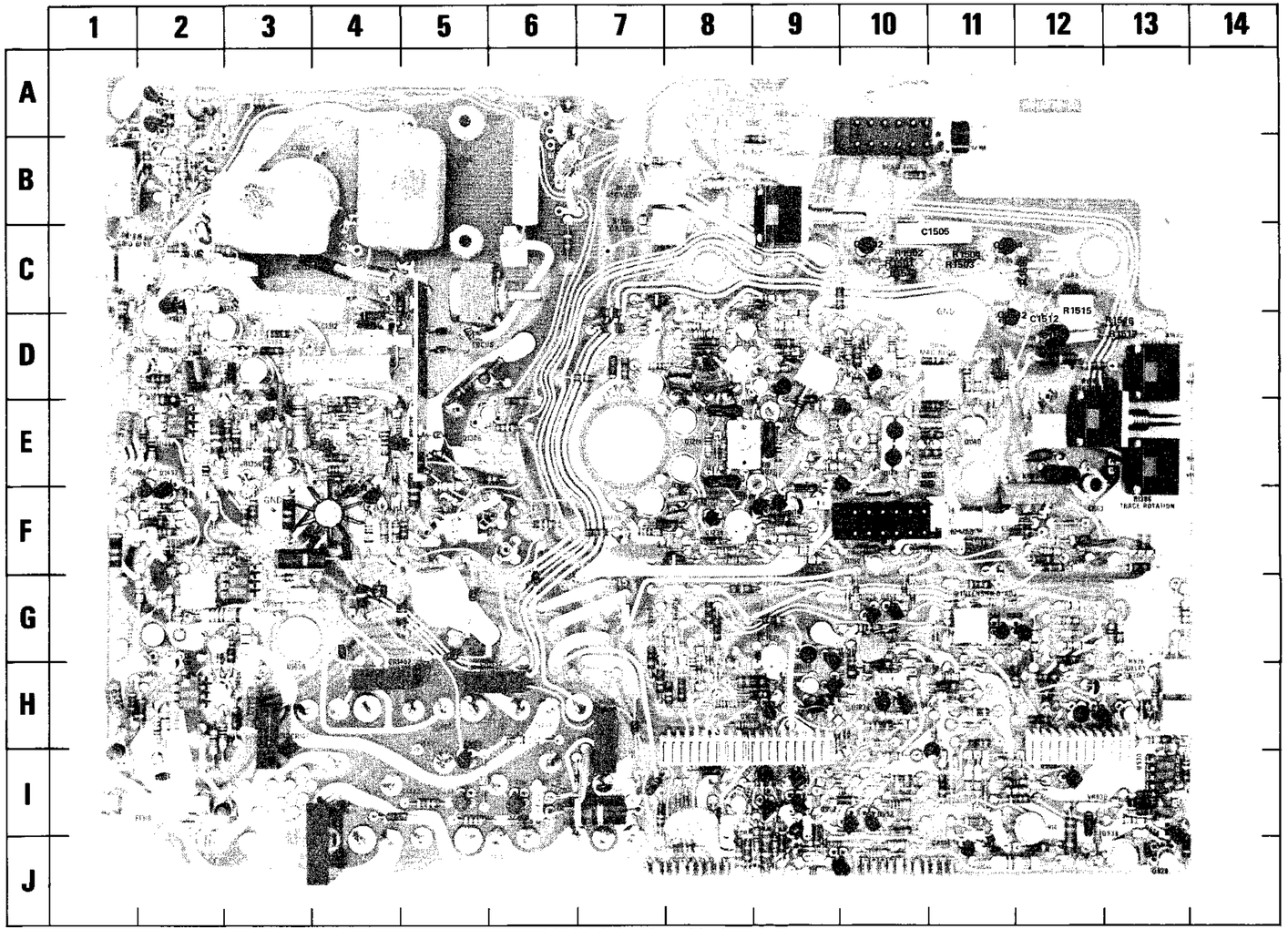


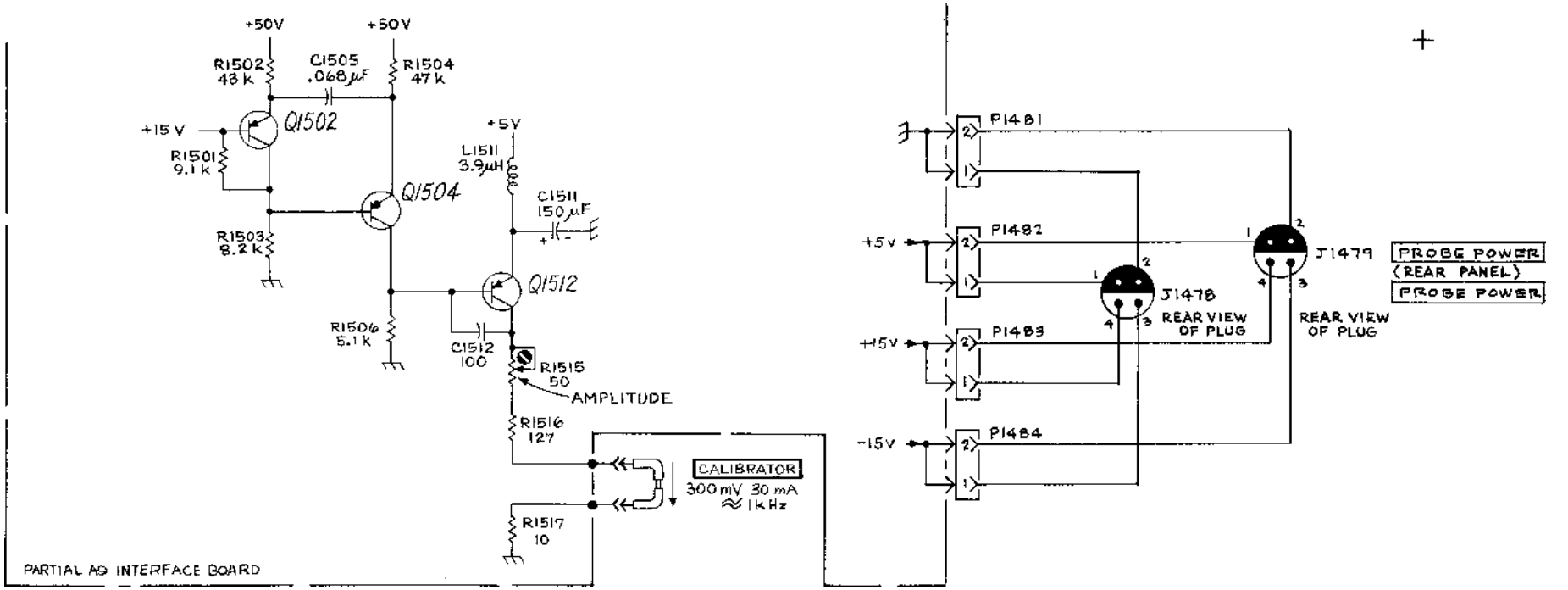
Fig. 7-21. P/O A9 Interface circuit board.

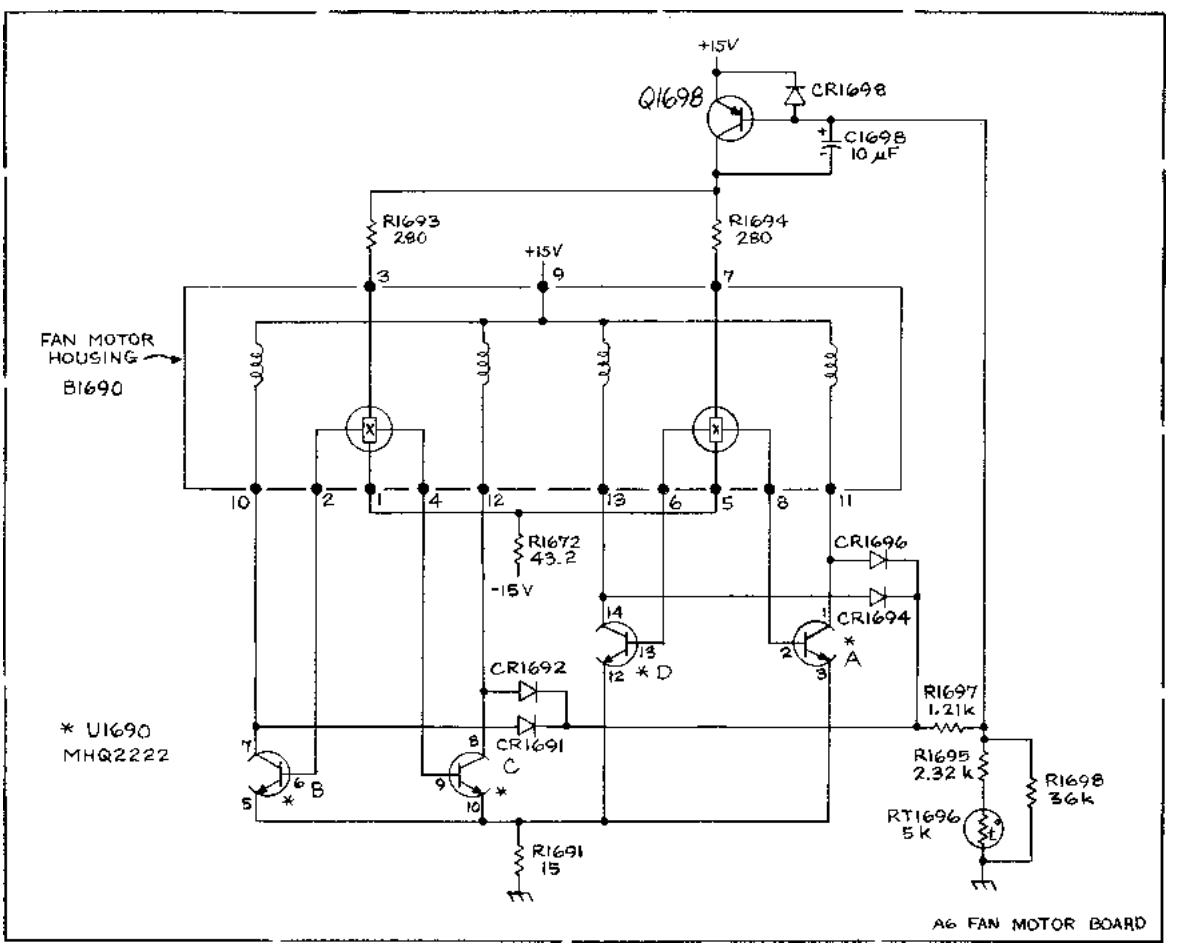
Fig. 7-20. A6 Fan Motor circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
B1690	2B	Q1698	1A	RT1696	1A
C1698	2A	R1691	5B	U1690	4C
		R1692	4B		
CR1691	3C	R1693	4A		
CR1692	2C	R1694	4B		
CR1694	2C	R1695	1B		
CR1696	3C	R1697	2C		
CR1699	2B	R1698	1B		

Fig. 7-21. Interface circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC
C1505	10C	Q1512	11C
C1511	12D		
C1512	12D	R1501	10C
		R1502	10C
		R1503	11C
L1511	10C	R1504	11C
		R1506	12C
		R1515	12C
Q1502	10C	R1516	13D
Q1504	11C	R1517	13D





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CALIBRATOR AND FAN CIRCUIT 13

MECHANICAL PARTS LIST

Replacement parts should be ordered from the Tektronix Field Office or Representative in your area. Changes to Tektronix products give you the benefit of improved circuits and components. Please include the instrument type number and serial number with each order for parts or service.

ABBREVIATIONS

BHB	binding head brass	h	height or high	OHB	oval head brass
BHS	binding head steel	hex.	hexagonal	OHS	oval head steel
CRT	cathode-ray tube	HHB	hex head brass	PHB	pan head brass
csk	countersunk	HHS	hex head steel	PHS	pan head steel
DE	double end	HSB	hex socket brass	RHS	round head steel
FHB	flat head brass	HSS	hex socket steel	SE	single end
FHS	flat head steel	ID	inside diameter	THB	truss head brass
Fil HB	fillister head brass	lg	length or long	THS	truss head steel
Fil HS	fillister head steel	OD	outside diameter	w	wide or width

FRONT PANEL

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-1	200-1411-00			1		BEZEL
	- - - - - -			-		bezel includes:
-2	213-0313-00			4		THUMBSCREW, 4-40 x 0.45 inch, knurled
-3	337-1674-00			1		SHIELD, implosion, blue
-4	366-0494-00			3		KNOB, gray--POSITION, A TRIG HOLDOFF
	- - - - - -			-		each knob includes:
	213-0153-00			1		SETSCREW, 5-40 x 0.125 inch, HSS
-5	358-0378-01			14		BUSHING, sleeve
-6	358-0216-00			3		GROMMET, gray, plastic
-7	366-1031-02			2		KNOB, red--VAR
	- - - - - -			-		each knob includes:
	213-0153-00			1		SETSCREW, 5-40 x 0.125 inch, HSS
-8	366-1425-00			2		KNOB, gray--VOLTS/DIV
	- - - - - -			-		each knob includes:
	213-0153-00			2		SETSCREW, 5-40 x 0.125 inch, HSS
-9	366-0215-02			2		KNOB, lever switch
-10	366-1402-31			1		PUSHBUTTON--INVERT
-11	366-1402-32			1		PUSHBUTTON--BEAM FIND
-12	378-0803-01			2		LENS, indicator light
-13	366-1257-20			1		PUSHBUTTON--CH 2
-14	366-1402-37			1		PUSHBUTTON--CHOP
-15	366-1257-16			1		PUSHBUTTON--ADD
-16	366-1402-36			1		PUSHBUTTON--ALT
-17	366-1257-19			1		PUSHBUTTON--CH 1
-18	426-0681-00			16		FRAME, pushbutton
-19	366-1023-01			3		KNOB, gray--INTENSITY-FOCUS-SCALE ILLUM
	- - - - - -			-		each knob includes:
	213-0153-00			1		SETSCREW, 5-40 x 0.125 inch, HSS
-20	366-1346-02			1		KNOB, red--VAR
	- - - - - -			-		knob includes:
	213-0153-00			1		SETSCREW, 5-40 x 0.125 inch, HSS
-21	366-1219-00			1		KNOB, interlocking--TIME/DIV
	- - - - - -			-		knob includes:
	213-0153-00			2		SETSCREW, 5-40 x 0.125 inch, HSS

FRONT PANEL (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-22	354-0442-00			1		RING, knob skirt
	- - - - - -			-		ring includes:
	213-0153-00			1		SETSCREW, 5-40 x 0.125 inch, HSS
-23	401-0080-00			1		BEARING, knob skirt
-24	366-1327-00			1		KNOB, gray--FINE
	- - - - - -			-		knob includes:
	213-0153-00			1		SETSCREW, 5-40 x 0.125 inch, HSS
-25	366-1280-00			3		KNOB, gray--HORIZ POSITION, LEVEL
	- - - - - -			-		each knob includes:
	213-0153-00			1		SETSCREW, 5-40 x 0.125 inch, HSS
-26	366-1402-33			1		PUSHBUTTON--X10 MAG
-27	366-1402-35			1		PUSHBUTTON--B DLY'D
-28	366-1402-44			1		PUSHBUTTON--A INTEN
-29	366-1257-29			1		PUSHBUTTON--SINGLE SWP
-30	366-1402-34			1		PUSHBUTTON--A
-31	366-1402-38			1		PUSHBUTTON--AUTO
-32	366-1402-39			1		PUSHBUTTON--NORM
-33	366-1402-29			1		PUSHBUTTON--MIX
-34	378-0803-00			5		LENS, indicator light
-35	366-1278-00			2		KNOB, gray--SLOPE
	- - - - - -			-		each knob includes:
	213-0153-00			1		SETSCREW, 5-40 x 0.125 inch, HSS
-36	- - - - - -[1]			1		RESISTOR, variable, w/hardware
	- - - - - -			-		mounting hardware: (not included w/resistor)
-37	331-0328-00			1		DIAL, control--DELAY TIME POSITION
	- - - - - -			-		dial includes:
	213-0048-00			1		SETSCREW, 4-40 x 0.125 inch, HSS
-38	378-0635-00			4		LENS, indicator light
-39	333-1636-00			1		PANEL, front
-40	- - - - - -[1]			4		RESISTOR, variable
	- - - - - -			-		mounting hardware for each: (not included
	- - - - - -			-		w/resistor)
-41	210-0583-00			1		NUT, hex., 0.25-32 x 0.312 inch
-42	210-0940-00			1		WASHER, flat, 0.25 ID x 0.375 inch OD
						- - - * - - -
-43	131-0955-00			2		CONNECTOR, electrical, female, BNC, w/hardware
	- - - - - -			-		mounting hardware for each: (not included
	- - - - - -			-		w/connector)
-44	210-0255-00			1		TERMINAL, lug, solder
						- - - * - - -
-45	119-0373-00			1		CURRENT LOOP
	- - - - - -			-		mounting hardware: (not included w/current
	- - - - - -			-		loop)
-46	210-0586-00			2		NUT, keps, 4-40 x 0.25 inch
-47	210-0994-00			2		WASHER, flat, 0.125 ID x 0.25 inch OD
-48	210-0849-00			2		WASHER, fiber, shouldered, 0.11 ID x 0.187 inch OD
-49	361-0059-01			1		SPACER, current loop
-50	210-0593-00			2		NUT, current loop

[1]Refer to Electrical Parts List for part number.

FRONT PANEL (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-51	384-1162-00			1		SHAFT, extension, w/knob, 11.42 inches long
-52	386-2330-00			1		SUBPANEL, front
	- - - - - -			-		mounting hardware: (not included w/subpanel)
-53	213-0107-00			11		SCREW, thread forming, 4-40 x 0.25 inch,
	- - - - - -			-		100 deg. csk, FHS
						- - - * - - -
-54	352-0340-00			2		HOLDER, lamps
	- - - - - -			-		mounting hardware for each: (not included
	- - - - - -			-		w/holder)
-55	211-0001-00			1		SCREW, 2-56 x 0.25 inch, PHS
						- - - * - - -
-56	348-0276-00			ft		SHIELDING GASKET, electrical, 2.75 feet
-57	426-0926-01			1		FRAME, cabinet, front
	- - - - - -			-		mounting hardware: (not included w/frame)
	213-0183-00			4		SCREW, thread froming, 6-32 x 0.50 inch, PHS
	- - - - - -			-		(not shown)
						- - - * - - -
-58	386-2340-00			4		SUPPORT, CRT, front
-59	- - - - - -[1]			1		CIRCUIT BOARD ASSEMBLY--GRATICULE ILLUM A10
	- - - - - -			-		circuit board assembly includes:
-60	378-0728-00			1		REFLECTOR, light
-61	352-0329-00			1		HOLDER, lamps
-62	175-0825-00			ft		WIRE, electrical, 2 wire ribbon, 0.478 ft.
-63	131-0707-00			2		CONNECTOR, terminal
-64	352-0169-02			1		HOLDER, terminal connector, 2 wire (red)

[1]Refer to Electrical Parts List for part number.

