

WARNING

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

465B
OSCILLOSCOPE
WITH OPTIONS

SERVICE

INSTRUCTION MANUAL

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

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OPERATORS SAFETY SUMMARY

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

TFRMS

In This Manual

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

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

As Marked on Equipment

CAUTION indicates either a personal injury hazard not immediately accessible as you read the marking or a hazard to property including the equipment itself.

DANGER or WARNING—HIGH VOLTAGE indicates a personal injury hazard immediately accessible as you read the marking.

SYMBOLS

In This Manual



This symbol is used on schematic diagrams having static-sensitive components.

As Marked on Equipment



DANGER — High voltage.



Protective ground (earth) terminal.

PRECAUTIONS

Power Source

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

Grounding the Product

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

Use the Proper Power Cord

Use only the power cord and connector specified for your product. Use only a power cord that is in good condition.

For detailed information on power cords and connectors, see Installation instructions in Section 2 of this manual.

Refer cord and connector changes to qualified service personnel.

Use the Proper Fuse

To avoid fire hazard, use only the fuse specified in the parts list for this product and having identical type, voltage rating, and current rating characteristics (see Installation instructions in Section 2 of this manual).

Refer internal fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

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

Do Not Remove Covers or Panels

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

SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary.

Do Not Service Alone

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

Use Care When Servicing With Power On

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

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

Power Source

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



Figure 1-1. 465B Oscilloscope.

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INTRODUCTION AND SPECIFICATION

INTRODUCTION

The TEKTRONIX 465B Oscilloscope is a dual-channel, four-trace portable instrument, providing traces for two input channels, a trigger view from an external trigger input, and an add function. Calibrated deflection factors from 5 millivolts/division to 5 volts/division are provided by the dc-to-100 MHz vertical system for the input channels and add function. Sweep trigger circuits are capable of stable triggering over the full bandwidth capabilities of the vertical deflection system. The horizontal deflection system provides calibrated sweep rates from 0.5 second/division to 0.02 microsecond/division along with delayed sweep features for accurate relative-time measurements. A X10 magnifier extends the calibrated sweep rate to 2 nanoseconds/division. The instrument operates over a wide variation of line voltages and frequencies with maximum power consumption of approximately 100 watts.

megohms resistance, 0 to 1200 dc volts (+ or -), and -55°C to +150°C temperature (using a temperature probe). Measurement values are displayed on a 3 1/2-digit LED readout while the oscilloscope continues normal operation.

The digital multimeter and oscilloscope combine to provide a digital readout of time difference between any two points on the oscilloscope display. Both time measurement points are displayed simultaneously on the crt. Direct measurement of frequency is provided by a 1/TIME function.

Increased measurement capabilities are achieved by the 465B when it is equipped with an optional TEKTRONIX DM44 Digital Multimeter. The DM44 measures 0 to 20

This manual provides service information only for the 465B Oscilloscope. Service information for the DM44 Digital Multimeter is contained in a separate DM44 Service manual.

SPECIFICATION

The following electrical characteristics (Table 1-1) are valid only if the instrument has been calibrated at an ambient temperature between +20°C and +30°C, the instrument is operating at an ambient temperature between 0°C and +50°C (unless otherwise noted), and the instrument has had a warmup period of about 20 minutes.

Environmental characteristics of the 465B are presented in Table 1-2, and physical characteristics listed in Table 1-3.

Table 1-1
ELECTRICAL CHARACTERISTICS

Characteristics	Supplemental Information				
	VERTICAL SYSTEM				
Deflection Factor					
Range	5 mV per division to 5 V per division in 10 steps, with a 1-2-5 sequence.	- 1			
Uncalibrated (VAR) Range	Continuously variable between settings. Extends deflection factor to at least 12.5 V per division.				
Accuracy	Within 3%	Gain set at 5 mV per division.			

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
	VERTICAL SYSTEM (cont)	
Low-Frequency Linearity		0.1 division or less compression or expansion of a 2-division signal at center screen with waveform positioned to upper and lower extremes of graticule area.
Frequency Response Bandwidth		5-division reference signal centered vertically from a 25 Ω source with VAR VOLTS/DIV control in calibrated detent position.
−15°C to +40°C	Dc to at least 100 MHz	
+40°C to +55°C	Dc to at least 85 MHz.	
AC Coupled Lower -3 dB Point		
1X Probe	10 Hz or less.	
10X Probe	1 Hz or less.	
Step Response		5-division reference signal centered vertically, dc coupled at all deflection factors, from a 25 Ω source with VAR VOLTS/DIV control in calibrated detent position.
Rise Time (0°C to +40°C)	3.5 ns or less.	
Positive-Going Step (Excluding ADD Mode) Aberrations (0°C to +40°C)		+4%, -4%, 4% p-p or less (5 mV to 2 V) +6%, -6%, 6% p-p or less (5 V setting only).
Position Effect (0°C to +40°C)		Total aberrations less than +6%, -6%, 6% p-p; checked at 5 mV per division.
Negative-Going Step		Add 2% to all positive-going step specifications; checked at 5 mV per division.
ADD Mode Operation		Add 5% to all aberration specifications; checked at 5 mV per division.
Common-Mode Rejection Ratio (ADD Mode with Channel 2 Inverted)		At least 10:1 at 20 MHz for common mode signals of 6 divisions or less, with GAIN adjusted for best CMRR at 50 kHz.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
	VERTICAL SYSTEM (cont)	
Trace Shift as VAR VOLTS/DIV is Rotated		1.0 division or less.
Inverted Trace Shift		Less than 2 divisions when switching from noninverted to inverted.
Input Gate Current		
+20°C to +30°C		0.5 nA or less (0.1 division at 5 mV per division.
-15°C to +55°C		4 nA or less (0.8 division at 5 mV per division.
Channel Isolation		At least 100:1 at 25 MHz.
Position Range		At least +12 and -12 divisions from graticule center.
Chopped Mode Repetition Rate	Approximately 500 kHz.	Within 20%.
Input R and C		
Resistance	1 ΜΩ,	Within 2%.
Capacitance		Approximately 20 pF.
R and C Product (+20°C to +30°C)		Aberrations 2% or less using a P610 probe.
Maximum Input Voltage		
DC Coupled	250 V (dc + peak ac). 500 V (p-p ac at 1 kHz or less).	
AC Coupled	250 V (dc + peak ac). 500 V (p-p ac at 1 kHz or less).	
Cascaded Operation		CH 1 VERT SIGNAL OUT into CH 2 input; AC coupled; using 50 Ω, 42-inch, RG 58 C/U cable terminated in 50 Ω at CH 2 input.
Bandwidth	Dc to at least 50 MHz.	
Sensitivity	At least 1 mV per division	

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Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information	
	TRIGGER SYSTEM		
Sensitivity		When in EXT/10, multiply performance requirement by 10.	
AC Coupled Signal	0.3 division internal or 50 mV external from 30 Hz to 10 MHz, increasing to 1.5 divisions internal or 150 mV external at 100 MHz.		
LF REJ Coupled Signal	0.5 division internal or 100 mV external from 50 kHz to 10 MHz, increasing to 1.5 divisions internal or 300 mV external at 100 MHz.	Attenuates signals below about 50 kHz	
HF REJ Coupled Signal	0.5 division internal or 100 mV external from 30 Hz to 50 kHz.	Attenuates signals above about 50 kHz	
DC Coupled Signal	0.3 division internal or 50 mV external from dc to 10 MHz, increasing to 1.5 divisions internal or 150 mV external at 100 MHz.		
Trigger Jitter	0.5 ns or less at 100 MHz at 2 ns per division with X10 MAG depressed.		
External Trigger Inputs			
Maximum Input Voltage	250 V (dc + peak ac). 250 V (p-p ac at 1 kHz or less).		
Input Resistance	1 ΜΩ	Within 10%.	
Input Capacitance		Approximately 20 pF, within 10%.	
LEVEL Control Range			
EXT	At least +2 and -2 V; 4 V p-p.		
EXT/10	At least +20 and -20 V; 40 V p-p.		
Trigger View (A TRIGGER) Deflection Factor		DC trigger COUPLING only; checked with 1 kHz signal.	
EXT	100 mV per division $\pm 5\%$.		
EXT/10	1 V per division ±5%.		
Rise Time	5 ns or less	20 MHz BW LIMIT at full bandwidth (button out).	

Table 1-1 (cont)

Characteristics	Performance Requirements		Supplemental Information
	TRIGGER SY	STEM (cont)	
Delay Difference	$\leq \pm 0.15$ division ($\leq \pm 300$ ps at 2 ns per division).		With a 5-division signal having a 5-ns rise time or less from a 25 Ω source, centered vertically, with equal 50 Ω cable lengths from signal sources to vertical channel and external trigger inputs terminated in 50 Ω at each input.
Centering of Trigger Point			Within 1.0 division of center screen.
Flatness and Aberrations			+10%, -10%, 10% p-p.
	HORIZONTAL DEF	LECTION SYSTE	EM
Sweep Rate			
Calibrated Range			
A Sweep	0.5 s per division to 0.02 μs per division in 23 steps in a 1-2-5 sequence. X10 MAG extends maximum sweep rate to 2 ns per division.		
B Sweep	50 ms per division to 0.02 μs per division in 20 steps in a 1-2-5 sequence. X10 MAG extends maximum sweep rate to 2 ns per division.		
Accuracy	Unmagnified	Magnified	Accuracy specification applies over the full 10 divisions.
+20°C to +30°C	Within ±2%.	Within $\pm 3\%$.	When in X10 MAG, exclude first and las
−15°C to +55°C	Within ±3%.	Within ±4%.	50 ns of the sweep on 2-ns, 5-ns, 10-ns, and 20-ns sweep rates.
Two-Division Linearity Check			±5% over any two-division (or less) portion of the full 10 divisions. When in X10 MAG, exclude first and last magnified divisions when checking 2-ns, 5-ns, and 10-ns per division rates.
Alternate Sweep Trace Separation			≥±4 divisions.
Variable Range (A Only)	Continuously variable between calibrated settings. Extends slowest A Sweep rate to at least 1.25 s per division.		At least 2.5:1.
Sweep Length (A Only)			10.5 to 11.5 divisions.

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Table 1-1 (cont)

Characteristics	Performance Requirements		Supplemental Information
	HORIZONTAL DEF	LECTION SYSTEM (cont)
A Trigger Holdoff Variable	Increases A Sweep holdoff time by at least a factor of 10.		
X10 Magnifier Registration			Within 0.2 division from graticule center (X10 MAG on to X10 MAG off).
Position Range			Start of sweep must position to right of graticule center. End of sweep must position to left of graticule center.
Differential Time Measurement Accuracy	For Measure- ments of ≥1 Major Dial Division	For Measure- ments of <1 Major Dial Division	With the A TIME/DIV switch at 0.5 μ s and 0.2 μ s the differential time measurement accuracy limit is valid only for DELAY TIME POSITION
+15°C to +35°C	Within $\pm 1\%$.	Within ±0.01 major dial division.	dial settings between 1.50 and 8.50.
−15°C to +55°C	Within ±2.5%.	Within ±0.03 major dial division.	
Delay Time Jitter	One part (or less) in 50,000 (0.002%) of ten times the A TIME/DIV switch setting, when operating on power-line frequencies other than 50 Hz. One part (or less) in 20,000 (0.005%) of A TIME/DIV switch setting, when operating on 50 Hz power-line frequency.		
Calibrated Delay Time	Continuous from 0.2 μ s to at least 5 seconds after start of the delaying (A) sweep.		With VAR control in calibrated detent.
X-Y Operation			With TIME/DIV switch set to extreme counterclockwise position.
X-Axis			
Deflection Factor	Same as vertical channel.		With X10 MAG off.
Bandwidth	Dc to at least 4 MHz.		10-division reference signal.
Variable Range	Continuously variable between settings. Extends deflection factor to at least 12.5 V per division.		

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
	HORIZONTAL DEFLECTION SYSTEM	(cont)
X-Y Operation (cont)		
Input R and C		
Resistance	1 ΜΩ.	Within 2%.
Capacitance	Approximately 20 pF.	Within 3%.
Maximum Usable Input Voltage		
DC Coupled	250 V (dc + peak ac). 500 V (p-p ac at 1 kHz or less).	
AC Coupled	250 V (dc + peak ac). 500 V (p-p ac at 1 kHz or less).	
Phase Difference Between X and Y Axis Amplifiers		Within 3°, from dc to 50 kHz.
Deflection Accuracy	Within ±4%.	
	CALIBRATOR	
Output Voltage (0°C to +40°C) (-15°C to +55°C)	0.3 V, within 1%.	0.3 V, within 1.5%.
Repetition Rate	Approximately 1 kHz.	Within 25%.
Output Resistance		Approximately 10.3 Ω.
Output Current		
+20°C to +30°C	30 mA, within 2%.	
-15°C to +55°C		30 mA, within 2.5%.
	Z-AXIS INPUT	
Sensitivity	5-volt p-p signal causes noticeable modulation at normal intensity.	Positive-going signal decreases intensity.
Usable Frequency Range	Dc to 50 MHz.	
Maximum Input Voltage		25 V (dc + peak ac)

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
	SIGNAL OUTPUTS	
Channel 1 Output		
Voltage	At least 50 mV per division into 1 MΩ. At least 25 mV per division into 50 Ω.	
Resistance		Approximately 50 Ω.
Bandwidth	Dc to at least 50 MHz into 50 Ω.	
A and B Gates Output Resistance		Approximately 500 Ω.
	POWER SOURCE	
Line Voltage Ranges		
115 V Nominal		
(High)	108V to 132 V.	
(Medium)	104 V to 126 V.	
(Low)	99 V to 121 V.	
230 V Nominal		
(High)	216 V to 250 V.	
(Medium)	208 V to 250 V.	
(Low)	198 V to 242 V.	
Line Frequency	48 Hz to 440 Hz.	
Power Consumption		
Typical	65 W at 115 V, 60 Hz, medium range.	
Maximum	85 W at 115 V, 60 Hz, medium range.	
	CATHODE-RAY TUBE	
Display Area	8 X 10 cm.	
Geometry		0.1 division or less of tilt or bowing.
Trace Rotation Range		Adequate to align trace with horizontal center line.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
	CATHODE-RAY TUBE (cont)	
Raster Distortion		0.1 division or less.
Standard Phosphor	P31.	
Optional Phosphor	P11.	
Nominal Accelerating Potential		≈18,500 V.
	DM44	
Dc Voltage		
Ranges	0 to 1.2 kV in 5 steps: 200 mV, 2 V, 20 V, 200 V, and 1.2 kV.	
Resolution	100 μV.	
Accuracy	Within 0.1% of reading, ±1 count.	
Input Resistance	10 M Ω , all ranges (user has option to remove an internal wire strap to increase input resistance to 1000 M Ω on the 200 mV and 2 V ranges).	
Rejection Ratio		
Normal Mode	At least 60 dB at 50 and 60 Hz.	
Common Mode	At least 100 dB at dc; 80 dB at 50 and 60 Hz.	
Recycle Time	Approximately 3.3 measurements per second.	
Response Time	Within 0.5 second.	
Temperature Dependence	45 parts/million/°C.	
Maximum Safe Input Voltage, All Ranges	±1200 V (dc + peak ac) between + and COM inputs or between + input and chassis.	
COM (Common) Floating Voltage	±500 V (dc + peak ac) to chassis.	
Resistance		
Ranges	0 to 20 M Ω in six steps: 200 Ω , 2 k Ω , 20 k Ω , 200 k Ω , 2 M Ω , and 20 M Ω .	
Resolution	0.1 Ω.	

introduction and Specification—465B Service

Table 1-1 (cont)

	Та	ble 1-1 (cont)			
Characteristics	Performance Requirements		Supplemental i	nformation	
		DM44 (cont)			
Accuracy					
200 Ω and 2 $k\Omega$ Ranges	Within 0.25% ± 1 count, $+$ probe resistance.				
20 kΩ, 200 kΩ, and 2 MΩ Ranges	Within 0.25%,	±1 count.			
20 MΩ Range	Within 0.30%,	±1 count.			
Recycle Time	Approximatel per second.	y 3.3 measurer	ments		
Response Time					
200 Ω through 200 $k\Omega$ Ranges	Within 1 seco	nd.			
2 MΩ and 20 MΩ Ranges	Within 5 seco	nds.			
Maximum Safe Input Voltage	120 V rms between + and COM inputs for an indefinite time.			220 V rms between + for 1 minute or less.	and COM inputs
Temperature Dependence					
20 $k\Omega$ through 2 $M\Omega$				250 parts/million/° C.	
200 Ω , 2 k Ω , and 20 M Ω Ranges				350 parts/million/°C.	
Approximate current supplied to				Ω Range	Current
unknown resistance				200 Ω and 2 kΩ	1 mA
				20 kΩ	100 μΑ
				200 kΩ	10 μA
				2 ΜΩ	1 μΑ
				20 ΜΩ	100 nA
Temperature					
Range	-55°C to +150°C in one range.				
Accuracy (with constant	Ambient	Probe Tlp			
temperature and infinite	Temperature	Temperature	Accuracy		
heat source)	(°C)	(°C)	(°C)		
Probe Calibrated to DM44	+15 to +35	-55 to +150	±2		
	-15 to +55			1	
	-15 to +55	1	 	1	
Probe Not Calibrated to DM44	+15 to +35	-		1	
	-15 to +55			1	

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
	DM44 (cont)	
Time (Differential Delay)		
Accuracy		
+15°C to +35°C	Within 1% of reading, ±1 count.	
-15°C to +55°C	Within 2.5%, ±1 count.	
1/TIME		
Accuracy		
+15°C to +35°C	Within 2% of reading, ±1 count.	
-15°C to +55°C	Within 3.5%, ±1 count.	

Table 1-2
ENVIRONMENTAL CHARACTERISTICS

Characteristics	Description		
	NOTE: All of the following tests meet the requirements of MIL-T-28800B, Type III Class 3, Style D equipment.		
Temperature			
Operating	−15°C to +55°C.		
Non-operating	-62°C to +85°C.		
Altitude			
Operating	To 15,000 ft.		
Non-operating	To 15,000 m (50,000 ft).		
Humidity (Operating and Non-operating)	Five cycles (120 hr) referenced to MIL-T-28800B, para 3.9.2.2. 95% to 97% relative humidity.		
Vibration (Operating)	15 minutes along each of three major axes at a total displacement of 0.025 inch p-p (4 g at 55 Hz) with frequency varied from 10 Hz to 55 Hz to 10 Hz in one minute sweeps. After sweep vibration in each axis, frequency held steady at each major resonance for 10 minutes, or if no such resonances found, held at 55 Hz for 10 minutes.		
Shock (Operating and Non-operating)	30 g, half-sine, 11-ms duration, 3 shocks per axis each direction, for a total of 18 shocks.		
EMI	Meets MIL-STD-461A/462.		

Introduction and Specification—465B Service

Table 1-3
PHYSICAL CHARACTERISTICS

Characteristics	Description	
Weight		
With Panel Cover, Accessories, and Accessory Pouch	11.5 kg (25.3 lb).	
Without Panel Cover, Accessories and Accessory Pouch	10.4 kg (22.8 ib).	
Domestic Shipping Weight	14.9 kg (32.7 ib).	
Export Shipping Weight	Approximately 22 kg (48 lb)	
Height		
With Feet and Pouch	19.1 cm (7.5 in).	
Without Pouch	15.7 cm (6.2 in).	
Width		
With Handle	32.8 cm (12.9 in).	
Without Handie	29.2 cm (11.5 in).	
Depth		
Including Panel Cover	46.0 cm (18.1 in).	
With Handie Extended	51.6 cm (20.3 in).	

OPERATING INSTRUCTIONS

This section of the manual provides information on instrument installation and power requirements and describes the functions of controls, connectors, and indicators. In addition, it includes procedures intended to familiarize the operator with obtaining basic oscilloscope displays. For more complete operating information, refer to 465B/DM44 Operators Manual.

INSTALLATION

The 465B is shipped in its carton with the standard accessories listed on the Accessories tab page at the end of this manual. At installation time, save the shipping carton and packaging materials for repackaging. Refer to the Maintenance section of this manual for repackaging information.

Line Voltage Selection

WARNING

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

PREPARATION FOR USE

Safety Considerations

CAUTION

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

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

The 465B is designed to be used with a three-wire ac power system. If a three-to-two wire adapter is used to connect this instrument to a two-wire ac power system, be sure to connect the ground lead of the adapter to earth (ground). Failure to complete the ground system may allow the chassis of this instrument to be elevated above ground potential, thus posing a shock hazard.

This instrument operates from either a 115-volt or a 230-volt nominal line voltage source at 48 hertz to 440 hertz. To convert the instrument for operation from one line voltage range to the other, move the Line Voltage Selector switch located on the right side panel to the position indicating the correct nominal voltage.

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

Table 2-1
POWER CORD CONDUCTOR IDENTIFICATION

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

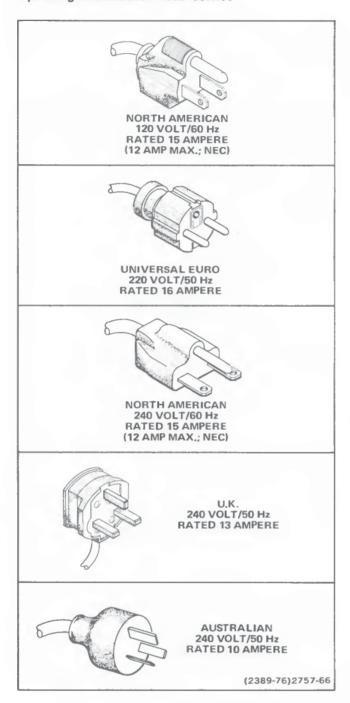


Figure 2-1. Commonly used power plugs.

Regulating Range Selection

The Regulating Range Selector assembly located on the rear panel contains the Regulating Range Selector bar and the line fuse. Verify that the selector bar is set for the average line voltage being used and that the proper line fuse is installed. To change the regulating range:

- 1. Disconnect the instrument from its power source.
- 2. Loosen the two captive screws that hold the cover on the selector assembly; then pull to remove the cover.

- Pull out the selector bar (see Figure 2-2). Select a range from Table 2-2 centered about the average line voltage and plug the selector bar into the desired position.
- Insert the proper fuse (selected from Table 2-3) into its holder.
- Gently push the cover on and tighten the captive screws.
- Before applying power to the instrument, verify that the Line Voltage Selector switch and the indicating tab on the Regulating Range Selector assembly are in their correct positions for the desired nominal line voltage and regulating range.

Table 2-2
REGULATING RANGE

Regulating	Regulation	ng Range
Range Selector Bar Position	115-Voit Nominal	230-Volt Nominal
Upper Holes	108 to 132 volts	216 to 250 volts
Middle Holes	104 to 126 volts	208 to 250 volts
Lower Holes	99 to 121 volts	198 to 242 volts

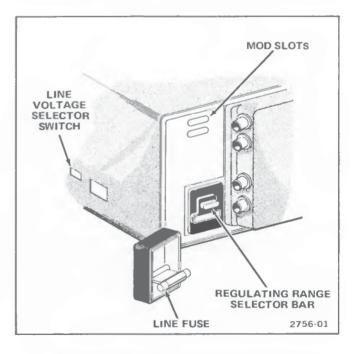


Figure 2-2. Regulating range selector and line fuse.

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Table 2-3
FUSE SELECTION

Line Voltage Selector Switch Position	Fuse Size
115-Volt Nominal	1.5 A, 3AG, Fast-blow
230-Volt Nominal	0.75 A, 3AG, Fast-blow

Instrument Cooling

To maintain adequate instrument cooling, the ventilation holes in the equipment cabinet must remain open, and the air filter must be cleaned or replaced when it gets dirty.

Rackmounting

For rackmounting details refer to the rackmounting installation instructions at the end of this section.

CONTROLS, CONNECTORS, AND INDICATORS

The major controls, connectors, and indicators for operation of the 465B are located on the front panel of the instrument. A few auxiliary functions are provided on the rear panel. Figures 2-3 through 2-7 show the front and rear panels of the instrument with the controls, connectors, and indicators called out. The circled numbers correspond to the discussions about particular controls, connectors, and indicators. If your instrument is equipped with a DM44 Digital Multimeter, refer to either the 465B/DM44 Operators Manual or the DM44 Service Manual for descriptions of DM44 controls, connectors, and indicators.

- 5 POSITION Controls—Determine the vertical position of the display on the crt. In the X-Y mode, the Channel 2 POSITION control moves the display vertically (Y-axis), and the Horizontal POSITION control moves the display horizontally (X-axis).
- 6 CH 1 OR X and CH 2 OR Y bnc Connectors—Provide for application of external signals to the inputs of the vertical amplifier. In the X-Y mode, the signal connected to the CH 1 OR X connector provides horizontal deflection, and the signal connected to the CH 2 OR Y connector provides vertical deflection. These connectors each include a coding ring that activates the scale-factor-switching circuit whenever a 10X scale-factor-switching probe is connected.

VERTICAL

Refer to Figure 2-3 for location of items 1 through 11.

- 1 VOLTS/DIV Switches—Select the vertical deflection factor for Channel 1 and Channel 2 in a 1-2-5 sequence. VAR control must be in the calibrated detent to obtain a calibrated deflection factor.
- VOLTS/DIV Readouts—Consist of two light emitting diodes (LED) for each channel, located beneath the skirt of each VOLTS/DIV knob. One LED or the other will light to indicate the correct deflection factor. The 10X LED is illuminated only when a 10X probe with a scale-switching coding-ring contact is connected to the input of the oscilloscope; otherwise, the 1X LED is illuminated.
- VAR—Provides continuously variable uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV switches.
- UNCAL Indicator—A LED that lights when the VAR VOLTS/DIV control is out of the calibrated detent, and the vertical deflection factor is uncalibrated.

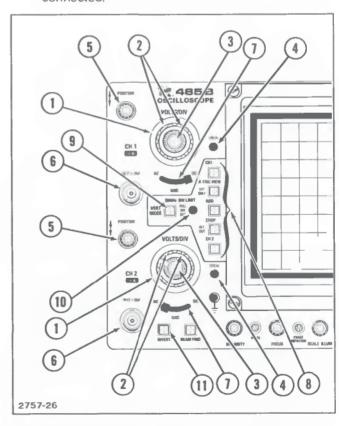


Figure 2-3. Vertical controls, connectors, and indicators.

Operating Instructions-465B Service

AC-GND-DC Switch—Selects the method used to couple a signal to the input of the vertical amplifier.

AC position—Signals are capacitively coupled to the vertical amplifier. The dc component of the input signal is blocked.

GND position—The input of the vertical amplifier is grounded to provide a ground reference and to allow the input coupling capacitor to precharge.

DC position—All frequency components of the input signal are passed to the vertical input amplifier.

8 VERT MODE Switches—Select mode of operation for vertical amplifier system. When either CHOP or ALT mode is selected, display of any combination of CH 1, CH 2, ADD, and A TRIG VIEW (EXT ONLY) is allowed. When all buttons are out, a single trace will be displayed, provided that either TRIG MODE is in AUTO or TRIG MODE is in NORM with a triggerable signal applied to a vertical input connector. This trace will not display intelligence and is unaffected by position controls.

NOTE

Four display traces may simultaneously be observed on the 465B crt. Each VERT MODE push button must be depressed and released a second time to remove the signal from the corresponding displays.

CH 1—Displays Channel 1 signals when pushbutton is pressed in.