FIG. 1 FRONT PANEL

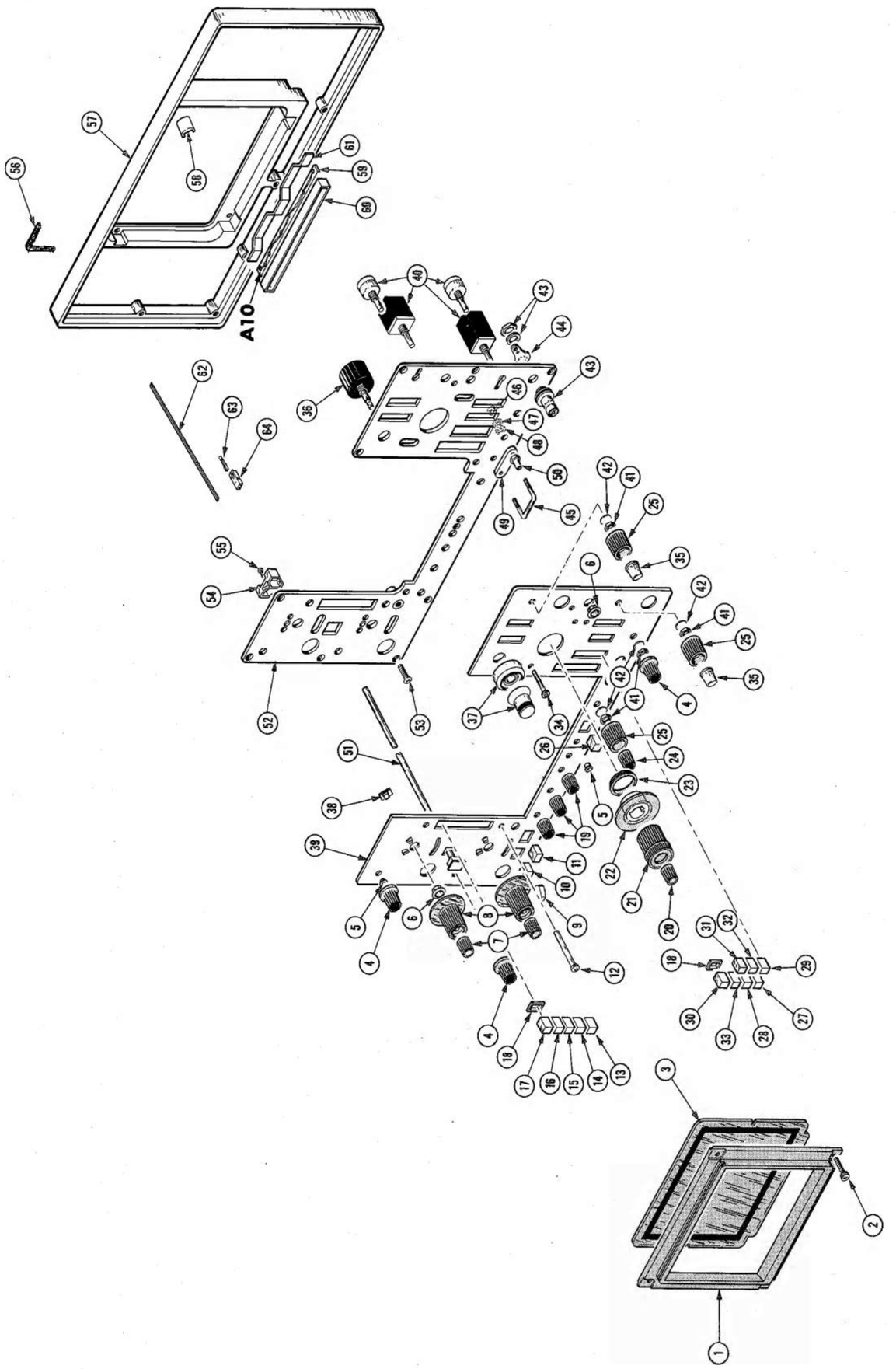
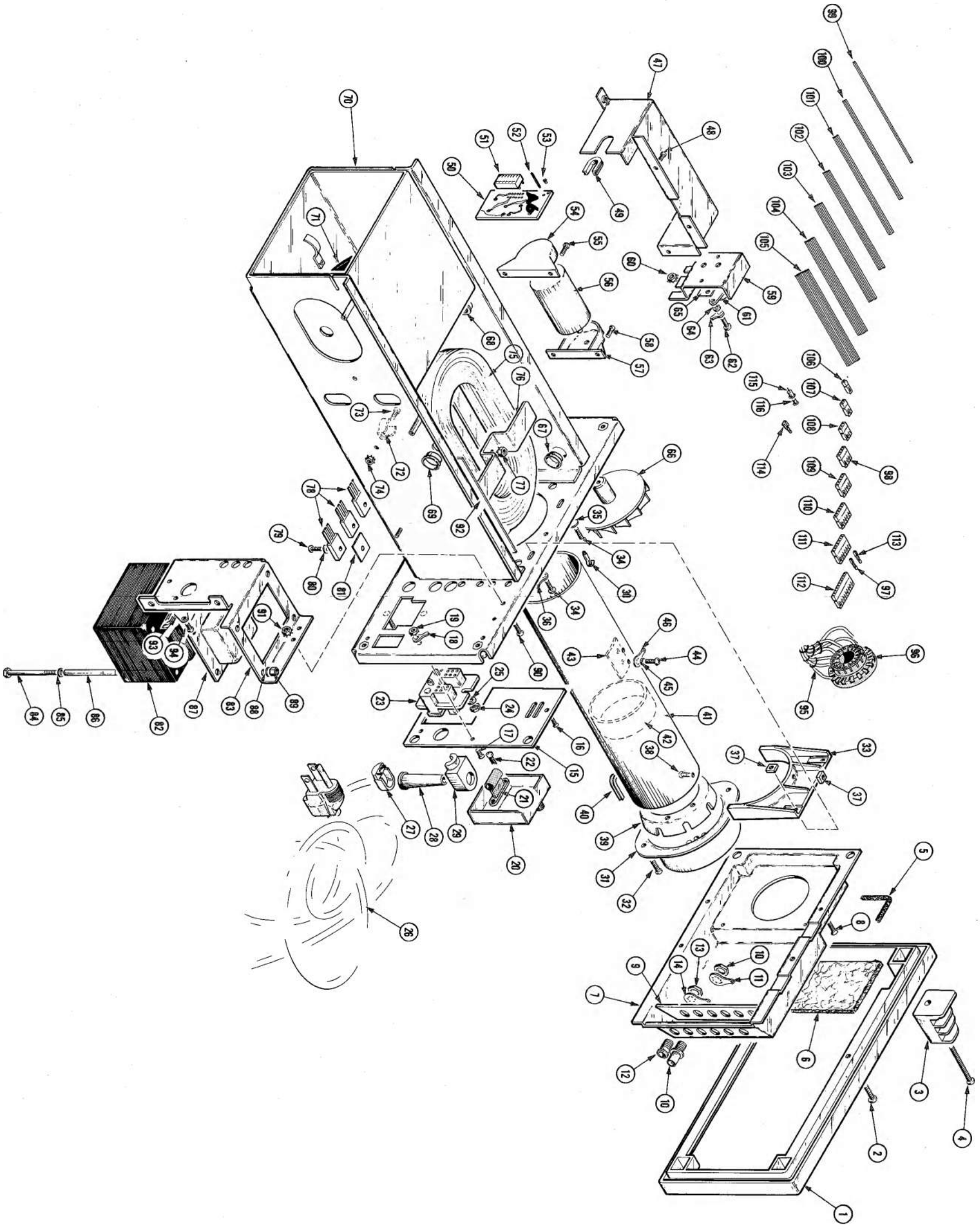


FIG. 2 MAIN FRAME



MAIN FRAME

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
2-1	426-0970-00			1		FRAME SECTION, cabinet rear
	- - - - - -			-		mounting hardware: (not included w/frame
	- - - - - -			-		section)
-2	211-0544-00			2		SCREW, 6-32 x 0.75 inch, THS
						- - - * - - -
-3	348-0039-00			4		FOOT, cabinet, w/cord wrap
	- - - - - -			-		mounting hardware for each: (not included
	- - - - - -			-		w/foot)
-4	212-0020-00			1		SCREW, 8-32 x 1 inch, PHS
						- - - * - - -
-5	348-0349-00			ft		SHIELDING GASKET, electrical, 2.75 feet
-6	378-0044-01			1		FILTER, air
-7	200-1414-02			1		COVER, rear
	- - - - - -			-		mounting hardware: (not included w/cover)
-8	211-0101-00			2		SCREW, 4-40 x 0.25 inch, 100 deg. csk, FHS
						- - - * - - -
-9	386-2408-00			1		PLATE, connector mounting
-10	131-0955-00			4		CONNECTOR, electrical, female, BNC, w/hardware
	- - - - - -			-		mounting hardware for each: (not included
	- - - - - -			-		w/connector)
-11	210-0255-00			1		TERMINAL, lug, solder, 0.391 inch ID
						- - - * - - -
-12	131-0771-00			2		CONNECTOR, receptacle, electrical
	- - - - - -			-		mounting hardware for each: (not included
	- - - - - -			-		w/connector)
-13	220-0551-00			1		NUT, hex., 0.437 OD
-14	210-0012-00			1		WASHER, lock, internal, 0.375 ID x 0.50 inch OD
						- - - * - - -
-15	386-2332-01			1		PANEL, rear
	- - - - - -			-		mounting hardware: (not included w/panel)
-16	211-0105-00			1		SCREW, 4-40 x 0.188 inch, 100 deg. csk, FHS
-17	211-0038-00			1		SCREW, 4-40 x 0.312 inch, 100 deg. csk, FHS
-18	210-0201-00			1		LUG, solder, SE #4
-19	210-0586-00			1		NUT, keps, 4-40 x 0.25 inch
						- - - * - - -
-20	200-1445-01			1		COVER, line voltage selector
	- - - - - -			-		cover includes:
-21	352-0102-00			1		HOLDER, fuse, plastic
	- - - - - -			-		mounting hardware: (not inlcluded w/holder)
-22	213-0034-00			1		SCREW, thread cutting, 4-40 x 0.312 inch, PHS
-23	204-0549-01			1		BODY, line voltage selector
	- - - - - -			-		mounting hardware: (not inlcluded w/body)
-24	210-0407-00			2		NUT, hex., 6-32 x 0.25 inch
-25	210-0006-00			2		WASHER, lock, split, 0.145 ID x 0.253 inch OD
						- - - * - - -
-26	161-0033-07			1		CABLE ASSEMBLY, power
-27	358-0372-00			1		BUSHING, strain relief, bottom
-28	200-1004-00			1		CABLE NIPPLE
-29	358-0371-00			1		BUSHING, strain relief, top

MAIN FRAME (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
2-30	343-0088-00			1		CLAMP, retaining, plastic
-31	200-1459-00			1		COVER, CRT, rear
	- - - - - -			-		mounting hardware: (not included w/cover)
-32	211-0008-00			2		SCREW, 4-40 x 0.25 inch, PHS
					- - - * - - -	
-33	407-1128-00			1		BRACKET, CRT shield, rear
	- - - - - -			-		mounting hardware: (not included w/bracket)
-34	211-0507-00			2		SCREW, 6-32 x 0.312 inch, PHS
-35	210-0803-00			1		WASHER, flat, 0.15 ID x 0.375 inch OD
-36	210-0202-00			1		LUG, solder, SE #6
-37	220-0419-00			3		NUT, square, 6-32 x 0.312 inch
-38	211-0590-00			1		SCREW, 6-32 x 0.25 inch, PHS
					- - - * - - -	
-39	386-2246-00			1		SUPPORT, CRT, rear
-40	348-0145-00			1		GROMMET, u-shape
-41	337-1645-00			1		SHIELD SECTION, CRT, neck
-42	- - - - - -			1		COIL, y axis
-43	343-0217-00			1		CLAMP, coil, plastic
	- - - - - -			-		mounting hardware: (not included w/clamp)
-44	211-0147-00			2		SCREW, 4-40 x 0.25 inch, PHS
-45	210-0994-00			2		WASHER, flat, 0.125 ID x 0.25 inch, OD
-46	210-0201-00			1		LUG, solder, SE #4
					- - - * - - -	
-47	337-1688-00			1		SHIELD, electrical, high voltage
	- - - - - -			-		mounting hardware: (not included w/shield)
-48	211-0065-00			3		SCREW, 4-40 x 0.188 inch, PHS
					- - - * - - -	
-49	348-0115-00			1		GROMMET, plastic, u-shape
-50	- - - - - -[1]			1		CIRCUIT BOARD ASSEMBLY--FAN MOTOR A6
	- - - - - -			-		circuit board assembly includes:
-51	136-0269-00			1		SOCKET, integrated circuit, 14 pin
-52	131-0608-00			2		TERMINAL, pin, 0.365 inch long
-53	136-0252-04			3		SOCKET, pin connector
-54	426-0781-00			1		MOUNT, motor
	- - - - - -			-		mounting hardware: (not included w/circuit
	- - - - - -			-		board assembly)
-55	213-0088-00			2		SCREW, thread forming, 4-40 x 0.25 inch, PHS
					- - - * - - -	
-56	337-1762-00			1		SHIELD, electrical, fan motor
-57	426-0781-00			1		MOUNT, motor
	- - - - - -			-		mounting hardware: (not included w/mount)
-58	213-0088-00			2		SCREW, thread forming, 4-40 x 0.25 inch, PHS
					- - - * - - -	
-59	407-1153-00			1		BRACKET, transistor
	- - - - - -			-		mounting hardware: (not included w/bracket)
-60	210-0586-00			2		NUT, keps, 4-40 x 0.25 inch

[1]Refer to Electrical Parts List for part number.

MAIN FRAME (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description
2-61	- - - - - -[1]			1	TRANSISTOR
	- - - - - -			-	mounting hardware: (not included w/transistor)
-62	211-0012-00			2	SCREW, 4-40 x 0.375 inch, PHS
-63	210-0205-00			1	LUG, solder, SE #8
-64	358-0214-00			2	BUSHING, insulator
-65	214-1610-00			1	HEATSINK, transistor
					- - - * - - -
-66	369-0031-00			1	IMPELLER, fan, w/setscrew
-67	348-0056-00			3	GROMMET, plastic, 0.375 inch
-68	348-0253-00			1	GROMMET, plastic, 1.145 inches
-69	348-0063-00			4	GROMMET, plastic, 0.50 inch
-70	441-1084-00			1	CHASSIS, main
-71	- - - - - -[1]			-	COIL, trace rotation
-72	344-0250-00			1	CLIP, electrical
	- - - - - -			-	mounting hardware: (not included w/clip)
-73	211-0008-00			1	SCREW, 4-40 x 0.25 inch, PHS
-74	210-0586-00			1	NUT, keps, 4-40 x 0.25 inch
					- - - * - - -
-75	- - - - - -[1]			1	DELAY LINE
-76	407-1138-00			1	BRACKET, delay line
	- - - - - -			-	mounting hardware: (not included w/bracket)
-77	210-0457-00			1	NUT, keps, 6-32 x 0.312 inch
					- - - * - - -
-78	- - - - - -[1]			3	TRANSISTOR
	- - - - - -			-	mounting hardware for each: (not included
	- - - - - -			-	w/transistor)
-79	211-0012-00			1	SCREW, 4-40 x 0.375 inch, PHS
-80	210-0071-00			1	WASHER, spring tension
-81	342-0163-00			1	INSULATOR, transistor
					- - - * - - -
-82	- - - - - -[1]			1	TRANSFORMER
	- - - - - -			-	transformer includes:
-83	407-1066-00			1	BRACKET, transformer
-84	212-0522-00			4	SCREW, 10-32 x 2.50 inches, HHS
-85	210-0812-00			4	WASHER, fiber, # 10
-86	166-0457-00			4	TUBE, insulating, 1.875 inches long
-87	200-1544-01			1	COVER, transformer
-88	210-0056-00			4	WASHER, lock, split, # 10
-89	220-0561-00			4	NUT, hex., 10-32 x 0.25 inch
	- - - - - -			-	mounting hardware: (not included w/transformer)
-90	211-0538-00			2	SCREW, 6-32 x 0.312 inch, 100 deg. csk, FHS
-91	210-0457-00			4	NUT, keps, 6-32 x 0.312 inch
					- - - * - - -
-92	337-1763-00			1	SHIELD, electrical, transformer
-93	260-0638-00			1	SWITCH, thermostatic
	- - - - - -			-	mounting hardware: (not included w/switch)
-94	213-0044-00			2	SCREW, thread forming, 5-32 x 0.188 inch, PHS

[1]Refer to Electrical Parts List for part number.

MAIN FRAME (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
2-95	136-0513-00			1		SOCKET ASSEMBLY, CRT
	- - - - - -			-		socket assembly includes:
-96	136-0202-01			1		SOCKET, CRT, 14 pin
-97	131-0707-00			4		CONNECTOR, terminal
-98	352-0162-00			1		HOLDER, terminal connector, 4 wire
-99	175-0825-00			ft		WIRE, electrical, 2 wire ribbon, 7.375 inches
-100	175-0826-00			ft		WIRE, electrical, 3 wire ribbon, 14 inches
-101	175-0827-00			ft		WIRE, electrical, 4 wire ribbon, 13.50 inches
-102	175-0828-00			ft		WIRE, electrical, 5 wire ribbon, 9 inches
-103	175-0829-00			ft		WIRE, electrical, 6 wire ribbon, 8 inches
-104	175-0830-00			ft		WIRE, electrical, 7 wire ribbon, 6.50 inches
-105	175-0833-00			ft		WIRE, electrical, 10 wire ribbon, 5.50 inches
-106	352-0171-00			2		HOLDER, terminal connector, 1 wire
-107	352-0169-00			2		HOLDER, terminal connector, 2 wire
-108	352-0161-00			4		HOLDER, terminal connector, 3 wire
	352-0162-00			2		HOLDER, terminal connector, 4 wire
-109	352-0163-00			2		HOLDER, terminal connector, 5 wire
-110	352-0164-00			1		HOLDER, terminal connector, 6 wire
-111	352-0165-00			1		HOLDER, terminal connector, 7 wire
-112	352-0168-00			1		HOLDER, terminal connector, 10 wire
	131-0707-00			63		CONNECTOR, terminal (small)
-113	131-0371-00			2		CONNECTOR, terminal (large)
-114	131-1119-00			4		CONNECTOR, terminal (deflection leads)
-115	210-0774-00			5		EYELET, metallic, 0.152 inch OD
-116	210-0775-00			5		EYELET, metallic, 0.126 inch OD

RIGHT SIDE

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
3-1	407-1133-00			1		BRACKET, power switch
	- - - - - -			-		mounting hardware: (not included w/bracket)
-2	210-0406-00			2		NUT, hex., 4-40 x 0.188 inch
-3	210-0994-00			2		WASHER, flat, 0.125 ID x 0.25 inch OD
						- - - * - - -
	200-1536-00	XB050000		1		COVER, switch hole
-4	260-1300-01			1		SWITCH, slide--LINE
	- - - - - -			-		mounting hardware: (not included w/switch)
-5	211-0007-00			2		SCREW, 4-40 x 0.188 inch, PHS
						- - - * - - -
-6	260-0834-00			1		SWITCH, toggle--POWER
	- - - - - -			-		mounting hardware: (not included w/switch)
-7	210-0562-00			1		NUT, hex., 0.25-40 x 0.312 inch
-8	210-0046-00			1		WASHER, lock, internal, 0.261 ID x 0.40 inch OD
						- - - * - - -
-9	214-1756-00			1		ACTUATOR, power switch
-10	384-1159-00			1		SHAFT, extension
-11	- - - - - -[1]			1		CIRCUIT BOARD ASSEMBLY--TRIG GEN & SWP LOGIC A8
	- - - - - -			-		circuit board assembly includes:
-12	214-0579-00			10		TERMINAL, test point
-13	131-0566-00			11		LINK, terminal connecting
-14	131-1003-00			8		RECEPTACLE, coaxial cable
-15	136-0252-04			210		SOCKET, connector pin, 0.181 inch long
-16	131-0608-00			14		TERMINAL, pin, 0.365 inch long
-17	136-0499-02			1		SOCKET, circuit board, 2 contact
-18	136-0499-10			1		SOCKET, circuit board, 10 contact
-19	136-0499-12			1		SOCKET, circuit board, 12 contact
-20	355-0175-00			2		STUD, press mount, 4-40 x 0.35 inch
-21	200-0945-01			2		COVER HALF, transistor
-22	200-0945-00			2		COVER HALF, transistor
	- - - - - -			-		mounting hardware for each: (not included
	- - - - - -			-		w/cover half)
-23	211-0062-00			1		SCREW, 2-56 x 0.312 inch, PHS
						- - - * - - -
-24	352-0331-00			3		HOLDER, lamp
-25	131-1031-00			23		CONTACT ASSEMBLY, top
-26	210-0779-00			17		RIVET, tubular
-27	386-2376-00			1		PLATE, lever mounting
-28	210-0657-01			2		EYELET
	105-0399-00			2		ACTUATOR ASSEMBLY, slide switch--COUPLING
	- - - - - -			-		each actuactor assembly includes:
-29	105-0419-00			1		ACTUATOR, switch, slide
-30	351-0355-00			1		GUIDE, switch, slide
-31	214-1126-00[2]			-		SPRING, flat, gold
	214-1126-01[2]			-		SPRING, flat, green
	214-1126-02[2]			-		SPRING, flat, red
-32	214-1127-00			2		ROLLER, detent
-33	376-0142-00			1		COUPLER, slide to shaft
	213-0048-00			1		SETSCREW, 4-40 x 0.125 inch, HSS (not shown)

[1] Refer to Electrical Parts List for part number.

[2] Replace only with part bearing the same color code as the original part in your instrument.

RIGHT SIDE (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
3-	105-0400-00			1	ACTUATOR ASSEMBLY, slide switch--A SOURCE
	- - - - - -			-	actuator assembly includes:
-34	105-0418-00			1	ACTUATOR, switch, slide
-35	351-0355-00			1	GUIDE, switch, slide
-36	214-1126-00[1]			-	SPRING, flat, gold
	214-1126-01[1]			-	SPRING, flat, green
	214-1126-02[1]			-	SPRING, flat, red
-37	214-1127-00			2	ROLLER, detent
-38	376-0142-00			1	COUPLER, slide to shaft
	213-0048-00			1	SETSCREW, 4-40 x 0.125 inch, HSS (not shown)
	105-0401-00			1	ACTUATOR ASSEMBLY, slide switch--B SOURCE
	- - - - - -			-	actuator assembly includes:
-39	105-0417-00			1	ACTUATOR, switch, slide
-40	351-0355-00			1	GUIDE, switch, slide
-41	214-1126-00[1]			-	SPRING, flat, gold
	214-1126-01[1]			-	SPRING, flat, green
	214-1126-02[1]			-	SPRING, flat, red
-42	214-1127-00			2	ROLLER, detent
-43	376-0142-00			1	COUPLER, slide to shaft
	213-0048-00			1	SETSCREW, 4-40 x 0.125 inch, HSS (not shown)
-44	384-1160-00			4	SHAFT, extension, lever switch
-45	214-1770-00			4	LEVER, slide switch
-46	354-0165-00			2	RING, retaining
	- - - - - -			-	mounting hardware: (not included w/circuit
	- - - - - -			-	board assembly)
-47	211-0116-00			5	SCREW, sems, 4-40 x 0.312 inch, PHB
-48	129-0386-00			1	POST, hex., 1.613 inches long
					- - - * - - -
-49	- - - - - -[2]			1	CIRCUIT BOARD ASSEMBLY--TIMING A7
	- - - - - -			-	circuit board assembly includes:
	105-0363-00			1	ACTUATOR ASSEMBLY, cam switch--TIME/CM
	- - - - - -			-	actuator assembly includes:
-50	200-1420-00			1	COVER, cam switch
	- - - - - -			-	mounting hardware: (not included w/cover)
-51	211-0008-00			6	SCREW, 4-40 x 0.25 inch, PHS
-52	210-0004-00			6	WASHER, lock, internal, 0.12 ID x 0.26
	- - - - - -			-	inch OD
	210-0406-00			5	NUT, hex., 4-40 x 0.188 inch (not shown)
					- - - * - - -
-53	131-0963-00			2	CONTACT, electrical, grounding
-54	354-0391-00			2	RING, retaining
-55	401-0081-00			1	BEARING, cam switch, front
-56	214-1139-00[1]			-	SPRING, flat, gold
	214-1139-02[1]			-	SPRING, flat, green
	214-1139-03[1]			-	SPRING, flat, red
-57	214-1127-00			4	ROLLER, detent
-58	105-0361-00			1	ACTUATOR, cam switch, front
-59	401-0115-00			1	BEARING, cam switch, center
-60	105-0362-00			1	ACTUATOR, cam switch, rear
-61	401-0081-04			1	BEARING, cam switch, front, w/insert

[1]Replace only with part bearing the same color code as the original part in your instrument.
[2]Refer to Electrical Parts List for part number.

RIGHT SIDE (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
3-62	105-0410-00			1	STOP ASSEMBLY, cam switch
-63	210-0406-00			5	NUT, hex., 4-40 x 0.188 inch
	- - - - - -			-	mounting hardware: (not included w/actuator
	- - - - - -			-	assembly)
-64	211-0116-00			6	SCREW, sems, 4-40 x 0.312 inch, PHB
					- - - * - - -
-65	131-0604-00			36	CONTACT, electrical, spring
-66	- - - - - -[1]			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-67	361-0515-00			1	SPACER, switch, plastic
					- - - * - - -
-68	376-0039-00			1	COUPLING, shaft
	- - - - - -			-	coupling includes:
	213-0075-00			2	SETSCREW, 4-40 x 0.094 inch, HSS
-69	131-0252-04			21	SOCKET, pin connector, 0.181 inch long
-70	131-0566-00	B010100	B010315X	1	LINK, terminal connecting
-71	131-1261-00			30	CONTACT, electrical, F-shape
-72	388-3283-00	B010100	B010315X	1	CIRCUIT BOARD
-73	131-0158-00	B010100	B010315X	4	SPACER, stand-off
-74	337-1799-00	B010100	B010315	1	SHIELD
	337-0896-00	B010316		2	SHIELD
-75	260-1422-00			1	SWITCH, pushbutton--TRIG MODE
-76	361-0411-00			4	SPACER, pushbutton switch
-77	384-1068-00			1	SHAFT, extension, 8 inches long
-78	352-0331-00			2	HOLDER, lamp
-79	260-1423-00			1	SWITCH, pushbutton--HORIZ MODE
-80	361-0385-00			4	SPACER, pushbutton switch
	- - - - - -			-	mounting hardware: (not included w/circuit
	- - - - - -			-	board assembly)
-81	211-0116-00			1	SCREW, sems, 4-40 x 0.312 inch, PHB
					- - - * - - -
-82	384-1136-00			3	SHAFT, extension, 0.95 inch long
-83	384-1101-00			4	SHAFT, extension, 4.13 inches long
-84	- - - - - -[1]			1	CIRCUIT BOARD ASSEMBLY--VERT OUTPUT A5
	- - - - - -			-	circuit board assembly includes:
-85	- - - - - -			1	INTEGRATED CIRCUIT
-86	407-1201-00			1	BRACKET, integrated circuit, grounding
-87	131-0608-00			3	TERMINAL, pin
-88	136-0252-04			34	SOCKET, pin connector
	- - - - - -			-	mounting hardware: (not included w/circuit
	- - - - - -			-	board assembly)
-89	211-0116-00			2	SCREW, sems, 4-40 x 0.312 inch, PHB
-90	220-0456-00			1	NUT, hex., 6-32 x 0.25 inch
-91	210-1092-00			1	WASHER, flat, 0.147 ID x 0.312 inch OD
-92	361-0008-00			3	SPACER, plastic

[1]Refer to Electrical Parts List for part number.

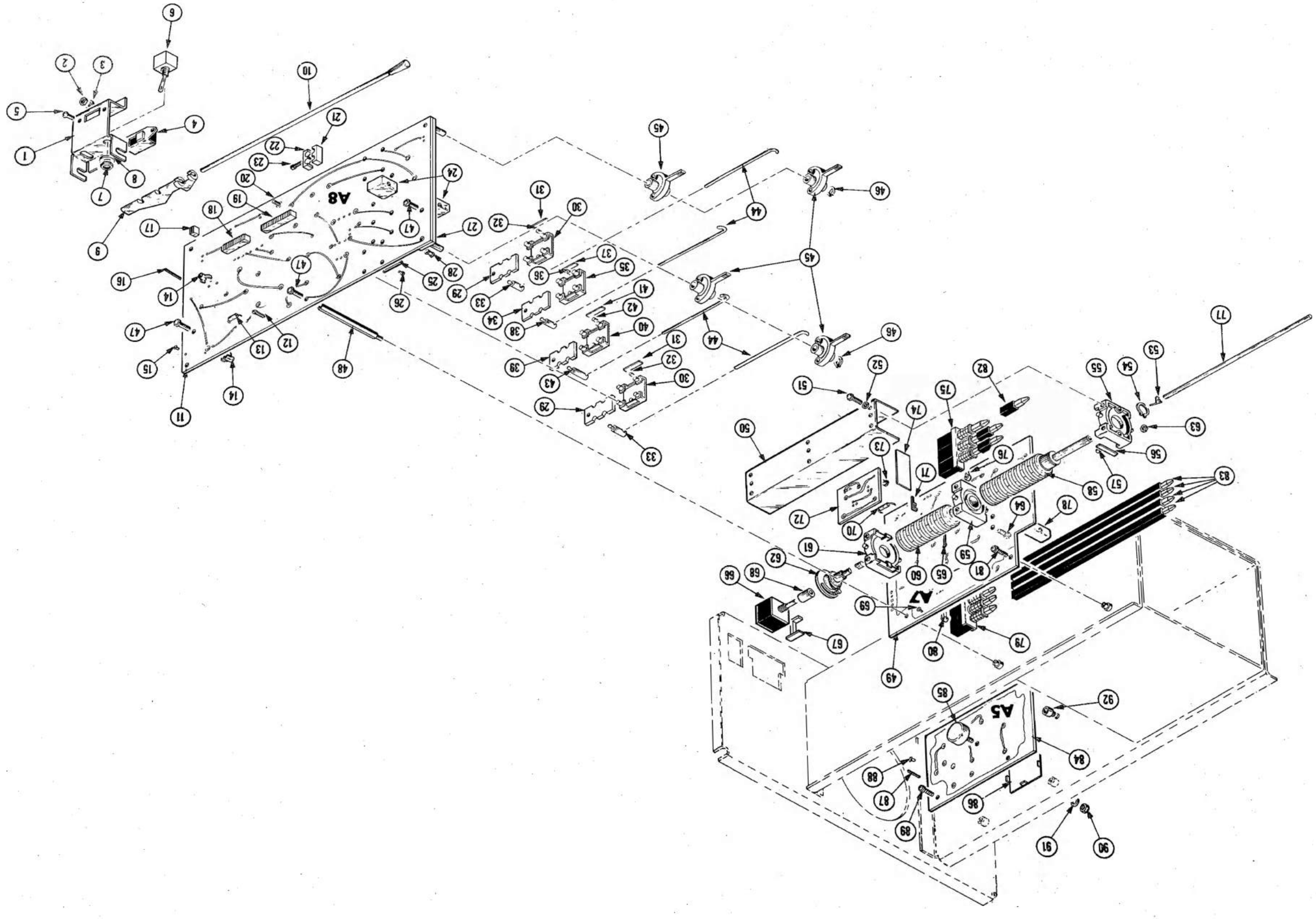


FIG. 3 RIGHT SIDE

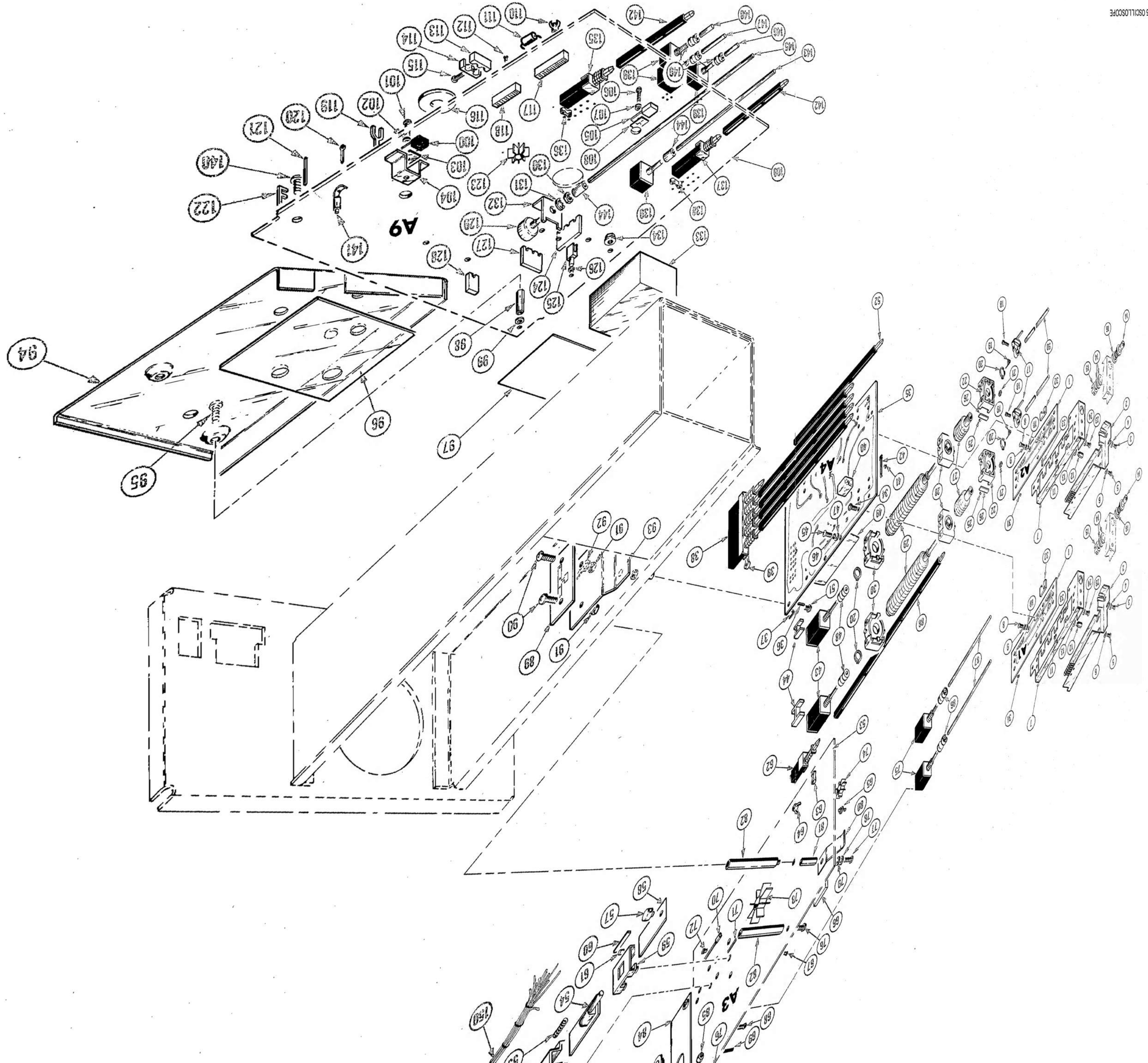


FIG. 4. LEFT SIDE & BOTTOM

LEFT SIDE & BOTTOM

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
4-	672-0045-00			1		CIRCUIT BOARD ASSEMBLY--ATTENUATOR
	- - - - - -			-		circuit board assembly includes:
-1	- - - - - -[1]			2		CIRCUIT BOARD ASSEMBLY--CH-1 & CH-2
	- - - - - -			-		ATTEN A1 & A2
	- - - - - -			-		each circuit board assembly includes:
-2	200-1439-00			1		COVER, chassis, attenuator
	- - - - - -			-		mounting hardware: (not included w/cover)
-3	213-0055-00			1		SCREW, thead forming, 2-32 x 0.188 inch, PHS
-4	210-0845-00			1		WASHER, flat, 0.109 ID x 0.25 inch OD
-5	211-0008-00			4		SCREW, 4-40 x 0.25 inch, PHS
-6	210-0994-00			4		WASHER, flat, 0.125 ID x 0.25 inch OD
						- - - * - - -
-7	441-1058-00			1		CHASSIS, attenuator
	- - - - - -			-		mounting hardware: (not included w/chassis)
-8	211-0001-00			2		SCREW, 2-56 x 0.25 inch, PHS
-9	210-0053-00			2		WASHER, lock, split, 0.092 ID x 0.175
	- - - - - -			-		inch OD
-10	210-0938-00			2		WASHER, flat, 0.109 ID x 0.25 inch OD
-11	210-0405-00			2		NUT, hex., 2-56 x 0.188 inch
-12	129-0299-00			4		POST, hex., 0.333 inch long
-13	210-0004-00			4		WASHER, lock, internal, 0.12 ID x 0.26
	- - - - - -			-		inch OD
						- - - * - - -
-14	131-0679-00			1		CONNECTOR, electrical, BNC, w/hardware
-15	220-0569-00			1		NUT, knurled, 0.50-28 x 0.235 inch
-16	361-0424-00			1		SPACER, ring
						- - - * - - -
-17	105-0243-00	B010100	B029999	1		LEVER, switch--AC DC
	105-0243-01	B030000		1		LEVER, switch--AC DC
	- - - - - -			-		mounting hardware: (not included w/lever)
-18	213-0214-00			1		SCREW, 2-56 x 0.375 inch, CAP SOC
						- - - * - - -
	131-1314-00	XB030000		1		CONTACT, electrical, grounding (not shown)
-19	131-0963-00			2		CONTACT, electrical, grounding
-20	354-0391-00			2		RING, retaining
-21	210-0406-00			10		NUT, hex., 4-40 x 0.188 inch
-22	401-0081-02			1		BEARING, cam switch, front
	- - - - - -			-		mounting hardware: (not included w/bearing)
-23	211-0097-00			2		SCREW, 4-40 x 0.312 inch, PHS
-24	210-0004-00			2		WASHER, lock, internal, 0.12 ID x 0.26 inch OD
						- - - * - - -
-25	214-1127-00			4		ROLLER, detent
-26	214-1139-00[2]			-		SPRING, flat, gold
	214-1139-02[2]			-		SPRING, flat, green
	214-1139-03[2]			-		SPRING, flat, red
-27	105-0282-00			1		DRUM, cam switch
-28	401-0115-00			1		BEARING, cam switch, center
-29	105-0343-00			1		ACTUATOR, cam switch
-30	401-0081-00			1		BEARING, cam switch, front
-31	136-0252-01			36		SOCKET, pin connector, 0.178 inch long

[1]Refer to Electrical Parts List for part number.
[2]Replace only with part bearing the same color code as the original part in your instrument.

LEFT SIDE & BOTTOM (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description
4-	136-0333-00			2	SOCKET, pin connector
-32	337-1406-00			1	SHIELD, electrical, cam switch
-33	131-1030-00			10	CONTACT ASSEMBLY, cam switch, bottom
	131-1031-00			10	CONTACT ASSEMBLY, cam switch, top
	- - - - - -			-	mounting hardware for each: (not included w/circuit board assembly)
	- - - - - -			-	
-34	211-0116-00			6	SCREW, sems, 4-40 x 0.312 inch, PHB
-35	- - - - - -[1]			1	CIRCUIT BOARD ASSEMBLY--GAIN SWITCH A4
	- - - - - -			-	circuit board assembly includes:
-36	131-0608-00			29	TERMINAL, pin, 0.365 inch long
-37	131-0589-00			6	TERMINAL, pin, 0.46 inch long
-38	260-1424-00			1	SWITCH, pushbutton--VERT MODE
-39	361-0411-00			4	SPACER, pushbutton switch
-40	352-0331-00			2	HOLDER, lamp
-41	131-1031-00			10	CONTACT ASSEMBLY, cam switch, top
-42	136-0252-04			12	SOCKET, pin connector
-43	- - - - - -			2	RESISTOR, variable
-44	361-0515-00			2	SPACER, switch, plastic
	- - - - - -			-	mounting hardware: (not included w/circuit board assembly)
	- - - - - -			-	
-45	213-0277-00			6	SCREW, thread forming, 2-56 x 0.312 inch, PHS
-46	210-0053-00			6	WASHER, lock, split, 0.092 ID x 0.175 inch OD
-47	210-1134-00			6	WASHER, flat, 0.09 ID x 0.25 inch OD
-48	376-0051-00			2	COUPLING, flexible
	- - - - - -			-	each coupling includes:
	213-0022-00			4	SETSCREW, 4-40 x 0.188 inch, HSS
-49	337-1418-01			2	SHIELD, electrical
-50	384-1178-00			2	SHAFT, extension, 6.1 inches long
	- - - - - -			-	mounting hardware: (not included w/circuit board assembly)
	- - - - - -			-	
-51	211-0116-00			2	SCREW, sems, 4-40 x 0.312 inch, PHB
-52	384-1129-00[1]			5	SHAFT, extension
-53	- - - - - -[1]			1	CIRCUIT BOARD ASSEMBLY--VERTICAL PREAMP A3
	- - - - - -			-	circuit board assembly includes:
	105-0421-00			1	ACTUATOR ASSEMBLY, slide switch--MOMENTARY
	- - - - - -			1	actuator assembly includes:
-54	105-0420-00			1	ACTUATOR, slide switch
-55	214-1779-00			1	SPRING, helical
-56	351-0359-00			1	GUIDE, slide switch

[1]Refer to Electrical Parts List for part number.

LEFT SIDE & BOTTOM (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description
4-	105-0423-00			1	ACTUATOR ASSEMBLY, slide switch--BANDWITH LIMIT
	- - - - - -			-	actuator assembly includes:
	213-0048-00			1	SETSCREW, 4-40 x 0.125 inch, HSS (not shown)
-57	376-0146-00			-	COUPLER, shaft
-58	105-0422-00			1	ACTUATOR, slide switch
-59	351-0355-00			1	GUIDE, slide switch
-60	214-1126-00[1]			1	SPRING, flat, gold
	214-1126-01[1]			1	SPRING, flat, green
	214-1126-02[1]			1	SPRING, flat, red
-61	214-1127-00			2	ROLLER, detent
-62	260-1208-00			1	SWITCH, pushbutton--INVERT
-63	361-0411-00			2	SPACER, pushbutton switch
-64	131-1003-00			8	RECEPTACLE, coaxial cable
-65	131-0158-00			2	TERMINAL, feedthru
-66	136-0269-00			3	SOCKET, integrated circuit, 14 pin
-67	136-0252-04			139	SOCKET, pin connector, 0.178 inch long
-68	214-0579-00			2	TERMINAL, test point
-69	131-0608-00			1	TERMINAL, pin, 0.365 inch long
-70	131-1031-00			7	CONTACT ASSEMBLY, cam switch, top
-71	131-1030-00			6	CONTACT ASSEMBLY, cam switch, bottom
-72	210-0779-00			7	RIVET, tublar, 0.115 inch long
-73	214-1799-00			1	HEATSINK, transistor
-74	214-1813-00			2	HEATSINK, transistor
-75	- - - - - -[2]			2	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/circuit
	- - - - - -			-	board assembly)
-76	211-0116-00			4	SCREW, sems, 4-40 x 0.312 inch, PHB
-77	211-0008-00			1	SCREW, 4-40 x 0.25 inch, PHS
-78	210-0054-00			1	WASHER, lock, split, 0.118 ID x 0.212 inch OD
-79	210-0994-00			1	WASHER, flat, 0.125 ID x 0.25 inch OD
-80	214-0276-00			1	SPRING, ground
-81	129-0413-00			1	POST, metallic, stud, hex., 0.62 inch long
-82	129-0385-00			2	POST, metallic, hex., 1.77 inches long
					- - - * - - -
	337-1810-00			1	SHIELD, electrical, vertical preamp (not shown)
	- - - - - -			-	mounting hardware: (not included w/shield)
	213-0088-00			4	SCREW, thread forming, 4-40 x 0.25 inch, PHS
	- - - - - -			-	(not shown)
-83	348-0253-00			1	GROMMET, plastic, 1.145 inches
-84	407-1127-00			1	BRACKET, preamp, rear
	- - - - - -			-	mounting hardware: (not included w/bracket)
-85	210-0586-00			2	NUT, keps, 4-40 x 0.25 inch
					- - - * - - -
-86	376-0051-00			2	COUPLING, flexible
	- - - - - -			-	each coupling includes:
	213-0022-00			4	SETSCREW, 4-40 x 0.188 inch, HSS
-87	384-1175-00			2	SHAFT, extension, 5.7 inches long
-88	384-1100-00[2]			1	SHAFT, pushbutton switch
-89	- - - - - -[2]			1	RESISTOR, thick film
	- - - - - -			-	mounting hardware: (not included w/resistor)
-90	211-0507-00			2	SCREW, 6-32 x 0.312 inch, PHS
-91	210-0457-00			2	NUT, keps, 6-32 x 0.312 inch
-92	210-0202-00			1	LUG, solder, SE #6

[1]Replace only with part bearing the same color code as the original part in your instrument.
[2]Refer to Electrical Parts List for part number.

LEFT SIDE & BOTTOM (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
4-93	407-1236-00			1	BRACKET, resistor
	- - - - - -			-	mounting hardware: (not included w/bracket)
	210-0586-00			2	NUT, keps, 4-40 x 0.25 inch (not shown)
					- - - * - - -
-94	337-1711-00			1	SHIELD, electrical, high voltage
	- - - - - -			-	mounting hardware: (not included w/shield)
-95	211-0008-00			4	SCREW, 4-40 x 0.25 inch, PHS
					- - - * - - -
-96	342-0164-00			1	INSULATOR, film, HV, 3.65 x 4.7 inches
-97	342-0159-00			1	INSULATOR, film
-98	129-0413-00			4	POST, hex., 0.62 inch long
	- - - - - -			-	mounting hardware for each: (not included
	- - - - - -			-	w/post)
-99	210-0994-00			1	WASHER, flat, 0.125 ID x 0.25 inch OD
					- - - * - - -
-100	- - - - - -[1]			1	TRANSISTOR
	- - - - - -			-	mounting hardware: (not included w/transistor)
-101	211-0062-00			1	SCREW, 2-56 x 0.312 inch, PHS
-102	210-1156-00			1	WASHER, shouldered, plastic, 0.091 ID x 0.121
	- - - - - -			-	inch OD
-103	342-0166-00			1	INSULATOR, transistor
-104	214-1845-00			1	HEATSINK
					- - - * - - -
-105	- - - - - -[1]			1	TRANSISTOR
	- - - - - -			-	mounting hardware: (not included w/transistor)
-106	211-0180-00			1	SCREW, sems, 2-56 x 0.25 inch, PHB
-107	210-1156-00			1	WASHER, shouldered, plastic, 0.091 ID x 0.121
	- - - - - -			-	inch OD
-108	342-0166-00			1	INSULATOR, transistor
					- - - * - - -
-109	- - - - - -[1]			1	CIRCUIT BOARD ASSEMBLY--INTERFACE A9
	- - - - - -			-	circuit board assembly includes:
-110	131-1003-00			4	RECEPTACLE, coaxial cable
-111	131-0566-00			12	LINK, terminal connecting
-112	136-0252-04			267	SOCKET, pin connector
-113	200-0945-01			1	COVER HALF, transistor, 2-56 thread
-114	200-0945-00			1	COVER HALF, transistor
	- - - - - -			-	mounting hardware: (not included w/cover half)
-115	211-0062-00			1	SCREW, 2-56 x 0.312 inch, PHS
					- - - * - - -
-116	210-0966-00			2	WASHER, insulating, rubber, 0.875 inch ID
-117	136-0499-12			1	SOCKET, circuit board, 12 contact
-118	136-0499-10			2	SOCKET, circuit board, 10 contact
-119	344-0154-00			2	HOLDER, fuse
-120	214-0579-00			19	TERMINAL, test point
-121	131-0608-00			24	TERMINAL, pin, 0.365 inch long
-122	131-1261-00			24	CONTACT, electrical, F-shape
-123	214-1291-00			1	HEATSINK, transistor

[1]Refer to Electrical Parts List for part number.