A TRIG VIEW—Displays the A external trigger input signal when push button is pressed in and when the A TRIGGER SOURCE switch is set to EXT or EXT/10.

ADD—Displays the algebraic sum of the Channel 1 and Channel 2 input signals when ADD push button is pressed in. The INVERT switch in Channel 2 allows the display to be either CH 1 plus CH 2 or CH 1 minus CH 2. The ADD capability is useful for common-mode rejection to remove an undesired signal or dc offset.

CHOP ALT: OUT—The 465B "chops" (switches) between two or more of the display modes at a 500-kHz rate when CHOP ALT: OUT button is pressed in. When released, the 465B "alternates"

between two or more of the four display modes at the end of each trace sweep. CHOP and ALT functions are disabled if only one VERT MODE push button (CH 1, CH 2, ADD, or A TRIG VIEW) is selected or if the X-Y mode is selected.

CH 2—Displays Channel 2 signals when push button is pressed in.

- 20 MHz BW LIMIT (FULL BW OUT) Switch—Limits the bandwidth of the vertical amplifier to approximately 20 MHz when pressed in. Push button must be depressed and released a second time to regain full 100-MHz bandwidth operation.
- 20 MHz BW LIMIT Indicator—This LED is illuminated whenever the 20 MHz BW LIMIT push button is pressed in, and bandwidth is limited to 20 MHz.
- 11) INVERT—Inverts Channel 2 display when push button is pressed in. Push button must be depressed and released a second time to present a noninverted display.

DISPLAY AND CALIBRATOR

Refer to Figure 2-4 for location of items 12 through 19.

- 12 Internal Graticule—Eliminates parallax. Risetime and amplitude measurement points are indicated at the left edge of the graticule.
- BEAM FIND Switch—Compresses the display to within the graticule area and provides a visible viewing intensity to aid in locating off-screen displays.
- 14 INTENSITY Control—Determines overall brightness of the A Sweep and B Sweep crt displays. Interacts with B INTENSITY control on B Sweep crt displays.
- 15 FOCUS Control—Adjusts for optimum display definition.

- CALIBRATOR Loop—A combination 30-milliamp current loop and 0.3-volt square-wave voltage output (approximately 1 kilohertz) that permits the operator to compensate voltage probes and to check oscilloscope vertical operation. It is not intended to verify precise time-base calibration.
- SCALE ILLUM Control—Adjusts graticule illumination.
- ASTIG Control—Screwdriver control used in conjunction with the FOCUS control to obtain a well-defined display. It does not require readjustment during normal use of the instrument.
- TRACE ROTATION Control—Screwdriver control used to align trace with the horizontal graticule lines.

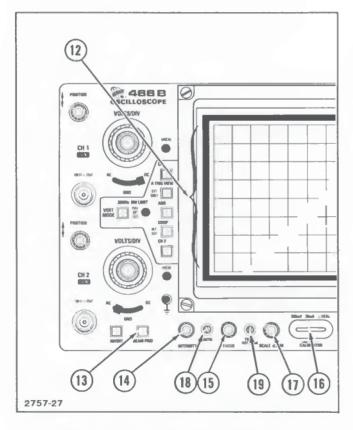


Figure 2-4. Display controls and calibrator.

TRIGGER (A and B where applicable)

Refer to Figure 2-5 for location of items 20 through 28.

TRIG MODE Switches—Three push button switches determine the mode of trigger operation for the A Sweep.

AUTO—Sweep is initiated by the applied trigger signal. In the absence of an adequate trigger signal, or if the trigger repetition rate is less than about 20 hertz, the sweep free runs and provides a bright reference trace.

NORM—Sweep is initiated by the applied trigger signal. In the absence of an adequate trigger signal, there is no trace. When the trigger rate is too low for AUTO, use NORM.

SINGL SWP—When this push button is pressed, the A Sweep operates in the single-sweep mode. After a single sweep is displayed, further sweeps cannot be presented until the SINGL SWP push button is again pressed. SINGL SWP is useful in displaying and photographing either non-repetitive signals or signals that cause unstable conventional displays (e.g., signals that vary in amplitude, shape, or time).

- READY Indicator—LED illuminates to indicate that A Sweep is "armed" and will present a single-sweep display upon receipt of an adequate trigger signal.
- TRIG Indicator—LED illuminates to indicate that A Sweep is triggered and will produce a stable display. It is useful for setting up the trigger circuits when a trigger signal is available without a display on the crt (for example, when using external triggers).
- A TRIGGER HOLDOFF Control—Provides continuous control of time between sweeps. Allows triggering on aperiodic signals (such as complex digital words). In the fully clockwise position (B ENDS A), the A Sweep is automatically terminated at the end of the B Sweep to provide the fastest possible sweep repetition rate for delayed-sweep presentations and low-repetition rate signals. In this position, Holdoff is approximately ten times NORM. Use the A trigger controls for most stable triggering before setting the A TRIGGER HOLDOFF control to a position other than NORM.

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COUPLING Switch—Determines method used to couple signals to the trigger generator circuit.

AC—Signals are capacitively coupled to the input of the trigger circuit. Dc is rejected, and signals below about 30 hertz are attenuated. Triggering is allowed only on the ac portion of the vertical signal.

LF REJ—Signals are capacitively coupled to the input of the trigger circuit. Dc is rejected, and signals below about 50 kilohertz are attenuated. It is useful for providing a stable display of the high-frequency components of a complex waveform.

HF REJ—Signals are capacitively coupled to the input of the trigger circuit. Dc is blocked, and signals below about 30 hertz and above 50 kilohertz are attenuated. It is useful for providing a stable display of the low-frequency components of a complex waveform.

DC—All frequency components of a trigger signal are coupled to the input of the trigger circuit. It is useful for providing a stable display of low-frequency or low-repetition rate signals.

- SLOPE Switch—Selects the slope of the signal that triggers the sweep.
 - +: Sweep can be triggered from the positivegoing portion of a trigger signal.
 - -: Sweep can be triggered from the negativegoing portion of a trigger signal.
- **LEVEL Control**—Selects the amplitude point on the trigger signal at which the sweep is triggered. It is usually adjusted for the desired display after trigger SOURCE, COUPLING, and SLOPE have been selected.
- SOURCE Switch—Determines the source of the trigger signal coupled to the input of the trigger circuit.

NORM—Trigger source is a sample of the signal displayed on the crt.

CH 1—A sample of the signal applied to the Channel 1 input is used as a trigger signal. Channel 2 signal is unstable if it is not time-related.

CH 2—A sample of the signal applied to the Channel 2 input is used as a trigger signal. Channel 1 crt display is unstable if it is not time-related.

LINE (A Trigger Circuit Only)—A sample of the power-line sinusoidal waveform is used as a trigger signal. It is useful when the input signal is time-related (multiple or submultiple) to the line frequency or when it is desirable to provide a stable display of a line-frequency component in a complex waveform.

EXT—Signals connected to the External Trigger input connectors are used for triggering. External signals must be time-related to the displayed signal for a stable display. It is useful when the internal signal is either too small or contains undesired signals that could cause unstable triggering. It is also useful when operating in the CHOP mode. EXT and EXT/10 trigger signals may be viewed on the crt by selecting A TRIG VIEW on the VERT MODE switch.

EXT/10 (A Trigger Circuit Only)—External trigger signal is 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 control and is independent of the B Trigger signal. When making differential time measurements, you must use this mode to obtain valid measurements. On instruments equipped with a DM44 you must use this mode to obtain valid measurements when using the TIME or 1/TIME functions.

External Trigger Input Bnc Connectors—Connect external trigger input signals for A TRIGGER and B (DLY'D) TRIGGER circuits, when either EXT or EXT/10 (A Trigger only) SOURCE is selected.

2-6

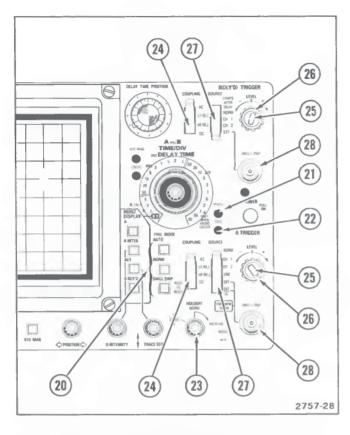


Figure 2-5. Trigger controls, connectors, and indicators.

HORIZONTAL AND POWER

Refer to Figure 2-6 for location of items 29 through 40.

- A AND B TIME/DIV AND DELAY TIME Switches—A TIME/DIV (clear plastic skirt) selects the sweep rate of the A Sweep circuit for A Sweep operation only. Also selects the basic delay time (used in conjunction with the DELAY TIME POSITION control) for delayed sweep operation. B TIME/DIV switch (pull out and rotate to unlock) selects the sweep rate for the B Sweep circuit for delayed sweep operation only. VAR control must be in the calibrated detent for calibrated A Sweep rates. When the A TIME/DIV switch is rotated fully counterclockwise to the X-Y position, the horizontal (X-axis) deflection is controlled by the Channel 1 input signal.
- **POSITION Control**—Positions the display horizontally for A Sweep and B Sweep, or on the X-axis (horizontally) in the X-Y mode. Provides both coarse and fine control action. Reverse the direction of rotation to actuate fine positioning action.

- X10 MAG Switch—When pressed in, increases displayed sweep rate by a factor of 10. Extends fastest sweep rate to 2 nanoseconds/division. The magnified sweep expands the center division of the unmagnified display (0.5 division either side of the center graticule line).
- 32) VAR Control—Provides continuously variable sweep rates between the calibrated settings of the A TIME/DIV switch. It extends the slowest A Sweep rate to at least 1.25 seconds/division. The A Sweep rate is calibrated when the control is set fully clockwise to the calibrated detent. It must be in the detent position to make accurate differential time measurements. On instruments equipped with a DM44, the VAR control must be in the detent position to make accurate measurements in the TIME and 1/TIME functions.
- **UNCAL Indicator**—LED illuminates to indicate that the A Sweep rate is uncalibrated (VAR control is out of the calibrated detent).
- X10 MAG Indicator—LED illuminates to indicate that the X10 magnifier is on.
- 35 DELAY TIME POSITION Control—Selects the amount of delay time between the start of A Sweep and start of B Sweep. Delay time is variable to at least 10 times the time indicated by the A TIME/DIV switch.
- 36 POWER Switch—PULL ON turns instrument power on; button pushed in turns power off.
- POWER ON Indicator—LED illuminates when power is applied to the instrument.
- HORIZ DISPLAY Switches—Four push button switches determine the mode of operation for the horizontal deflection system.

A—Horizontal deflection is provided by A Sweep at a sweep rate determined by the setting of the A TIME/DIV switch. Only A Sweep is displayed; B Sweep is inoperative.

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Operating Instructions-465B Service

A INTEN—Displays the A Sweep at a rate determined by the A TIME/DIV switch. An intensified portion can appear on the display during the B Sweep time. This switch position provides an indication of both the duration and position of the B Sweep (delayed sweep) with respect to the A Sweep (delaying sweep).

ALT—Alternates the displays between the A INTEN and B DLY'D Sweeps. In ALT operation, use TRACE SEP to vertically position B Trace; use B INTENSITY control to adjust B Trace intensity.

B DLY'D—Displays only the B Sweep. The B Sweep rate is determined by the B TIME/DIV switch, with the delay time determined by the setting of both the A TIME/DIV switch and the DELAY TIME POSITION control.

- 39 TRACE SEP Control—Positions the B Sweep vertically when the ALT HORIZ DISPLAY mode is selected.
- **B INTENSITY Control**—Determines the intensity of the B Trace (interacts with INTENSITY control).

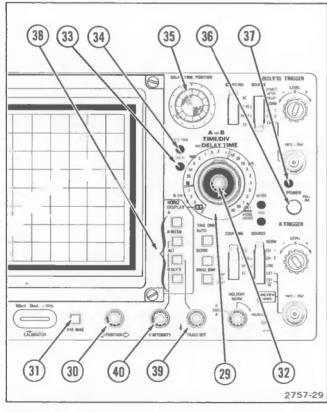


Figure 2-6. Horizontal and power connectors, controls, and indicators.

REAR PANEL

Refer to Figure 2-7 for location of items 41 through 50.

- A +GATE—Output bnc connector provides a positive-going pulse coincident with the A Sweep time.
- **B** +GATE—Output bnc connector provides a positive-going pulse coincident with the B Sweep time.
- CH 1 VERT SIGNAL OUT—Output bnc connector provides a sample of the signal applied to the Channel 1 preamplifier via the input connector.
- **EXT Z-AXIS**—Input bnc connector permits the application of an external signal to intensity modulate the crt display. Does not affect display wave-shape. Signals with fast rise time and fall time provide the most abrupt intensity change. Signals must be time-related to the display for a stable presentation on the crt. The connector is useful for adding time markers in uncalibrated modes of operation.
- Regulating Range Selector Bar—Selects the regulating range of the 465B power supplies to match the available power input source. It is shown on Figure 2-2 in the Medium regulating range. See Table 2-2 for change information.
- Line Fuse Holder—Contains the line fuse and the regulating range selector. See Table 2-3 for change information.
- 47 Line Cord—Makes the connection between the oscilloscope and the power source. The cord may be conveniently stored by wrapping around the feet on rear panel.
- MOD Slots—A number in either slot indicates the instrument contains an option or other modification.

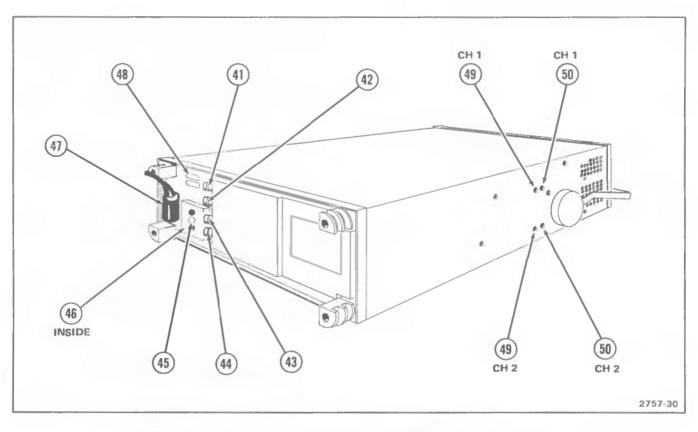


Figure 2-7. Rear panel and left side panel controls, connectors, and indicators.

LEFT SIDE PANEL

- Vertical Gain Controls (accessible through left side panel)—Screwdriver adjustments to set the gain of the vertical channels.
- Variable Balance Controls (accessible through left side panel)—Screwdriver adjustments to set balance of the vertical channels.

RIGHT SIDE PANEL

51) Line Voltage Selector Switch—Selects either 115 volts or 230 volts nominal line voltage. Refer to Table 2-2 for ranges and to Figure 2-2 for location of the switch. Change the fuse to match the range selected.

BASIC OSCILLOSCOPE DISPLAYS

The procedures in this subsection will allow you to set up and operate your instrument to obtain the most commonly used basic oscilloscope displays. Before proceeding with these instructions, verify that the Line Voltage Selector switch and the Regulating Range Selector bar are placed in the proper positions and that the correct fuse is installed for the line voltage being used. Refer to the preceding Preparation for Use subsection for the information and procedures relating to line voltage, regulating range, and fuse selection. Verify that the POWER switch is off (push button pressed in) before plugging the power cord into the line voltage socket.

PRESET INSTRUMENT CONTROLS

Preset the instrument controls as follows:

Vertical

VERT MODE

CH 1

VOLTS/DIV

Proper setting determined by amplitude of signal to

be applied

VOLTS/DIV VAR

Calibrated detent

AC-GND-DC

AC

POSITION

Midrange

20 MHz BW LIMIT

Not limited (push button

INVERT

Off (push button out)

Display

INTENSITY

Fully counterclockwise

FOCUS SCALE ILLUM Midrange Midrange

Horizontal

TIME/DIV Switches

Locked together at 1 ms Calibrated detent

A TIME/DIV VAR HORIZ DISPLAY

X10 MAG

Off (push button out)

POSITION Midrange

Trigger (Both A and B if applicable)

SLOPE LEVEL

+ 0

SOURCE

NORM

COUPLING

AC

TRIG MODE (A only)

AUTO

HOLDOFF

NORM

NORMAL SWEEP DISPLAY

1. Preset instrument controls and pull the POWER switch (on). After allowing the instrument to warm up, connect a signal to the CH 1 input connector.

NOTE

Instrument warmup time required to meet all specification accuracies is 20 minutes.

- 2. Adjust the INTENSITY control for the desired display brightness. If the display is not visible with the INTENSITY control at midrange, press the BEAM FIND push button and hold it in while adjusting the CH 1 VOLTS/DIV switch to reduce the vertical display size. Center the compressed display using the vertical and horizontal POSITION controls; release the BEAM FIND push button. Adjust the LEVEL control if necessary.
- 3. Set the CH 1 VOLTS/DIV switch and the vertical and horizontal POSITION controls to locate the display within the graticule area.
- 4. Adjust the A TRIGGER LEVEL control for a stable display.
- 5. Set the A TIME/DIV switch for the desired number of cycles of displayed signal; then adjust the FOCUS control as necessary.

MAGNIFIED SWEEP DISPLAY

- 1. Preset instrument controls and obtain 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 (0.5 division on each side of the center vertical graticule line). Change the TIME/DIV switch setting as desired
- 3. Push the X10 MAG switch (on) and adjust the horizontal POSITION control for precise positioning of the magnified display. Divide the TIME/DIV setting by 10 to determine the magnified sweep rate.

DELAYED SWEEP DISPLAY

1. Preset instrument controls and obtain a Normal Display.

NOTE

Differential time measurements and measurements using the TIME or 1/TIME functions of the DM44 are invalid when the B TRIGGER SOURCE switch is not set to STARTS AFTER DELAY.

2. Set the HORIZ DISPLAY switch to A INTEN and the B TRIGGER SOURCE switch to STARTS AFTER DELAY.

- 3. Pull out on the BTIME/DIV knob and turn clockwise from counterclockwise stop until the intensified zone is the desired length. Adjust the INTENSITY and B INTENSITY controls as needed to make the intensified zone distinguishable from the rest of the display. If your instrument is equipped with a DM44, select a function other than TIME or 1/TIME for a single delayed sweep.
- 4. Adjust the DELAY TIME POSITION control to move the intensified zone to cover the portion of the display that will be displayed in delayed form.
- 5. Set the HORIZ DISPLAY switch to B DLY'D. The intensified zone adjusted in steps 3 and 4 is now displayed in delayed form. The delayed sweep rate is indicated by the dot on the B TIME/DIV knob.
- 6. To obtain a delayed display with 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.

ALTERNATE SWEEP DISPLAY

- Preset instrument controls and obtain a Normal Sweep Display.
- 2. Pull out on the B TIME/DIV knob to unlock it and turn clockwise to the desired sweep rate.
- 3. Set the HORIZ DISPLAY switch to ALT. Set B (DLY'D) TRIGGER SOURCE to STARTS AFTER DELAY. Adjust Channel 1 POSITION and TRACE SEP as required to display A Sweep above B Sweep. This will provide a display that alternates between A INTEN trace (upper) and B DLY'D trace (lower). Adjust B INTENSITY as necessary to view the B DLY'D trace.
- 4. The start of B Sweep may be changed by adjusting the DELAY TIME POSITION control.
- 5. If the instrument is equipped with a DM44 and a time difference (or period) measurement is desired, select the TIME function and adjust the Δ TIME control to move the time-measurement point with respect to the reference point.
- 6. The display now contains a second intensified zone on the A INTEN trace (upper) and a second signal, which may be partially or fully superimposed, on the B DLY'D trace (lower).

7. The DELAY TIME POSITION control will change the position of both delayed displays (reference and time measurement), while the Δ TIME control will position only the second (measurement point) delayed display.

SINGLE SWEEP DISPLAY

- 1. Preset instrument controls and obtain a Normal Sweep Display. For random signals, set the trigger circuit to trigger on a signal that is approximately the same amplitude and frequency as the random signal.
- 2. Press the SINGL SWP push button on the A TRIG MODE switch. The next trigger pulse starts the sweep and displays a single trace. If no triggers are present, the READY indicator should illuminate, indicating that the A Sweep Generator circuit is set and waiting for a trigger.
- 3. When the sweep is complete, the circuit is "locked out", and the READY indicator turns off.
- 4. Press the SINGL SWP push button again to prepare the circuit for another Single Sweep Display.

X-Y DISPLAY

- 1. Preset instrument controls and pull the POWER switch (on). Allow the instrument to warm up.
- 2. Set the A TIME/DIV switch fully counterclockwise to X-Y. Apply the vertical signal to the CH 2 OR Y input connector and the horizontal signal to the CH 1 OR X 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 and hold in the BEAM FIND push button while adjusting the CH 1 and CH 2 VOLTS/DIV switches until the display is reduced in size, both vertically and horizontally. Center the compressed display with the POSITION controls (Channel 2 POSITION control for vertical movement, and horizontal POSITION control for horizontal movement). Release the BEAM FIND push button. Adjust the FOCUS control for a well-defined display.

@ **2-11**

RACKMOUNTING

The TEKTRONIX R465B Oscilloscope is designed to mount in a 19-inch rack. When mounted in accordance with the following mounting procedure, the instrument will meet all electrical and environmental characteristics given in Section 1 of this manual.

DIMENSIONS

Dimensional drawings of the R465B are shown in Figures 2-8 and 2-9.

Rack Height

At least seven inches of vertical space is required to mount this instrument in a rack.

Rack Width

Minimum width of the opening between the left and right front rails of the rack must be 17 5/8 inches. This allows room on each side of the instrument for the slide-out tracks to operate freely, permitting the instrument to move smoothly in and out of the rack.

Rack Depth

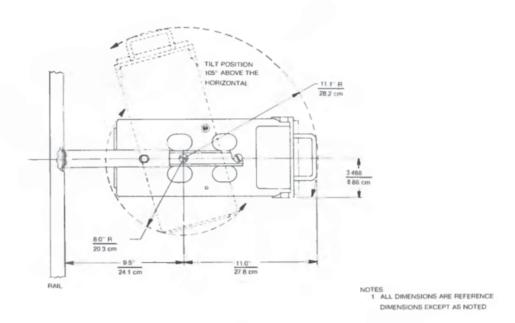
Total depth necessary to mount the R465B in a cabinet is 18 inches. This allows room for air circulation, power cord and signal connections and the necessary mounting hardware.

SLIDE-OUT TRACKS

The slide-out tracks provided with the R465B permit it to be extended out of the rack for maintenance or calibration without removing the instrument from the rack. In the fully extended position, the R465B can be tilted up so the bottom of the instrument can be reached for maintenance or calibration. To operate the R465B in the extended position, be sure the power cord and any interconnecting cables are long enough for this purpose.

The slide-out tracks consist of two assemblies-one for the left side of the instrument and one for the right side. Figure 2-10 shows the complete slide-out track assemblies. The stationary section of each assembly attaches to the front and rear rails of the rack, and the chassis section is attached to the instrument. The intermediate section slides between the stationary and chassis sections and allows the R465B to be extended out of the rack. When the instrument is shipped, the stationary and immediate sections of the tracks are packaged as matched sets and should not be separated. To identify the left or right assembly, note the position of the automatic latch (see Figure 2-10). When mounted in the rack, the automatic latch should be at the top of both assemblies. The chassis sections are installed on the instrument at the factory.

The hardware needed to mount the slide-out tracks is shown in Figure 2-11. Since the hardware supplied is intended to make the tracks compatible with a variety of cabinet racks and installation methods, not all of it will be needed for this installation. Use only the hardware that is required for the mounting method used.



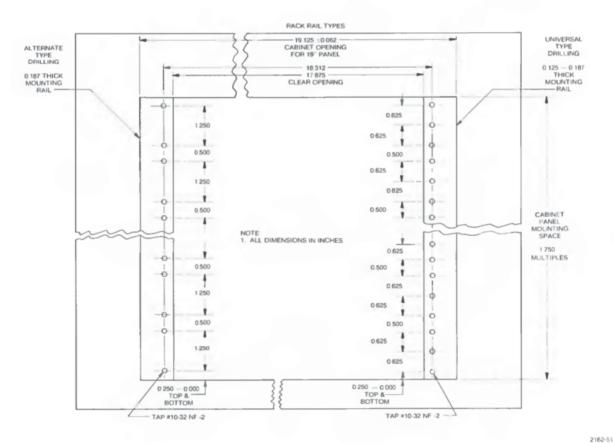


Figure 2-8. Dimensional drawing.

@

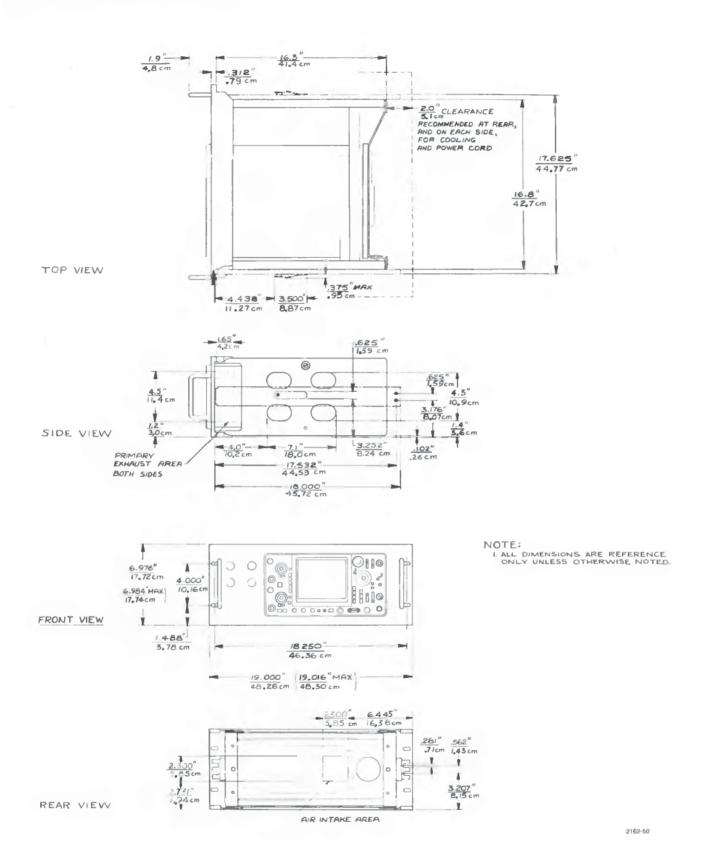


Figure 2-9. Dimensional drawing (cont).

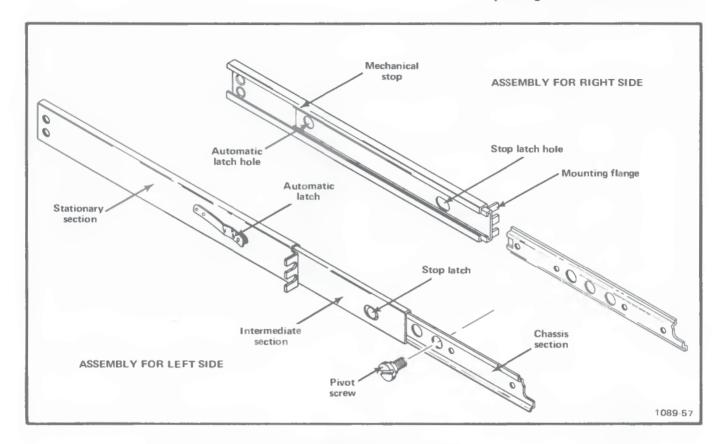


Figure 2-10. Slide-out track assemblies.