LEFT SIDE & BOTTOM (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
4-124	124-0120-00			1	STRIP, ceramic, 4 notch
	- - - - - -			-	strip includes:
-125	355-0046-00			2	STUD, plastic
-126	124-0092-00			1	STRIP, ceramic, 3 notch
	- - - - - -			-	strip includes:
	355-0046-00			1	STUD, plastic
-127	124-0118-00			3	STRIP, ceramic, 3 notch
	- - - - - -			-	each strip includes:
	355-0046-00			1	STUD, plastic
-128	358-0214-00[1]			12	BUSHING
-129	- - - - - -[1]			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-130	210-0583-00			1	NUT, hex., 0.25-32 x 0.312 inch
	210-0940-00			1	WASHER, flat, 0.25 ID x 0.375 inch OD (not shown)
	- - - - - -			-	
-131	210-0046-00			1	WASHER, lock, 0.261 ID x 0.40 inch OD
					- - - * - - -
-132	386-2433-00[1]			1	SUPPORT, resistor
-133	- - - - - -[1]			1	MULTIPLIER
	- - - - - -			-	mounting hardware: (not included w/multiplier)
-134	220-0661-00			2	NUT, self-locking, hex., 8-32 x 0.344 inch
					- - - * - - -
-135	260-1209-00			1	SWITCH, push--X10 MAG
-136	361-0384-00			2	SPACER, pushbutton switch, 0.133 inch long
-137	260-1310-01			1	SWITCH, push--BEAM FINDER
-138	361-0385-00[1]			2	SPACER, pushbutton switch, 0.164 inch long
-139	- - - - - -[1]			4	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/circuit
	- - - - - -			-	board assembly)
-140	211-0116-00			7	SCREW, sems, 4-40 x 0.312 inch, PHB
	210-0261-00	XB030000		1	LUG, solder (not shown)
					- - - * - - -
-141	343-0088-00			1	CLAMP, retaining
-142	384-1101-00			2	SHAFT, extension, 4.14 inches long
-143	384-1175-00			1	SHAFT, extension, 5.7 inches long
-144	376-0029-00			2	COUPLING, shaft, rigid
	- - - - - -			-	each coupling includes:
	213-0022-00			2	SETSCREW, 4-40 x 0.188 inch, HSS
-145	384-1179-00			1	SHAFT, extension, 9.312 inches long
-146	384-1176-00			1	SHAFT, extension, 1.45 inches long
-147	384-1172-00			1	SHAFT, extension, 1.7 inches long
-148	384-1171-00			1	SHAFT, extension, 1.05 inches long
-149	376-0051-00			3	COUPLING, flexible
	- - - - - -			-	each coupling includes:
	213-0022-00			4	SETSCREW, 4-40 x 0.188 inch, HSS
-150	179-1934-00			1	WIRING HARNESS, trigger
	- - - - - -			-	wiring harness includes:
-151	210-0774-00			5	EYELET, metallic, 0.152 inch OD
-152	210-0775-00			5	EYELET, metallic, 0.126 inch OD

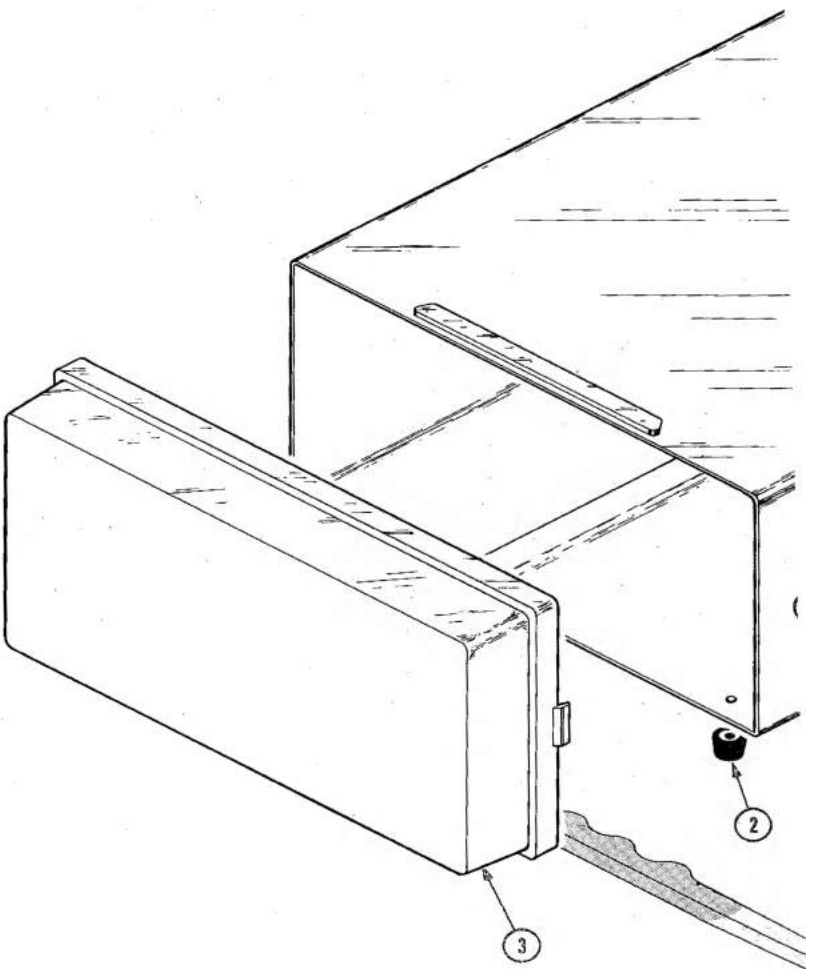
[1]Refer to Electrical Parts List for part number.

LEFT SIDE & BOTTOM (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
4-	179-1907-00			1	WIRING HARNESS, main
	- - - - - -			-	wiring harness includes:
-153	131-0707-00			2	CONNECTOR, terminal
-154	352-0171-00			2	HOLDER, temrinal connector, 1 wire
	210-0774-00			10	EYELET, metallic, 0.152 inch OD
	210-0775-00			10	EYELET, metallic, 0.126 inch OD
	179-1906-00			1	WIRING HARNESS, probe power
	- - - - - -			-	wiring harness includes:
	131-0707-00			8	CONNECTOR, terminal
-155	352-0169-00			4	HOLDER, terminal connector, 2 wire

CABINET

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
5-1	437-0141-01			1	CABINET, oscilloscope
	- - - - - -			-	cabinet includes:
-2	348-0080-01			4	FOOT, cabinet
-3	200-1412-00			1	COVER, front
-4	200-0602-00			2	COVER, handle, latch
-5	367-0140-03			1	HANDLE, carrying
	- - - - - -			-	mounting hardware: (not included w/handle)
-6	211-0512-00			4	SCREW, 6-32 x 0.50 inch, 100 deg. csk, FHS
					- - - * - - -
	334-1999-00			1	PLATE, identification (not shown)
-7	214-0516-00			2	SPRING, handle index
-8	214-0513-00			2	INDEX, handle ring
-9	214-0515-00			2	INDEX, handle hub
	- - - - - -			-	mounting hardware for each: (not included
	- - - - - -			-	w/index)
-10	213-0182-00			1	SCREW, 0.25-20 x 0.75 inch, Cap HS
-11	210-0805-00			1	WASHER, flat, 0.204 ID x 0.438 inch OD


2
3

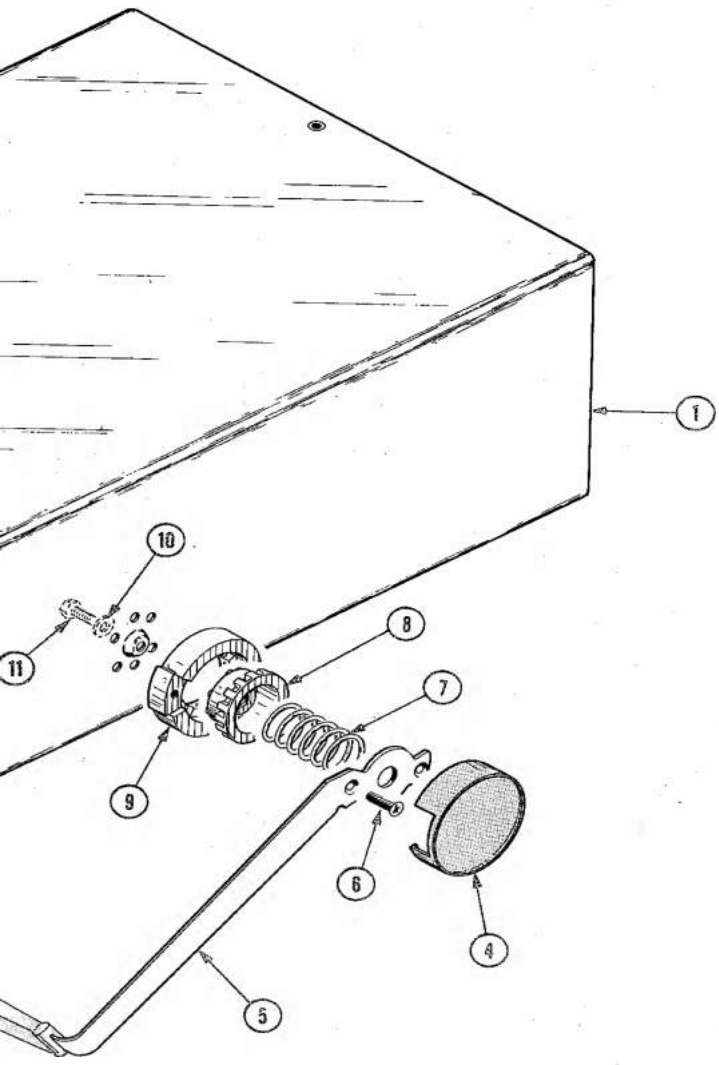


FIG. 5 CABINET

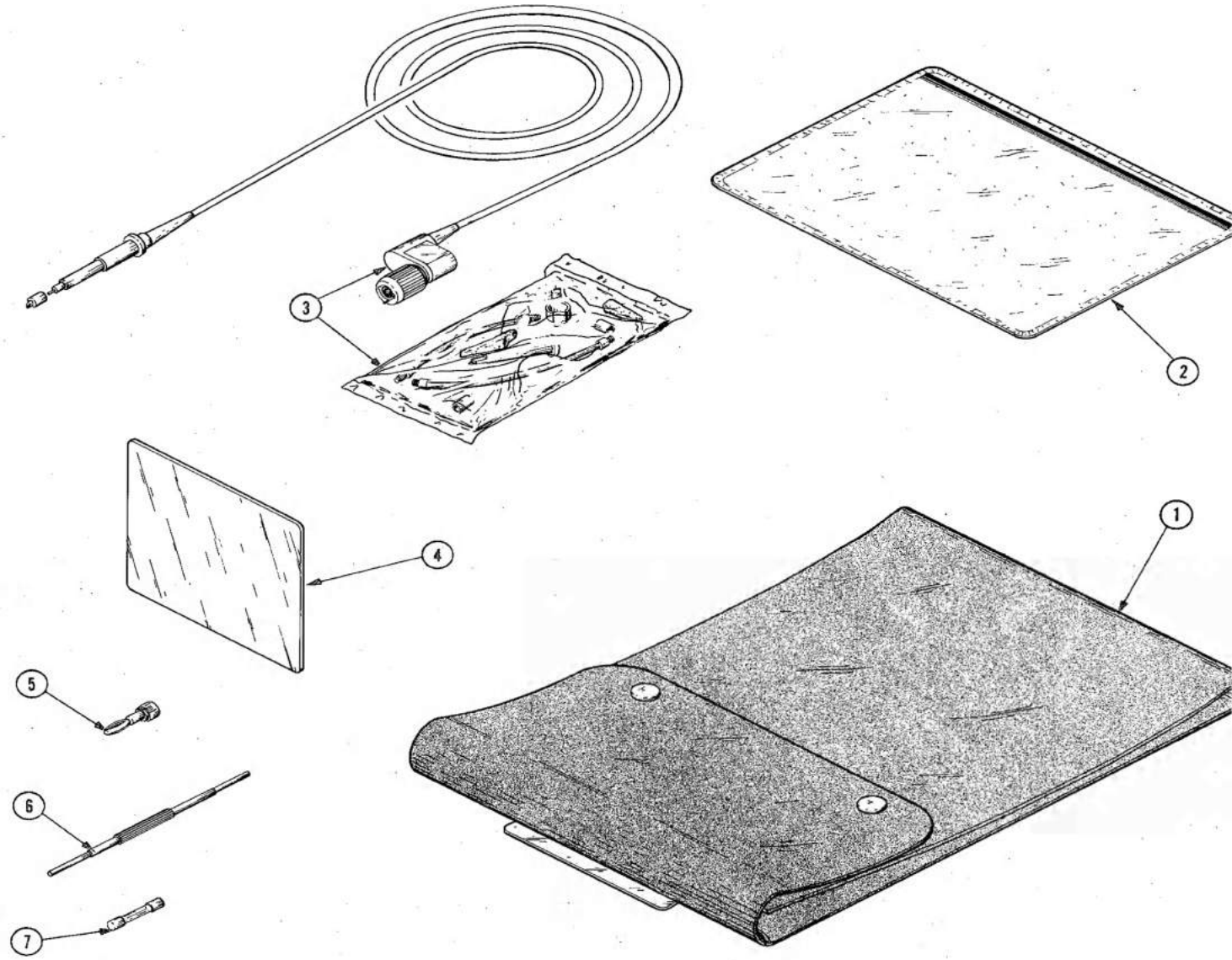


FIG. 6 & 7 ACCESSORIES & REPACKAGING

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
6-1	016-0535-02			1		POUCH, accessory, w/hardware
-2	016-0537-00			1		POUCH, accessory, w/zipper
-3	010-6075-03			2		PROBE PACKAGE
-4	337-1674-01			1		SHIELD, implosion, clear
-5	134-0016-01			1		PLUG, tip, w/binding post
-6	003-0301-00			1		TOOL, alignment
-7	159-0016-00			2		FUSE, 1.5 A, fast-blo
	159-0042-00			1		FUSE, 0.75 A, fast-blo
	070-1332-00			1		MANUAL, instruction (not shown)
	070-1333-00			1		MANUAL, operators (not shown)

REPACKAGING

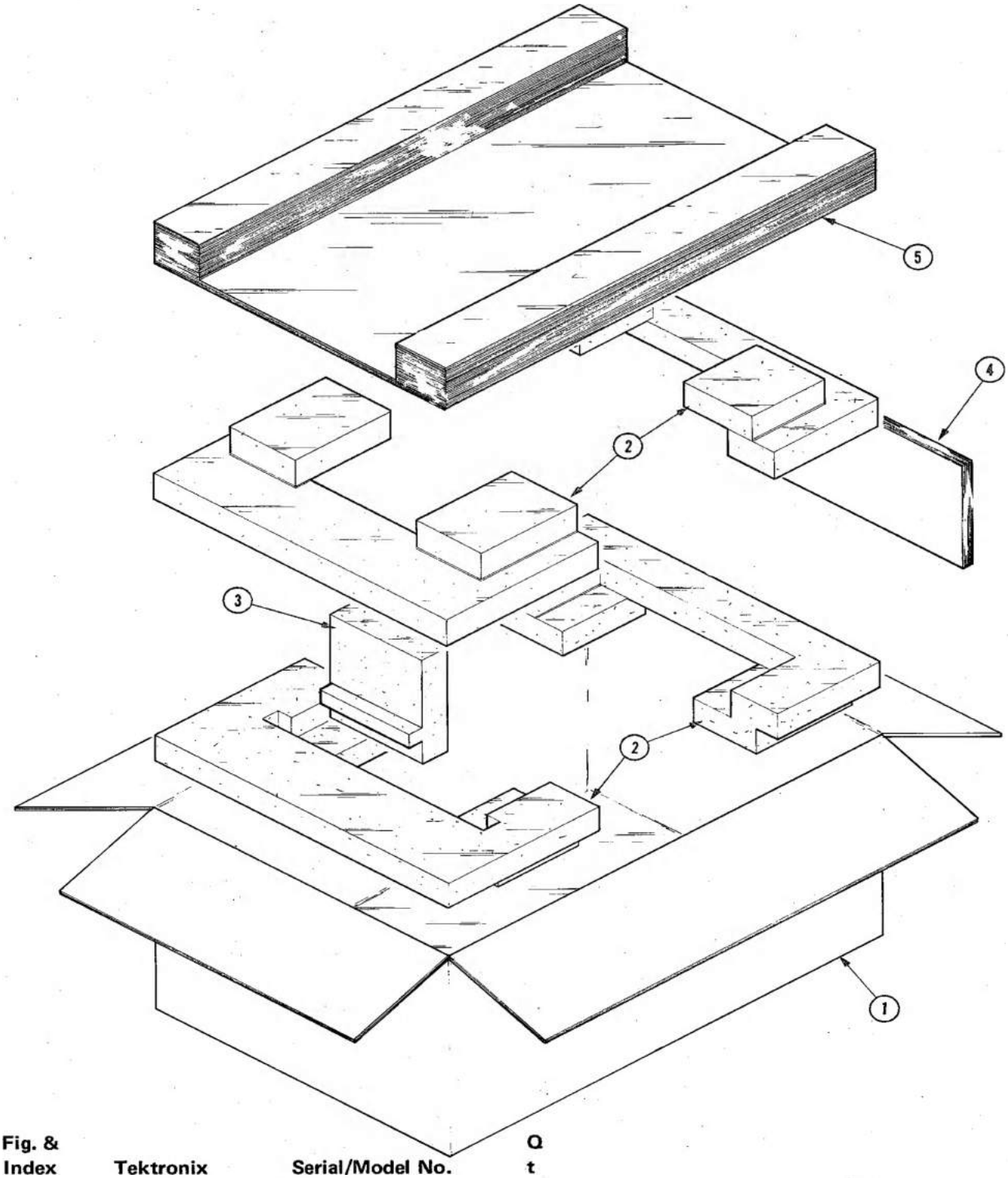


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5	Description
7-	065-0185-00			1		CARTON ASSEMBLY
	- - - - - - - - - -			-		carton assembly includes:
-1	004-0850-00			1		BOX
-2	004-1208-00			2		FRAME
-3	004-1209-00			1		FRAME, front pad
-4	004-1149-00			1		PAD
-5	004-1158-00			1		PAD

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. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. 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 in this section, your manual is correct as printed.

Includes corrections and changes with starting S/N as follows:

B020000	M19,949				
B030000	M20,017				
B040000	M19,283	M19,915			
B050000	M20,104	M19,994			
B060000	M19,883	M20,310	M19,855	M19,935	M20,205
B070000	M19,947				

ELECTRICAL PARTS LIST CORRECTIONS

(Changed portions are underlined, ADD's are all new)

ACTION	CKT NO.	PART NUMBER	S/N	DESCRIPTION
Chg	A4	670-2243-00	ALL	VERT MODE-GAIN SW. Ckt. Brd. Assy.
Chg	A9	670-2239-00	ALL	INTERFACE Ckt. Brd. Assy.
Chg	C420	281-0547-00	B060000	2.7 pF, Cer, 500 V
Chg	C494A	283-0198-00	B050000	0.22 µF, Cer, 50 V, 20%
Add	C494B	283-0341-00	B050000	0.047 µF (added when required)
Chg	C515	281-0605-00	B060000	200 pF, Cer, 500 V
Remove	C517	281-0579-00	B059999X	21 pF, Cer, 500 V, 5%
Remove	C708	281-0579-00	B059999X	21 pF, Cer, 500 V, 5%
Chg	C735	281-0605-00	B060000	200 pF, Cer, 500 V
Chg	C913	290-0523-00	B060000	2.2 µF, Elect., 20 V, 20%
Add	CR910	152-0141-02	B060000	Silicon, 1N4152
Remove	L552	276-0528-00	B059999X	Core, ferramic suppressor
Remove	L562	276-0528-00	B059999X	Core, ferramic suppressor
Add	L669	276-0507-00	B030000	Core, ferramic suppressor
Remove	L794	276-0507-00	B059999X	Core, ferramic suppressor
Chg	Q552	151-0434-00	B060000	Silicon, PNP, 2N4261
Chg	Q562	151-0434-00	B060000	Silicon, PNP, 2N4261
Chg	Q772	151-0434-00	B060000	Silicon, PNP, 2N4261
Chg	Q782	151-0434-00	B060000	Silicon, PNP, 2N4261
Chg	R32, R34, R35, R36, R447, & R454 are selected parts, nominal installed value is listed.			

ACTION	CKT NO.	PART NUMBER	S/N	DESCRIPTION
Chg	R494A	317-0621-00	B050000	620 Ω, 1/8 W, 5%
Add	R494B	311-0633-00	B050000	5 kΩ, Var, (added when required)
Add	R550	317-0560-00	B060000	56 Ω, 1/8 W, 5%
Add	R560	317-0560-00	B060000	56 Ω, 1/8 W, 5%
Add	R584	316-0220-00	B060000	22 Ω, 1/4 W, 10%
Add	R792	316-0220-00	B060000	22 Ω, 1/4 W, 10%
Chg	R806	315-0681-00	B060000	680 Ω, 1/4 W, 5%
Add	R824	316-0220-00	B060000	22 Ω, 1/4 W, 10%
Add	R910	321-0220-00	B060000	1.91 kΩ, 1/8 W, 1%
Chg	R911	321-0314-00	B060000	18.2 kΩ, 1/8 W, 1%
Chg	R912	321-0261-00	B060000	5.11 kΩ, 1/8 W, 1%
Chg	R952	321-0198-00	B060000	1.13 kΩ, 1/8 W, 1%
Add	R1103	315-0272-00	B060000	2.7 kΩ, 1/4 W, 5%
Chg	T1400	120-0799-01	B070000	LV Power

SCHEMATIC DIAGRAM and BOARD PHOTO CHANGES

Schematic ◇1◇

R125 was a variable resistor in early production. Second board outline down from top of page should be titled: PARTIAL A4 VERTICAL MODE-GAIN SWITCH BOARD.

Output at right of T178 should read:

CH 1 + VERT SIGNAL ◇3◇ to Pin 11 U370 ◇3◇.

Output at right of R189 should read:

CH 1 - VERT SIGNAL To Pin 10 U370 ◇3◇.

Refer to accompanying partial schematic for other changes.

Fig. 7-7 Title for board in photo and grid location chart should read: A4 Vertical Mode-Gain Switch Circuit Board.

Schematic Diagram and Board Photo Changes

Fig. 7-8 C213, R213 and C219 are moved to the back of the board in later production. R293, R294, R296 and R298 are located on back of board.

Schematic ◇2◇

R225 was a variable resistor in early production. Second board outline down from top of page should be titled: PARTIAL A4 VERTICAL MODE-GAIN SWITCH BOARD

Output at right of T278 should read:

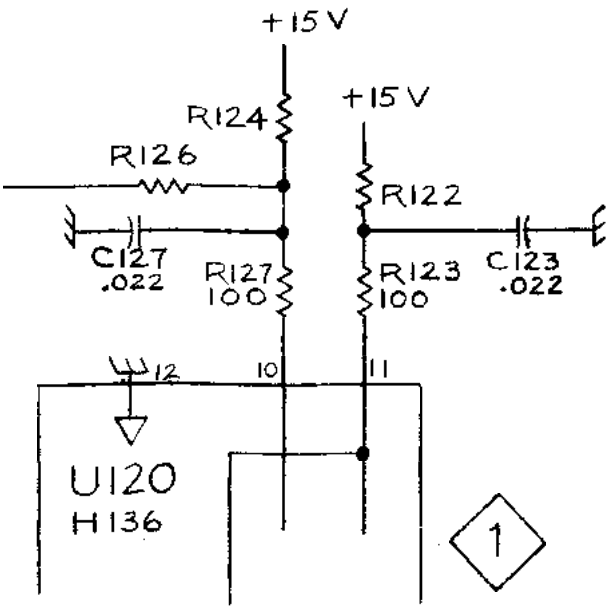
CH 2 + VERT SIGNAL To Pin 3, U370 ◇3◇.

The line between R293 and R295 should be connected.

Output at right of R289 should read:

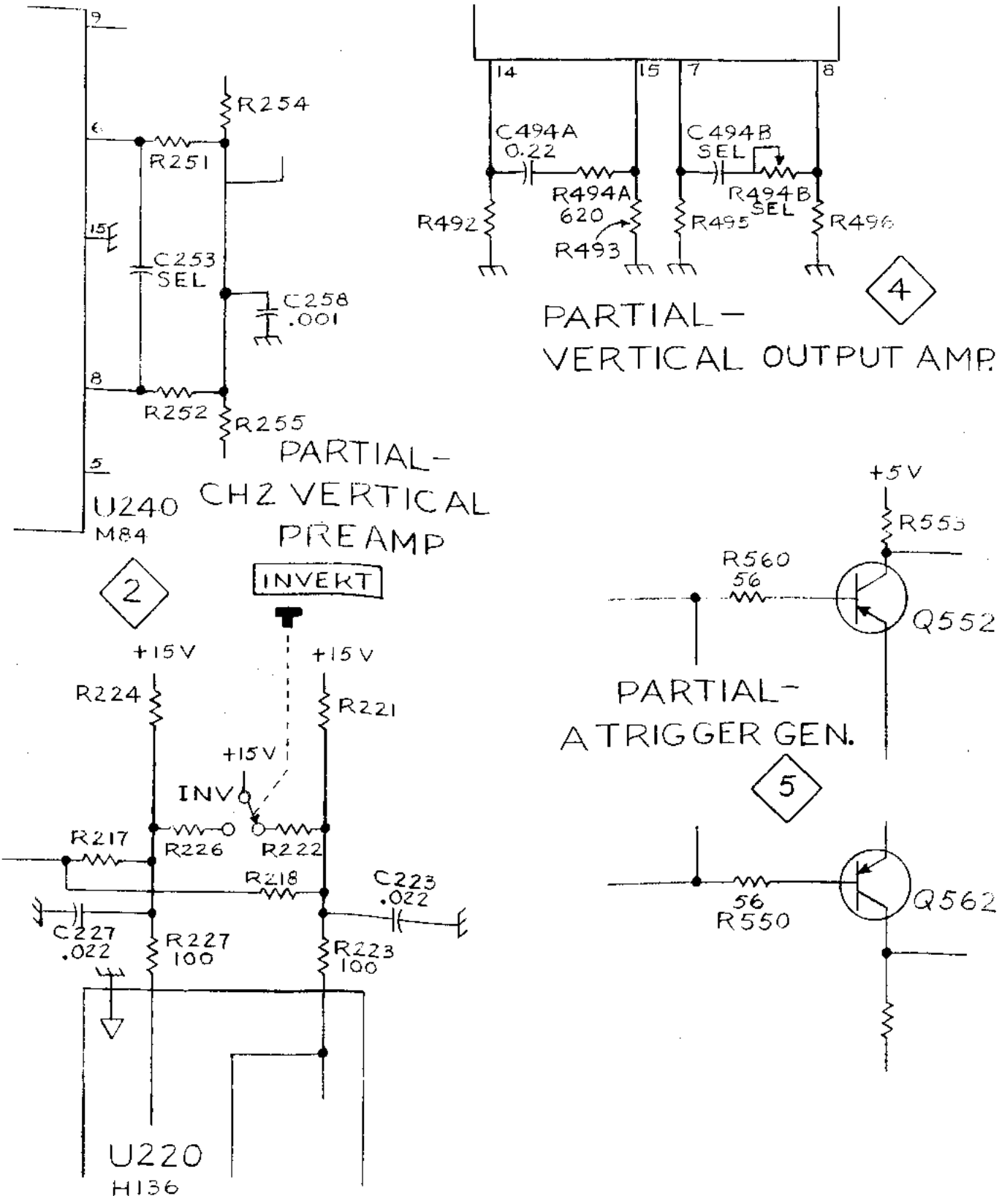
CH 2 - VERT SIGNAL To Pin 2 U370 ◇3◇.

Refer to accompanying partial schematics for other changes.



PARTIAL—
CH I VERTICAL PREAMP

SCHEMATIC CORRECTIONS



Schematic Diagram and Board Photo Changes

Fig. 7-9 Board title should read: A4 Vertical Mode-Gain Switch Circuit Board.

C329 is added to board above P300.

Schematic 3

Board title at left should read PARTIAL A4, VERT MODE-GAIN SW BOARD

P300 Pin 1 (Index) input should read: From CR1102 10

The input to R320 should read: CH 2 SCALE FACTOR From S53 1

The input to R310 should read CH 1 SCALE FACTOR From S13 1

U370 Pin 11 input should read: CH 1 + VERT SIG From Q178 2 1

J410 output should read: CH 2 TRIG SIG TO CR703

C420 value is changed to 2.7 pF

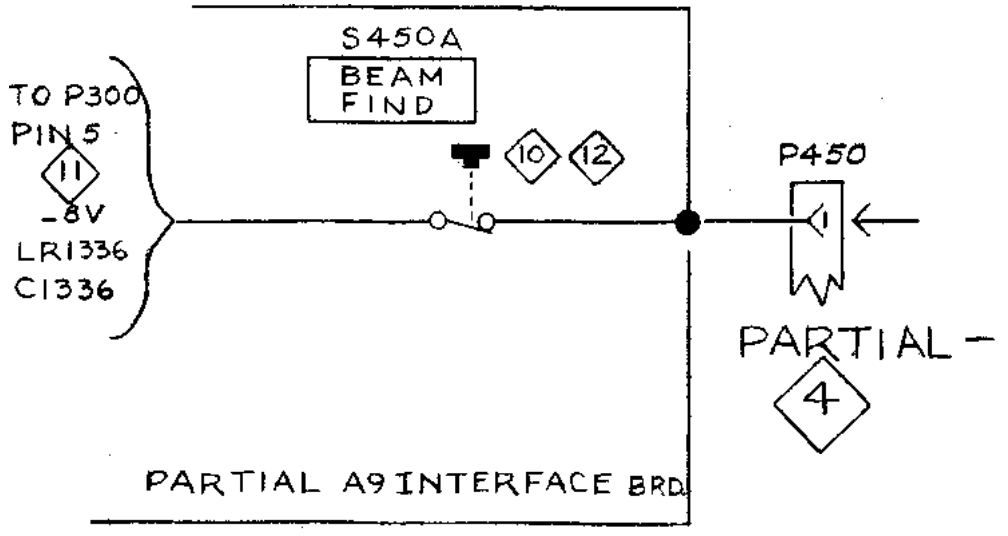
Fig. 7-11

C494A and C494B are added at the right of R492 and R493

Preexisting R494 and C494 are changed to R494B & C494B

Schematic 4

Change the details for S450A and U470 as indicated in the attached partial schematics.



R447 nominal value is 3.01 K.

Schematic Diagram and Board Photo Changes

Fig. 7-12

L562 or R550 location is directly below Q562

L552 or R560 location is directly below Q552

Schematic ◇5◇

C517 is removed in later production.

See Electrical Parts List changes for C515, L669 & C669.

L552 is replaced with R560 (56 Ω)

L562 is replaced with R550 (56 Ω)

Output at right of R568 should read: "A' GATE TO BASE OF Q572 ◇7◇

Schematic ◇6◇

C708 is removed in later production

C735 value is changed to 200 pF

Input to Base of Q712 should read:

CH 2 INT TRIG SIG FROM CR703.

R721, C721 and J720 are located outside of the A8 Board outline.

The output for the lead shown connected to the right contact of the left section of S705 should read: TO CR814 ◇7◇

Fig. 7-14 These parts are located as follows for some S/N:

C644 below VR647

C572 left of Q572

C575 right of R574

L600 right of R600

C811 below CR811

L802 left of Q802

L804 right of Q802

C813 right of R814

R792 right of R797

L588 left of Q588

L826 below Q826

C798 below CR824

C583 below L584

C584 left of L584

R580 in place of L584

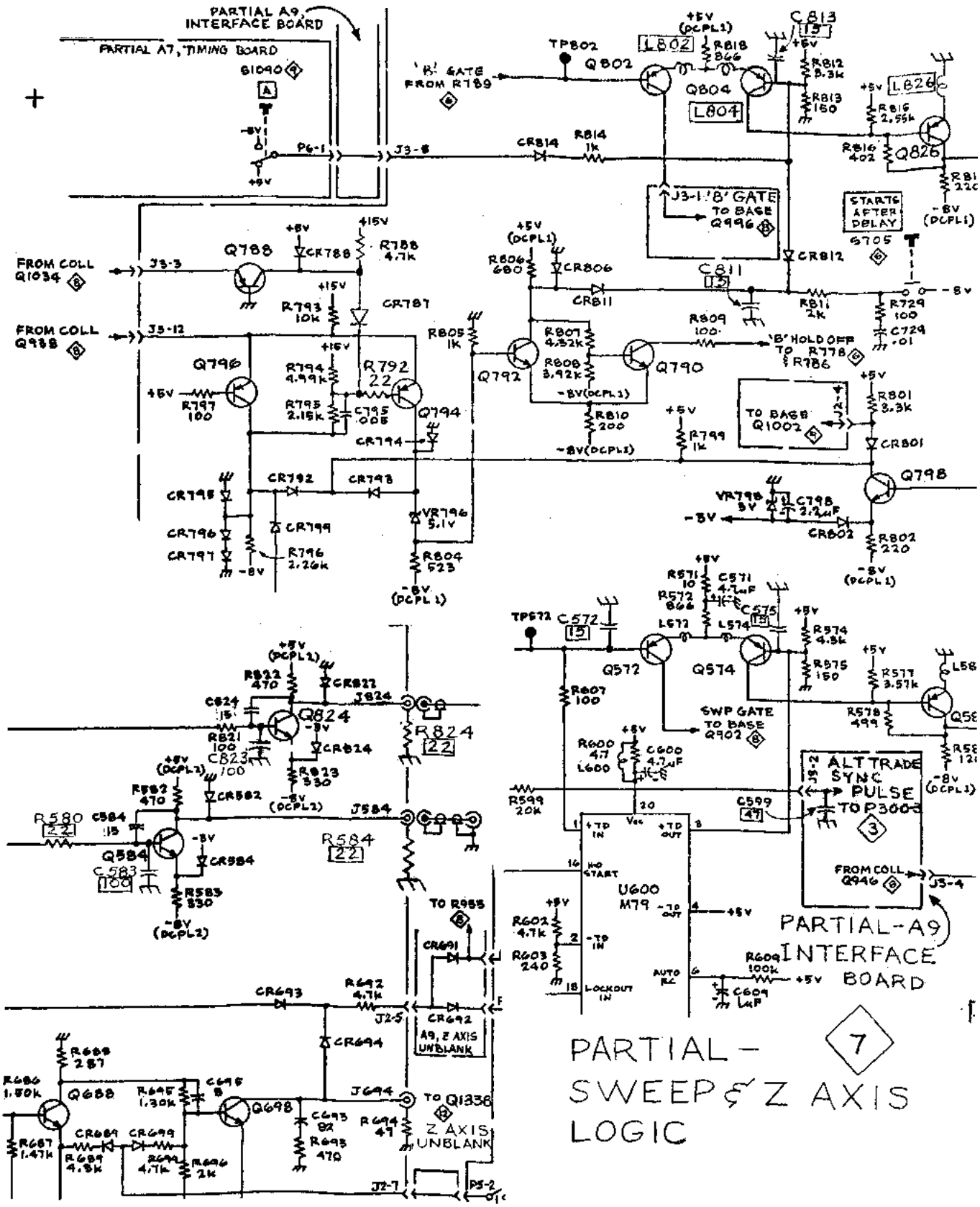
C823 right of Q824

C824 above Q824

R824 below J824

R584 below J584

SCHEMATIC CORRECTIONS



Schematic Diagram and Board Photo Changes

Schematic 7

Refer to attached partial 7 schematic.

Fig. 7-15

R910 is added at left of R986 for some S/N.

CR910 is added at right of CR1036 for some S/N.

R911 is moved to left of R917 for some S/N.

Schematic 8

Input to anode of CR910 should read to J3-8 7 & J6-1 9.

Voltage source for R911 should be +50 V.

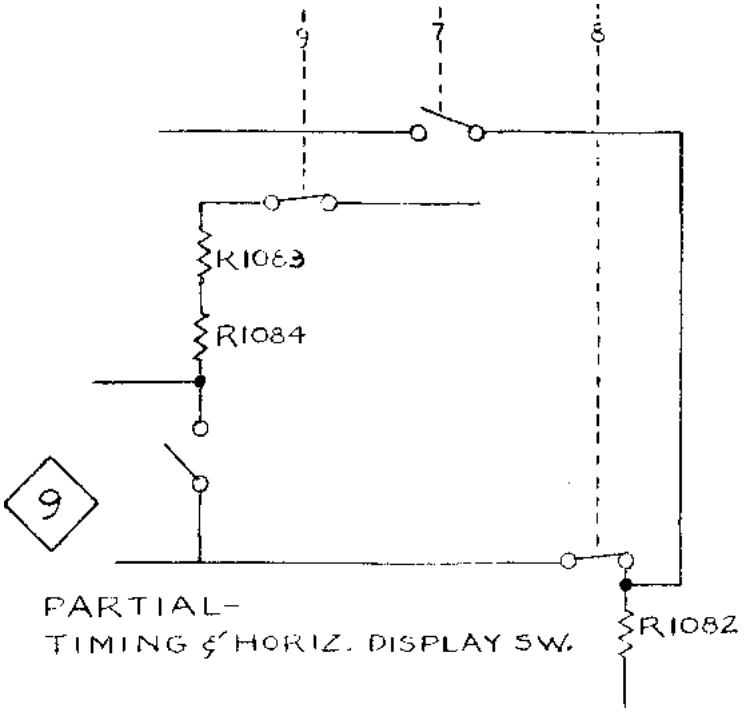
Components at left of J5-10 are located on A7 Timing Board.

Input to J5-3 should read: FROM CR1075 9.

Schematic 9

Connectors P6-5 right to P4-1 should read: FROM 11

For S1050 row 7 and 8 detail, refer to attached partial schematic 9.



SCHEMATIC CORRECTIONS

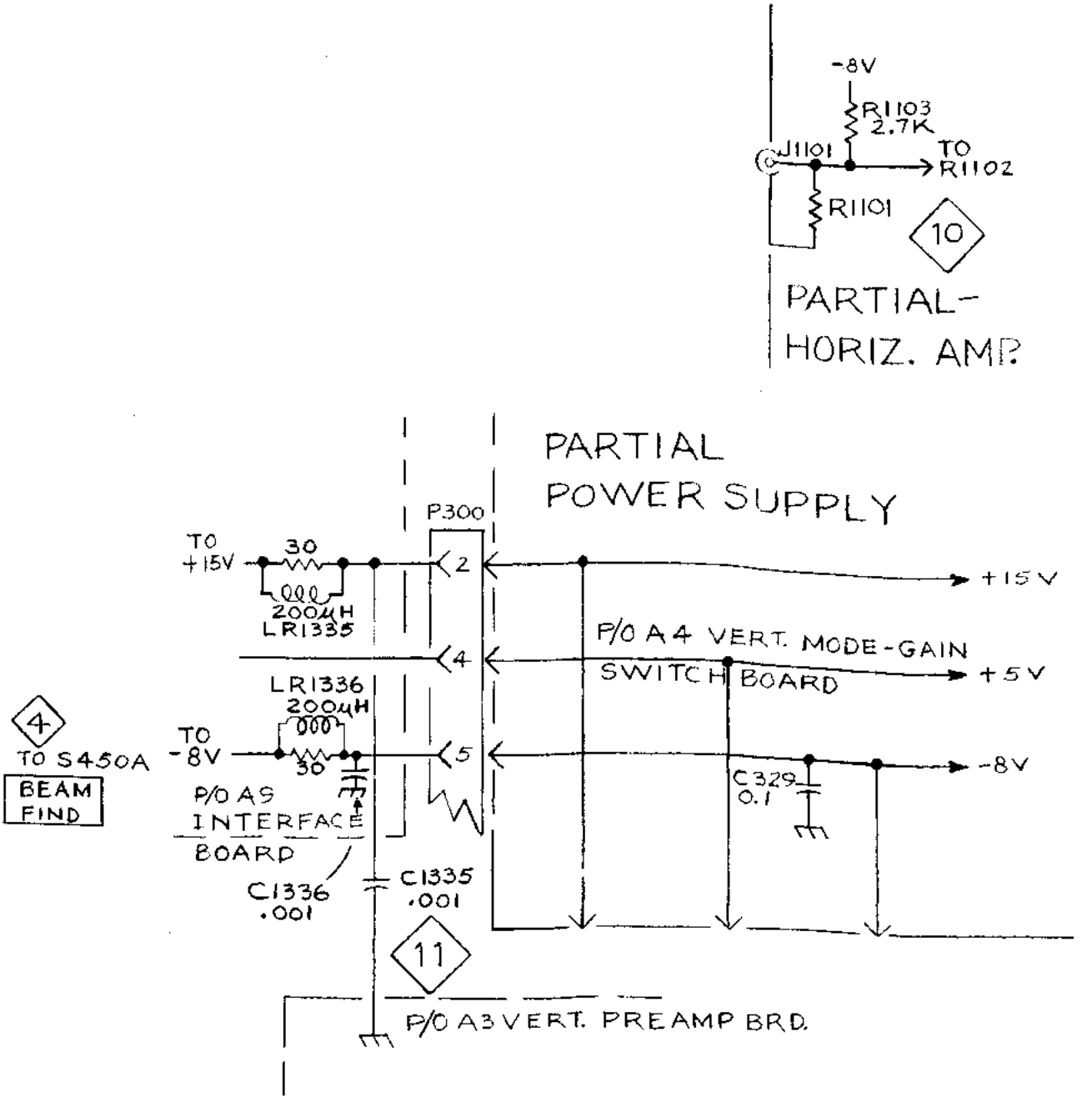
P6-1 output should read:

To CR814 (7), R908, R922, CR910, & CR1036 (8).

P4-7 output should read to R683, R684 (7).

Fig. 7-17

R1103 is added below R1140 for some S/N.



Schematic Diagram and Board Photo Changes

Schematic ⟨10⟩

Refer to attached partial schematic ⟨10⟩ for R1103 details.

Input to Q1114 collector, R1106, and S1110B X10 terminal should read:

SWEEP IN FROM Q956, Q1026 ⟨8⟩.

Schematic ⟨11⟩

Refer to attached partial schematic ⟨11⟩ for changes near P300.

Change voltage for Q1482 collectors to +5V (UNREG.)