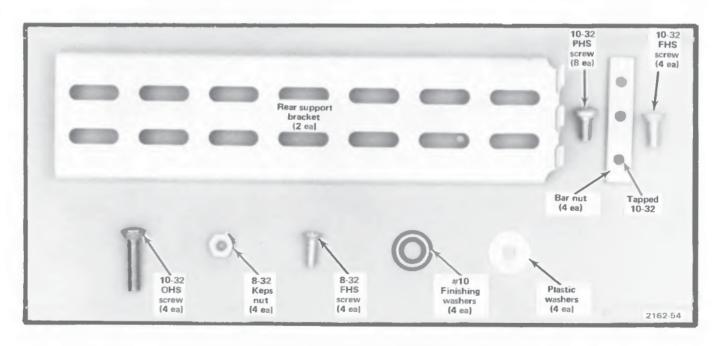


Figure 2-11. Hardware needed to mount the instrument in the cabinet rack.

MOUNTING PROCEDURE

The following mounting procedure uses the rear support kit (see Figures 2-12 and 2-13) to meet the environmental characteristics of the instrument (shock and vibration). Two alternative mounting methods are described at the end of this procedure. However, when mounted according to these alternative methods, the instrument may not meet the given environmental characteristics for shock and vibration.

The mounting flanges of the stationary sections may be mounted in front of or behind the front rails of the rack depending on the type of rack. If the front rails of the rack are tapped for 10-32 screws, the mounting flanges are placed in front of the rails. If the front rails of the rack are not tapped for 10-32 screws, the mounting flanges are placed behind the front rail and a bar nut is used. Figure 2-14 shows these methods of mounting the stationary sections.

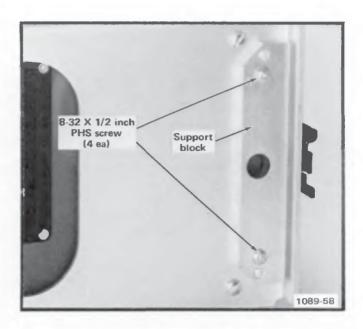


Figure 2-13. Installing the support block on the instrument.

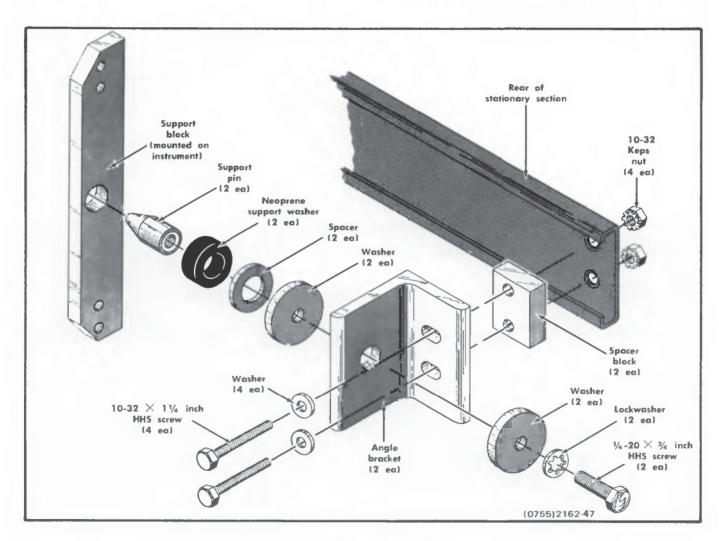


Figure 2-12. Rear support kit.

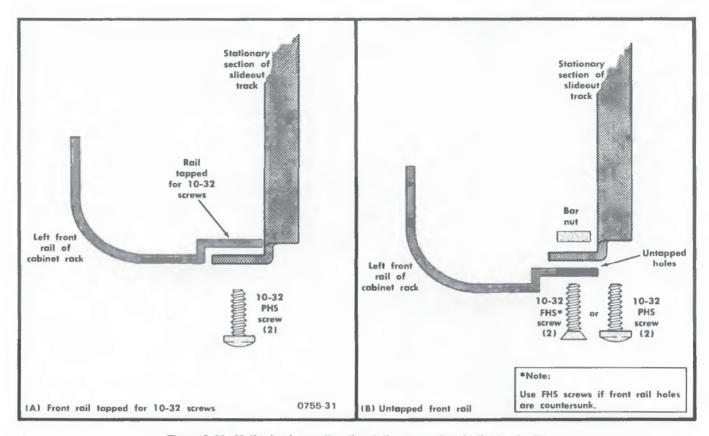


Figure 2-14. Methods of mounting the stationary section to the front rails.

The rear of the stationary sections must be firmly supported to provide a shock-mounted installation. This rear support must be located 17.471 inches, ± 0.031 inch, from the outside surface of the front rail when the mounting flange is mounted outside of the rail, or 17.531 inches, ± 0.031 inch, from the rear surface of the front rail when the mounting flange is mounted behind the front rail. If the cabinet rack does not have a strong supporting member located the correct distance from the front rail, an additional support must be added. The instrument will not meet the environmental specifications unless firmly sup-

ported at this point. Figure 2-14 illustrates a typical rear installation using the rear support kit and gives the necessary dimensions.

Use the following procedure to install the R465B in a rack:

 Select the proper front-rail mounting holes for the stationary section using the measurements shown in Figure 2-15.

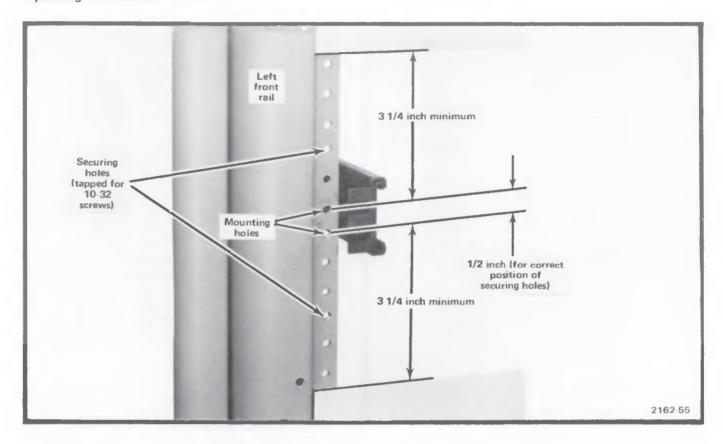


Figure 2-15. Locating the mounting holes for the left stationary section. Same dimensions apply to right stationary section.

- 2a. If the mounting flanges of the stationary sections are to be mounted in front of the front rails (rails tapped for 10-32 screws), mount each stationary section as shown in Figure 2-16(A).
- 2b. If the mounting flanges of the stationary sections are to be mounted behind the front rails (rails not tapped for 10-32 screws), mount each stationary section as shown in Figure 2-16(B).
- 3. Attach an angle bracket to both rear rails of the rack through the spacer block, stationary section and into the rear rail of the rack. Note that the holes in the spacer block are not centered. Be sure to mount the block with the narrow edge toward the front of the rack; otherwise, the

instrument may not slide all the way into the rack. Do not tighten the mounting screws. Figure 2-12 shows the parts in the rear support kit and the order in which they are assembled.

- 4. Assemble the support pin to the angle bracket in the order shown in Figure 2-12. Leave the spacer (washer) off, but install the neoprene washer.
- Install a support block on each side of the instrument as shown in Figure 2-13.

(a)

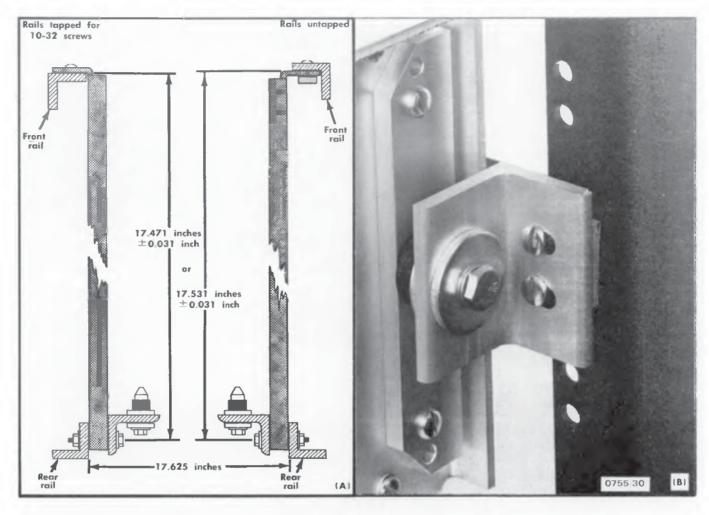
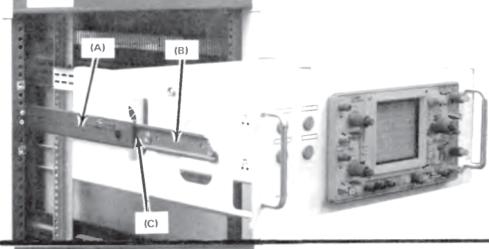


Figure 2-16. Supporting the rear stationary sections: (A) Dimensions necessary; (B) Completed installation.

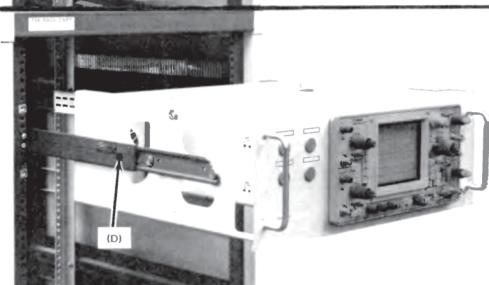
- 6. Refer to Figure 2-17 to insert the instrument in the rack. Do not connect the power cord or install the securing screws until all adjustment have been made.
- 7. With the instruments pushed all the way into the rack, adjust the angle brackets so the neoprene washers on the support pins are seated firmly against the rear of the instrument and the support pins are correctly positioned in the support block on the rear of the instrument. Tighten all screws.
- 8. Pull the instrument partially out of the rack.
- 9. Remove the neoprene washers from the support pins and place the spacers on the pins. Replace the neoprene washers.
- 10. Position the instrument so the pivot screws (widest part of the instrument) are approximately even with the front rails.

TO INSERT THE R465:

- Pull the intermediate section (A) of each slide-out track out to its fully extended position.
- Insert the chassis section
 (B) (on instrument) into the intermediate sections.
- 3. Press both stop latches (C) and push the instrument into the rack until the latches snap into the stop latch holes (D).

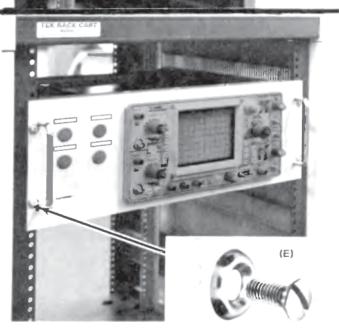


- 4. Connect the power cord to the power source.
- Again press the stop latches (D) and push the instrument all the way into the rack.
- 6. To secure the R465 to the rack, insert the 4 securing screws (E), with finishing washers and teflon washers, through the siots in the instrument front panel and screw them into the front rails of the rack.



TO REMOVE THE R465:

- Remove the securing screws and washers (E).
- Pull the Instrument outward until the stop latches snap into the stop latch holes.
- Disconnect the power cord.
- Press both stop latches
 (D) and pull the instrument out of the rack.



1861-32

(a)

Figure 2-17. Procedure for inserting or removing the instrument after the slide-out tracks have been installed

- 11. Adjust the alignment of the stationary sections according to the procedure outlined in Figure 2-18. (If the rear alignment is changed, recheck the rear support pins for correct alignment.)
- 12. After the tracks operate smoothly, connect the power cord to the power source.
- 13. Push the instrument all the way into the rack and secure it to the rack with the securing screws and washers as shown in Figure 2-17.

NOTE

The securing screws are an important part of the shock-mounted installation. If the front rails are not tapped for the 10-32 securing screws, other means must be provided for securing the instrument to the rack

ALTERNATIVE REAR MOUNTING METHODS

CAUTION

Although the following methods provide satisfactory mounting under normal conditions, they do not provide solid support at the rear of the instrument. If the instrument is subjected to severe shock or vibration when mounted using the following methods, it may be damaged.

An alternative method of supporting the rear of the instrument is shown in Figure 2-19. The rear support brackets supplied with the instrument allow it to be mounted in a rack which has a spacing between the front and rear rails of 11 to 24 inches. Figure 2-19(A) illustrates the mounting method if the rear rails are tapped for 10-32 screws, and Figure 2-19(B) illustrates the mounting method if the rear rails are not tapped for 10-32 screws. The rear support kit is not used for this installation.

If the rack does not have a rear rail, or if the distance between the front and rear rails is too large, the instrument may be mounted without the use of the slide-out tracks. Fasten the instrument to the front rails of the rack with the securing screws and washers. This mounting method should be used only if the instrument will not be subjected to shock or vibration and if it is installed in a stationary location.

REMOVING OR INSTALLING THE INSTRUMENT

After initial installation and adjustment of the slide-out tracks, the R465B can be removed or installed by following the instructions given in Figure 2-17. No further adjustments are required under normal conditions.

SLIDE-OUT TRACK LUBRICATION

The slide-out tracks normally require no lubrication. The special finish on the sliding surfaces provides permanent lubrication. However, if the tracks do not slide smoothly even after proper adjustment, a thin coating of paraffin rubbed onto the sliding surfaces may improve operation.

TO ADJUST ALIGNMENT:

- Position the instrument with the pivot screws approximately even with the front rails.
- Loosen the mounting screws at the front of both stationary sections (left side shown).
- Allow the tracks to seek their normal positions with the instrument centered in the rack.
- 4. Tighten the mounting screws.
- Push the instrument all the way into the rack. If tracks do not slide smoothly, check for correct spacing between the rear supports.
- Check the vertical positioning of the R465 front panel with respect to adjacent instruments or panels. If not correct, reposition as necessary.

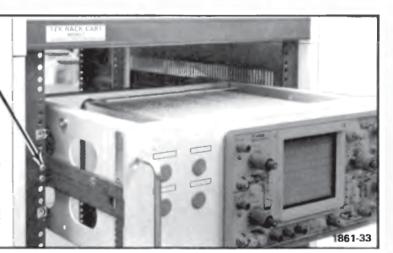


Figure 2-18. Alignment adjustment for correct operation.

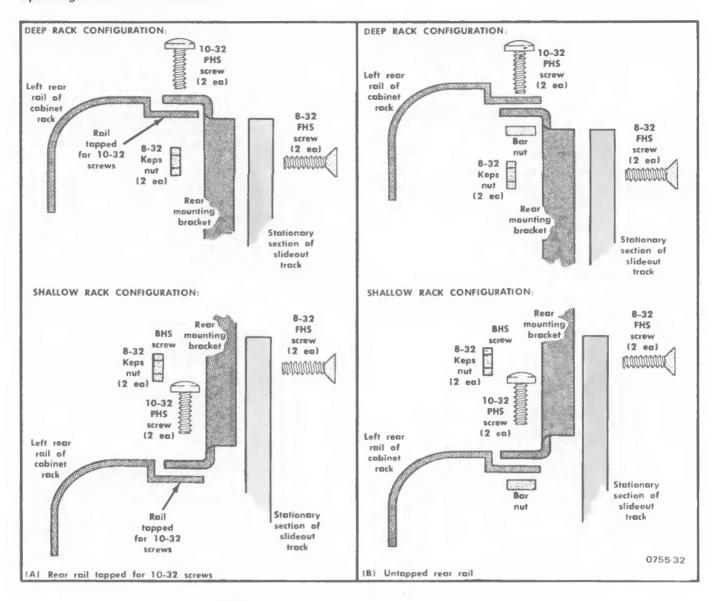


Figure 2-19. Alternative method of installing the instrument using rear support brackets.

THEORY OF OPERATION

INTRODUCTION

SECTION ORGANIZATION

This section of the manual contains a functional description of the circuitry used in the 465B Oscilloscope. It begins with a general summary of the instrument, using the basic block diagram shown in Figure 3-1. As an additional reference, a comprehensive overall block diagram is provided in the tabbed Diagrams section at the back of this manual.

Each major circuit is explained in detail, using additional functional block diagrams to show the interconnections between parts comprising the circuit, to indicate circuit components, and to identify

interrelationships with front panel controls. Schematic diagrams also are provided in the Diagrams section of the manual and are keyed to their respective circuit descriptions by numbered diamond symbols. For optimum understanding of the circuit being described, you should refer to both the appropriate schematic diagram and functional block diagram.

INTEGRATED CIRCUIT DESCRIPTIONS

Digital Logic Conventions

Digital logic techniques are used to perform many functions within this instrument. Function and operation of the logic circuits are represented by logic symbology

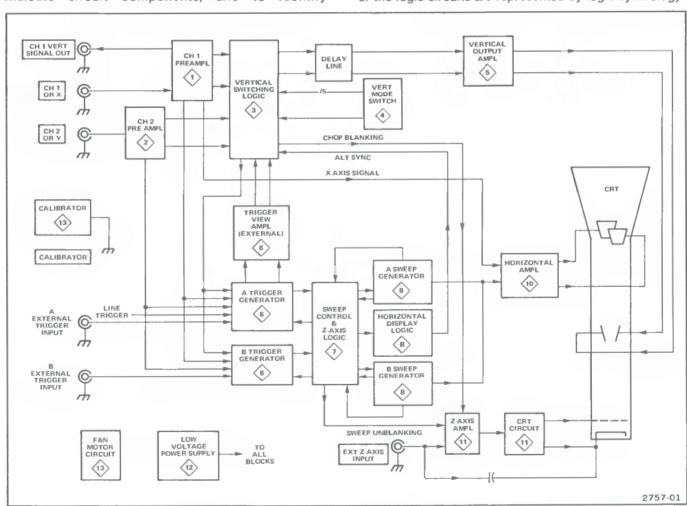


Figure 3-1. Basic block diagram of the 465B Oscilloscope.

Theory of Operation-465B Service

and terminology. All logic functions are described using the positive logic convention. Positive logic is a system of notation whereby the more positive of two levels is the true, or 1 state; the more negative level is the false, or 0 state. In the logic description the true state is referred to as HI, and the false state is referred to as LO. The specific voltages which constitute a HI or a LO state vary between specific devices.

Linear Devices

The functioning of individual linear integrated circuit devices is described in this section using waveforms or other techniques to illustrate their operation.

GENERAL DESCRIPTION

The following discussion provides an overall functional description of the 465B Oscilloscope. Refer to the basic block diagram, Figure 3-1, and to the detailed block diagram located in the Diagrams section of this manual. Each major block in these diagrams represent a major circuit within the instrument. The numbered diamond symbol on each block refers to the appropriate schematic diagram also located in the Diagrams section.

Signals to be displayed on the crt are applied to the CH 1 OR X input connector or the CH 2 OR Y input connector. These input signals then are amplified by the Preamplifiers. Each channel includes separate vertical deflection factor, input coupling, balance, gain, and variable attenuation switches or controls. A trigger pickoff stage in each Vertical Preamplifier supplies a sample of that channel's signal to the Trigger Generator circuit. A sample of the Channel 1 signal is also supplied to the CH 1 VERT SIGNAL OUT connector on the instrument rear panel.

In the X-Y mode of operation the Channel 1 signal is connected to the input of the Horizontal Amplifier circuit to provide the X-axis deflection. The Channel 2 signal is amplified by the Vertical Output Amplifier circuit to provide the Y-Axis deflection. The Channel 2 Vertical Preamplifier circuit contains an invert feature to allow the operator to invert the Channel 2 signal displayed on the crt.

The outputs of both Vertical Preamplifier circuits and the output of the A Trigger View Amplifier circuit are connected to the Vertical Switching circuit. The Vertical Mode Switch circuit uses the inputs from the VERT MODE switches and the X-Y position of the A TIME/DIV switch to set the Vertical Switching circuit into the chosen Vertical Mode of operation. The Vertical Switching circuit then will select the input(s) to be displayed on the crt.

The Chopped Blanking signal, used to blank the switching transients between channels when the chopped mode of operation is selected, is produced in the Vertical Switching circuit and fed to the Z-Axis Amplifier circuit. A

Normal Trigger pickoff stage at the output of the Vertical Switching circuit provides a sample of the displayed signal(s) to the Trigger Generator circuits.

The output of the Vertical Switching circuit is connected to the Vertical Output Amplifier through the Delay Line. The Vertical Output Amplifier circuit provides final amplification of the signal before it is connected to the vertical deflection plates of the crt. This circuit includes part of the BEAM FINDER switch, which, when activiated, limits vertical deflection to within the graticule area so that location of off-screen displays is facilitated.

The A and B Trigger Generator circuits each create an output pulse which initiates the sweep produced by either the A or B Sweep Generator circuits. The input signal to the A and B Trigger Generator circuits can be individually selected from any of the following sources: Channel 1 signal, Channel 2 signal, signal(s) displayed on the crt (Normal), signal(s) connected to the External Trigger Input connectors, or a line voltage sample (A Trigger only). Each trigger circuit contains level, slope, coupling, and source controls. The A External Trigger input is also fed to the A Trigger View Amplifier where it is amplified and made available to the Vertical Switching circuit for selection to be viewed on the crt.

The A Sweep Generator circuit, when activated by the A Trigger Generator circuit, produces a linear sawtooth output signal, the slope of which is controlled by the A TIME/DIV switch. The TRIG MODE switches control the operating mode of the A Trigger Generator circuit. When AUTO is selected, the absence of an adequate trigger signal for about 100 milliseconds after the end of holdoff causes an A Sweep start gate to be generated. When NORM is selected, a horizontal sweep is presented only when triggered by an adequate trigger signal. Pushing the SINGL SWP push button sets the Sweep Logic to initiate one sweep after a trigger pulse is received.

The Z-Axis logic circuit produces a gate signal to unblank the crt so that the display can be presented. This gate signal is coincident with the sawtooth produced by the A Sweep Generator circuit. The A gate signal, which is also coincident with the sawtooth, is available at the A +GATE connector on the instrument rear panel. The Sweep Control Logic circuit also produces a Horizontal Alternate Sync pulse. This pulse is fed to the Horizontal Display Logic circuit to switch the display between A Intensified and B Delayed sweeps when the ALT Horizontal Display mode is selected.

The B Sweep Generator circuit is basically the same as the A Sweep Generator circuit. However, this circuit only produces a sawtooth output signal when a delay time period, determined by the DELAY TIME POSITION dial has lapsed, or when a trigger pulse is received from the B Trigger Generator circuit. If the B TRIGGER SOURCE switch is set to the STARTS AFTER DELAY position, the B Sweep Generator begins to produce the sweep immediately following the selected delay time. If the SOURCE switch is in one of the remaining positions, the B Sweep Generator circuit does not produce a sweep until it receives a trigger pulse from the B Trigger Generator circuit

The output of either the A or B Sweep Generator is amplified by the Horizontal Amplifier circuit to produce horizontal deflection for the crt, except when the A TIME/DIV switch is in the fully counterclockwise (X-Y) position. The Horizontal Amplifier circuit contains a X10 magnifier that may be selected to increase the sweep rate 10 times in any A or B TIME/DIV switch position. Other deflection signals may 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 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, Vertical Switching circuit (chopped blanking), Z-Axis Logic circuit (unblanking), and the EXT 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 the 465B. Low voltage power is distributed to all circuits in the instrument.

The Calibrator circuit produces a square-wave output (with both accurate voltage and current amplitudes) that is useful for both checking the calibration of the instrument and compensating probes. The CALIBRATOR current loop provides an accurate current source for calibration of current-measuring probe systems.

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DETAILED DESCRIPTION

CHANNEL 1 PREAMP



Introduction

The Channel 1 Preamplifier circuit, shown in Figure 3-2, provides control of input coupling, vertical deflection factor, gain and dc balance. Input signals for vertical deflection on the crt are connected to the CH 1 OR X input connector. When the TIME/DIV switch is set to the X-Y mode, the input signal applied to the CH 1 OR X connector provides the horizontal (X-axis) deflection.

Input Coupling

Signals applied to the input connector can be either accoupled or dc-coupled or, they can be internally disconnected from the input to the Vertical Input Amplifier stages. When Input Coupling switch S30A 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 C13012 which prevents the dc component of the input signal from passing to the

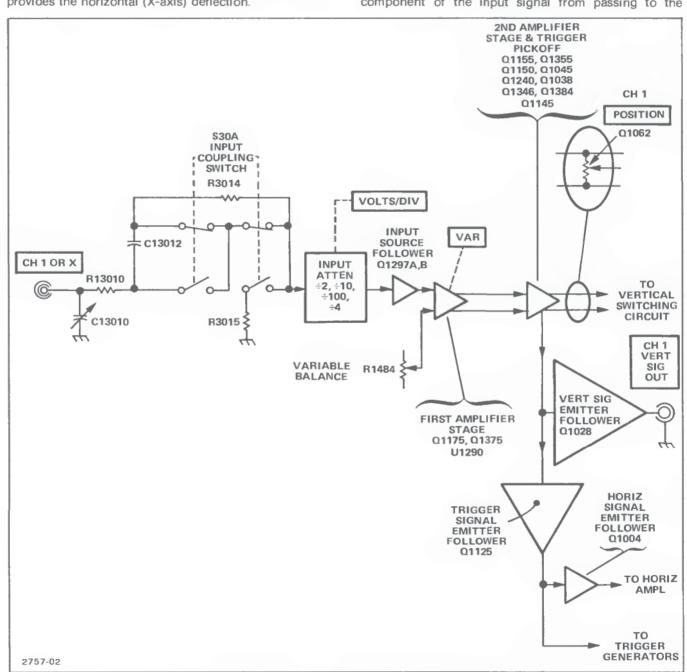


Figure 3-2. Detailed block diagram of the Channel 1 Preamplifier circuit.

amplifier. In the GND position of S30A, the signal path is opened and the input of the amplifier is connected to ground through R3015. This provides a ground reference without the need to disconnect the applied signal from the input connector. Resistor R3014 is a high resistance connected across Input Coupling switch S30A, which allows C13012 to be precharged when the switch is in the GND position. Therefore the trace remains within the viewing area of the crt when the switch is placed in the AC position.

Input Attenuator

The effective overall deflection factor of each vertical channel of the 465B is determined by the setting of the Channel VOLTS/DIV switch. The basic deflection factor of the Vertical Deflection System is 5 millivolts/division of crt deflection. To achieve the deflection factor values marked on the front panel, precision attenuators are switched into the input to the Vertical Preamplifier circuit.

For VOLTS/DIV switch positions above 5 millivolts, frequency compensated-voltage dividers (attenuators) are switched into the circuit to produce the vertical deflection factors indicated on the front panel. Each channel has a 2X, 4X, 10X and 100X attenuator which may be selected in various combinations. A constant attenuation is provided at all frequencies within the bandwidth range of the instrument. The Input Attenuators are designed to maintain the same input characteristics (1 megohm and approximately 20 picofarads) 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.

Source Follower

The Channel 1 signal from the input attenuator is connected to Source Follower Q1297A through R3042, C3042, and R3045. Resistor R3039 provides the input resistance and resistor R3045 functions as a damping resistor. Q1297B is a constant current source for Q1297A. Q1297A and B provide a high input impedance for the attenuators and the current drive needed for the First Amplifier.