Fig. 7-19

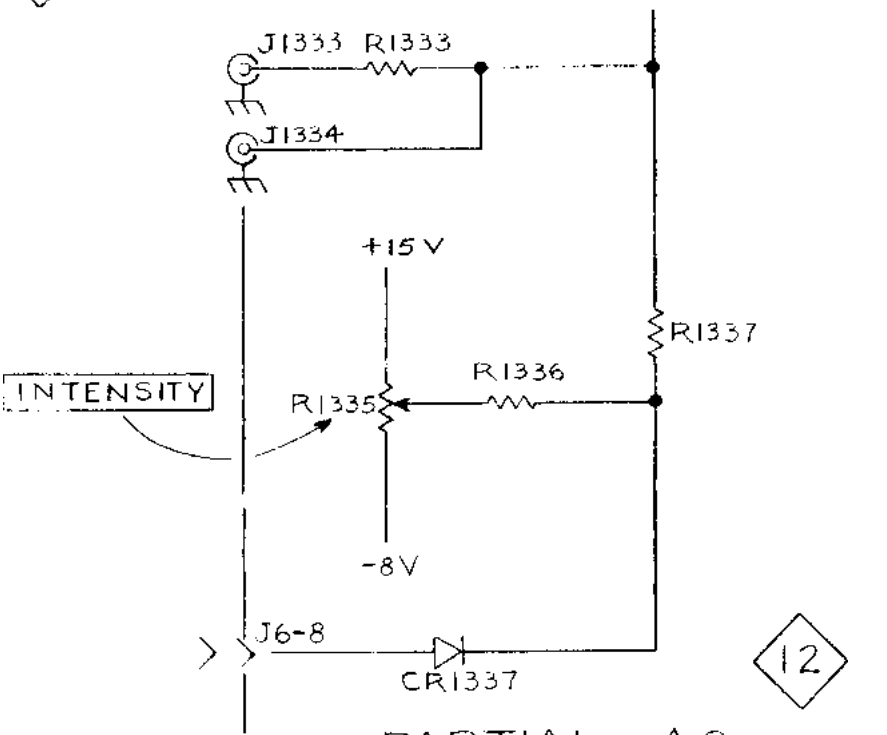
R1352 is located above C1352 for some S/N.

C599 is located below R1335 for some S/N.

C1335, C1336, LR1335, LR1336 are located or connect above and left of R1396 for some S/N.

Schematic ⟨12⟩

Change R1335 INTENSITY control details per the attached partial ⟨12⟩ schematic.



PARTIAL- A9
INTERFACE BOARD

Calibration Procedure
Corrections for all Serial Numbers, and changes
for SN B030000 and up

Page 5-2 Table 5-1

CHANGE: Tolerance of item 3 (DC VOLTMETER) to read: "calibrated to 1% accuracy at -2450 Volts."
Description and Example of item 8 to read: "With charge line, example Tektronix Type 113 Delay Line."
Item 18; quantity of two are required.

Page 5-4 Preliminary Control Settings

CHANGE: Under "Triggering Controls (both A and B if applicable)" B SOURCE setting should read: STARTS AFTER DELAY

Page 5-7 Step 6a

ADD: pull 20 MHz (20 or 100 MHz for SN B100000-up) BW switch fully out and set A and B TIME/DIV switches to 10µs.

Page 5-8 Step 12a & 12b

ADD: at the end of 12a; push 20 MHz (20 or 100 MHz for later SN) BW switch fully in (FULL BW). Set VERT MODE switch to CH-1.
For step 12b, two X10 BNC attenuators in series may be required.

Page 5-14 Step 1a

CHANGE to read:

1a. CHECK-+50 V supply, ±0.5%. ADJUST R1430 ONLY if supply is outside of this tolerance. (see accompanying note to follow step 1c on page 5-25)

Page 5-15 Step 15

CHANGE to read:

15a. Both VOLTS/DIV to 2 mV,----------

Page 5-16 For Serial Numbers B030000 and up:

REPLACE: Existing steps 17 and 18 with the attached new text for Steps 23 and 24 on pages 5-32 and 5-33.

GENERAL For all SN, in steps such as 23d & 24j on page 5-17, 30d on page 5-35, & 31p on page 5-36, where a Fast-Rise High Amplitude Pulse Generator (type 109) is used, a charge line such as the Tektronix Type 113 Delay Line should be connected to the Chg Line 2 of the 109 to provide adequate pulse width to perform the adjustments.

Page 5-25 Following Step 1c

ADD:

NOTE

If +50 V supply is readjusted the entire calibration procedure will have to be performed.

Page 5-26 Step 3c and 3j

CHANGE to read:

3c. CHECK-CRT display for a well-defined dot.

3j. ---------controls to mid-range, and TRIGGER MODE to AUTO.

Page 5-27 Step 7a, Fig. 5-4, and Step 7d

CHANGE to read:

7a. Connect 1.0 ms and 0.1 ms time marks ----------

Fig. 5-4: See accompanying photo for correct TP1366 location.

7d. --------for one bright (1.0 ms) marker per division

Page 5-28 Step 9d

CHANGE to read:

9d. Adjust the Test Oscilloscope trigger and Time/Div controls to view the positive step of a 1 volt display of the Z axis signal. Adjust the 475 INTENSITY control to set the 1 Volt level.

Page 5-29 Fig. 5-6 and 5-7 replace with accompanying new photos.

Step 11d

CHANGE a portion to read --- between TP1395 (see new Fig. 5-6)----

Step 12a

CHANGE a portion to read --- of the delay line (see new Fig. 5-7)---

Page 5-30 Fig. 5-8 replace with accompanying new photo.

Page 5-31 Fig. 5-9 replace with accompanying new photo.

Page 5-32 Fig. 5-11 and 5-12 replace with accompanying new photos.

Step 22a add to existing text:
Set CH-2 AC-GND-DC Switch to AC.
For SN Below B030000 in steps 23i and 23j change 100 mV to read 250 mV.

Page 5-32 and 5-33

For SN B030000 and up, replace the existing steps 23 and 24 with the following steps. Refer to the accompanying revised Figures for correct location of adjustments.

Page 5-32

23. Adjust CH 1 and Vertical Output Gain (SN B030000-up)

a) Set the Vertical Mode Switch to CH 1, the CH 1 VOLTS/DIV switch to 2 mV and the CH 1 AC-GND-DC switch to DC.

b) Adjust the STANDARD AMPLITUDE CALIBRATOR for a 10 mV output.

c) Connect the STANDARD AMPL. CALIBRATOR to the CH 1 input.

d) d) Set the Test Oscilloscope: Vertical Mode to ADD, CH 2 to invert, both Volts/Div switches to 5 mV.

e) Connect two X10 probes from the Test Oscilloscope to the preamp side of the delay line.

f) Adjust CH 1 2 mV Gain Adjustment, R195 (see new Fig. 5-12) for a 250 mV (Peak-to-Peak) display on the Test Oscilloscope.

g) Remove the X10 probes from delay line.

h) Adjust Vertical Output Gain Adjustment, R449 (see Fig. 5-13) for 5 divisions of deflection.

i) Set the CH 1 VOLTS/DIV to 5 mV and adjust the STANDARD AMPL. CALIBRATOR for a 20 mV output.

j) Adjust-CH 1 5 mV Gain Adjustment, R165 (see new Fig. 5-12) for 4 divisions of deflection.

k) CHECK-Accuracy of the CH 1 Volts/Div switch using the settings given in Table 5-6. The deflection factor accuracy for each position must be within 3%.

24. Adjust CH 2 Gain (SN B030000-up)

a) Set the Vert Mode switch to CH 2, the CH 2 Volts/Div switch to 2 mV, and AC-GND-DC switch to DC.

b) Move the test signal to the CH 2 input.

c) Adjust the STANDARD AMPL. CALIBRATOR for 10 mV output.

d) Adjust-CH 2 2 mV Gain, R295 for 5 divisions of deflection.

e) Set the CH 2 Volts/Div switch to 5 mV and adjust the STANDARD AMPL. CALIBRATOR for 20 mV output.

f) Adjust-CH 2 5 mV Gain Adjustment, R265 (see new Fig. 5-14), for 4 divisions of deflection.

g) CHECK-Accuracy of the CH 2 Volts/Div switch using the settings given in Table 5-6. Deflection factor accuracy must be within 3% in all positions.

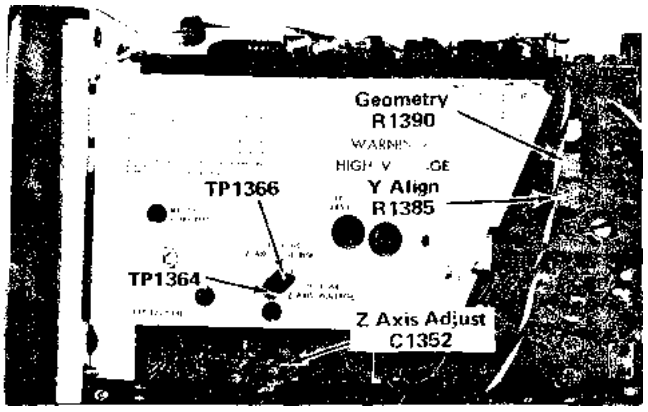


Fig. 5-4. Location of Y-Axis Align, Z-Axis, and Geometry adjustments and test point.

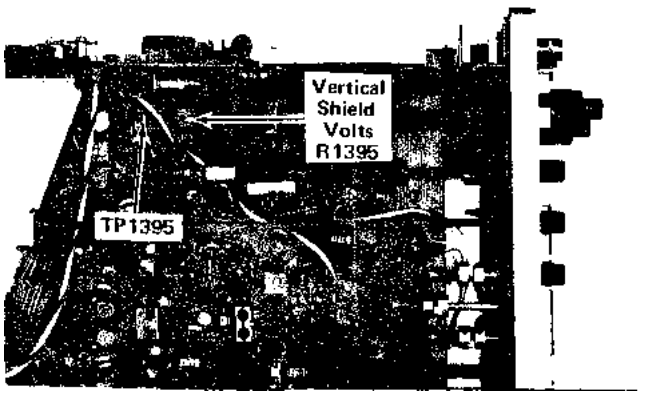


Fig. 5-6. Location of Vertical Shield Voltage adjustment and TP1395.

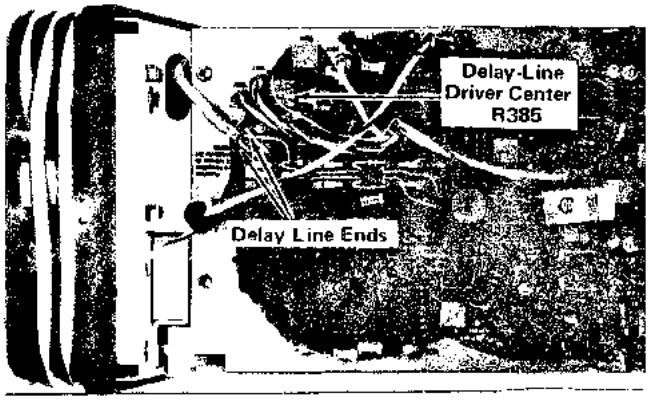


Fig. 5-7. Location of Delay-Line Driver Centering adjustment R385 and delay line ends.

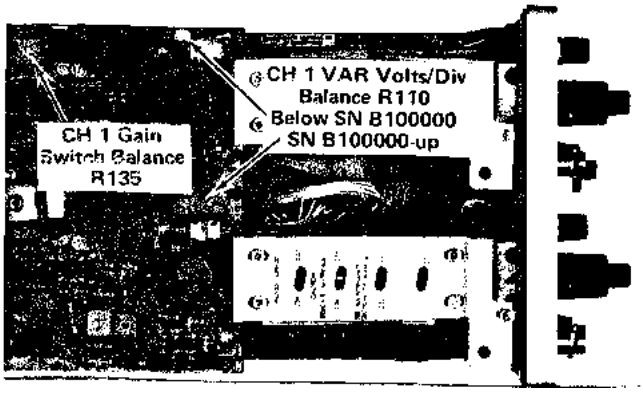


Fig. 5-8. Location of CH 1 Var Volts/Div Balance and Gain Switch Balance adjustments.

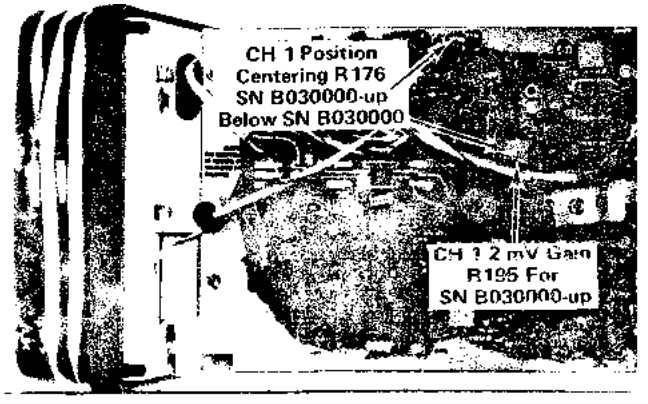


Fig. 5-9. Locations of CH 1 position centering adjustment R176 and CH 1 2 mV Gain R195 (SN B030000-up).

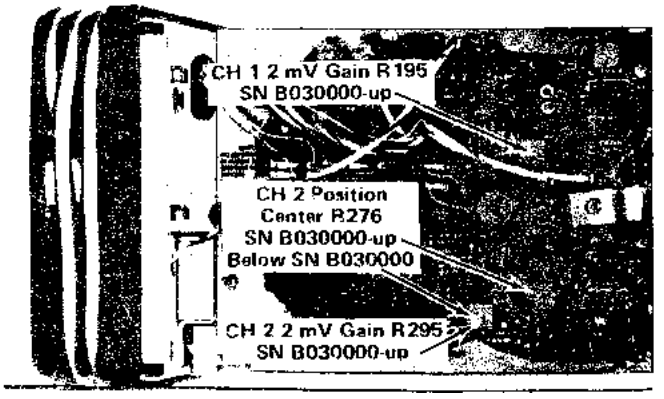


Fig. 5-11. Locations of CH 2 position center R276, CH 2 2 mV Gain R295, and CH 1 2 mV Gain R195 for SN B030000-up.

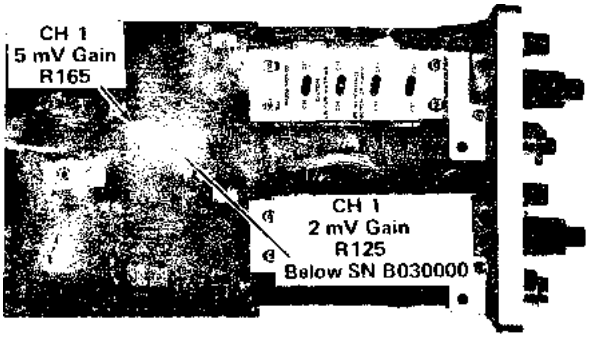


Fig. 5-12. Location of CH 1 5 mV Gain R165 (all SN) and CH 1 2 mV Gain R125 (Below SN B030000).

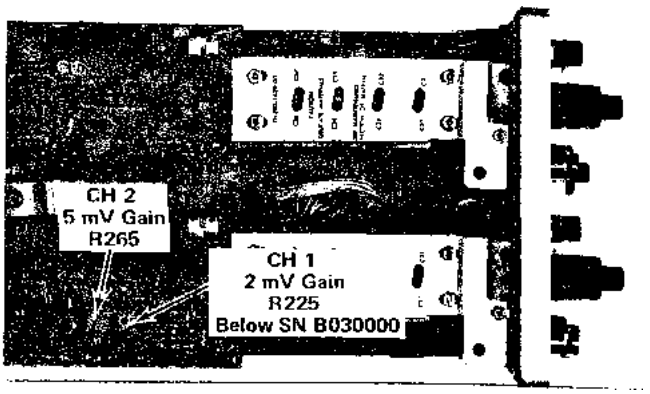


Fig. 5-14. Location of CH 2 5 mV Gain R265 (all SN) and CH 1 2 mV Gain R225 (Below SN B030000).

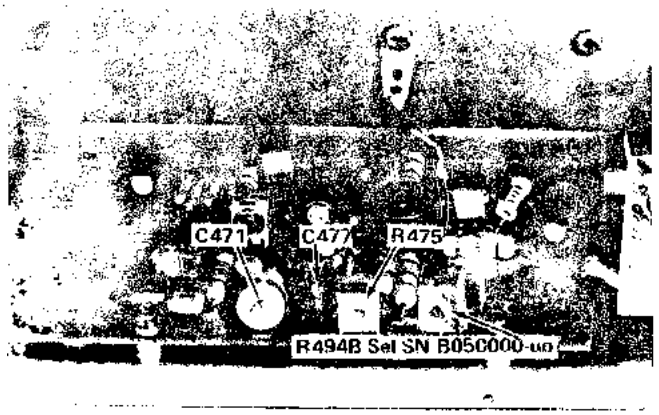


Fig. 5-18. Location of R475, C471, C477 and R494B (Selected SN B050000-up).

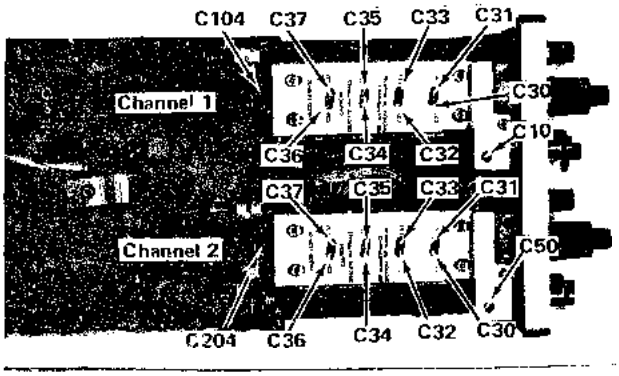


Fig. 5-19. Location of VOLTS/DIV Compensation adjustments.

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

CHANGE TO:

A3	670-2240-01	VERT PREAMP Circuit Board Assembly
C109	283-0191-00	0.022 μF, Cer, 50 V
C112	281-0122-00	2.5-9 pF, Var
C139	283-0238-00	0.01 μF, Cer, 50 V
C209	283-0191-00	0.022 μF, Cer, 50 V
C212	281-0122-00	2.5 -9 PF, Var
C239	283-0238-00	0.01 μF, Cer, 50 V
C398	281-0628-00	15 pF, Cer, 600 V
L171	276-0528-00	Core, ferramic suppressor, selected
L174	276-0528-00	Core, ferramic suppressor, selected
L271	276-0528-00	Core, ferramic suppressor, selected
L274	276-0528-00	Core, ferramic suppressor, selected
Q178	151-0434-00	Silicon, PNP, 2N4261
Q188	151-0434-00	Silicon, PNP, 2N4261
Q278	151-0434-00	Silicon, PNP, 2N4261
Q288	151-0434-00	Silicon, PNP, 2N4261
R109	311-1268-00	10 kΩ, Var
*R110	311-1228-00	10 kΩ, Var
R113	317-0681-00	680 Ω (nominal value) selected
R137	317-0242-00	2.4 kΩ (nominal value) selected
R138	317-0202-00	2 kΩ (nominal value) selected
R145	315-0620-00	62 Ω, 1/4 W, 5%
R176	311-1226-00	2.5 kΩ, Var
R209	311-1268-00	10 kΩ, Var
R213	317-0681-00	680 Ω (nominal value) selected

M19,911/573

*Note: SN B010100-B099999 R110 was 311-1268-00.