In the event that excessively high-amplitude signals are applied to Source Follower Q1297A, the signal will be limited by CR1298 and the gate-source junction of Q1297A. If the negative signal amplitude causes CR1298 to become forward biased, Q1297A gate is clamped to approximately -8.7 volts. Excessive positive signal amplitude will forward bias the gate-source junction of Q1297A. As soon as gate current flows, the gate voltage will cease increasing. Gate current is limited to a safe value by the high resistance of R3042.

First Amplifier

The First Amplifier stage is an integrated emitter-coupled, push-pull, cascode amplifier U1290. The input signal on pins 13 and 16 is converted from a single-ended signal to a push-pull signal by a paraphase amplifier and then is fed to the common base output stage to produce the current drive to Q1175 and Q1375. The CH 1 VAR VOLTS/DIV control, which is connected to pin 11 of U1290, varies the gain of the First Cascode Amplifier stage. This control provides variable vertical deflection at each position of the VOLTS/DIV switch. With the VAR control in its calibrated detent (wiper at ground), the A and D output transistors of U1290 are conducting. The B and C output transistors are biased off. Thus, the signal current available to the following amplifier stage is the collector current flowing in output transistors A and D.

When the VAR control is rotated out of its calibrated detent, the B and C output transistors of U1290 begin to conduct by an amount determined by the position of the VAR control. This causes two events to occur:

- 1. The signal current flowing in the A and D output transistor is reduced by the amount of signal current flowing in the B and C output transistors.
- 2. Output transistors A and C and output transistors B and D conduct current of opposite polarity. The output of transistor C is added to the output of transistor A to reduce the signal current available at pins 5 and 6, and the output current of transistor B is added to the output current of transistor D to reduce the signal current available at pins 8 and 9.

The component values selected for the variable function provide a variable attenuation ratio of approximately 2.5 to 1. Channel 1 Variable Balance adjustment R1484 is adjusted so that no trace shift in the display occurs when rotating the VAR control. When the Channel 1 VAR control is out of its calibrated detent the Channel 1 UNCAL LED is illuminated. The components connected between pins 2 and 3 of U1290 provide frequency compensation for the stage.

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Theory of Operation-465B Service

Q1175 and Q1375 are common-base amplifiers that convert the output current signals from U1290 into voltage signals to be amplified in the Second Amplifier circuit. Gain adjust R1482 allows setting of the overall gain of the Channel 1 Vertical Preamplifier by adjusting the signal voltage to the bases of Q1155 and Q1355.

Second Amplifier

Q1155 and Q1355, in conjunction with Q1344 and Q1346 in the Vertical Switching circuit, form a push-pull cascode amplifier. CR1263, CR1264, and RT1267 provide temperature compensation for the high-frequency gain amplifier to ensure constant gain in the presence of varying ambient temperature. As temperature increases, the resistance value of RT1267 decreases, and the reverse bias on both CR1263 and CR1264 decreases. CR1263 and CR1264 are voltage-variable capacitors whose capacitance increases as reverse bias decreases. The increase in capacity at higher temperatures provides additional high-frequency peaking to counteract the effects of increased temperature on the amplifier's gain.

The push-pull signals at the emitters of Q1155 and Q1355 are converted to a single-ended signal by Q1150, Q1250, Q1045, and Q1145. The current signal from Q1145 is converted to a voltage signal by common-base amplifier stage Q1038 and applied to the bases of Q1125 and Q1028. Q1028 provides the output signal to the CH 1 VERT SIGNAL OUT output connector located on the instrument rear panel. CR1014, CR1024, CR1023, and CR1013 protect the emitter circuit of Q1028 in the event large signal levels are accidentally connected to the CH 1 VERT SIGNAL OUT connector. The output signal at the emitter of Q1125 is used as the trigger signal source in the CH 1 positions of the Trigger SOURCE switches and as the signal source for emitter follower Q1004. R1126 adjusts the dc level of the CH 1 trigger source signal. When in the X-Y mode, Q1004 provides the X-axis signal from the Channel 1 Preamplifier to the Horizontal Amplifier.

R1055 is the Channel 1 Vertical POSITION control. When set to its mid-position, the constant current supplied by Q1062 flows equally through each side of R1055 into the collectors of Q1155 and Q1355. As the POSITION control is rotated off its mid-point, one side of the amplifier receives more current while the other side of the amplifier receives less current. This proportionally changes the amount of current flowing into the Delay Line Drivers, therefore causing the trace to be positioned vertically on the crt. The mid-range operating point of the POSITION control is set by adjusting R1135.

CHANNEL 2 PREAMP



Introduction

The Channel 2 Preamplifier circuit is virtually the same as the Channel 1 Preamplifier circuit. The only differences between the two circuits are described in this part. Input signals for vertical deflection on the crt are connected to the CH 2 OR Y input connector. When the TIME/DIV switch is set to the X-Y mode, the Channel 2 input signal provides the vertical (Y-axis) deflection.

First Amplifier

Basically, the First Amplifier stage in Channel 2 operates the same as the First Amplifier stage in Channel 1. However, the Channel 2 circuit also contains the INVERT switching function. This allows the Channel 2 crt display to be inverted. When pushed in, the INVERT switch changes the biasing on the output transistors of U1790 so that the normally inactive transistors (B and C) now carry the signal. Since their outputs are cross-coupled from side to side, the output signal is of opposite polarity from the signal available when the INVERT switch is in the normal (button out) position. Channel 2 Invert Balance potentiometer R1975 allows the dc balance of the stage to be adjusted to eliminate baseline shift in the display when switching from a normal to an inverted display.

VERTICAL SWITCHING LOGIC



Introduction

The Vertical Switching Logic (Figure 3-3) determines he input signal or combination of input signals to be connected to the Vertical Output Amplifier. Possible input signal combinations that may be displayed are selected by a read-only memory (ROM) integrated circuit that is controlled by the VERT MODE switches and the X-Y position of the TIME/DIV switch.

Diode Gates

The Channel 1, Channel 2, and Trigger View Diode Gates, consisting of four diodes each, act as switches that are controlled by the Vertical Switching Logic circuit. Outputs Q_0 , Q_1 , and Q_2 of U1705 (pins 2, 7, and 10) control the switching transistors that switch the Diode Gates on or off. These output signals also are fed into the A_0 , A_1 , and A_2 inputs of ROM U1605 (pins 5, 6, and 7), to indicate the state of the switches. (Refer to the Maintenance section of this manual for a Logic Table of the ROM functions.) A LO indicates that a particular switch is on, and a HI indicates it is off. The ROM is programmed to use the state indicators from U1705 and the selected VERT MODE inputs to U1605 A_3 through A_7 (pins 4, 3, 2, 1, and 15) to turn on the correct Diode Gates for obtaining the selected signal, or combination of signals, to be displayed.

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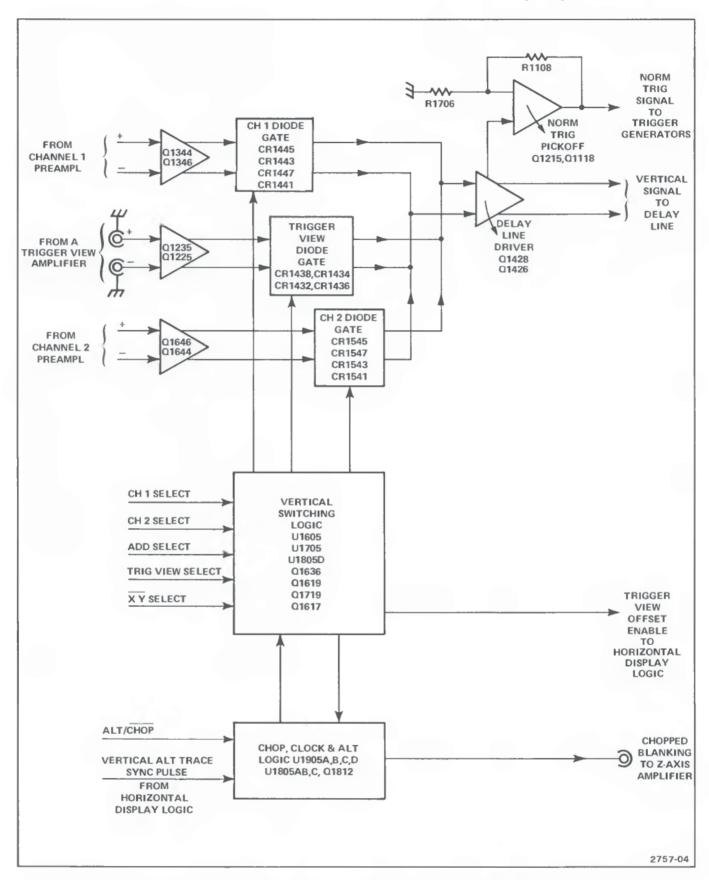


Figure 3-3. Detailed block diagram of the Vertical Switching Logic circuit.

Theory of Operation-465B Service

CHANNEL 1 DISPLAY ONLY. When the CH 1 VERT MODE push button is pressed, a HI is applied to the A_3 input of U1605. The A_4 , A_5 , and A_6 inputs will be LO and the A_7 input (controlled by the X-Y position of the A TIME/DIV switch) will be HI. This combination of inputs is decoded to switch transistor Q1619 on, which turns on the Channel 1 Diode Gate. The O_1 output of U1605 will be LO, the O_2 and O_3 outputs will be HI. The O_4 output, which controls the CHOP oscillator, will be low. A LO will disable the CHOP clock and U1705 will remain in a state that allows the Diode Gates to pass only the Channel 1 input signal to the Delay Line Driver.

With Channel 1 only selected, the Q_0 output of U1705 will be LO. The LO will turn on transistor Q1619 and the junction of CR1447 and CR1443 will be returned to the ± 5 -volt supply through R1625 and Q1619. This raises the junction voltage to reverse bias CR1447 and CR1443. Then CR1445 and CR1441 are forward biased and the Channel 1 input signal passes through CR1441 and CR1445 to the Delay-Line Driver.

CR1432 and CR1434 in the Trigger View Diode Gate and CR1547 and CR1543 in the Channel 2 Vertical Signal Diode Gate remain forward biased through the pull-down resistors to the -8 volt power supply. Trigger View signals and the Channel 2 input signals are shunted to the -8 volt supply and are blocked from the Delay Line Driver because CR1438 and CR1436 in the Trigger View Diode Gate and CR1545 and CR1541 in the Channel 2 Vertical Signal Diode Gate are reverse biased.

CHANNEL 2 DISPLAY ONLY. When CH 2 VERT MODE is selected, Q1719 turns on; Q1619 and Q1617 remain off. The center diodes of the Channel 1 Diode Gate and the center diodes of the Trigger View Diode Gate are forward biased, and the center diodes of the Channel 2 Diode Gate are reverse biased. Trigger view and Channel 1 signals are blocked from the Delay Line Driver, and the Channel 2 input signal is connected to the Delay Line Driver.

A TRIGGER VIEW (EXT ONLY). When A TRIG VIEW is selected, the Channel 1 and Channel 2 Diode Gates are biased off, and the Trigger View Diode Gate is biased on to allow the External Trigger signal to be connected to the Delay Line Driver. In all single input selections (CH 1 only, CH 2 only, or A TRIG VIEW only) the clock is disabled and U1705 remains in a state to select only the single input chosen to be displayed.

ADD VERTICAL MODE. U1605 is programmed to turn on transistor Q1619 (CH 1) and Q1719 (CH 2). The logic from U1705 will turn on Q1636 (ADD) at the same time, if ADD VERT MODE is selected. It is not necessary to select Channel 1 or Channel 2 to obtain the ADD display. With ADD selected, the Q_0 and Q_1 outputs of U1705 will be LO,

and the Q_0 and Q_1 outputs will be HI. This will cause both Channel 1 and Channel 2 Diode Gates to be on. With Q_0 and $\overline{Q_1}$ HI, U1805D will be enabled to turn on Q1636. The junction of R1532 and R1534 will have —8 volts applied to provide sufficient additional current to keep both Diode Gates turned on without altering the dc levels associated with the Delay Line Driver. By selecting additional VERT MODEs, it is possible to view the Channel 1 input, the Channel 2 input, the A External Trigger input, and ADD MODE on the crt during one display cycle on four separate traces.

X-Y MODE. When the A TIME/DIV switch is set to X-Y, a LO is applied to pin 15 of U1605. The ROM is programmed to produce outputs that turn on Channel 2 switching transistor Q1719 and disable the CHOP clock. This action causes the Channel 2 input to be connected to the Delay Line Driver for the Y-axis signal. It is not necessary to select Channel 2 VERT MODE, since the ROM will not respond to any other input while the X-Y mode is selected.

Chop Clock and Alternate Logic

U1905B, U1805A, R1904, R1903, and C1804 make up the Chop Clock Oscillator circuit. When the O4 output of U1605 is HI and the CHOP MODE is selected, a HI is present on pin 5 of U1905B, U1805A will alternately put a HI and then a LO on pin 4 of U1905B. Assume an initial LO on pin 4 of U1905B. U1905B is a NAND gate, so its output will be HI. C1804 charges toward a HI and as soon as its charge reaches the threshold level of U1805A, U1805A will switch to a HI output. The HI output of U1805A pin 3 will assert a HI on U1905B pin 4. This HI is NANDed with the HI already present on pin 5 of U1905B to produce a LO at pin 6 of U1905B. Now C1804 has to discharge toward a LO. As soon as the charge on C1804 reaches the LO threshold of U1805B, U1805B will switch to a LO output and the cycle will repeat. The Chop Clock oscillator frequency is approximately 1 megahertz and depends on the RC-time constant of R1903 and C1804, as well as the threshold level of U1805A (see Figure 3-4).

When CHOP is selected, pin 2 of U1905A will be LO. Pin 3 of U1905A will be HI which enables U1805C to pass the CHOP clock oscillator frequency to pin 9 of U1705. U1705 changes state for every positive transition of the clock

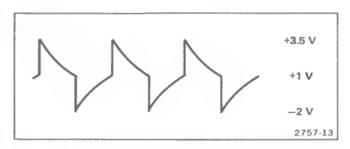


Figure 3-4. Switching waveform at the junction of R1903 and R1904.

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oscillator (once each cycle) effectively performing a divide-by-two. Therefore, the CHOP frequency is approximately 500 kilohertz. The CHOP clock oscillator will not be enabled unless more than one input is selected. As stated previously, a single-input VERT MODE selection will cause U1705 to remain in a state that will allow only the selected input to be passed on to the Delay Line Driver.

If multiple inputs are selected for display, U1705 will be clocked to select the appropriate inputs programmed for display. Transistors Q1619, Q1719, Q1617, and Q1636 (if ADD is selected) are being switched at the Chop clock frequency (CHOP Mode). As the displays are being incremented, the Q_0 , Q_1 , and Q_2 outputs of U1705 are being used as state indicators to the A_0 , A_1 , and A_2 inputs of ROM U1605 to indicate the next input to be selected for display. The order of priority of the switching is: CH 1, CH 2, ADD, then TRIG VIEW.

ALTERNATE TRACE SYNC. With ALT Vertical Mode selected, a HI will be present at U1905D pin 12. If more than a single-input display is selected, a HI will also be present at pin 13. The CHOP clock will then be disabled. U1905A will be enabled to pass the Alternate Trace Sync pulse to U1805C pin 9, and U1805C will be enabled to pass the pulse to U1705 pin 9 (clock input). U1705 will now be switching between selected inputs at a rate determined by the Alternate Trace Sync pulse from the Horizontal Display Logic circuit.

If a single input is selected for display, U1805B pin 5 will be LO and the Chop clock will remain disabled. The Alternate Trace Sync pulse will be present at U1705 pin 9, but with only one input selected by the VERT MODE switches, U1705 will not change state and the switching transistor for the selected input to be displayed will remain on.

When Alternate Horizontal Display is chosen, the Alternate Trace Sync input becomes a square wave with a

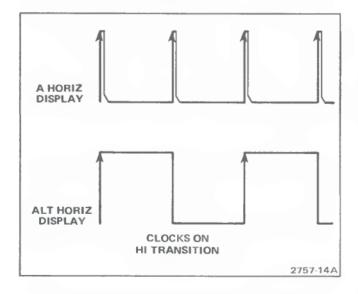


Figure 3-5. Vertical Alt Sync Pulse at U1705 pin 9.

period equal to twice the time between Alternate Trace Sync pulses. This will allow the display of the A sweep and the B sweep before switching to the next vertical input signal to be displayed (see Figure 3-5).

Chopped Blanking Amplifier

When CHOP Mode is selected, a LO on U1905D pin 12 holds U1905D pin 11 HI. This HI enables U1905C to pass the Chop pulse to C1813. C1813 and R1916 differentiate the Chop pulse to produce positive and negative spikes having sufficiently fast rise times necessary for the Chopped Blanking. CR1918 limits the positive spike and R1815 limits the base current of Q1812. The positive portion of the waveform reverse biases Q1812, but when the waveform switches from the positive portion to the negative portion, Q1812 is driven rapidly into conduction. The blanking time is determined by the charging time of C1813 through R1916 and R1815. The positive-going output pulse, which is coincident with trace switching, is connected to the Z-Axis Amplifier circuit through R1914.

Delay-Line Driver

The output from the Diode Gates is applied to the Delay Line Driver composed of Q1426 and Q1428. Transistors Q1426 and Q1428 are connected as feedback amplifiers, with R1328 and R1522 providing feedback from the collector to the base of their respective transistors. A sample of the signal in the collector circuit of R1426 is used for triggering in the Normal mode of trigger operation. Bandwidth Limit switch S1414 connects a pi filter (composed of C1306, C1405, L1412, and L1512) between the output signal lines of the Delay Line Driver to reduce the upper —3 decibel bandwidth limit of the Vertical Amplifier system to approximately 20 megahertz. Resistors R1314 and R1514 provide reverse termination for any reflections in the delay line.

Normal Trigger Pickoff Amplifier

The trigger signal for Normal trigger operation is obtained from the collector of Q1426. Normal Trigger DC Balance Adjustment R1202 sets the dc level of the normal trigger output signal such that the sweep is triggered at the zero level of the displayed signal whenever the trigger LEVEL control is set to zero. Q1215 and Q1118 are connected as a feedback amplifier, with the signal applied to the base of Q1215 and the feedback connected between the output and emitter of Q1215 through R1108.

VERTICAL MODE SWITCH



Introduction

The Vertical Mode Switch circuit produces the logic necessary for placing the Vertical Switching Logic circuit into the correct state for the Vertical Mode selected. The Scale-Factor Switching circuit selects the correct scale-factor LED to be illuminated with each Vertical Mode selection.

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Exclusive-NOR Switching Circuit

The Exclusive-NOR Switching circuits produce a LO pulse on the ALT/CHOP select line whenever a VERT MODE push button is either pressed or released. While the ALT Vertical Mode is selected, the LO pulse will enable the Chop oscillator, momentarily producing clock pulses which enable the Vertical Switching Logic circuit to select the correct Vertical Mode for the next display.

Assume that the CH 1 VERT MODE push button has been pressed. The condition of Exclusive-NOR circuit U5235D is as follows: A Hi is on pins 12 and 13 of U5235D, and a HI is present at output pin 11; C5135 has charged to a HI level through R5135. When the push button is released, a LO is immediately applied to pin 12, but C5135 is still charged to a HI level, so the HI remains on pin 13. These input conditions to the Exclusive-NOR circuit will produce a LO at output pin 11 to enable the Chop oscillator. Then C5135 discharges toward a LO level through R5135, and when the LO threshold voltage is reached, both inputs to the Exclusive-NOR circuit will be LO. The output of U5235D will switch back to HI, turning off the Chop oscillator.

When the X-Y Horizontal Display is selected, —8 volts is applied through R5212 to the \overline{XY} select input of the Vertical Switching Logic circuit (placing it in the X-Y Mode of operation) and through the series combination of R5211 and R5214 to the ALT/ \overline{CHOP} select to enable the Chop oscillator if the Alternate Vertical Mode is selected.

Scale-Factor Switching Circuit

The vertical deflection factor for each channel is indicated by back-lighting the appropriate figures imprinted on the flange of each VOLTS/DIV knob. Because the operation of the Channel 1 and Channel 2 Scale-Factor Switching circuits are similar, only the circuit action of the Channel 1 Scale-Factor Switching circuits is described.

When CH 1 or ADD Vertical Mode is selected, or when X-Y Horizontal Display Mode is selected, —8 volts is applied to the Q5017 base biasing voltage divider network composed of R5114 and R5015. The base of Q5017 will be biased negative, saturating Q5017. When Q5017 is saturated, the X10 and X1 scale-factor LED DS9040 and DS9060 will have a return path to ground through the transistor and are enabled. (10X LED or 1X LED is lighted depending on the type of probe or cable attached to the CH 1 OR X input connector.)

The X-Y position of A TIME/DIV switch S6111 puts —8 volts on both Channel 1 and Channel 2 scale-factor LED-enabling transistors Q5017 and Q5241 through blocking diodes CR5115 and CR5116. This allows the appropriate scale-factor LED to be illuminated on both CH 1 and CH 2 (10X or 1X).

With either a coaxial cable or 1X probe attached to the CH 1 OR X input connector, the probe-coding ring portion

of the input connector is not contacted. Q5057 will be biased off by the -8 volts through R5055. A voltage divider network composed of R5053, R5041, R5042, and R5052 between Q5017 and the -8 volt supply will bias Q5056 into conduction; the 1X LED in series with Q5056 will be on. The 10X LED is in parallel with R5053, and the voltage drop across R5053 will not be sufficient to cause the 10X LED to light.

When a 10X probe equipped with a scale-factor-switching connector is attached to the CH 1 OR X input connector, the probe coding ring will be contacted. The base of Q5057 will now be connected to ground through R15102 and an internal resistor located within the probe connector body. A bias voltage divider is formed, biasing Q5057 into saturation. The collector of Q5057 will drop to about -7.2 volts. This voltage level is enough to light the 10X LED, and when it is applied to the Q5056 base bias voltage divider composed of R5042 and R5052, it is sufficient to bias Q5056 off and turn off the 1X LED.

VERTICAL OUTPUT AMPLIFIER



Introduction

The Vertical Output Amplifier circuit provides the final amplification for the vertical deflection signal. The circuit includes the Delay Line, part of the Beam Finder circuitry, and part of the Trace Separation circuitry. Pushing the BEAM FIND button compresses an overscanned display to within the viewing area. The Trace Separation circuit provides vertical positioning of the B trace when the ALT Horizontal Display mode is selected.

Delay Line

Delay line DL11405 (Diagram 3) provides approximately 120 nanoseconds delay of the vertical signal to allow the Sweep Generator circuits sufficient time to initiate a sweep before the vertical signal reaches the deflection plates of the crt. When using internal triggering, the instrument is allowed to display the leading edge of the signal originating the trigger pulse. Resistors R2214 (R2206 below SN B030000) and R2218 (R2202 below SN B030000) provide forward termination for the Delay Line.

Input Amplifier

The Input Amplifier consists of integrated circuit amplifier U2225 (U2210 below SN B030000) and the frequency compensation network connected across pins 2 and 3, Gain Adjust R2025 (R2005 below SN B030000) sets the gain of the amplifier. BEAM FIND switch S4075, when pressed, reduces the dynamic swing capabilities of the stage, thereby limiting the display to within the display area on the crt.

Trace Separation

During B sweep the Trace Separation circuit (Q2115, Q2306, and Q2308) is enabled by the alternate pulse on

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the base of Q2115. This switches Q2115 on and Q2105 off. This switching action allows the B trace to be vertically positioned independently of the Atrace. Normally, Q2105 provides a constant amount of current to U2225; however, when in ALT mode, turning Q2115 on supplies current through Q2306 and Q2308. The TRACE SEP control supplies the variable voltage at the base of Q2308 and determines the position of the B sweep display relative to the A sweep display.

The current supplied to U2225 must remain constant so that the A sweep display positioning is not affected. U2005 senses the voltage at the base of Q2308 and compensates by raising or lowering the voltage at the base of Q2306. Potentiometer R2117 centers the B trace around the A trace so that the B trace moves equally above and below the A trace.

For instruments below SN B030000 transistors Q2140 and Q2130 receive a variable current from R14498 (Diagram 13), the TRACE SEP control. The Trace Separation circuit is enabled during B sweep whenever the ALT Horizontal Display mode is selected. Q2140 and Q2130 supply an offset current to the signal current from U2210 during the B sweep. The offset current is not supplied during A sweep. The switching action allows the B sweep display to be vertically positioned independently from the A sweep display.

Output Amplifier

Integrated circuit U2255 (U2260 below SN B030000) is a multi-stage cascode amplifier cell that provides the final amplification for the vertical signal. The input signal is applied push-pull between pins 1 and 5, and the output signal is taken from pins 9 and 12. Integrated circuit amplifier U2385 (U2480 below SN B030000) monitors the emitter currents of the output transistors and automatically sets the dc levels of the output stage to obtain the maximum undistorted gain from U2255 (U2260 below SN B030000).

A AND B TRIGGER GENERATORS



Introduction

The Trigger Generator circuits produce trigger pulses to start the Sweep Generator circuits. These trigger pulses are derived either from the internal trigger signal (sampled from the vertical deflection system), an external signal connected to the external trigger connectors, or a sample of the line voltage applied to the instrument. Controls are provided in each circuit to select trigger level, slope, coupling, and source.

An A Trigger View Amplifier is provided which amplifies the external A Trigger signal for application to the Trigger View Diode Gate where it may be selected for viewing. The trigger view display provides a method of making a quick and convenient check of the external trigger signal being used to trigger the A Sweep Generator. The external trigger input signal may be continually monitored by selecting the A TRIG VIEW Vertical Mode.

Since the A and B Trigger Generator circuits are virtually the same, only the A Trigger Generator circuit action and the differences between the A and B Trigger Generator circuits are described.

Trigger Source

Trigger SOURCE switch S7312 selects the source of the trigger signal. The sources available to the A Trigger Generator circuit are the signal(s) being displayed (NORM), Channel 1 (CH 1), Channel 2 (CH 2), LINE, and EXT. The EXT/10 (A trigger circuit only) position attenuates the external trigger signal by a factor of 10. The B Trigger SOURCE switch does not have a LINE or an EXT/10 position, but has a STARTS AFTER DELAY position.

The STARTS AFTER DELAY position of the B Trigger SOURCE switch is used in conjunction with the DELAY TIME POSITION control. When STARTS AFTER DELAY is selected as a trigger source for the B Sweep, the B Sweep will begin to run immediately after the delay time selected by the DELAY TIME POSITION control has elapsed.

In the LINE mode of triggering, a sample of the power line frequency is obtained from the secondary of power transformer T14500 located in the Low Voltage Power Supply circuit. To prevent unwanted attenuation of the trigger signal by the LF REJ circuit, the A Trigger COUPLING switch should not be in LF REJ when using line voltage as a trigger 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 C7313 or C7317. Frequency components below 60 hertz are attenuated when using AC coupling, and components below about 50 kilohertz are attenuated 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 kilohertz) and low-frequency components (below 60 hertz) are attenuated, while the remaining frequency components are passed with minimal attenuation. The DC mode of trigger coupling passes all signals from dc to at least 100 megahertz without attenuation.

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Theory of Operation—465B Service

Input Source Follower

Transistor Q7324A is a field-effect transistor (FET) source follower. It provides both a high input impedance for the trigger signal and isolation between the Trigger Generator circuit and the trigger signal source. Diode CR7322 provides input protection for Q7324A if an excessively high amplitude negative-going input signal is present. If a high-amplitude positive signal is applied, the source-gate junction of Q7324A becomes forward biased and clamps the voltage at that level. The second FET of the matched pair (Q7324B) is a high-impedance, constant-current source for Q7324A. Since both FETs are matched and mounted in the same heat sink, both will display equal temperature effects, and Q7324B will provide temperature compensation for Q7324A.

Paraphase Amplifier

U7331 is a paraphase amplifier stage that converts the single-ended input from Source Follower Q7324A into a push-pull output applied to the Tunnel Diode Driver stage. Trigger Level Centering adjustment R7224 sets the level at pins 14 and 15 of U7331 so that the display is correctly triggered when the LEVEL control is centered. LEVEL control R17305 varies the level at pins 14 and 15 of U7331 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 SLOPE switch S17305. When the SLOPE switch is set to the \pm position, the output signal present at pin 8 of U7331 is in phase with the input signal, and the output signal at pin 9 is inverted with respect to the input signal. When the SLOPE switch is set to the - position, the output signal at pin 8 is inverted with respect to the input signal, and the output signal at pin 9 is in phase with the input signal.

Tunnel Diode Driver

Transistors Q7344 and Q7345 are common-emitter amplifier stages that provide signal currents necessary to switch the Trigger Firing tunnel diodes. CR7350 and CR7349 are approximately 4.7 milliamp tunnel diodes. Quiescently, CR7349 and CR7350 are biased into their low-voltage states. Q7344 cannot provide sufficient current to switch CR7349 to its high voltage state. However, Q7345 can provide sufficient current to bias CR7350 into its high voltage state. When Q7345 conducts triggering signal current, the anode of CR7350 steps positive to approximately +0.5 volt. Since only approximately 1 milliamp of current is required to maintain CR7350 in its high-voltage state, this makes approximately 3 milliamps of additional current available with which to switch CR7349 to its high-voltage state. Thus, the next time Q7344 conducts signal current, CR7349 steps to its high-voltage state, sending a positive pulse to the logic circuit to initiate sweep action. The A Trigger Sensitivity adjustment, R7348, adjusts the tunnel diode bias to a level

that will not allow CR7349 to be switched to its high-voltage state until CR7350 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 anode of CR7350, thereby resetting both CR7349 and CR7350 to their low voltages states. The reset level remains during holdoff time to ensure that a sweep gating signal will not be generated until the sweep circuit has returned to its quiescent state.

Trigger View Amplifier

Transistors Q7424 and Q7422 make up half of a cascode, push-pull amplifier. In the Vertical Switching Logic circuit (Diagram 3), Q1235 and Q1225 form the rest of the Trigger View Amplifier. The Trigger View Amplifier requires that the A Trigger SOURCE switch be set to EXT or EXT/10 and the A TRIG VIEW Vertical Mode be selected before the amplifier is enabled to pass the external trigger signal to the Diode Gate and on to the Vertical Output Amplifier. If the trigger view display is selected, the Vertical Switching Logic circuit will turn on the Trigger View Diode Gate during the proper time to pass the signal on to the Delay Line Driver.

A sample of the push-pull external trigger signal is taken from pins 1 and 16 of U7331 and amplified by Q7424 and Q7422. The Trigger View Centering control (R7526) is used to vertically position the trigger view display. R7439 is adjusted to set the gain of the Trigger View Amplifier, and C7425, L7525, C7529, and R7423 provide HF compensation. Diodes VR7520, CR7521, and CR7536 are used to clamp the collectors of Q7424 and Q7422 to approximately +5.7 volts whenever Trigger View is disabled. Q1225 and Q1235 will be reverse biased during this time.

SWEEP AND ZAXIS LOGIC CIRCUIT (7)



Introduction

The Sweep and Z-Axis Logic circuit, shown in Figure 3-6, develops 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.

A Sweep Gate

The A Sweep Gate circuit is comprised of Q7254 and Q7256. They form an emitter-coupled stage where only one transistor can be conducting at any time. The input signal to the stage is the positive-going trigger signal from the A Trigger Firing tunnel diode in the A Trigger Generator circuit. The signal at the collector of Q7254 is connected to the A Sweep Z-Axis Gate circuit to control the crt unblanking and to generate the A +Gate signal. The signal at the collector of Q7256 is connected to the emitter of Sweep Disconnect Amplifier Q4497 in the A Sweep Generator circuit to initiate A Sweep generation.

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B Sweep Gate

The B Sweep Gate circuit is comprised of Q7053 and Q7055. These transistors also form an emitter-coupled stage where only one transistor can be conducting at any time. The input signal to the stage is the positive-going trigger signal from the B Trigger Firing tunnel diode in the B Trigger Generator circuit. The signal at the collector of Q7053 is connected to the B Sweep Z-Axis Gate circuit (Q7093 and Q7095) to control crt unblanking and to generate the B+Gate signal. The signal at the collector of Q7055 is connected to the emitter of Sweep Disconnect Amplifier Q4565 in the B Sweep Generator circuit to initiate B Sweep generation.

Sweep Control Integrated Circuit

The Sweep Control integrated circuit is U7375. 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 is the positive Auto Sense input. The signal connected here comes from the A Trigger Firing tunnel diode.

Pin 2 is a reference input to the Auto Sense circuit. A fixed dc level established by R7277 and R7276 is connected here.

Pin 3 is the + auto gate terminal. In the AUTO mode of operation, if no trigger signals are applied to pin 1 of U7375 during the approximately 100 milliseconds following the end of holdoff, the gate level at pin 3 steps LO to turn Q7256 on which initiates a sweep.

Pin 4 is not used in this application.

Pin 5 is the input terminal for negative voltage supply.

Pin 6 is the auto gate timing terminal. R7272 and C7273 determine the amount of time between the end of holdoff and the generation of the auto gate.

Pin 7 output lights the TRIG LED when a triggered gate has occurred.

Pin 6 is the holdoff timing terminal. The RC network connected to this terminal (selected by the A TIME/DIV switch) determines the length of holdoff time.

Pin 9 is the ground terminal.

Pin 10 is the Holdoff output terminal. The gate level present here is LO during sweep holdoff time and HI otherwise.

Pin 11 output lights the READY LED when operating in the single sweep mode.

Pin 12 is the single sweep mode terminal. When +5 volts is applied 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 is not used in this operation.

Pins 14 & 15 are the single sweep reset terminals. Pushing the SINGL SWP button prepares the single sweep circuitry to respond to the next triggering event, and also causes the READY LED to come on.

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

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

Pin 16 is the sweep lockout input. ± 5 volts applied to this terminal disables all sweep action.

Pin 19 is the auto mode terminal. Grounding this terminal enables auto sweep operation.

Pin 20 is the input terminal for positive voltage supply.

Holdoff Timing

A resistor and capacitor network located in the A and B Timing Switch circuit connects to pin 8 of U7375 via pin 8 of J4571. Various resistor and capacitor combinations switch into the circuit, depending on the setting of the A TIME/DIV switch. At sweep end, pin 8 of U7375 is released, and the timing capacitors in the holdoff timing network start to charge. Q7465 is biased off during the sweep holdoff time by a LO at pin 10 of U7375 which allows the voltage at pin 8 to rise due to charging of the timing capacitors. When the charge on the capacitors rises to approximately +4 volts at pin 8, pin 17 goes HI and pin 10 goes HI to turn on Q7465. The holdoff timing capacitors

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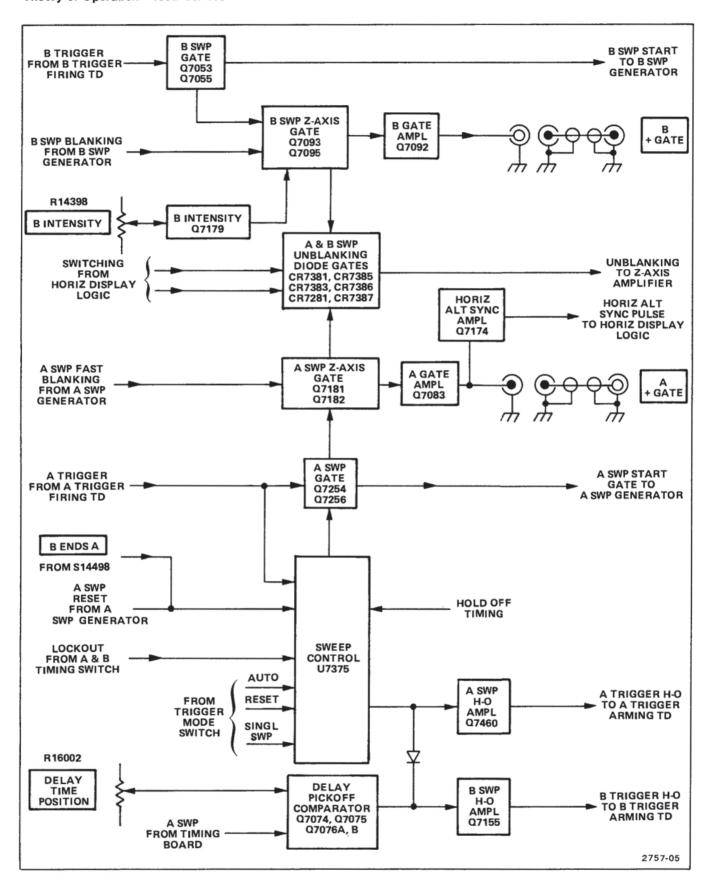


Figure 3-6. Detailed block diagram of the Sweep and Z-Axis Logic circuit.

discharge rapidly through Q7465 as pin 8 goes LO. C6121, C6122, C6112, R6115 and R6114 in the A and B Timing Switch circuit compose the holdoff timing circuits which are switch selectable, and A Trigger HOLDOFF R14498 is a variable resistor that allows lengthening of the time constant to increase holdoff time.

A Sweep Holdoff Amplifler

The A Sweep Holdoff Amplifier is Q7460. The holdoff gate waveform from pin 17 of U7375 is applied to the base of Q7460 through R7461 and C7461. When Q7460 is turned off (during holdoff time), its collector is LO and CR7451 is forward biased, thus resetting both the Arm and Firing Trigger tunnel diodes in the A Trigger Generator. When Q7460 is turned on (any time other than holdoff time), its collector level is HI and CR7451 is reverse biased. This allows the trigger tunnel diodes in the A Trigger Generator to respond to the next adequate triggering signal.

B Sweep Holdoff Amplifier

The B Sweep Holdoff Amplifier is Q7155. Its circuit action is identical to that described for the A Sweep Holdoff Amplifier with the exception that two gate signal sources control the state of the stage. The two sources are the holdoff gate from pin 17 of U7375 (through CR7363) and the collector of Q7075 in the Delay Pickoff Comparator. Both gate sources must be in their LO state for B Sweep to be triggerable. Either source in its HI state will disable the B Trigger Generator tunnel diodes.

A Sweep Z-Axis Gate

Q7181 and Q7182 comprise the A Sweep Z-Axis Gate. They form an emitter-coupled stage where only one transistor can be conducting at any time. The controlling signals consist of inputs from the collector of Q7254 in the A Sweep Gate, the unblanking signal from Q4582 in the A Sweep Generator, and Q4492 in the Horizontal Display Logic circuit. The unblanking signal for use in the Z-Axis Amplifier is taken from the collector of Q7182 (through CR7387). The collector signal of Q7181 is applied to the A +Gate Emitter Follower (Q7083).

The Horizontal Display Logic circuit controls the bias voltage on CR7281. When the diode is reverse biased, as it is for all horizontal modes except for B DLY'D, -8 volts is connected to the anode of CR7281 through Q4492. This allows the gate signal at the collector of Q7182 to pass through CR7387 creating the unblanking signal to the Z-Axis Amplifier. In the B DLY'D mode, Q4492 is turned off and CR7281 is forward biased through R7281 to the +5 volts supply. CR7387 will now be reverse biased, and the A unblanking signal is blocked from reaching the Z-Axis Amplifier. In the ALT Horizontal Display mode, CR7281 will be reverse biased during the A sweep and forward biased during the B sweep.

B Sweep Z-Axis Gate

The B Sweep Z-Axis Gate is comprised of Q7093 and Q7095. These transistors form an emitter-coupled stage where only one transistor can be conducting at any time. The controlling signals come from the collector of Q7053 (B Sweep Gate), and the blanking signal from the collector of Q4562 in the B Sweep Generator. The emitter current in the gate transistors is supplied partly by Q7195 which is controlled by B INTENSITY control R14398. The B INTENSITY control sets the level of the B Sweep unblanking signal to control the B Sweep intensity separately from the overall display intensity. The collector of Q7095 supplies the unblanking signal to the Z-Axis amplifier and the collector of Q7093 supplies the signal to the B +Gate Emitter Follower (Q7092).

When the A Horizontal display is selected, —8 volts from Q4491 in the Horizontal Display Logic circuit is applied to the cathode of CR7381. This reverse biases CR7383 and allows the collector of Q7095 to be pulled positive through CR7385 and R7283 to the +5 volt supply. CR7386 will be reverse biased and the B Sweep Z-Axis Gate (Q7093 and Q7095) will not affect crt unblanking. When either A INTEN, ALT, or B DLY'D Horizontal Display is selected, —8 volts is applied to the anode of CR7385 to reverse bias it and allow the Horizontal Display Logic circuit to control the B Sweep Z-Axis Gate.

In A Intensified Horizontal Display, CR7381 becomes reverse biased and CR7383 becomes forward biased. Diode CR7386 is still reverse biased, but when B Sweep starts, the collector of Q7095 steps negative enough to forward bias CR7386 and add a slight amount of unblanking to the A Sweep unblanking already present. This provides further intensification for the B Sweep portion of an A Intensified display. In ALT Horizontal Display, the Horizontal Display Logic circuit controls the A Sweep Z-Axis Gate (Q7181 and Q7182) and the B Sweep Z-Axis Gate (Q7093 and Q7095). The B Sweep unblanking signal is added to the A Sweep unblanking signal during the A Intensified display, the A Sweep unblanking signal is blocked during the B DLY'D display. In B DLY'D Horizontal Display, the A Sweep Z-Axis Gate output diode CR7387 is held reverse biased, and the only unblanking signal presented to the Z-Axis amplifier input is the B Sweep unblanking signal.

A +Gate and B +Gate Emitter Followers

Emitter followers Q7083 and Q7092 provide the A +Gate and the B +Gate output signals available at the instrument rear panel. The output signals are positive-going rectangular waveforms, approximately +5.5 volts in amplitude. The amplitude is set in the collectors of Q7181 and Q7093. For example, when Q7181 is conducting, the base of Q7083 can go no more negative than approximately -0.7 volt (limited by CR7078). When Q7181 is not conducting, the base of Q7083 rises to the +5 volts power

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supply level through R7184. Diodes CR7084, CR7085, CR7097, and CR7098 provide protection against accidental application of damaging voltage levels to the A \pm Gate and B \pm Gate output connectors.

Horiz Alt Sync Pulse Amplifier

The pickoff amplifer for the Horiz Alt Sync pulse is Q7174. It is biased into saturation, so its quiescent output voltage is approximately zero. A sample of the A +Gate is coupled to the base of Q7174 by C7174 where the positivegoing gate is integrated by the action of C7174 and R7171. The positive-going portion of the integrated signal cannot increase the collector current of Q7174 beyond its saturation level, so no signal output is obtained. When the A +Gate negative-going edge occurs, C7174 cannot change its charge instantaneously so the entire negative transition is felt on the base of Q7174 across R7171. The negative peak of the signal is enough to cutoff Q7174, and the collector voltage rises in response to the base voltage decrease. The base voltage rapidly returns to a positive level, and the transistor again saturates, ending the Horiz Alt Sync pulse.

A AND B SWEEP GENERATORS



Introduction

The A and B Sweep Generators produce sawtooth voltages which are amplified by the Horizontal Amplifier circuit to provide horizontal deflection on the crt. These sawtooth voltages are produced on command (Sweep start gate) from the Sweep Logic 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. Figure 3-7 shows a detailed block diagram of the A Sweep Generator circuit that will be described in the following discussion. Since the B Sweep Generator circuit is very similar to the A Sweep Generator, the only discussion of the B Sweep Generator will be on the differences in operation between the two.

Disconnect Amplifier

After holdoff, but before the next sweep, Disconnect Amplifier Q4497 is biased on and conducts through R4587 and R_t back to $\pm V_t$. This sets the charge on C_t in preparation for the beginning of the next A Sweep and prevents current from the Miller Integrator circuit from

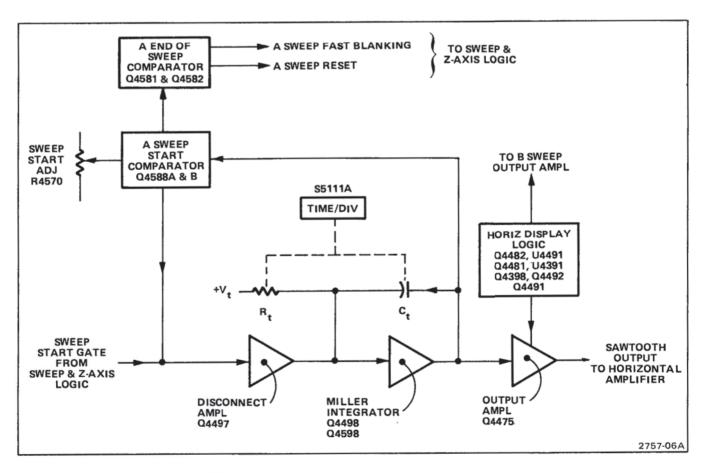


Figure 3-7. Detailed block diagram of the A Sweep Generator circuit.

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changing the charge on C_t . When the positive-going A Sweep Start Gate is applied to the emitter of Q4497, CR4592 becomes forward biased and turns off Q4497. Now the A Sweep starts, and the Miller Integrator circuit begins to change the charge on C_t . Q4497 will remain off until retrace is initiated and the A Start Sweep Gate is removed. Then Q4497 will become forward biased again, and C_t will rapidly charge to its quiescent value for the start of the next A Sweep.

modes of operation. In the A and A INTEN modes of operation, the A sweep signal passes through Q4475 to the Horizontal Amplifier. In the ALT mode, Q4475 is enabled for the A sweep and turned off for the B sweep by the Horizontal Display Logic circuit. In the B DLY'd mode, Q4475 is held off, and Q4465 in the B Sweep Generator is held on to pass the B sweep sawtooth to the Horizontal Amplifier.

Sawtooth Generator

The Miller Integrator circuit is comprised of Q4498 and Q4598. It works on the principle that if the charging current to a capacitor can be held constant, then the charging curve will be linear rather than exponential. The action starts when Disconnect Amplifier Q4497 is turned off by the A Sweep Start Gate. The selected capacitor for the chosen setting of the TIME/DIV switch (Ct) begins to charge through the Rt. This causes the junction of Ct and R_t to start positive in the direction of +V_t, thereby causing the gate of Q4498 to start positive. The Q4498 source then starts in a positive direction and increases the forward bias on Q4598 causing the collector voltage to move in a negative direction (less positive). This couples back through Ct and opposes the positive change at the gate of Q4498. Capacitor C_t is attempting to charge toward +V_t, but the action of Q4498 gate being held virtually constant. and the collector of Q4598 going more negative, results in the reduction of the charge on C₁ (it discharges). The gate of Q4498 rises positive about 10 millivolts over the entire sweep generation time. Since the voltage at the gate of Q4498 remains relatively constant, both the voltage across R_t and the current through R_t (the current discharging from C_t) remain constant. The linear rate of discharge of C_t results in a linear ramp across it. The resultant output at the collector of Q4598 appears as a negative-going ramp, dropping from approximately +13 volts to approximately +2 volts.

When the ramp reaches ± 2 volts, Q4581 sends a pulse to U7375 initiating retrace. Transistor Q4497 turns on, and its collector goes more negative. This moves the gate of Q4498 in the negative direction, causing the voltage on the base of Q4598 to go more negative, thereby causing its collector voltage to go more positive. Now C_1 charges rapidly through Q4497 to its quiescent state in preparation for the next A Sweep start gate.

Output Amplifier

The Output Amplifier is a common-base amplifier with the signal current-driven into the emitter. It provides the output sawtooth current signal to the Horizontal Amplifier and provides a measure of isolation between the Sawtooth Generator and the Horizontal Amplifier. The Horizontal Display Switching circuit connects to this stage and controls the A sawtooth output in the various horizontal

A Sweep Start Comparator

Just before the sweep starts to run down, the levels at the bases of Q4588A and Q4588B are approximately equal. When the sweep starts to run down, the base of Q4588B goes negative, following the collector of Q4598. This increases the forward bias on CR4581 which in turn decreases the forward bias on CR4582. Very shortly after start of the sweep, CR4582 becomes reverse biased and interrupts the current through Q4588A. The circuit remains in this condition until after the sweep retrace is complete. When the circuit returns to quiescence, Q4588A again begins to conduct through R4587. This sets the currents through Q4497, establishing the starting point for the sweep. Sweep Start adjustment R4570 sets the base level of Q4588A. This level is also connected to the base of Q4565 in the B Sweep Generator to ensure that the B sweep starts at the same level as the A sweep.

A Sweep End of Sweep Comparator

The A Sweep End of Sweep Comparator is a switching circuit comprised of Q4581 and Q4582. At quiescence, Q4582 is conducting and Q4581 is turned off. When the sweep starts to run, the negative-going ramp at the collector of Q4498 is coupled through the base of Q4588B and through CR4581 to the cathode of CR4577. When the collector of Q4498 reaches about +2 volts, the cathode of CR4577 reaches about +4 volts. CR4577 begins conducting and turns on Q4581, which then turns off Q4582. The resulting positive step at the collector of Q4581 is fed to pin 16 of U7375 where it is used to initiate retrace and holdoff. The negative-going pulse at the collector of Q4582 is applied to the A Sweep Z-Axis Logic Gate to blank the crt as soon as a sweep-end command is generated.

B Sweep Generator Differences

There are two main differences between the A Sweep Generator and the B Sweep Generator. The first is that Q4545 is used as a constant current source in the B Sweep Start Comparator circuit. The second is that one of the outputs of the B Sweep Generator is controlled by the B ENDS A switch associated with the A Trigger HOLDOFF control. In the B ENDS A position, the end of the B sweep also ends the A display on the crt.

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Theory of Operation-465B Service

Horizontal Display Switching

Switching transistors Q4482 and Q4481 are controlled by the Horizontal Display Logic circuit. They are switched off and on as required to allow A sweep output transistor Q4475 and B sweep output transistor Q4465 to pass the A or B sawtooth to the Horizontal Amplifier.

When HORIZ DISPLAY is set to A, a LO on the base of Q4481 keeps the transistor biased off. The A sawtooth is allowed to pass to the emitter of Q4475 to be amplified and sent to the Horizontal Amplifier. AHI on the base of Q4482 turns it on, and the B sawtooth passes to ground through the transistor, thereby preventing the B sawtooth from going to the Horizontal Amplifier. The same conditions exist when the HORIZ DISPLAY is set to AINTEN. Setting the HORIZ DISPLAY to ALT will cause the Horizontal Display Logic circuit to alternately turn Q4481 and Q4482 off and on to first pass the A sawtooth and then the B sawtooth to the Horizontal Amplifier. When the HORIZ DISPLAY is set to B DLY'D, Q4482 will be biased off and Q4481 will be on. The B sawtooth will go to the Horizontal Amplifier, and the A sawtooth will be shunted to ground.

HORIZONTAL DISPLAY LOGIC (8)



Introduction

The Horizontal Display Logic circuit produces the signals that switch the A and B Sweep Generators and the A Sweep and B Sweep Z-Axis Gates. It also provides a Vertical Alt Sync pulse to the Vertical Switching circuit. Switching transistor Q4398 enables the TRACE SEP potentiometer (R14498) during ALT Horizontal Display.

Vert Alt Sync Pulse

A gating circuit is formed by U4391B and U4391D to control the Vertical Alt Sync pulse. The pulse is used in the Vertical Switching circuit for clocking U1705 whenever the ALT Vertical Mode is selected. In all Horizontal Display modes except ALT, a HI at pin 6 of U4391B will put a LO at pin 3 of U4391D. Pin 2 of U4391D has the positive-going Horiz Alt Sync pulse present. This pulse is inverted through U4391D and fed to the Vertical Switching circuit. In ALT Horizontal Display mode, pin 6 of U4391B will be LO, and the signal at pin 5 will control output pin 4. The signal present at pin 6 of U4491A, which changes state with every Horiz Alt Sync pulse, now controls U4391D, and the Vert Alt Sync pulse becomes a rectangular pulse having a period equal to twice the time between Horiz Alt Sync pulses.

Trace Separation

Transistor Q4398 acts as a switch to control the enabling voltage to TRACE SEP potentiometer R14498. In the ALT Horizontal Display mode the voltage is applied to the potentiometer during the B Sweep time to supply an

offset signal to Q2140 and Q2130 in the Vertical Output Amplifier. This circuit allows control of the vertical separation between the A Sweep display and the B Sweep display on the crt. During B Sweep, in ALT Horizontal Display mode, a HI will be present on pin 4 of U4391B. The HI will raise the base voltage of Q4398 to turn it on and the —8 volts on the emitter will be supplied to the TRACE SEP potentiometer.

A and B Sweep Switching

Flip-flop U4491A controls Horizontal Display Switching transistors Q4482 and Q4481 in the A and B Sweep Generators. The HORIZ DISPLAY switch S6260 sets the flip-flop input to do one of the following:

- 1. Turn off Q4481 and turn on Q4482 to allow the A Sweep signal to go to the Horizontal Amplifier;
- 2. Turn off Q4482 and turn on Q4481 to allow the B Sweep signal to go to the Horizontal Amplifier; or
- 3. Alternately turn the two transistors off and on to display both sweeps in ALT Horizontal Display mode.

U4491A is clocked by the Horiz Alt Sync when the Horizontal Display is set to ALT. When the Horizontal Display is set to A, A INTEN, or B DLY'D, the state of the outputs of U4491A is determined by the logic levels present at pins 1 and 4. The HORIZ DISPLAY switches set these logic levels.

Flip-flop U4491B controls the A and B Sweep Z-Axis Gate switching transistors Q4492 and Q4491. These transistors switch the bias on CR7281 and CR7381 in the A and B Sweep Z-Axis Gates to either allow the unblanking gates to pass to the Z-Axis Amplifier or block them. U4491B is controlled by both the signal on pin 5 of U4491A and the A position of the HORIZ DISPLAY switch.

HORIZONTAL AMPLIFIER



Introduction

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 and the HORIZ DISPLAY switch. This signal can come from either the sweep generators within the instrument or some external signal applied to the CH 1 OR X input connector (X-Y Horizontal Display). Horizontal positioning, X10 magnifier circuitry, and the horizontal portion of the beam finder circuitry are also contained in the Horizontal Amplifier. Figure 3-8 shows a detailed block diagram of the Horizontal Amplifier circuit.