CHANGE TO:

R237	317-0242-00	2.4 kΩ (nominal value) selected
R238	317-0202-00	2 kΩ (nominal value) selected
R245	315-0620-00	62 Ω, 1/4 W, 5%
R276	311-1226-00	2.5 kΩ, Var
R348	315-0331-00	330 Ω, 1/4 W, 5%
R398	317-0430-00	43 Ω, 1/8 W, 5%
R399	315-0330-00	33 Ω, 1/4 W, 5%
R425	311-1227-00	5 kΩ, Var
RT452	307-0125-00	500 Ω, Thermal
S375A	263-1019-00	Actuator assembly, slide, 100 or 20 MHz, BW
U120	155-0085-01	Hybrid, dual FET input & amplifier
U220	155-0085-01	Hybrid, dual FET input & amplifier
VR144	152-0166-00	Selected from 1N753A, 0.4 W, 6.2 V, 5%
VR244	152-0166-00	Selected from 1N753A, 0.4 W, 6.2 V, 5%
VR290	152-0166-00	Selected from 1N753A, 0.4 W, 6.2 V, 5%
VR396	152-0166-00	Selected from 1N753A, 0.4 W, 6.2 V, 5%

REMOVE:

C375	281-0544-00	5.6 pF, Cer, 500 V, 10%
C376	281-0589-00	170 pF, Cer, 500 V, 5%
R149	321-0260-00	4.99 kΩ, 1/8 W, 1%
RT149	307-0124-00	5 kΩ, Thermal
R249	321-0260-00	4.99 kΩ, 1/8 W, 1%
RT249	307-0124-00	5 kΩ, Thermal
R391	321-0154-00	392 Ω, 1/8 W, 1%

ADD:

C377	281-0564-00	24 pF, Cer, 5%
C378	283-0640-00	160 pF, 100 V, 1%

ADD:

LR377	108-0760-00	67 nH
LR378	108-0760-00	67 nH
R107	317-0101-00	100 Ω, 1/8 W, 5%
R108	317-0101-00	100 Ω, 1/8 W, 5%
R207	317-0101-00	100 Ω, 1/8 W, 5%
R208	317-0101-00	100 Ω, 1/8 W, 5%
R391A	321-0163-00	487 Ω, 1/8 W, 1%
R391B	315-0182-00	1.8 kΩ, 1/4 W, 5%

MECHANICAL PARTS LIST CORRECTION

Page 8-2

CHANGE TO:

Fig. 1-39	333-1636-02	1	PANEL, front
Fig. 1-51	384-1162-01	1	SHAFT, extension w/Knob, TRIG VIEW, BW

ADD: (Page 8-12)

Fig. 4-53	129-0385-00	1	POST, standoff
Fig. 4-53	211-0116-00	1	SCREW, 4-40 x .312 w/2 lockwashers

Page 8-12

CHANGE TO:

Fig. 4-53	105-0421-00	1	ACTUATOR, ASSEMBLY, slide switch-TRIG VIEW

Page 8-13

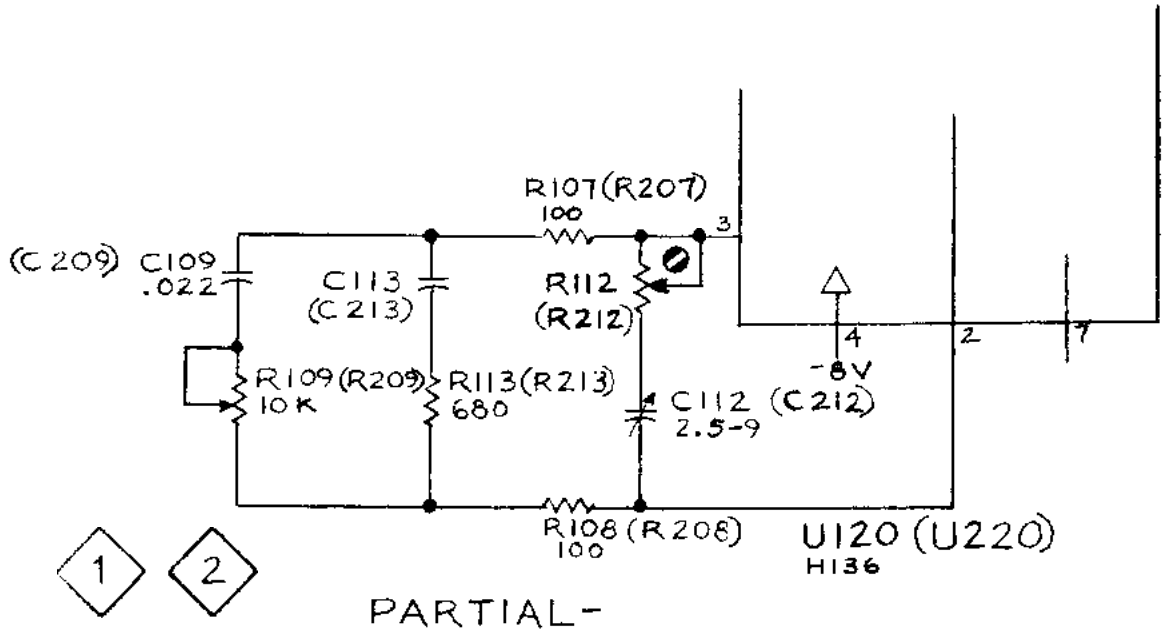
CHANGE TO:

Fig. 4-	263-1019-00	1	ACTUATOR ASSEMBLY, 100 or 20 MHz BW
	- - - - - -		actuator assembly includes:
Fig. 4-57	376-0146-00	1	COUPLER, shaft
-58	105-0517-00	1	ACTUATOR, slide switch
-59	351-0355-00	1	GUIDE, slide switch
-60	214-1126-00	2	SPRING, detent

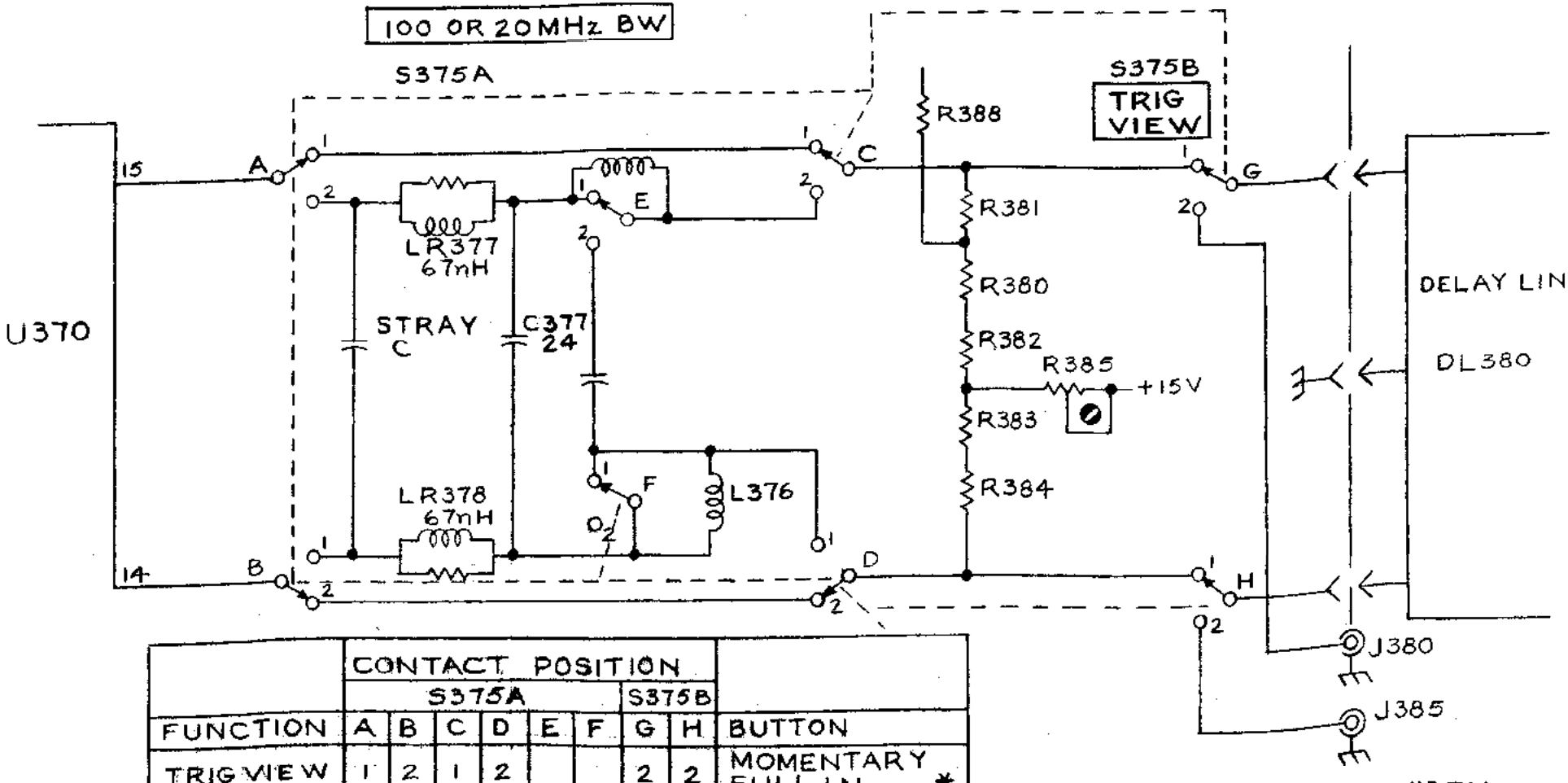
CHANGE TO:

Fig. 4-60	214-1127-00	2	SPRING, detent
	366-1471-01	1	KNOB (not shown)
	255-0345-00	1	ROD, glass epoxy

SCHEMATIC CORRECTION



PARTIAL-
CH 1 & 2 VERTICAL PREAMP



FUNCTION	CONTACT POSITION S375A A	B	C	D	E	F	S375B G	H	BUTTON
TRIG VIEW	1	2	1	2			2	2	MOMENTARY FULL IN *
FULL BW	1	2	1	2			1	1	FIRST DETENT FROM FULL IN
100 MHz	2	1	2	1	1	1	1	1	CENTER DETENT
20MHz	2	1	2	1	2	2	1	1	FULL OUT

* NOTE: S375C ON (5) IS IN CLOSED POSITION FOR TRIG VIEW

SHOWN IN FULL BANDWIDTH

VERTICAL CHANNEL SWITCHING

(3)

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

CHANGE TO:

A9	670-2239-01	Interface Circuit Board Assembly
C1124	283-0116-00	820 pF, 500 V, 5%
C1134	283-0116-00	820 pF, 500 V, 5%
C1178	283-0644-00	150 pF
C1326	281-0519-00	47 pF, 500 V
C1512	281-0512-00	27 pF, 500 V
CR1489	152-0107-00	Silicon, TI60 or 1N647
L1232	276-0507-00	Core, ferramic suppressor (selected)
Q1114	151-0127-00	Silicon, NPN, selected from 2N2369
Q1140	151-0223-00	Silicon, NPN, 2N4275
Q1496	151-0280-00	Silicon, PNP, MM4003
R1114	321-0126-00	200 Ω, 1/8 W, 1%
R1116	315-0182-00	1.8 kΩ, 1/4 W, 5%
R1117	315-0303-00	30 kΩ, 1/4 W, 5%
R1124	315-0361-00	360 Ω, 1/4 W, 5%
R1128	321-0045-00	28.7 Ω, 1/8 W, 1%
R1134	315-0431-00	430 Ω, 1/4 W, 5%
R1138	321-0045-00	28.7 Ω, 1/8 W, 1%
R1141	321-0190-00	931 Ω, 1/8 W, 1%
R1259	321-0287-00	9.53 kΩ 1/8 W, 1%
R1483	315-0472-00	4.7 kΩ, 1/4 W, 5%
R1484	315-0203-00	20 kΩ, 1/4 W, 5%
R1485	315-0273-00	27 kΩ, 1/4 W, 5%
R1488	308-0127-00	2.5 kΩ, 5 W

REMOVE:

C1112	283-0010-00	0.05 µF, Cer, 50 V
C1116	283-0000-00	0.001 µF, Cer, 500 V, +100%-0%

REMOVE:

C1171	281-0564-00	24 pF, Cer, 500 V, 5%
C1381	283-0002-00	0.01 μF, Cer, 500 V
C1486	281-0523-00	100 pF, Cer, 350 V, 20%
L1209	108-0245-00	3.9 μH
R1112	321-0258-00	4.75 kΩ, 1/8 W, 1%
R1113	321-0243-00	3.32 kΩ, 1/8 W, 1%
R1115	315-0470-00	47 Ω, 1/4 W, 5%
R1121	315-0560-00	56 Ω, 1/4 W, 5%
R1122	315-0201-00	200 Ω, 1/4 W, 5%
R1335	311-1373-00	5 kΩ, Var
VR1381	152-0247-00	1N989B, 0.4 W, 150 V, 5%

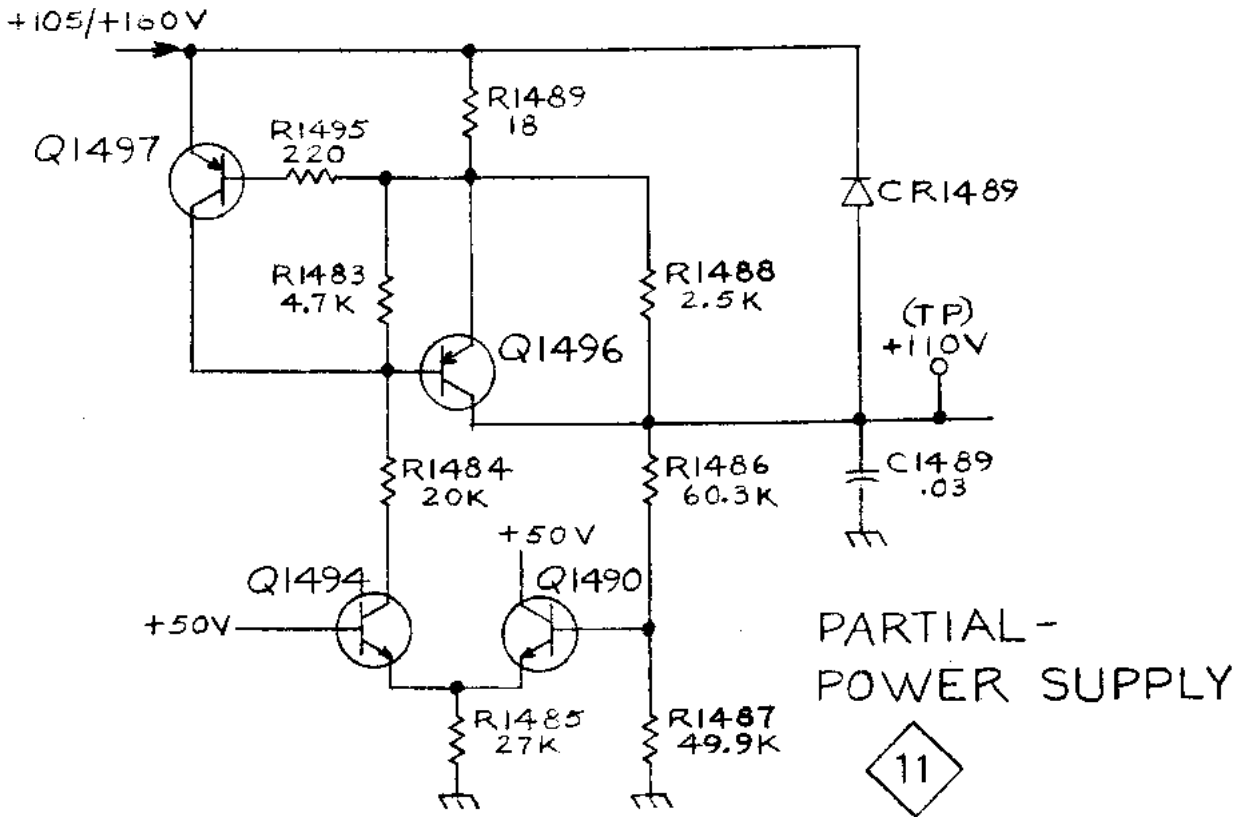
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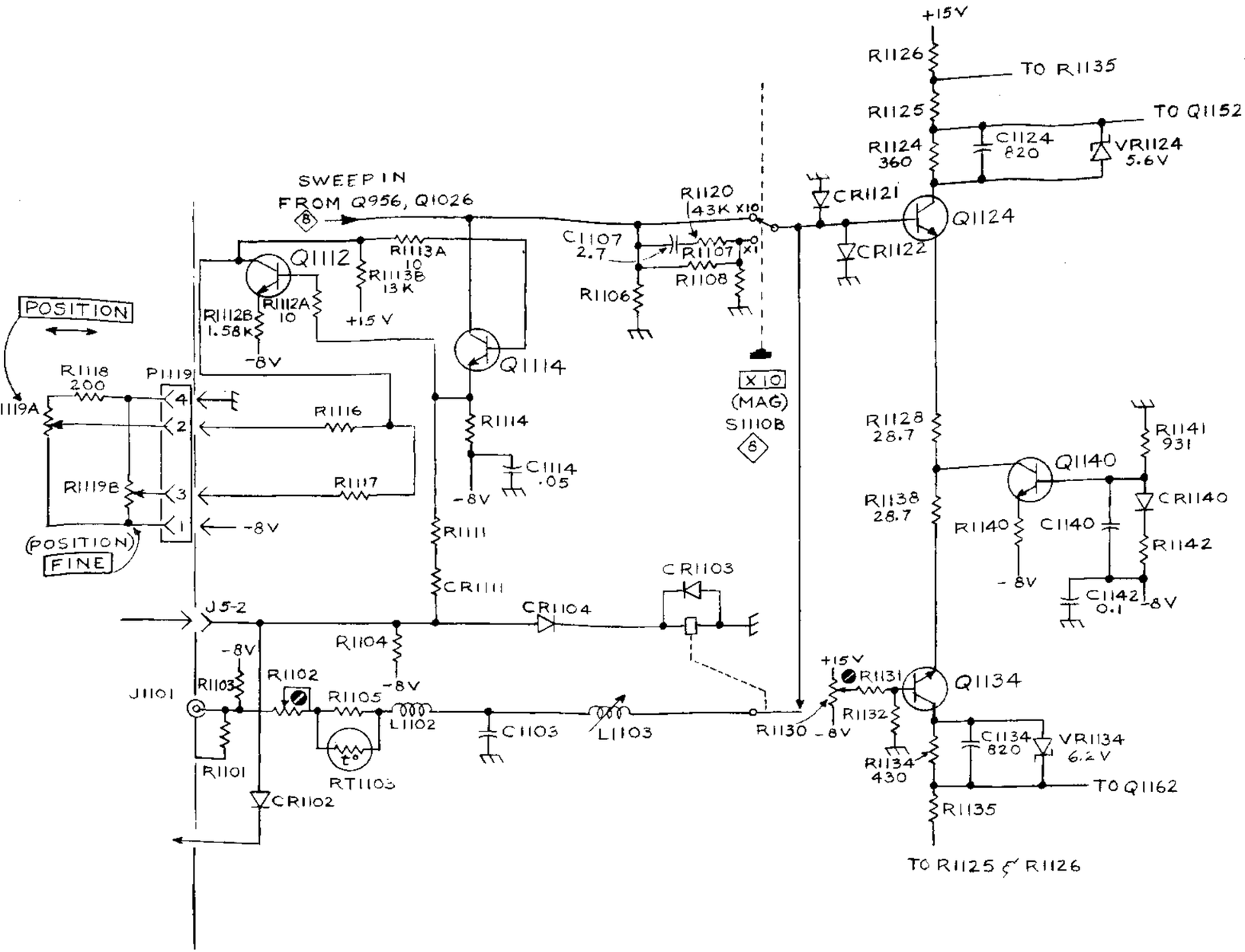
C1107	281-0547-00	2.7 pF, 500 V, 10%
C1114	283-0010-00	0.05 μF, Cer, 50 V
C1142	283-0111-00	0.1 μF, Cer, 50 V
C1329	283-0002-00	0.01 μF, Cer, 500 V
C1455	283-0004-00	0.02 μF, Cer, 150 V
C1504	281-0551-00	390 pF, 500 V
CR1329	152-0107-00	Silicon, TI60 ro 1N647
CR1512	152-0141-02	Silicon, 1N4152
L1252	276-0507-00	Core, ferramic suppressor
Q1112	151-0302-00	Silicon, NPN, 2N2222A
Q1497	151-0301-00	Silicon, PNP, 2N2907
R1112A	316-0100-00	10 Ω, 1/4 W, 10%
R1112B	321-0212-00	1.58 kΩ, 1/8 W, 1%
R1113A	316-0100-00	10 Ω, 1/4 W, 10%
R1113B	321-0300-00	13 kΩ, 1/8 W, 1%

ADD:

R1118	315-0201-00	200 Ω, 1/4 W, 5%
R1120	315-0433-00	43 kΩ, 1/4 W, 5%
R1232	317-0621-00	620 Ω, 1/8 W, 5%
R1252	317-0621-00	620 Ω, 1/8 W, 5%
R1329	316-0106-00	10 MΩ, 1/4 W, 10%
R1335A	311-1533-00	5 kΩ
R1335B		Dual 2.5 MΩ
R1489	315-0180-00	18 Ω, 1/4 W, 5%
R1495	316-0221-00	220 Ω, 1/4 W, 10%
VR1124	152-0175-00	5.6 V, Zener Diode
VR1134	152-0166-00	Selected from 1N753A, 0.4 W, 6.2 V, 5%

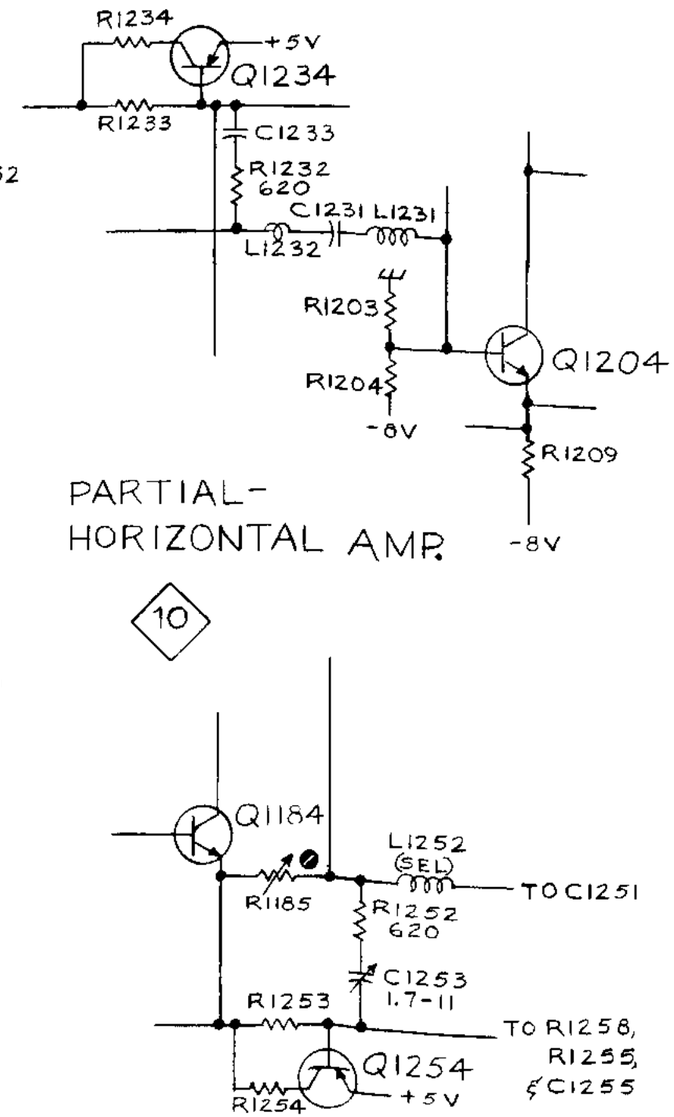
NOTE: C1455 is added in parallel with R1444.