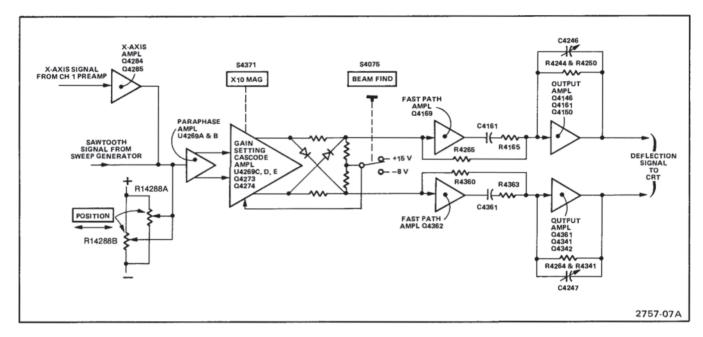


Figure 3-8. Detailed block diagram of the Horizontal Amplifier circult.

X-AxIs Amplifler

In all positions of the TIME/DIV switches except X-Y, the input signal to the base of U4269A will be sawtooth waveforms from the sweep generators. In the X-Y position, however, the sweeps are disabled, and the signal applied to Q4269A comes from the Channel 1 Preamplifier via the X-Axis Amplifier. This stage includes Q4284, Q4285 and associated circuitry.

Transistor Q4284 is connected as a feedback amplifier, with R4285 as the feedback element. The input resistance is made up of R4384 and the gain-setting adjustment of R4381. When not operating in the X-Y Horizontal Display, the base of Q4284 rises toward the +15 volt supply, but is clamped at approximately +5.7 volts by CR4287 and R4287. This reverse blases the base-emitter junction of Q4284. The base of Q4285 also rises to approximately +5.7 volts and with the junction of R4281-R4280 at approximately 0 volt, Q4285 is biased off.

When the A TIME/DIV switch is set to X-Y position (fully counterclockwise), -8 volts is applied to the junction of R4382 and R4383. In addition, +5 volts is applied to the emitter circuit of Q4285 through CR4285. This biases the X-Axis Amplifier into conduction. The +5 volts is also applied to pin 18 of U7375 in the Sweep and Z-Axis Logic circuit to disable sweep generation.

Input Paraphase Amplifier

The Input Paraphase Amplifier is comprised of U4269A and U4269B (part of a transistor array). This is an emitter-coupled amplifier stage that converts the single-ended

input signal to a push-pull output signal. The signal at the collector of U4269A is opposite in phase to the input signal, while the signal at the collector of U4269B is in phase with the input signal. Thermistor RT4373 reduces its value with increases in ambient temperature to increase the gain of the stage. This compensates for slight changes in amplifier gain that occur as operating temperatures vary.

The Horizontal POSITION potentiometers, R14288A (Coarse) and R14288B (Fine), are mounted on the same shaft in a mechanical arrangement that allows R14288B to rotate about one-eighth turn in either direction before R14288A moves. The Fine Potentiometer has approximately one-tenth the range of the Coarse potentiometer.

Gain Setting Cascode Amplifler

A cascode push-pull amplifier stage is made up of Q4273, Q4274, U4269C and U4269D. The gain of the Horizontal Amplifier is controlled by adjusting the resistance connected between the emitters of Q4273 and Q4274. The X1 Gain adjustment, R4274, is used to adjust the unmagnified horizontal gain and the X10 Gain adjustment, R4373, is used to adjust the magnified horizontal gain. Magnifier Registration adjustment, R4275, is used to balance the quiescent dc current in Q4273 and Q4274 so that a center screen display does not change positions when switching between magnified and unmagnified display.

Theory of Operation—465B Service

When the BEAM FIND push button is pressed, ± 15 volts is removed from the junction of R4167 and R4361, and ± 8 volts is applied to the junction through R4075. The following actions occur:

- 1. The base voltage of Q4269C and Q4269D is lowered to decrease the current through the two transistors. The reduced current flow decreases the voltage drop across R4266 and R4267 and the diode clamps (CR4266 and CR4267) clamp at a much lower voltage. This action limits the horizontal deflection on the crt; and
- 2. R4167 and R4361 are now no longer connected to +15 volts, therefore less current flows through these resistors. This compensates for the decreased current flowing through Q4269C and Q4269D and maintains the output stage in a linear operating region.

Output Amplifier

The push-pull signal from the Gain Setting Cascode Amplifier is connected to the bases of Q4169 and Q4362, through R4265 and R4360 and on to the bases of Q4161 and Q4361. At lower sweep frequencies, the signal path is through R4265 and R4360 to the bases of Q4161 and Q4361. These transistors are inverting amplifiers whose collector signals drive the emitters of complementary amplifiers Q4146-Q4150 and Q4341-Q4343, respectively. Capacitor C4262 provides emitter peaking for fast ac signals. Capacitors C4150 and C4341 transfer part of the high-frequency signal to the emitters of Q4146 and Q4342 to maintain the gain of the output stage at high sweep speeds. Resistors R4244-R4250 and R4254-R4341 are the feedback elements, with C4246 and C4247 providing highfrequency compensation. As frequency of the sweep signal increases, the reactance of C4246 and C4247 decreases and feedback current increases. To compensate for the increase in drive required to maintain the gain of the output stage, Q4169 and Q4362 (fast-path amplifiers) increase signal current to the bases of Q4161 and Q4361. High-frequency signal current is shunted around R4265 by C4165 and R1165, and C4361 and R4363 shunt high-frequency signal current around R4369. The Output Amplifiers are limited from being over-driven by CR4267 and CR4266. If the output signal from U4269D or U4269C becomes too large, the diodes become forward biased and prevent further increase in the signal level. These diodes operate mainly to clamp the signal whenever the X10 Magnification circuitry is operating. The signal level is limited to the forward drop across the diodes plus the drop across R4266 and R4267.

CRT CIRCUIT (1)

Introduction

The CRT circuit provides the voltage levels and control circuitry necessary for operation of the cathode-ray tube (crt). Figure 3-9 shows a detailed block diagram of the CRT circuit.

High-Voltage Oscillator

The high-voltage oscillator is comprised of Q14009 and associated circuitry. It produces the drive for high-voltage transformer T4015. When the instrument is turned on, transistor Q4008 is forward biased and conducts through the base circuit of Q14009 to forward bias Q14009. The increasing collector current of Q14009, through the primary winding of T4015, induces a voltage across the feedback winding. Because the feedback winding is connected to the base of Q14009 and the feedback is positive, the collector current increases rapidly toward saturation. Soon the rate of increase slows to a point where the voltage induced in the feedback winding starts to decrease. This decreases the current through Q14009, further decreasing the feedback voltage. The cycle continues until Q14009 turns off, and the magnetic field around the primary winding of T4015 starts to collapse. Transistor Q14009 is held off until the field has collapsed sufficiently to allow the base of Q14009 to become biased into conduction and the cycle is repeated.

The voltage waveform at the collector of Q14009 is a sinusoidal wave at the resonant frequency of T4015. The amplitude of sustained oscillations depends on the average current delivered to the base of Q14009. Frequency of oscillation is approximately 50 kilohertz. Fuse F4508 protects the unregulated +15 volt supply in the event the High-Voltage Oscillator stage becomes shorted. C4006 and L4006 decouple the unregulated +15 volt supply to prevent current changes (present in the High-Voltage Oscillator) from affecting the +15 volt supply.

High-Voltage Regulator

Once the output voltage from the High-Voltage Oscillator has reached its stable level after the instrument is turned on, regulation occurs as follows. A sample of the —2450 volt crt cathode supply is applied to the base of Q4228 through R4127D which, with the voltage supplied by the bias network composed of R4332, R4127C, C4327, and CR4329, sets the forward bias on Q4228. Any change in the —2450 volts changes the conduction level of Q4228 to produce a proportional dc change on its collector.

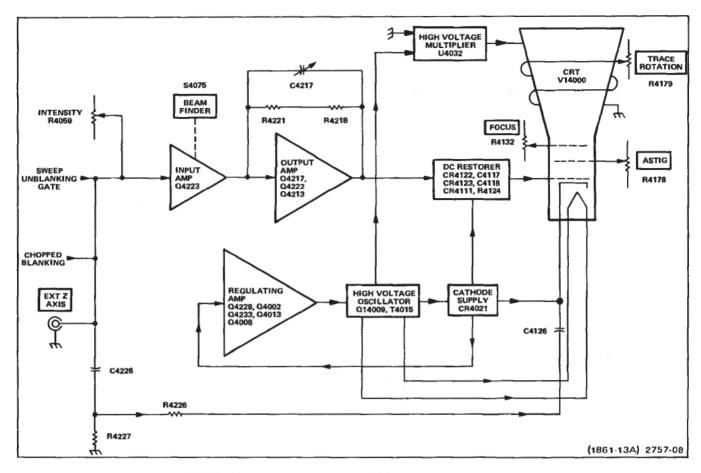


Figure 3-9. Detailed block diagram of the CRT and Z-Axis Amplifier circuits.

Assume that the —2450 volts supply starts to go positive (less negative). The positive-going change is applied to the base of Q4228 and causes the collector current to increase, which in turn, causes Q4233 and Q4008 to conduct harder. This results in greater bias current to the base of Q14009 through the feedback winding of T4015. Now Q14009 is biased closer to its conduction level, and it will conduct sooner in the oscillation cycle of T4015 to increase the average current delivered to the primary of T4015. This increases the amplitude of oscillation and induces a larger voltage into the high-voltage secondary of T4015 to correct the original positive-going change. By sampling the output of the crt cathode supply in this manner, the total output of the High-Voltage Supply is held relatively constant.

Overvoltage protection is provided by Q4002, Q4103, and associated circuitry. Normally Q4002 and Q4103 are biased off, but if the crt cathode supply voltage approaches approximately —3000 volts, the voltage level at the emitter of Q4008 will be approximately —6 volts. At this point Q4002 will be biased into conduction, which in turn biases Q4103 into conduction to reduce the forward bias on Q4008. This reduces the base drive to Q14009 in order to limit the amplitude of oscillations in T4015, and the crt cathode supply is prevented from going more negative than approximately —3000 volts.

High-Voltage Rectifiers and Output

High-voltage transformer T4015 has two secondary windings. One winding provides heater voltage for the cathode-ray tube. The heater voltage is supplied from the High-Voltage Supply, since the cathode-ray tube has a very low heater current drain, and this allows the cathode and heater of the crt to be connected together to prevent cathode-to-heater breakdown. The high-voltage winding is the source for the negative crt cathode potential and the source for High-Voltage Multiplier U4032. 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 supplied by both the Z-Axis Amplifier and the crt negative cathode potential.

The positive accelerating potential is supplied by High-Voltage Multiplier U4032. Regulated output voltage is approximately +15,500 volts. The negative cathode potential of -2450 volts is supplied by half-wave rectifier CR4021. Voltage variations in this supply are monitored by the High-Voltage Regulator circuit to provide a regulated high-voltage output.

Theory of Operation-465B Service

CRT Control Circuits

Focus of the crt display is controlled by FOCUS control R4132. ASTIG adjustment R4178, 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 R4069 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-Axis adjustment R4072 controls current through L14165, 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 R4179 controls the current through L14176 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. Input transistor Q4223 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. Current signals from the various control sources are connected to the emitter of Q4223, and the algebraic sum of these signals determines the collector conduction level.

Transistors Q4222, Q4217, and Q4213 are configured in a feedback amplifier arrangement with R4218 and R4221 as feedback elements and with C4217 providing high-frequency compensation. Emitter follower Q4222 provides the drive to complementary amplifier Q4217-Q4213. Diodes CR4321, CR4218, and CR4115 provide protection in the event of high-voltage arcing.

The Z-axis portion of the Beam Find circuit acts on the input to the Z-Axis Amplifier. When the BEAM FIND push button is pressed, two events occur: First, +15 volts is applied to the anode of CR4144 which lifts the emitter of Q4223 sufficiently positive to ensure nonconduction of the transistor. Second, R4321 becomes connected to -8 volts through R4314 to establish a fixed and predetermined unblanking level at the output of the amplifier. Thus, the INTENSITY control and all of the input unblanking signals have no control over the intensity level of the crt display whenever the BEAM FIND push button is pressed, and a bright trace will be displayed.

DC Restorer

The DC Restorer circuit provides crt control grid bias and couples both dc and low frequency components of the Z-Axis Amplifier unblanking signal to the crt control grid. This circuit allows the Z-Axis Amplifier output to control the intensity of the crt display. The potential difference between the Z-Axis Amplifier output and the control grid (about 2465 volts) prevents direct signal coupling.

The DC Restorer circuit's ac drive is taken from the center tap of T4015. Voltage on the center tap is approximately 300 volts p-p at 50 kilohertz. A sample of this sinusoidal voltage is fed through C4010 and R4112 to the junction of CR4111, CR4112, and R4111. The Crt Bias Adjust (R4109) sets the voltage level on the cathode of CR4111 to approximately \pm 100 volts dc. When the ac sample voltage rises to \pm 100 volts, CR4111 becomes forward biased and clamps the junction of CR4111 and CR4112 to approximately \pm 100 volts.

The Z-Axis Amplifier output voltage level is applied via R4113 to the anode of CR4112. This voltage level varies between +15 volts and +95 volts, depending on the setting of the INTENSITY control. The sample voltage will hold CR4112 reverse biased until the voltage falls below the Z-Axis Amplifier output level. At that point CR4112 becomes forward biased and clamps the junction of CR4111 and CR4112 to the Z-Axis Amplifier output level (see Figure 3-10). Clamping the sample between +100 volts and the positive voltage level set by the INTENSITY control produces an approximate square-wave signal with a positive dc offset level.

The DC Restorer circuit is referenced to the -2450 volts, present on the crt cathode, through R4126 and CR4123 to the junction of C4117 and CR4122. Initially, C4117 will charge to a level determined by the difference between the Z-Axis Amplifier output level and the -2450 volt reference voltage. The charging path is from the -2450 volt line, through R4126, CR4123, C4117, R4111, CR4112, and R4113 to the Z-Axis output.

Initially, C4118 will also be charged to approximately the same voltage as C4117 through R4126, CR4123, and CR4122 to the Z-Axis output.

When the sinusoidal sample voltage starts its positive transition from the lower clamped level (+15 to +95 volts) toward the higher clamped level (+100 volts), the charge on C4117 increases due to the rising voltage at the anode of CR4111. The additional charge acquired by C4117 is proportional to the amplitude of the positive transition of the clamped sample voltage.

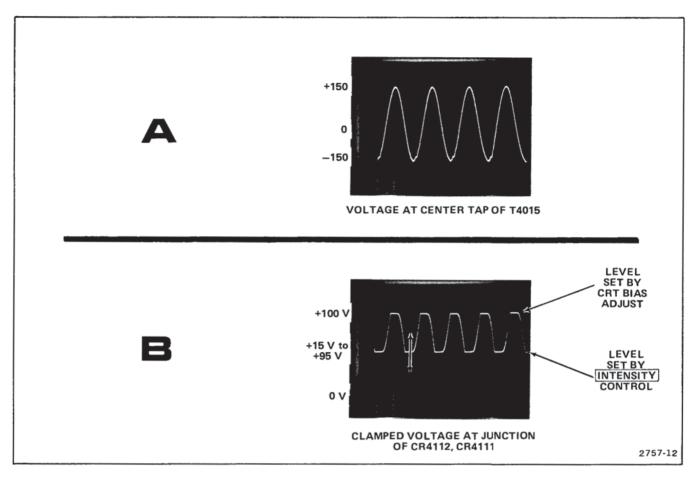


Figure 3-10. (A) Sinusoidal sample voltage at center tap of T4015. (B) Clamped sample voltage at the junction of CR4111 and CR4112.

When the sample voltage starts its negative transition from its upper clamped level toward its lower clamped level, the negative transition is coupled through C4117 to reverse bias CR4123 and forward bias CR4122. When CR4122 becomes forward biased, the charge on C4117 is transferred to C4118 as C4117 attempts to discharge to the Z-Axis output. The amount of charge that is transferred is proportional to the setting of the INTENSITY control, since the INTENSITY control sets the lower clamping level of the sample voltage from T4015 (see Figure 3-11).

If the INTENSITY control is set so the lower level of the sample voltage is clamped at +15 volts, a voltage change of approximately 75 volts is coupled through CR4122. The 75-volt negative excursion is added to the charge already present on C4118. This causes the control grid to be sufficiently negative with respect to the crt cathode to keep the crt blanked. When the INTENSITY control is set to increase the display intensity, the lower clamping level of the sample voltage is moved toward the +100 volt upper clamping level. This makes the swing of the negative transitions less, therefore less charge will be added to C4118. The voltage on the crt control grid becomes less

negative with respect to the cathode and allows more beam current to flow in the crt. The more positive the lower clamping level is made, the brighter the trace on the crt.

During periods that C4117 is charging, the voltage on the control grid is held constant by the filter action of C4118 as it discharges through R4124 back to the -2450 volt line. R4124 is a very high resistance, so the RC time constant of C4118 and R4124 is long in respect to the frequency of the sample voltage from T4015. Whatever charge is leaked off of C4118 during the positive transitions of the sample voltage will be replaced by C4117 when the sample voltage makes its negative transitions.

The fast rise and fall of the unblanking pulses from the Z-Axis Amplifier are coupled by C4118 to the control grid to start the crt beam current change. The DC Restorer output level then follows the Z-Axis output level to set the new bias level on the control grid.

In the event of a failure that causes a loss of potential on either the control grid or the cathode, protection against arcing is provided by DS4124 and DS4125.

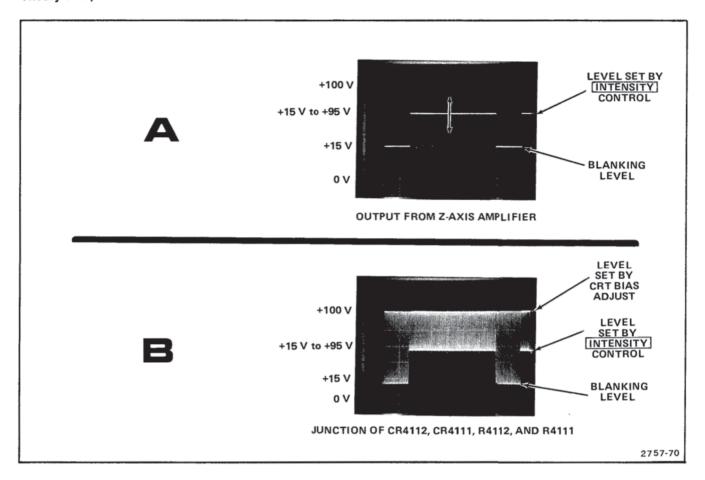


Figure 3-11. (A) Z-Axis Amplifier output. (B) Clamped sample voltage at the junction of CR4111 and CR4112.

CALIBRATOR (13)

Introduction

The Calibrator circuit produces a square-wave output signal with accurate voltage and current amplitudes. This output is available as both a voltage and a current at the CALIBRATOR current loop on the instrument front panel. Figure 3-12 shows a detailed block diagram of the Calibrator circuit.

Multivibrator

Transistors Q4182 and Q4196 and associated circuitry are configured as an astable multivibrator. The basic frequency of the multivibrator is approximately I kilohertz and is primarily determined by the resistance and capacitance of C4187, R4186, R4191, R4184, and R4185. Transistors Q4182 and Q4196 alternately conduct, producing a square-wave output signal. This output is taken from the collector of Q4196.

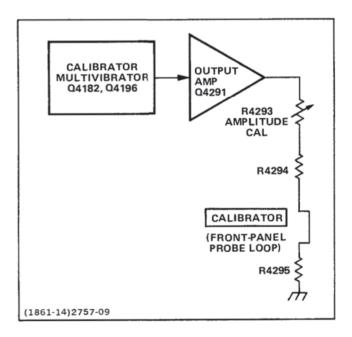


Figure 3-12. Detailed block diagram of the Calibrator circuit.

Refer to Figure 3-13 for the following discussion. At t_0 assume that the circuit is operating and has reached its normal operating conditions. Also assume Q4182 is off and Q4196 is on. At t_0 , the emitter of Q4182 is at approximately +9 volts, and the emitter of Q4196 is at +7.5 volts with its base at approximately +7.0 volts. From t_0 to t_1 , C4187 charges toward the +55 volt supply through R4186. When the emitter of Q4182 reaches +15.6 volts, Q4182 becomes forward biased. At t_1 , the collector of Q4182 rises to approximately +14.6 volts, and since the base of Q4196 is directly connected to the collector of Q4182, Q4196 is cut off.

Now C4187 charges in the opposite direction. At t₁, as C4187 starts charging through R4191 and Q4182, the emitter of Q4196 rises from +7.6 volts to approximately +14.6 volts. When +14.6 volts is reached at t₂, Q4196 begins to conduct, reducing both the charging current through C4187 and the collector current of Q4182. At t₂ the collector voltage of Q4162 drops in a negative direction and Q4196 conduction increases. The emitter of Q4196 drops from +14.6 volts to +7.6 volts. This negative transition is coupled through C4187 to the emitter of Q4182 to cut Q4162 off and the cycle repeats itself.

Output Amplifier

The output signal from the Multivibrator drives Output Amplifier Q4291 to produce a square wave at the output. When the base of Q4291 goes positive, the transistor is cut off and its collector voltage drops to zero. When the base goes negative, Q4291 is biased into saturation, and the collector voltage rises in a positive direction to about ± 5 volts. Amplitude adjustment R4293 is used to adjust the resistance between the collector of Q4291 and ground to control the amount of current allowed to flow. This in turn determines the voltage developed across R4295. The output voltage, at the calibrator current loop on the 465B oscilloscope, is 300 millivolts $\pm 1.0\%$ and the output current is 30 milliamps $\pm 2.0\%$.

LOW-VOLTAGE POWER SUPPLY



Introduction

The Low-Voltage Power Supply circuit provides the operating power for this instrument from five regulated supplies and one unregulated supply. Regulation provides stable, low-ripple output voltages. Figure 3-14 shows a detailed block diagram of the Power Supply circuit.

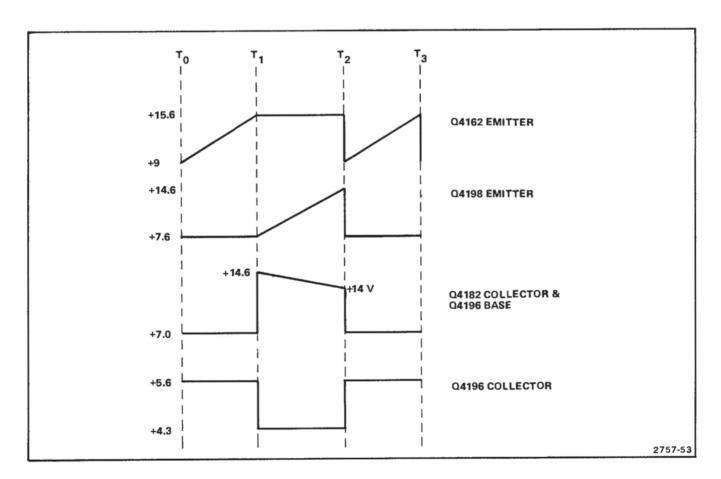


Figure 3-13. Calibrator circuit waveform diagram.

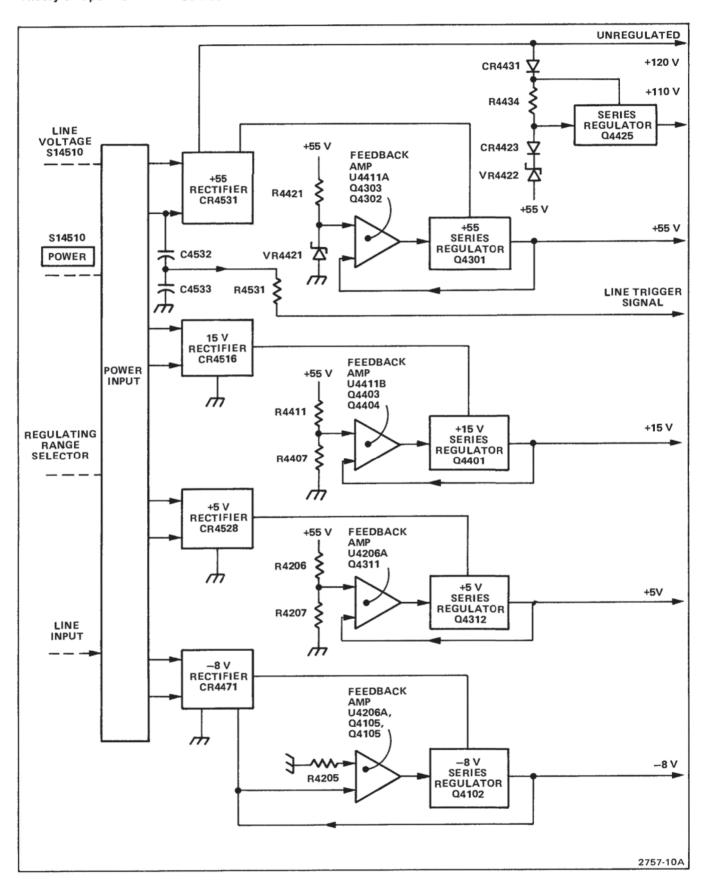


Figure 3-14. Detailed block diagram of the Low-Voltage Power Supply circuit.

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Power Input

Power is applied to the primary of transformer T14500 through Line Fuse F14500, POWER switch S14510, Thermal Cutout S14520, Line Voltage Selector switch S14500, and the Regulating Range Selector assembly. Line Voltage Selector switch S14500 connects the split primaries of T14500 either in parallel for 115-volt nominal operation or in series for 230-volt nominal operation. Line Fuse F14500 value is selected to provide the required protection for each nominal line voltage. Refer to Replaceable Electrical Parts list for correct fuse values.

The unused windings between pins 10, 11, and 12 of T14500 are intended for use with the optional Inverter Circuit Board (Option 07) or DM-series Digital Multimeters. Option 07 allows the instrument to be operated from an external dc power source or an 1106 Power Supply. Option 07 and the DM-series Digital Multimeters cannot be used at the same time.

Secondary Circuit

The -8 volt, +5 volt, +15 volt, and +55 volt power supplies are series-regulated supplies. U4411A, U4411B, U4206A, and U4206B are two-channel, high-gain amplifier cells with differential inputs. These amplifiers monitor voltage variations in the output voltages and supply correction information to the series-regulating transistors. The +55 volt supply is the source of the reference voltage for the remaining supplies and its output must be correct or the -8 volt, +5 volt, and +15 volt supplies will not operate within their limits.

Current-limiting circuits provide short circuit protection for each of the regulated supplies. The following description applies only to the +55 volt current limiting circuit; the other current-limiting circuits operate in a similar manner.

In the +55 volt supply, Q4303 is normally biased off. Under normal conditions the base of Q4303 sets at about +55 volts. Under conditions of power supply loading, when the supply current increases, the voltage drop across R4303 increases. This increasing voltage is coupled through the base of Q4301 to the voltage divider, comprised of R4302 and R4208, causing the base of Q4303 to go more positive. When the supply current increases sufficiently, Q4303 turns on. The collector of Q4303 moves in the negative direction and begins turning off Q4302 and Q4301. Transistor Q4301 will continue conducting some current, even when the supply is limited, in order to produce enough voltage drop across R4303 to keep Q4303 biased on. The limited supply output voltage can be any value between its regulated value and zero, depending on the extra load it is trying to supply (see Figure 3-15). The limiting transistors for the other supplies are:

+15 V	Q4404
+5 V	Q4311
−8 V	Q4106
+110 V	Q4431

Figure 3-15 also shows the action of the current limit (foldover) circuit. At point A, Q4303 begins conducting. At point B the supply is directly shorted to ground through a current meter.