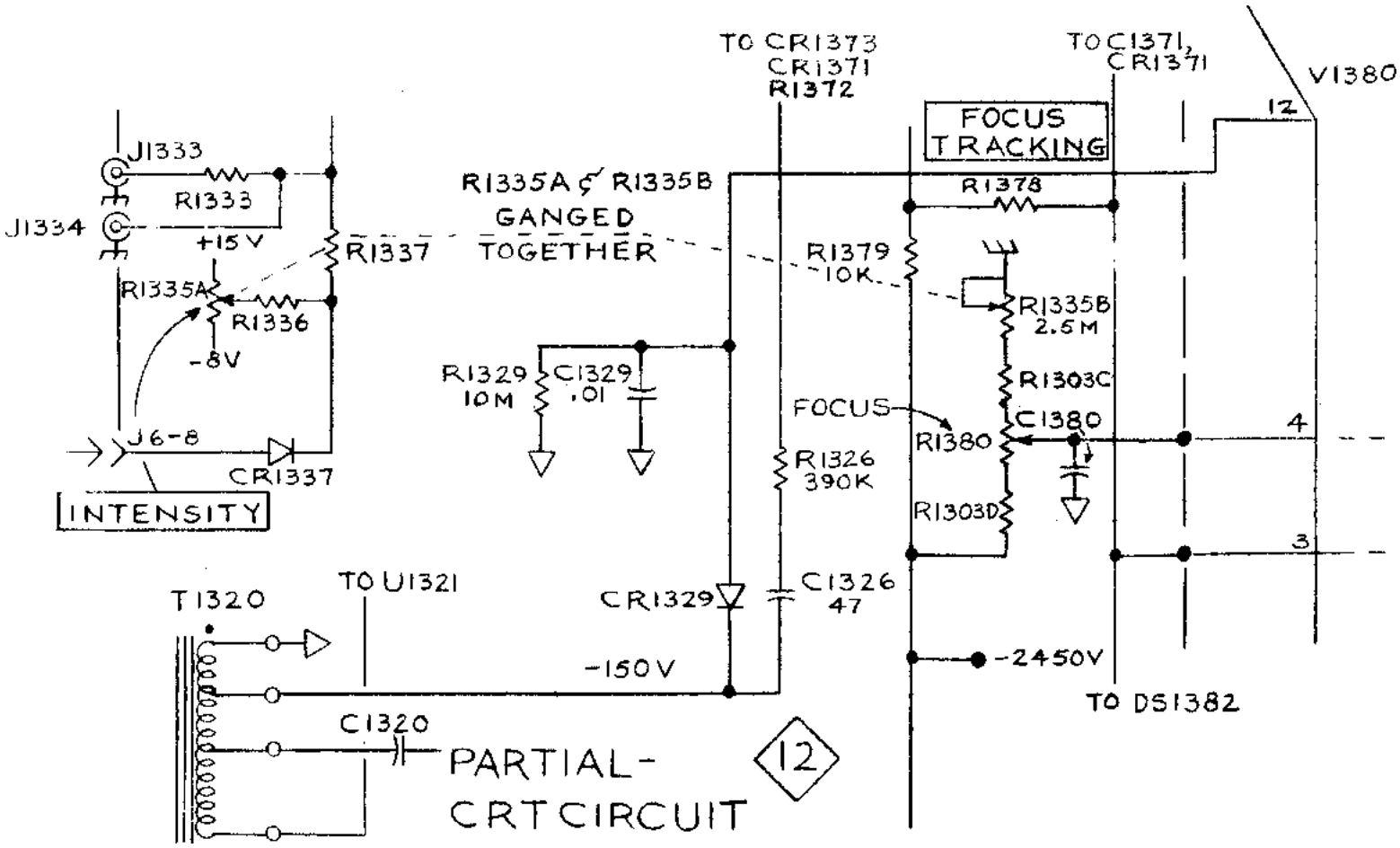
PARTIAL-
HORIZONTAL AMP.

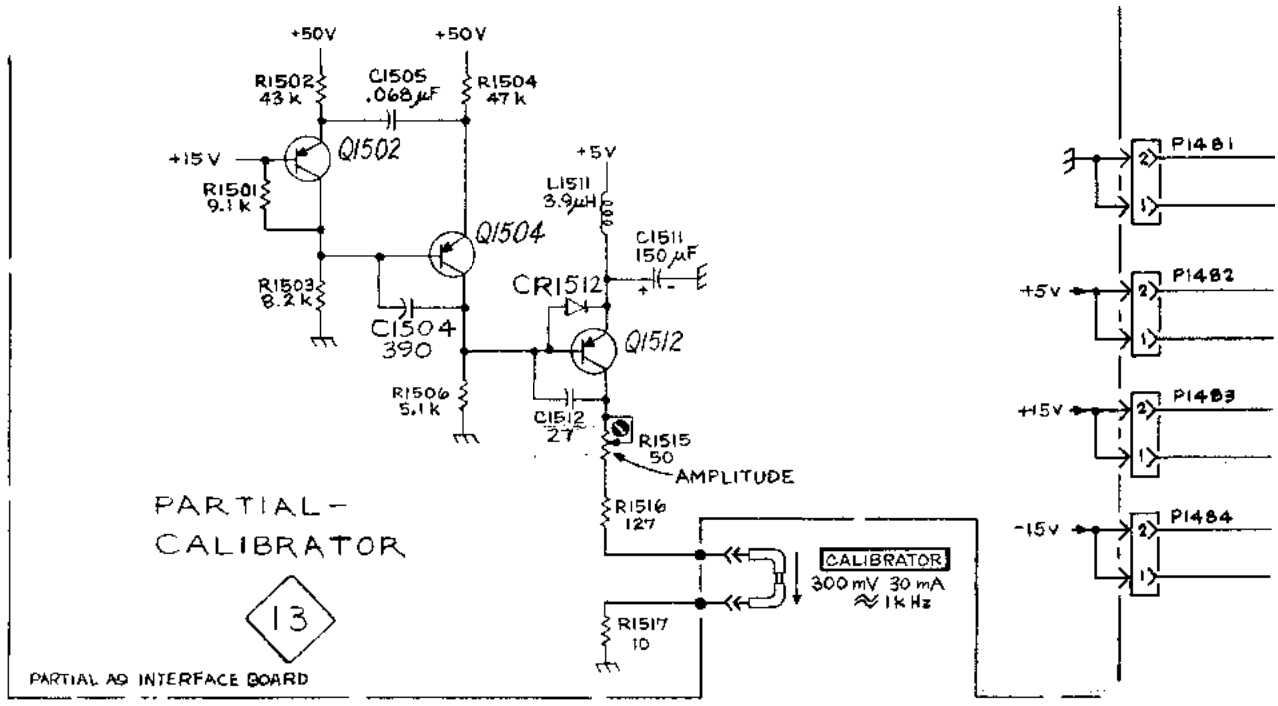
10



M19,919/473

SCHEMATIC CORRECTIONS





M19,919/473

475 EFF SN B100000-up

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

CR104	152-0323-01	Silicon, SE365
CR105	152-0323-01	Silicon, SE365
CR204	152-0323-01	Silicon, SE365
CR205	152-0323-01	Silicon, SE365

ADD:

CR103	152-0323-01	Silicon, SE365
CR203	152-0323-01	Silicon, SE365

(Add CR103 and CR203 in series with CR104 and CR204 respectively.)

475 EFF SN B110000-up

MECHANICAL PARTS LIST CORRECTION

CHANGE TO:

Page 8-6

Fig. 2-66	369-0031-00	B010100	B109999	1	IMPELLER, fan w/setscrew
	369-0031-01	B110000		1	IMPELLER, fan w/setscrew
	105-0507-00	XB110000		1	STOP, end play

475 EFF SN B100000-up

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

U140	155-0078-07	Monolithic, vertical amplifier, selected
U240	155-0078-07	Monolithic, vertical amplifier, selected
U450	155-0078-05	Monolithic, vertical amplifier, selected

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

CHANGE TO:

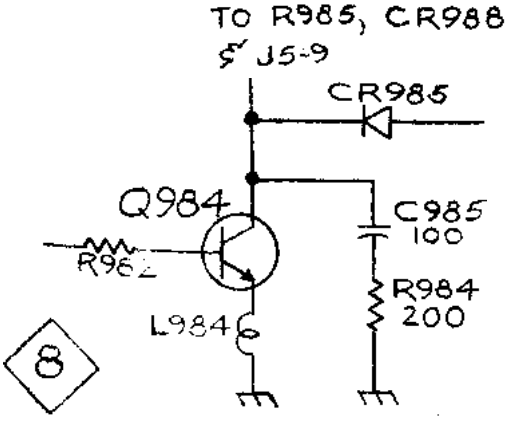
Q1124	151-0212-00	Silicon, NPN, 2N3572
Q1134	151-0212-00	Silicon, NPN, 2N3572
R922	315-0471-00	470 Ω, 1/4 W, 5%

REMOVE:

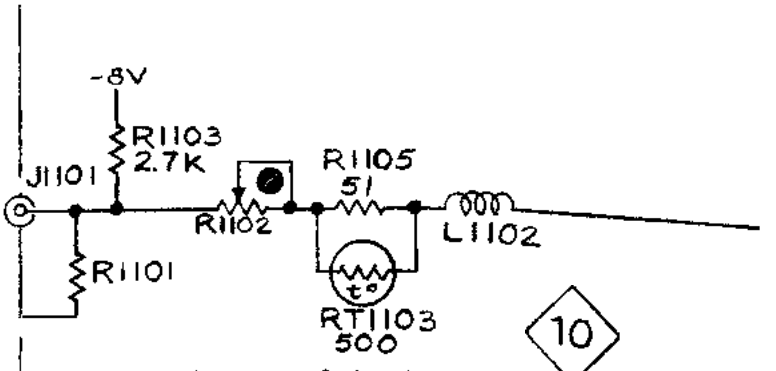
C984	281-0503-00	8 pF, 500 V
RT1123	307-0124-00	5 kΩ, Thermal

ADD:

C985	281-0523-00	100 pF, 350 V
R984	315-0201-00	200 Ω, 1/4 W, 5%
R1105	315-0510-00	51 Ω, 1/4 W, 5%
RT1103	307-0125-00	500 Ω, Thermal



PARTIAL-
SWEEP GEN.



PARTIAL-
HORIZONTAL AMP.

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

CHANGE TO:

C477	281-0123-00	5-25 pF, Cer, 100 V
R447	321-0227-00	2.26 kΩ, 1/8 W, 1%
R448	321-0164-00	499 Ω, 1/8 W, 1%
R454	317-0681-00	680 Ω (nominal value) selected (per M20,104 also)
R455	317-0102-00	1 kΩ (nominal value) selected
R466	311-1278-00	250 Ω, Var
R467	317-0240-00	24 Ω (nominal value) selected
R468	321-0061-00	42.2 Ω, 1/8 W, 1%
R469	321-0061-00	42.2 Ω, 1/8 W, 1%
R470	311-1279-00	500 Ω, Var
R474	317-0240-00	24 Ω (nominal value) selected
R477	315-0821-00	820 Ω, 1/4 W, 5%

REMOVE:

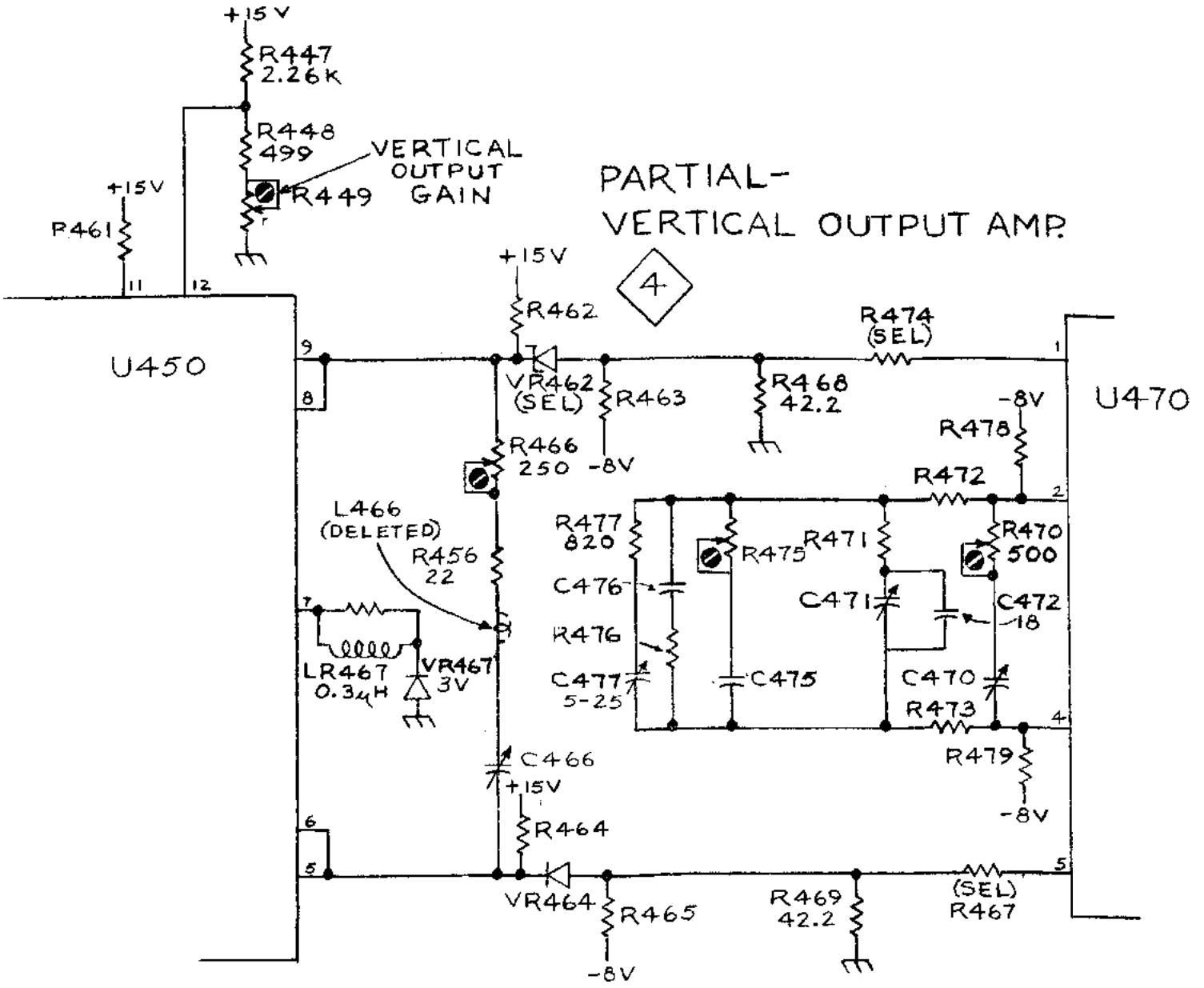
L466		#22 Bare Strap
R446	321-0136-00	255 Ω, 1/8 W, 1%

ADD:

C472	281-0558-00	18 pF, Cer, 500 V
LR467	108-0328-00	0.3 μH
R456	315-0220-00	22 Ω, 1/4 W, 5%
VR467	152-0278-00	1N4372A, 0.4 W, 3V, 5%

475

SCHEMATIC CORRECTION



Note: Original schematic was in error, R466 always connected to U450 pins 8 and 9, and C466 always connected to pins 5 and 6 with L466 located between R466 and C466. (This mod removes L466)

475 EFF SN B070000-up

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

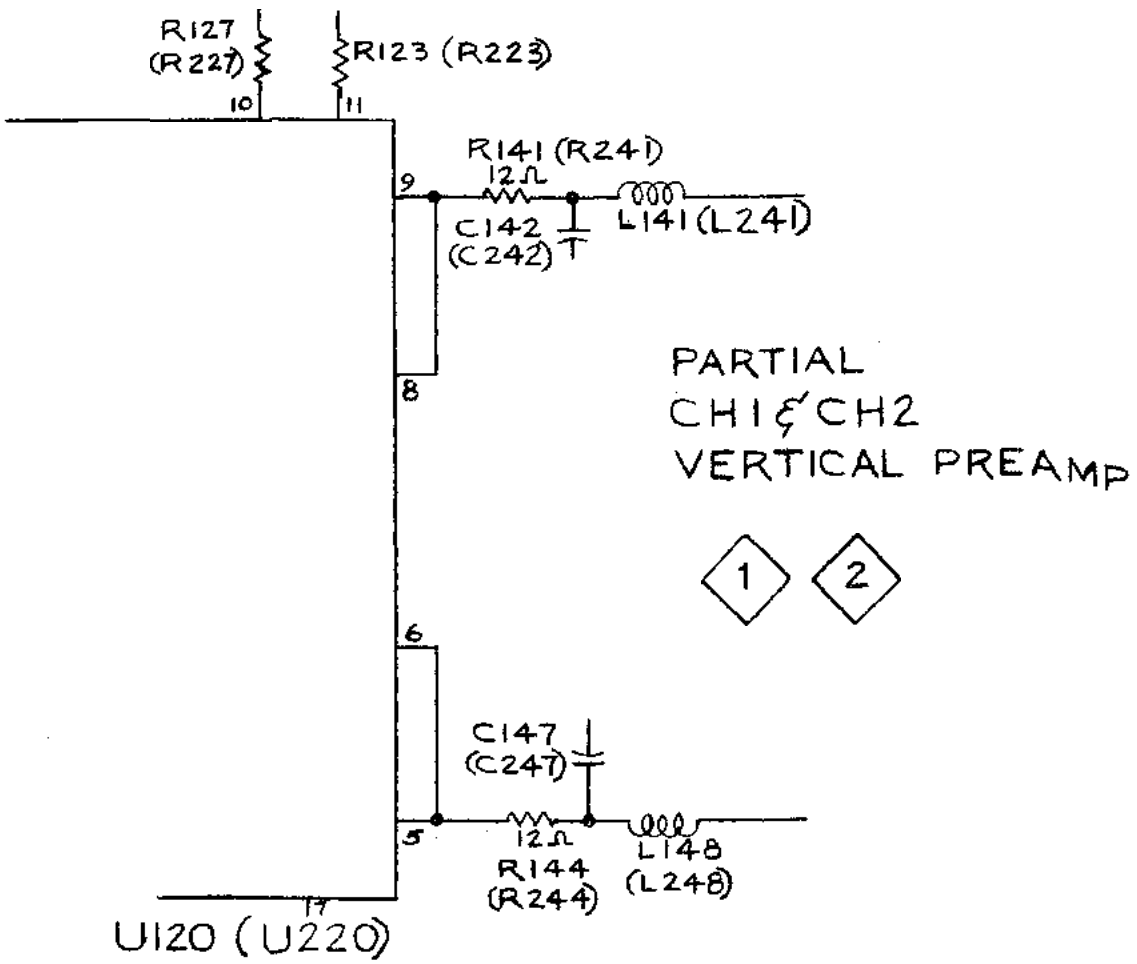
R142	321-0072-00	54.9 ohm (nominal value) selected
R143	321-0072-00	54.9 ohm (nominal value) selected
R242	321-0072-00	54.9 ohm (nominal value) selected
R243	321-0072-00	54.9 ohm (nominal value) selected

475 EFF SN B050000-up

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

ADD:

R141	317-0120-00	12 Ω, 1/8 W, 5% (Added when required)
R144	317-0120-00	12 Ω, 1/8 W, 5% (Added when required)
R241	317-0120-00	12 Ω, 1/8 W, 5% (Added when required)
R244	317-0120-00	12 Ω, 1/8 W, 5% (Added when required)



475 EFF SN B120000-up

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

CHANGE TO:

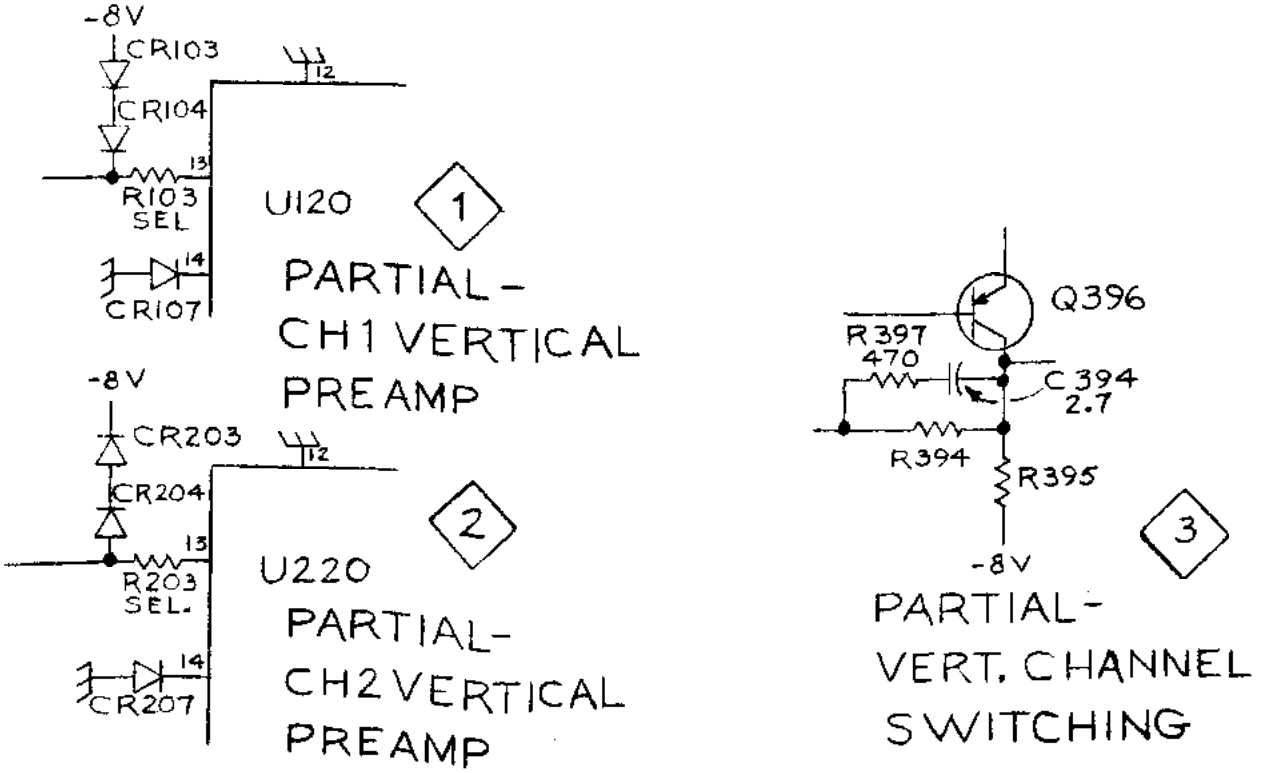
Q390	151-0441-00	Silicon, NPN, 2N2857

REMOVE:

R396 (replaced by a bare strap)	315-0100-00	10 Ω, 1/4 W, 5%

ADD:

C394	281-0547-00	2.7 pF, Cer, 500 V
R103	317-0120-00	12 Ω (nominal value) selected
R203	317-0120-00	12 Ω (nominal value) selected
R397	315-0471-00	470 Ω, 1/4 W, 5%



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