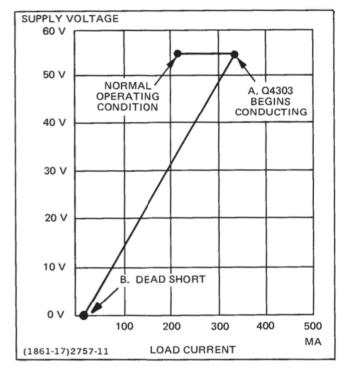


Figure 3-15. Foldover circuit action.

Components C4533, C4532, and R4527 are configured in a wave-shaping circuit arrangement that provides a sample of the ac voltage (present in the secondary of T14500) to the trigger circuitry for use in the LINE position of the A TRIGGER SOURCE switch.

FAN MOTOR CIRCUIT



The fan motor used in the 465B is a brushless dc fan motor using Hall Effect devices. Motor circuitry varies the rotational speed of the fan with variations in operating temperature. When the ambient temperature increases. the value of thermistor RT8038 is reduced. This causes the forward bias on Q8067 to increase and Q8067 conducts more current through the Hall Effect devices. Higher currents through the Hall Effect devices cause the potential difference across them (e.g., 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. In the example, if fan pin 8 is more positive than pin 6, U8061A will be on and U8061D will be off. The higher the potential difference between pin 8 and pin 6, the harder the on transistor will conduct; the harder the transistor conducts, the faster the fan rotates.

3-27

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CALIBRATION PROCEDURE

Introduction

This section of the manual is in two parts; Performance Check and Adjustment Procedure. Each subsection has a different purpose and important information regarding their use is included at the beginning of both subsections. equipment is provided in the Performance Check subsection to list the required test equipment type to complete the Performance Check only.

Test Equipment Required

The test equipment listed in Table 4-1, or an equivalent piece of test equipment, is required if the complete Performance Check and Adjustment Procedure is to be accomplished on the oscilloscope. A partial list of test

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

Table 4-1
TEST EQUIPMENT REQUIRED

Description	Minimum Specifications	Usage	Examples
Variable Autotransformer	Capable of supplying 1.2 A over a range of 104 to 127 V.	Power supply regulation check.	General Radio W8MT3VM Variac Autotransformer.
2. Digital Voltmeter	Range, 0 to 140 V; dc voltage accuracy, within 0.15%; display 4 1/2 digits.	Low-Voltage Power Supply checks and adjustments. CRT Grid Bias adjustment. Vertical and Horizontal Centering adjustments. Calibrator Output Voltage adjustment.	a. TEKTRONIX DM 501 Digital Multimeter*. b. Any digital voltmeter that meets minimum specifications.
3. DC Volt- meter	Range, 0 to 2500 V; calibrated to 1% accuracy at -2450 V.	High-Voltage Power Supply adjustment.	a. Triplett Model 630-NA.b. Simpson Model 262.
4. Test Oscillo- scope with 10X probe and 1X probe. (1X probe is optional accessory)	Bandwidth, dc to 100 MHz; minimum deflection factor, 5 mV/division; accuracy, within 3%; dual trace. Scale-factor switching.	Power Supply Ripple Check. CRT Z-Axis Compensation; Vertical gain adjustment. A Trigger Holdoff check. A and B +Gate output signals check.	a. TEKTRONIX 465B Oscilloscope with 2 (included) 10X probes. b. TEKTRONIX 475 Oscilloscope with 2 (included) 10X probes. c. TEKTRONIX P6101 1X probe 010-6101-03.

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Calibration Procedure—465B Service Performance Check

Table 4-1 (cont)

Description	Minimum Specifications	Usage	Examples
5. Calibration Generator	Standard-amplitude accuracy, within 0.25%; signal amplitude, 2 mV to 50 V; output signal, 1 kHz square wave. Fastrise repetition rate, 1 to 100 kHz; rise time, 1 ns or less; signal amplitude, 100 mV to 1 V; aberrations, within 2%. High-amplitude output, 60 V pulse supplying at least 10 mA.	Vertical checks and adjust- ments. Trigger View checks and adjustments. X Gain adjustment. Z-axis check.	a. TEKTRONIX PG 506 Calibration Generator. ^a b. Standard Amplitude Calibrator (Amplitude Calibrator only). Tektronix Part number 067-0502-01. c. TEKTRONIX Type 106 Square Wave Generator (Fast rise and High Amplitude only).
6. Sine-wave Generator	Frequency, 350 kHz to above 100 MHz; output amplitude variable from 0.5 to 5.5 V peak-to-peak; output impedance; 50 Ω; reference frequency, 50 to 350 kHz; amplitude accuracy, constant within 3% of reference frequency as output frequency changes.	Vertical Centering. Bandwidth and Isolation checks. Trigger checks and adjustments. X-Y Phase Difference. X Bandwidth check.	 a. TEKTRONIX SG 503 Leveled Sine-wave Generator.^a b. TEKTRONIX Type 191 Constant-Amplitude Signal Generator.
7. Time-Mark Generator	Marker outputs, 2 ns to 0.5 s; marker accuracy, within 0.1%; trigger output, 1 ms to 0.1 μ s, time coincident with markers.	CRT Y-Axis and geometry adjustments. Auto Trigger check. Horizontal timing checks and adjustments.	TEKTRONIX TG 501 Time- Mark Generator. ^a
8. Low Fre- quency Generator	Frequency, 60 Hz to 100 kHz; output amplitude, variable from 30 mV to 4 V peak-to- peak. Positive square-wave output amplitude, 5 V.	Low-Frequency Trigger checks. Vertical Compensation	TEKTRONIX SG 502 Oscillator.ª
9. 50 Ω Signal Pickoff	Frequency response, 50 kHz to 100 MHz; impedance 50 Ω for signal input, signal output, and trigger output.	Trigger checks and adjust- ments.	TEKTRONIX CT-3 Signal Pick- off. Part Number 017-0061-00.
10. Cable (2 Required)	Impedance, 50 Ω; length, 42 inches; connectors, bnc	Signal Interconnection.	Tektronix Part Number 012-0057-01.
11. Cable (2 Required)	Impedance, 50 Ω; length, 18 inches; connectors, bnc	Signal interconnection.	Tektronix Part Number 012-0076-00.
12. Adapter	Connectors, GR874-to-bnc female.	Signal interconnection.	Tektronix Part Number 017-0063-00.
13. Adapter	Connectors, GR874-to-bnc male.	Signal interconnection.	Tektronix Part Number 017-0064-00.

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Table 4-1 (cont)

Description	Minimum Specifications	Usage	Examples
14. Adapter	Connectors, bnc female-to- bnc female.	Signal interconnection.	Tektronix Part Number 103-0028-00.
15. Adapter	Connectors, bnc-female-to-coaxial cable connector.	Signal interconnection.	Tektronix Part Number 131-1315-01.
16. Adapter	Connectors, bnc-male-to- miniature probe tip.	Signal interconnection.	Tektronix Part Number 013-0084-01.
17. Dual- Input Coupler (2 required)	Connectors, bnc female-to-2-bnc male.	Vertical checks. Trigger checks and adjustments. X-Y Phase check.	Tektronix Part Number 067-0525-01.
18. T Con- nector	Connectors, bnc.	Signal interconnection.	Tektronix Part Number 103-0030-00.
19. 10X Attenuator (2 required)	Ratio, 10X; impedance, 50 Ω; connectors, bnc.	Vertical Compensation. Vertical Bandwidth check. Trigger adjustments.	Tektronix Part Number 011-0059-02.
20. 5X Attenuator	Ratio, 5X; impedance, 50 Ω ; connectors, bnc.	Vertical System Compensation adjustments. Trigger adjustments.	Tektronix Part Number 011-0060-02.
21. 2X Atten- uator	Ratio, 2X; impedance, 50 Ω ; connectors, bnc.	Vertical System Compensation. Trigger adjustments.	Tektronix Part Number 011-0069-02.
22. Termi- nation (2 required)	Impedance, 50 Ω ; connectors, bnc.	Signal termination.	Tektronix Part Number 011-0049-01.
23. Screw- driver	Length, 3-inch shaft, bit size, 3/32 inch.	Adjust variable resistors.	Xcelite R-3323.
24. Low-Capa- citance Screw- driver	Length, 1-inch shaft; bit size, 3/32 inch.	Adjust all variable capacitors.	J.F.D. Electronics Corp. Adjustment Tool Number 5284.
25. Shorting Strap		Calibrator adjustment.	

^aRequires a TM 500 Series power module.



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VERTICAL

Equipment Required

- 1. Calibration Generator
- 2. Leveled Sine-wave Generator
- 3. 42-inch, 50 Ω Bnc Cable (2 required)
- 4. 10X Scale-factor-switching Probe
- 5. 50Ω Bnc Termination (2 required)
- 6. 10X Bnc Attenuator

- 7. 5X Bnc Attenuator
- 8. 2X Bnc Attenuator
- 9. Bnc T Connector
- 10. Bnc-to-probe Tip Adapter
- 11. Dual-input coupler

465B Control Settings

POWER

ON

1. Check TRACE ROTATION

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

CRT

INTENSITY

As desired

FOCUS

Best focused display

As desired SCALE ILLUM

b. Check that the trace is parallel with the center horizontal graticule line. Readjust TRACE ROTATION if necessary (front-panel screwdriver adjustment).

Vertical (CH 1 and CH 2)

VERT MODE POSITION

CH₁ Midrange

VOLTS/DIV

5 mV

VAR VOLTS/DIV

Calibrated detent

AC-GND-DC

GND

INVERT 20 MHz BW LIMIT Normal (button out) Full bandwidth

(button out)

Trigger (A and B)

COUPLING

AC

LEVEL

Midrange

SLOPE SOURCE

TRIG MODE

NORM **AUTO**

A TRIGGER HOLDOFF

NORM

Sweep (A and B)

HORIZ DISPLAY

Α

TIME/DIV

1 ms

VAR TIME/DIV

Calibrated detent

DELAY TIME POSITION

Fully counterclockwise

X10 MAG

Off (button out)

POSITION (Horizontal)

Midrange

2. Check ALT Mode

NOTE

VERT MODE switches are push-push switches that must be pressed to select a particular VERT MODE and pressed again to remove the trace from the crt display. For example, selecting CH 1 VERT MODE does not release any VERT MODEs previously selected, and the CH 1 VERT MODE switch must be pressed again to remove the CH 1 trace from the display.

a. Set:

VERT MODE

CH 1, CH 2, A TRIG

VIEW, ADD, and ALT

AC-GND-DC (both)

GND

A TRIGGER SOURCE

EXT

b. Use the CH 1 and CH 2 Vertical POSITION controls to spread the CH 1, CH 2, and ADD traces approximately 2 divisions apart. Use A TRIGGER LEVEL to position the A TRIG VIEW trace between the vertical channel traces.

- c. CHECK—Sweeps alternate in all settings of the A TIME/DIV switch except X-Y. The order of alternation is as follows: CH 1, CH 2, ADD, then A TRIG VIEW.
- d. Press ADD and A TRIG VIEW VERT MODE switches to remove their traces from the crt display.

3. Check CHOP Mode

a. Set:

A TIME/DIV 1 μ s A TRIGGER SOURCE NORM

VERT MODE CH 1, CH 2, and

CHOP

- b. Use the Channel 1 and Channel 2 Vertical POSITION controls to position the two traces about 4 divisions apart.
 - c. Adjust A TRIGGER LEVEL for a stable display.
 - d. CHECK—Period of one cycle is approximately 2 μ s.
- e. Press ADD and A TRIG VIEW VERT MODE switches.
 - f. CHECK-Chopped display has four levels.
- g. CHECK—Display for blanking of switching transients.
- h. Press ADD, A TRIG VIEW, and CH 2 VERT MODE switches to remove their traces from the crt display.

4. Check CH 1 Balance

a. Set:

VERT MODE CH 1 CH 1 VOLTS/DIV 20 mV

- b. Position the trace to the center horizontal graticule line.
- c. CHECK—Trace shift is 1.0 division or less as the CH 1 VAR VOLTS/DIV control is rotated from one extreme to the other extreme.

- d. CHECK—CH 1 UNCAL LED comes on when the VAR control is out of the detent position.
 - e. Beturn CH 1 VAB to calibrated detent.

5. Check CH 2 Balance

a. Set:

VERT MODE CH 2 CH 2 VOLTS/DIV 20 mV

- b. Position the trace to the center horizontal graticule line
- c. CHECK—Trace shift is 1.0 division or less as the CH 2 VAR VOLTS/DIV control is rotated from one extreme to the other extreme.
- d. CHECK—CH 2 UNCAL LED comes on when the VAR control is out of the detent position.
 - e Return CH 2 VAR to calibrated detent.
- f. Position the trace to the center horizontal graticule line.
- g. CHECK—Trace shift is 2 divisions or less when switching from normal to INVERT.

6. Check Vertical POSITION Range and Centering

a Set

CH 1 VOLTS/DIV 20 mV
CH 2 VOLTS/DIV 0.1 V
AC-GND-DC (both) DC

A TRIGGER LEVEL Fully Clockwise
INVERT Normal (button out)

- b. Connect the leveled sine-wave generator output to the CH 2 OR Y input via a 50 Ω bnc cable and a 50 Ω bnc termination. Set the generator frequency to 50 kHz and adjust output for a vertical display of 4.8 divisions.
 - c. Set CH 2 VOLTS/DIV to 20 mV.
- d. CHECK—Top of display can be positioned down to the center horizontal graticule line, and bottom of display can be positioned up to the center horizontal graticule line.

Calibration Procedure—465B Service Performance Check

- e. Move the signal from the CH 2 OR Y input to the CH 1 OR X input connector.
 - f. Set VERT MODE switches for CH 1 display.
 - g. Repeat Step 6, part d, for CH 1.

7. Check BEAM FIND Operation

- a. Push in and hold the BEAM FIND button.
- b. CHECK—A compressed trace is visible regardless of the settings of the:

CH 1 POSITION control, INTENSITY control, or Horizontal POSITION control.

- c. Return the Horizontal POSITION control and the INTENSITY control to midrange.
- d. While still holding in the BEAM FIND button, vertically position the trace to the center horizontal graticule line.
 - e. Release the BEAM FIND button.
 - f. CHECK-Trace remains within the graticule area.
 - g. Disconnect the test equipment.

8. Check CH 1 and CH 2 Deflection Factor

- a. Connect calibration generator standard-amplitude output to the CH 1 input connector via a 50 Ω bnc cable. Use no termination. Set the generator for a 20 mV signal and set the 465B AC-GND-DC switches to DC.
- b. CHECK—CH 1 deflection factor is within the limits given in Table 4-2.
- c. Set the VERT MODE switches to display CH 2, and move the signal from CH 1 OR X input to the CH 2 OR Y input connector.
- d. CHECK—CH 2 deflection factor is within the limits given in Table 4-2.

Table 4-2
DEFLECTION FACTOR LIMITS

VOLTS/DIV Switch Setting	Standard Amplitude Signal	Vertical Deflection in Divisions	3% Tolerance in Divisions
5 mV	20 mV	4	3.88 to 4.12
10 mV	50 mV	5	4.85 to 5.15
20 mV	0.1 V	5	4.85 to 5.15
50 mV	0.2 V	4	3.88 to 4.12
0.1 V	0.5 V	5	4.85 to 5.15
0.2 V	1.0 V	5	4.85 to 5.15
0.5 V	2.0 V	4	3.88 to 4.12
1.0 V	5.0 V	5	4.85 to 5.15
2.0 V	10.0 V	5	4.85 to 5.15
5.0 V	20.0 V	4	3.88 to 4.12

9. Check CH 1 and CH 2 VAR VOLTS/DIV Range

a. Set:

VOLTS/DIV (both) 20 mV

- b. Set the calibration generator for a 0.1 V standard-amplitude output signal.
- c. CHECK—Display reduces to less than 2 divisions when the CH 2 VAR VOLT/DIV control is rotated to its extreme counterclockwise position.
- d. Move the signal to the CH 1 OR X input connector and set the VERT MODE switches to display CH 1.
- e. CHECK—Repeat part c using the CH 1 VAR VOLTS/DIV control.
- f. Return the VAR controls to the calibrated detent position and remove the signal from the CH 1 input connector.

10. Check ADD Mode

a. Set:

VOLTS/DIV (both) 5 mV VERT MODE ADD

b. Connect calibration generator standard-amplitude signal to the CH 1 and CH 2 input connectors via a 50 Ω bnc cable and dual-input coupler.

- c. Set calibration generator for 10 mV output amplitude.
 - d. CHECK—Display is approximately 4 divisions.

11. Check INVERT Mode

- a. Press CH 2 INVERT push button in.
- b. CHECK—Display is approximately zero division.

12. Check Vertical Low-Frequency Compensation

a. Set:

TIME/DIV (both) 0.2 ms VOLTS/DIV (both) 5 mV

- b. Connect the calibration generator fast-rise + output to the CH 1 input connector via a 50 Ω bnc cable, 10X bnc attenuator, and 50 Ω bnc termination.
- c. Set the calibration generator to 1 kHz and adjust output controls for a vertical display of 5 divisions. Adjust the A TRIGGER LEVEL control for a stable display.
- d. CHECK—Rounding or overshoot is within 3% (0.15 division) at the frequencies listed in Table 4-3.

Table 4-3

LOW-FREQUENCY COMPENSATION SETUP

Calibration Generator Frequency	TIME/DIV Switch Setting
1 kHz	0.2 ms
10 kHz	20 μs
100 kHz	2 μs

13. Check CH 1 and CH 2 Volts/Division Compensation

a. Set:

VOLTS/DIV (both) 5 mV (see note) A TIME/DIV 0.2 ms

NOTE

In step 13 all VOLTS/DIV settings require the use of a 10X probe with scale-factor switching (preferably the probe supplied as a standard accessory with the oscilloscope you are performance checking). If it is necessary to use a 10X probe without scale-factor switching, set the VOLTS/DIV to indicate one tenth of the settings listed.

- b. Connect a 10X probe to the CH 1 input connector (note that the VOLTS/DIV Scale-Factor switching LED indicates 50 mV).
- c. Connect the square-wave generator high-amplitude output through a 2X, 5X, or 10X bnc attenuator (depending on generator amplitude), to a 50 Ω bnc termination that is connected to a bnc-to-probe tip adapter. Insert the 10X-probe tip into the probe-tip adapter.
- d. Adjust the square-wave generator for a 5-division, 1 kHz display, and add or remove attenuators and termination as necessary to maintain a 5-division display throughout step 13.
- e. Adjust the probe compensation for the best flat-top waveform. Do not re-adjust probe compensation throughout the remainder of step 13.
- f. CHECK—Rounding or overshoot on the waveform is within 3% (± 0.15 division) at all settings of the VOLTS/DIV switch between 50 mV and 5 V.
- g. Move the test setup to CH 2 input connector and set the VERT MODE switches to display CH 2.
- h. Repeat step 13, part f, for Channel 2 (add or remove attenuators as necessary to maintain a 5-division display).
 - i. Disconnect probe and generator.

14. Check CH 1 and CH 2 Transient Response

a. Set:

TIME/DIV (both) 0.05 μ s VOLTS/DIV (both) 5 mV A TRIGGER SLOPE +

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- b. Connect the calibration generator fast-rise + output to the CH 2 input connector via a 50 Ω bnc cable, 10X, 5X, or 2X bnc attenuator, and 50 Ω bnc termination. Set the generator frequency to 100 kHz and adjust output controls for a vertical display of 5 divisions. Adjust the generator output and add or remove attenuators as necessary to maintain a 5-division display throughout this check.
- c. CHECK—Flat-top waveform is within 4% or less (0.2 division) for the 5 mV, 10 mV, and 20 mV positions of the VOLTS/DIV switch.
- d. Move the test setup to the CH 1 input connector and set the VERT MODE switches to display CH 1.
 - e. CHECK-Repeat part c for Channel 1.
 - f. Disconnect the test setup.

15. Check CH 1 and CH 2 Bandwidth

a. Set:

VOLTS/DIV (both) 5 mV A TIME/DIV 0.2 ms

A TRIGGER LEVEL Fully clockwise

- b. Connect the leveled sine-wave generator output to the CH 1 input connector via a 50 Ω bnc cable, 10X bnc attenuator, and 50 Ω bnc termination.
- c. Set the sine-wave generator output for a vertical display of 5 divisions at 50 kHz. Change the sine-wave generator output frequency to 100 MHz.
- d. CHECK—Display amplitude is 3.5 divisions or greater.
- e. Repeat parts c and d for all CH 1 VOLTS/DIV switch settings from 5 mV to 0.5 V. Adjust the generator and add or remove attenuators as needed to maintain a 5-division, 50 kHz reference display.
- f. Move the sine-wave generator output signal from the CH 1 input to the CH 2 input connector and set the VERT MODE switches to display CH 2.
- g. Repeat parts c and d for all CH 2 VOLTS/DIV switch settings from 5 mV ro $0.5~\rm{V}.$

h. Disconnect the test setup.

16. Check Cascaded Gain and Bandwidth

a. Set:

VERT MODE CH 2
VOLTS/DIV (both) 5 mV
TIME/DIV 1 ms

- b. Connect the CH 1 VERT SIGNAL output connector (on the 465B rear panel) to the CH 2 input connector via a 50 Ω cable and a 50 Ω bnc termination.
- c. Connect the calibration generator standard-amplitude output to the CH 1 input connector via a 50 Ω bnc cable. Set the calibration generator output for 5 mV.
- d. $CHECK-Display\ vertical\ amplitude\ is\ 5\ divisions\ or\ greater.$
- e. Remove the calibration generator signal from the CH 1 input connector.
- f. Connect the leveled sine-wave generator output to the CH 1 input connector via a 50 Ω bnc cable, 10X bnc attenuator, and 50 Ω bnc termination. Set the generator frequency to 50 kHz and adjust output controls for a vertical display of 5 divisions. Adjust the generator output frequency to 50 MHz.
- g. CHECK—Display amplitude is 3.5 divisions or greater.
 - h. Disconnect the test setup.

17. Check Trigger View Centering and Gain

a. Set:

VERT MODE A TRIG VIEW
A TIME/DIV 0.2 ms
A TRIGGER COUPLING DC
A TRIGGER SOURCE EXT
A TRIG MODE AUTO

b. Connect the calibration generator standard-amplitude output to the A External Trigger input connector via a 50 Ω bnc cable. Use no termination. Set the generator output to 0.5 V.

- c. CHECK—Display amplitude is 5 divisions ±5% (5 divisions ±0.25 division).
- d. CHECK-Display will trigger symmetrically within one graticule division when the A TRIGGER SLOPE is switched between + and -.
- e. Set the ATRIGGER SOURCE to EXT/10 and change the output of the calibration generator to 5 V.
- f. CHECK—Display amplitude is 5 divisions $\pm 5\%$ (5 divisions ± 0.25 division).
- g. Disconnect the calibration generator standardamplitude signal from the A External Trigger input connector.

18. Check Trigger View Low-Frequency Compensation

a. Set:

A TRIGGER SOURCE

EXT

A TIME/DIV

0.1 ms

- b. Connect the calibration generator high-amplitude output to the A External Trigger input connector via a 50 Ω bnc cable and 50 Ω bnc termination. Set the calibration generator output for a vertical display of 5 divisions at 1 kHz.
- c. CHECK-Square wave has less than 10% overshoot or rounding.
- d. Set A TRIGGER SOURCE to EXT/10 and adjust generator output for a vertical display of 5 divisions.
- e. CHECK-Square wave has less than 10% overshoot or rounding.
- f. Disconnect the calibration generator amplitude output from the A External Trigger input connector.

19. Check Trigger View High-Frequency Compensation

a. Set:

A TRIGGER SOURCE

FXT

A TIME/DIV

0.2 ms

- b. Connect the calibration generator fast-rise + output to the A External Trigger input connector via a 50 Ω bnc cable, and 50 Ω bnc termination.
- c. Set the calibration generator frequency for 100 kHz and adjust output for a vertical display of 5 divisions.
- d. CHECK-Square-wave front-corner aberration is less than $\pm 10\%$ (± 0.5 division).
 - e. Disconnect test setup.

20. Check Zero Trigger View Delay

a. Set:

VERT MODE

CH 1 and A TRIG VIEW

A TIME/DIV

0.02 *μ*s

X10 MAG

On (button in)

A TRIGGER COUPLING AC CH 1 VOLTS/DIV 0.1 V

- b. Connect output of sine-wave generator via bnc T, two 42-inch (equal length) 50 Ω bnc cables, and 50 Ω bnc terminations; one to the CH 1 input connector, and one to the A External Trigger input connector. Set sine-wave generator for a 6-division display of A TRIG VIEW at 40 MHz, then adjust CH 1 VAR and VOLTS/DIV to match the amplitude of the CH 1 display to the amplitude of the A TRIG VIEW display.
- c. CHECK-Time difference with displays superimposed is ≤0.15 horizontal graticule divisions.

d. Set:

HORIZ DISPLAY

B DLY'D

A TIME/DIV

 $0.2 \mu s$

B TIME/DIV

 $0.02 \mu s$

- e. CHECK-Time difference with displays superimposed is ≤0.15 horizontal graticule division.
 - f. Disconnect test setup.

TRIGGERS

Equipment Required

- 1. Leveled Sine-wave Generator
- 2 Calibration Generator
- 3. 42-inch Bnc Cable (2 required)
- 4. Gr-to-bnc-female Adapter
- 5. Gr-to-bnc-male Adapter

- 6. 50 Ω Signal Pickoff Unit (Type CT-3)
- 7. 10X Bnc Attenuator
- 8. 2X Bnc Attenuator
- 9. 50Ω Bnc Termination (2 required)
- 10. Dual-input Coupler (2 required)

465B Control Settings

POWER ON

CRT

As desired INTENSITY

FOCUS Best focused display

SCALE ILLUM As desired

Vertical (CH 1 and CH 2)

CH₁ **VERT MODE** POSITION Midrange VOLTS/DIV 5 mV

Calibrated detent VAR VOLTS/DIV

AC-GND-DC DC

INVERT Normal (button out) 20 MHz BW LIMIT Full bandwidth (button out)

Trigger (A and B)

COUPLING AC LEVEL Midrange

SLOPE **NORM** SOURCE TRIG MODE AUTO A TRIGGER HOLDOFF NORM

Sweep (A and B)

HORIZ DISPLAY Α TIME/DIV $5 \mu s$

Calibrated detent VAR TIME/DIV **DELAY TIME POSITION** Fully counterclockwise

X10 MAG Off (button out) POSITION (Horizontal) Midrange

1. Check A and B Internal Triggering

- a. Connect the output of the leveled sine-wave generator to the A and B External trigger inputs via a 50 Ω cable. Gr-to-bnc-male adapter, 50 Ω signal pickoff unit (Type CT-3) THRU SIG OUT output, Gr-to-bnc-female adapter, 50 Ω bnc cable, 2X bnc attenuator, 10X bnc attenuator, 50 Ω bnc termination and dual-input coupler.
- b. Connect the SIG OUT 10% on the CT-3 to the CH 1 and CH 2 inputs via a 50 Ω bnc cable, 50 Ω bnc termination and dual-input coupler.
- c. Adjust the leveled sine-wave generator for either a 3-division, 50 kHz display and set both VOLTS/DIV switches to 50 mV (0.3 division of display), or a 5-division, 50 kHz display and set both VOLTS/DIV switches to 50 mV (0.5 division display) as necessary for parts d and f of step 1.
- d. CHECK-Stable display can be obtained by adjusting the A TRIGGER LEVEL control in the following A TRIGGER COUPLING and A TRIGGER SOURCE switch positions:

A TRIGGER COUPLING	A TRIGGER SOURCE	DISPLAY
AC	NORM, CH 1, CH 2	0.3 Div
DC	NORM, CH 1, CH 2	0.3 Div
LF REJ	NORM, CH 1, CH 2	0.5 Div
HF REJ	NORM, CH 1, CH 2	0.5 Div

e. Set:

B DLY'D HORIZ DISPLAY A TRIGGER LEVEL Fully clockwise

f. CHECK-Stable display can be obtained by adjusting the B TRIGGER LEVEL control in the following B TRIGGER COUPLING and B TRIGGER SOURCE switch positions:

B TRIGGER COUPLING	B TRIGGER SOURCE	DISPLAY
AC	NORM, CH 1, CH 2	0.3 Div
DC	NORM, CH 1, CH 2	0.3 Div
LF REJ	NORM, CH 1, CH 2	0.5 Div
HF REJ	NORM, CH 1, CH 2	0.5 Div

2. Check A and B External Triggering

a. Set:

CH 1 VOLTS/DIV 20 mV TRIGGER SOURCE (both) EXT TRIGGER COUPLING (both) AC

- b. Adjust leveled sine-wave generator output for 5 divisions of display on the crt.
- c. CHECK-Stable display can be obtained by adjusting B TRIGGER LEVEL control in the following B TRIGGER COUPLING switch positions:

AC, DC

- d. Remove the 2X bnc attenuator and set B TRIGGER COUPLING switch to LF REJ then HF REJ.
- e. CHECK-Stable display can be obtained by adjusting B TRIGGER LEVEL control.
 - f. Set:

HORIZ DISPLAY

A TRIGGER COUPLING

LF REJ then HF REJ

- g. CHECK-Stable display can be obtained by adjusting A TRIGGER LEVEL control with A TRIGGER COUPLING in both LF REJ and HF REJ.
 - h. Replace the 2X bnc attenuator.
- i. CHECK-Stable display can be obtained by adjusting A TRIGGER LEVEL control in the following A TRIGGER COUPLING switch positions:

AC, DC

- i. Remove the 10X bnc attenuator and set the A TRIGGER SOURCE switch to EXT/10.
- k. CHECK-Stable display can be obtained by adjusting the A TRIGGER LEVEL control in the following A TRIGGER COUPLING switch positions:

AC. DC

- I. Remove the 2X bnc attenuator and set A TRIGGER COUPLING switch to LF REJ then HF REJ.
- m. CHECK-Stable display can be obtained by adjusting A TRIGGER LEVEL control.

3. Check A NORM TRIG Mode

a. Set:

A TRIGGER COUPLING AC A TRIGGER SOURCE NORM A TRIG MODE **AUTO**

- b. Adjust A TRIGGER LEVEL for a stable display.
- c. Set TRIG MODE switch to NORM.
- d. CHECK-Stable display is visible.
- e. Set CH 1 AC-GND-DC switch to GND.
- f. CHECK-No visible display in the absence of an adequate trigger signal.

4. Check SINGL SWP TRIG Mode

- a. Set CH 1 AC-GND-DC switch to DC.
- b. Adjust A TRIGGER LEVEL until display just triggers.
 - c. Set CH 1 AC-GND-DC switch to GND.
 - d. Press SINGL SWP push button in.
 - e. CHECK-READY LED comes on and stays on.

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- f. Set CH 1 AC-GND-DC switch to DC.
- g. CHECK—READY LED goes out and a single sweep occurs.
 - h. Press SINGL SWP push button in.

- i. CHECK—Single sweep occurs every time SINGL SWP push button is depressed.
 - j. Disconnect test setup.

IMPORTANT NOTE

OSCILLOSCOPES WITH DIGITAL MULTIMETERS ATTACHED. REFER TO THE DIGITAL MULTIMETER MANUAL AT THIS POINT, THEN RETURN TO STEP 8 IN THE HORIZONTAL SECTION.

OSCILLOSCOPES WITHOUT DIGITAL MULTIMETERS, CONTINUE WITH THIS PROCEDURE.

HORIZONTAL

Equipment Required

1. Time-mark Generator

4. 42-inch, 50 Ω Bnc Cable

2. Calibration Generator

5. 50 Ω Bnc Termination

3. Leveled Sine-wave Generator

465B Control Settings

INTENSITY

SCALE ILLUM

FOCUS

POWER ON

SWEEP (A and B)

HORIZ DISPLAY Α

TIME/DIV 1 ms Calibrated detent VAR TIME/DIV

DELAY TIME POSITION Fully counterclockwise

Off (button out) X10 MAG POSITION (Horizontal) Midrange

CRT

As desired

As desired

Best focused display

VERTICAL (CH 1 and CH 2)

CH₁ **VERT MODE POSITION** Midrange VOLTS/DIV 0.5 V

VAR VOLTS/DIV Calibrated detent

AC-GND-DC

INVERT Normal (button out) 20 MHz BW LIMIT Full bandwidth (button out)

TRIGGER (A and B)

COUPLING AC LEVEL Midrange SLOPE A SOURCE NORM **B SOURCE** NORM TRIG MODE AUTO A TRIGGER HOLDOFF NORM

1. Check A and B TIME/DIV Accuracy

a. Connect the time-mark generator to CH 1 input via a 50Ω bnc cable and a 50Ω bnc termination.

b. CHECK-A and B timing accuracy according to Table 4-4. Timing to be accurate within 2% (0.2 division at the 11th time marker). If 11 time markers are not visible when checking B sweep, set the A TIME/DIV switch one step slower than the B TIME/DIV switch; for example:

A TIME/DIV 1 ms B TIME/DIV 0.5 ms

When checking B timing, set HORIZ DISPLAY to B DLY'D and use B TRIGGER LEVEL to stabilize the display.

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Table 4-4
A AND B TIMING ACCURACY

A and B TIME/DIV Switch Setting	Time-Mark Generator Output	CRT Display (Markers/ Division)
0.02 μs	20 ns ^a	1
$0.05~\mu s$	50 ns	1
.1 <i>μ</i> s	.1 <i>μ</i> s	1
.2 μs	.2 μs	1
.5 <i>μ</i> s	.5 <i>μ</i> s	1
1 <i>μ</i> s	1 <i>μ</i> s	1
2 μs	2 μs	1
5 <i>μ</i> s	5 <i>μ</i> s	1
10 μ s	10 <i>μ</i> s	1
20 μs	20 μs	1
50 <i>μ</i> s	50 <i>μ</i> s	1
.1 ms	.1 ms	1
.2 ms	.2 ms	1
.5 ms	.5 ms	1
1 ms	1 ms	1
2 ms	2 ms	1
5 ms	5 ms	1
10 ms⁵	10 ms	1
20 ms ^b	20 ms	1
50 ms ^b	50 ms	1
A SWEEP ONLY		

A SWEEP ONLY		
.1 s ^b	.1 s	1
.2 s ^b	.2 s	1
.5 s ^b	.5 s	1

^a If the time-mark generator used does not have a 1-2-5 sequence, set to 1 or 2 time-markers/division as necessary.

2. Check A VAR TIME/DIV Range

a. Set:

HORIZ DISPLAY A
A TRIG MODE AUTO
TIME/DIV 2 ms

- Select 5 ms time markers from the time-mark generator.
- c. CHECK—At least 1 marker per division can be obtained by adjusting the VAR TIME/DIV control.
- d. Return the VAR TIME/DIV control to the detent position.

3. Check Delay or Differential Time Linearity

a. Set:

A TIME/DIV 1 ms B TIME/DIV 5 μ S HORIZ DISPLAY B DLY'D

B TRIGGER SOURCE STARTS AFTER DELAY

- b. Select 1 ms time markers from the time-mark generator.
- c. Turn DELAY TIME POSITION to set time marker nearest 1.00 on dial to coincide with graticule center and note reading.
- d. Turn DELAY TIME POSITION to set time marker nearest 2.00 on dial to coincide with graticule center and note reading.
- e. CHECK—Difference in readings is 1.00 \pm 0.01 (0.99 to 1.01), from +15°C to +35°C; \pm 0.03 (0.97 to 1.03), from -15°C to +55°C.
- f. Turn DELAY TIME POSITION dial to set every adjacent time marker to coincide with graticule center and note reading.
- g. CHECK—Difference of readings between any two adjacent time markers is 1.00, ± 0.01 (0.99 to 1.01), from $+15^{\circ}$ C to $+55^{\circ}$ C; ± 0.03 (0.97 to 1.03), from -15° C to $+55^{\circ}$ C.

4. Check Delay or Differential Time Accuracy

a. Set:

 $\begin{array}{ll} \mbox{HORIZ DISPLAY} & \mbox{B DLY'D} \\ \mbox{A TIME/DIV} & \mbox{0.2 } \mu \mbox{s} \\ \mbox{B TIME/DIV} & \mbox{0.05 } \mu \mbox{s} \\ \end{array}$

b. Set the A TIME/DIV, B TIME/DIV and the time-mark generator to the settings given in Table 4-5. First set the DELAY TIME POSITION dial to 1.00. Adjust the horizontal POSITION control so the top of one of the displayed time markers crosses the center vertical graticule line. (If the top of the time marker at the beginning of the sweep isn't visible, then use the second time marker.) Without touching the horizontal POSITION control, set the DELAY TIME POSITION dial to 9.00. Slightly readjust the DELAY TIME POSITION dial to position the top of the displayed time marker to the center vertical graticule line.

^b For sweep time greater than 5 ms/div set TRIG MODE to NORM.

Table 4-5
DELAY OR DIFFERENTIAL TIME ACCURACY

A TIME/ DIV Switch Setting	B TIME/ DIV Switch Setting	Time- Mark Generator Output
.2 μs	.02 μs	.1 µs
.2 <i>μ</i> s	.05 μs	.1 <i>μ</i> s
.5 <i>μ</i> s	.05 μs	.5 <i>μ</i> s
1 μs	.1 μs	1 <i>μ</i> s
2 μs	.1 μs	1 <i>μ</i> s
5 <i>μ</i> s	.5 μs	5 <i>μ</i> s
10 μs	1 μs	10 <i>μ</i> s
20 <i>μ</i> s	1 μs	10 <i>μ</i> s
50 μs	5 <i>μ</i> s	50 <i>μ</i> s
.1 ms	10 μs	.1 ms
.2 ms	10 <i>μ</i> s	.1 ms
.5 ms	50 <i>μ</i> s	.5 ms
1 ms	.1 ms	1 ms
2 ms	.1 ms	1 ms
5 ms	.5 ms	5 ms
10 ms ^a	1 ms	10 ms
20 ms ^a	1 ms	10 ms
50 ms ^a	5 ms	50 ms
.1 s ^a	10 ms	.1 s
.2 s ^a	10 ms	.1 s
.5 s ^a	50 ms	.5 s

^aFor sweep times greater than 5 ms/div, set TRIG MODE to NORM.

- CHECK—DELAY TIME POSITION dial setting to be 8.92 to 9.08.
- d. Repeat parts b and c for each setting listed in Table 4-5.

5. Check Delay or Differential Jitter

a. Set:

DELAY TIME POSITION 9.00 A TIME/DIV 1 ms B TIME/DIV 0.2 μ s

- b. Select 1 ms time markers.
- Slightly readjust DELAY TIME POSITION dial to position a time marker on screen.

- d. CHECK—Jitter on leading edge of the time marker does not exceed 1 division (2.5 divisions if operating from a 50 Hz line voltage). Disregard slow drift.
- e. Set the DELAY TIME POSITION dial to 1.00 and repeat parts ${\bf c}$ and ${\bf d}$.
 - f. Disconnect the time-mark generator.

6. Check ALT Horizontal Display Trace Separation

a. Set:

HORIZ DISPLAY A INTEN
A TIME/DIV 1 ms
B TIME/DIV .1 ms

B INTENSITY As required for visible

display

- b. Use CH 1 Vertical POSITION control to align the trace with the center horizontal graticule line.
 - c. Select ALT Horizontal Display.
- d. CHECK—TRACE SEP control will move the B trace at least ± 4 vertical divisions from the center graticule line with A trace centered.

7. Check A INTEN and B ENDS A Operation

a. Set:

A TIME/DIV 1 ms
B TIME/DIV .1 ms
DELAY TIME POSITION About 5.00
HORIZ DISPLAY A INTEN

- b. CHECK—B portion of trace is intensified (about 1 division).
- c. Rotate A TRIGGER HOLDOFF control clockwise to the B ENDS A position (in the detent).
- d. CHECK—Trace ends at the end of the intensified portion.

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8. Check X Gain

a. Set:

TIME/DIV (both)	X-Y
VOLTS/DIV (both)	5 mV
CH 1 AC-GND-DC	AC
CH 2 AC-GND-DC	GND
HORIZ DISPLAY	Α
A TRIGGER HOLDOFF	NORM

- b. Connect a 20 mV standard-amplitude signal from the calibration generator to the CH 1 input via a 50 Ω bnc cable.
- c. CHECK—Display is 4 divisions (± 0.16 division) between the dots.
 - d. Disconnect test setup.

9. Check X Bandwidth

- a. Connect the leveled sine-wave generator to the CH 1input via a 50 Ω bnc cable and 50 Ω bnc termination.
- b. Adjust the generator for a horizontal display of 10 divisions at 50 kHz.
- c. Without touching the generator amplitude, adjust the generator frequency to 4 MHz.
 - d. CHECK-Display is at least 7 divisions in length.
 - e. Disconnect test setup.

ADJUSTMENT PROCEDURE

IMPORTANT-PLEASE READ BEFORE USING THIS PROCEDURE

Purpose

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

Limits and Tolerances

All limits and tolerances given in this procedure are calibration guides and should not be interpreted as instrument specifications unless they are also found in the Specification section of this manual.

Tolerances given are for the instrument under test and do not include test equipment error.

Step Titles

Where possible, instrument performance is checked before an adjustment is made. Steps containing checks and adjustments are titled Check/Adjust. Those with checks only are titled Check.

Line Voltage Selection

This procedure is for 115 Vac line, medium range. If a different range is to be used, set the Regulating Range Selector and Line Voltage Selector for the available line voltage (see Operating Voltage under Installation Instructions in Section 2 of this manual).

Internal Adjustments

Do not preset the internal controls or move the ± 55 volt supply adjustment as this will typically require complete recalibration of the oscilloscope.

Display

The most accurate display adjustments are made with a stable, well-focused, low-intensity display. Unless otherwise noted, adjust the Intensity, Astigmatism, Focus, and Trigger Level controls as needed.

Test Equipment Required

Refer to Table 4-1, at the beginning of this section, for a list of test equipment required, specifications, usage, and recommended types.

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

Calibration Equipment Alternatives and Partial Procedures. The Adjustment procedure is based on the first item of equipment given as an example. When other equipment is substituted, control settings or calibration setups might need to be altered. If the exact equipment listed is not available, check the Minimum Specification column carefully to see if any other equipment might suffice. Then check the Usage column to see where this item is used. If used for a check that is of little or no importance to your measurement requirements, the item and corresponding step(s) can be deleted.

If the applications for which you will use the 465B do not require the full performance available, the procedure and the equipment list can be shortened accordingly. For example, the basic measurement capabilities of this instrument can be verified by checking and adjusting as needed: vertical deflection factor, horizontal timing accuracy, and the calibrator signal. If any step requires more than a minor readjustment, check Table 4-6 for any possible interactions.

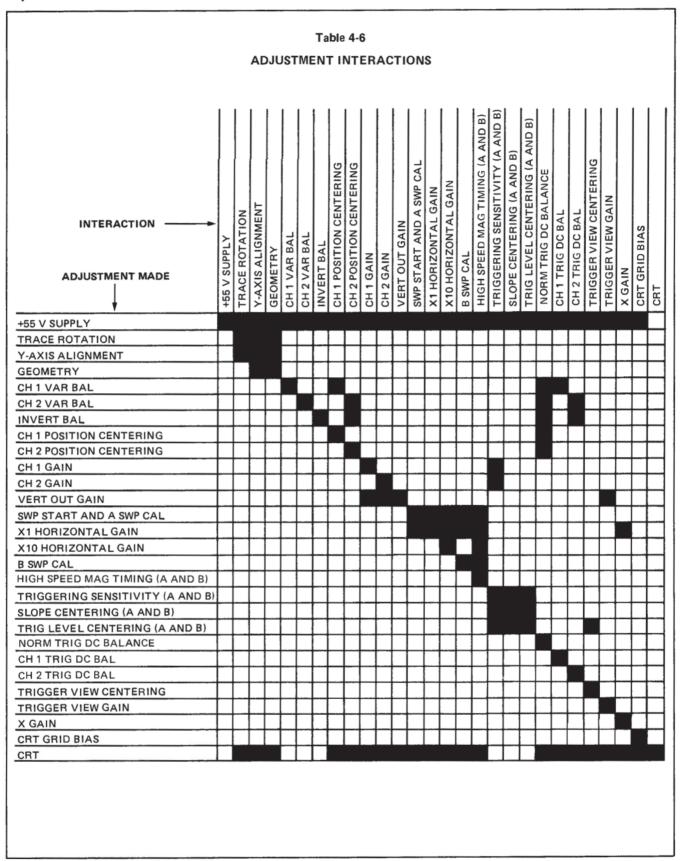
If a Performance Check indicates that only one subsection requires adjustment, each subsection (Vertical, Horizontal, etc.), except the Power Supply, may be adjusted independently. Also, if maintenance has been performed in a subsection, the adjustments for that area may be accomplished without completing the adjustments in other subsections. If any maintenance or adjustments are changed in the Power Supply circuitry, it is advisable to perform a complete adjustment procedure including all subsections.

Interactions

Table 4-6 shows calibration adjustments and the possible interaction each adjustment might have on other adjustments. The use of Table 4-6 is particularly important if only a partial procedure is performed or if a circuit requires recalibration due to component replacement.

To use this table, find the adjustment made in the column at the left of the table. Then move to the right across that row until you come to a darkened square. From

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Calibration Procedure—465B Service Adjustment Procedure

the darkened square move up the column and check the 12. Check/Adjust Gain (R1482, R2025, R1882) (R1482, R2005, R1882 below SN B030000) accuracy of the adjustment heading that column. Readjust 4-30 if necessary. 13. Check CH 1 and CH 2 Var Volts/Div Range . 4-31 Preparation 14. Check ADD mode 4-31 Remove the 465B cabinet by following the procedure listed under "Cabinet and Rack Adapter Removal and 15. Check Compression and Expansion 4-31 Replacement" in the Maintenance section of this manual. 16. Check/Adjust Low-Frequency Compensation 4-32 Connect test equipment and instrument to be calibrated to an appropriate power source. Turn on and 17. Check/Adjust CH 1 Volts/Div Compensation 4-34 allow a 20-minute warmup period before commencing Adjustment Procedure. 18. Check/Adjust CH 2 Volts/Div Compensation 4-34 INDEX TO ADJUSTMENT PROCEDURE 19. Check/Adjust CH 2 and Output High-Power Supply Frequency Compensation 4-35 Page 1. Check/Adjust Power Supply DC Levels, Regula-20. Check CH 2 Position Effect tion, and Ripple (R4318) 4-23 4-35 2. Check High Voltage Supply 4-24 21. Check/Adjust CH 1 High-Frequency Compensation 4-36 Display and Z Axis 22. Check CH 1 Position Effect 4-36 1. Check/Adjust CRT Grid Bias (R4109) 4-25 23. Check CH 1 Transient Response 4-36 2. Check/Adjust Trace Alignment ROTATION) 24. Check CH 2 Transient Response 4-25 4-36 3. Check/Adjust Y-Axis Alignment (R4072) 4-26 25. Check Bandwidth 4-36 4. Check/Adjust Geometry (R4069) 4-26 26. Check Cascaded Gain and Bandwidth 4-37 Check/Adjust Z-Axis Compensation (C4217) . 4-26 27. Check Channel Isolation 4-37 28. Check/Adjust Common-Mode Rejection Ratio Vertical (R1882) 4-37 1. Check Probe Indicator LED 4-28 29. Check Bandwidth Limit Operation 4-38 2. Check Input Coupling (AC-GND-DC) Switches 4-28 30. Check/Adjust Trigger View Centering and Gain 3. Check ALT Mode 4-28 (R7526, R7439) 4-38 4. Check CHOP Mode 4-28 31. Check/Adjust Trigger View Low-Frequency Compensation (C7505, C7506) 4-38 5. Check BEAM FIND 4-28 32. Check/Adjust Trigger View High-Frequency 6. Check/Adjust CH 1 Var Volts/Div Balance and Compensation (C7425, C7529, R7423) 4-39 VAR Indicator (R1484) 4-29 33. Check/Adjust Zero Trigger View Delay (R6011, 7. Check/Adjust CH 1 Position Centering (R1135) 4-29 R6152) 8. Check/Adjust CH 2 Var Volts/Div Balance and VAR Indicator (R1884) 4-29 9. Check/Adjust CH 2 Invert Balance (R1975) ... 4-29 **Triggers** 10. Check/Adjust CH 2 Position Centering 1. Check/Adjust A Trigger Sensitivity and TRIG (R1735) 4-29 LED (R7246) 4-39 11. Check CH 2 and CH 1 Gate Current 4-30 2. Check/Adjust B Trigger Sensitivity (R7045) ... 4-41

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POWER SUPPLY

Equipment Required

1. Digital Voltmeter

4. Autotransformer

2. DC Voltmeter

5. 3-Inch Slotted Screwdriver

3. Test Oscilloscope

See

ADJUSTMENT LOCATIONS 1

in the Diagrams section for adjustments and test points (TP).

NOTE

After performing the following control settings, connect the instrument to a power source through a Variable Autotransformer. Set the Autotransformer to 115 V before turning the instrument on.

Triggering Controls (both A and B if applicable)

LEVEL As needed for a stable

display

SLOPE +
COUPLING AC
SOURCE NORM
TRIG MODE AUTO

465B Control Settings

Power Controls

Regulating Range Selector Medium Line Voltage Selector 115 V POWER ON Sweep Controls

DELAY TIME POSITION Fully counterclockwise

A TIME/DIV 1 ms B TIME/DIV 1 ms

HORIZ DISPLAY

VAR TIME/DIV Calibrated detent
X10 MAG Off (button out)
POSITION (Horizontal) Midrange

A TRIGGER HOLDOFF NORM

CRT Controls

INTENSITY FOCUS As desired

SCALE ILLUM

Best focused display

As desired

1. Check/Adjust Power Supply DC Levels, Regulation, and Ripple (R4318)

Vertical Controls (both Channels if applicable)

VOLTS/DIV

5 mV

VAR

Calibrated detent

POSITION AC-GND-DC Midrange

VERT MODE

GND CH 1

INVERT 20 MHz BW LIMIT Normal (button out) Full bandwidth

(button out)

NOTE

Review the information at the beginning of the Adjustment Procedure before starting the procedure.

a. Connect the digital voltmeter common lead to chassis ground and the + lead to the test point given in Table 4-7. Voltage to be within the given limits.

Table 4-7
LOW VOLTAGE POWER SUPPLY LIMITS

Power Supply	Test Point	Reading	Tolerance
+55 V	TP4338	+54.62 to +55.39	±0.7%
+15 V	TP4339	+14.75 to +15.26	±1.7%
+5 V	TP4337	+4.92 to +5.09	±1.7%
-8 V	TP4439	−7.86 to −8.14	±1.7%
+110 V	TP4340	+106.7 to +113.3	±3.0%

NOTE

If the adjustment in step 1, part b, is made, the oscilloscope will require complete recalibration.

- b. Connect the digital voltmeter common lead to chassis ground and + lead to TP4338. ADJUST—+55 volt supply (R4318) for +55 volts. Recheck all supplies according to Table 4-7.
- c. Connect the test oscilloscope to the indicated test point and check the ripple amplitude according to Table 4-8 while varying the line voltage between 104 V and 126 V. For improved resolution when measuring ripple amplitude, use a 1X probe and cascaded gain on the test oscilloscope.

Table 4-8

TYPICAL LOW VOLTAGE
POWER SUPPLY RIPPLE

Power Supply	Test Point	Typical Ripple (Peak-to-Peak)
+55 V	TP4338	4 mV
+15 V	TP4339	2 mV
+5 V	TP4337	2 mV
-8 V	TP4439	2 mV
+110 V	TP4340	20 mV

d. Return line voltage to 115 V.

2. Check High Voltage Supply

- a. Connect the dc voltmeter common lead to chassis ground and the + lead to TP4129 on the interface board. (TP4129 is accessible through a hole in the high voltage cover.)
- b. CHECK—High Voltage supply for -2450 V $\pm 2.2\%$ (-2396 V to -2504 V).
 - c. Disconnect the dc voltmeter.

DISPLAY AND Z AXIS

Equipment Required

- 1. DC Voltmeter
- 2. Test Oscilioscope
- 3. Time-mark Generator
- 4. 50 Ω Bnc Cable

- 5. 50 Ω Bnc Termination
- 6. 10X Probe
- 7. 3-inch Slotted Screwdriver
- 8. Low-capacitance Slotted Screwdriver

See

ADJUSTMENT LOCATIONS 1

in the Diagrams section for adjustments and test points (TP).

465B Control Settings

Power Controls

Regulating Range Selector Medium Line Voltage Selector 115 V **POWER** ON

CRT Controls

INTENSITY

As desired

FOCUS SCALE ILLUM Best focused display Fully counterclockwise

Vertical Controls (both Channels if applicable)

VOLTS/DIV

5 mV

VAR

Calibrated detent

POSITION

Midrange

AC-GND-DC VERT MODE GND CH₁

INVERT

Normal (button out) Full bandwidth

20 MHz BW LIMIT

(button out)

Triggering Controls (both A and B if applicable)

LEVEL

As needed for a stable

display

SLOPE COUPLING SOURCE TRIG MODE

AC **NORM AUTO**

Sweep Controls

HORIZ DISPLAY

DELAY TIME POSITION

Fully Counterclockwise

Calibrated detent

A TIME/DIV

VAR TIME/DIV X10 MAG POSITION (Horizontal)

Off (button out) Midrange

A TRIGGER HOLDOFF

NORM

1. Check/Adjust CRT Grid Bias (R4109)

- a. Connect the digital voltmeter common lead to chassis ground and the + lead to TP4217. (TP4217 is accessible through a hole in the high voltage cover.)
- b. Set the INTENSITY control for +20 V on the digital voltmeter.
- c. CHECK-Display for a well defined, low intensity dot. Use FOCUS and ASTIG controls as needed.
- d. ADJUST-CRT Grid Bias (R4109) for a visible dot, then back off control until the dot just disappears.

2. Check/Adjust Trace Alignment (TRACE ROTATION)

a. Set:

A TIME/DIV INTENSITY

 $0.5 \, \text{ms}$

As desired SCALE ILLUM As desired

Calibration Procedure-465B Service **Adjustment Procedure**

- b. Position the trace to the center horizontal graticule line.
- c. CHECK-Trace is parallel with the center horizontal araticule line.
- d. ADJUST-TRACE ROTATION (front panel adjustment) to make the trace parallel with the center horizontal graticule line.

3. Check/Adjust Y-Axis Aiignment (R4072)

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

CH 1 AC-GND-DC DC CH 1 VOLTS/DIV

0.1 V

- c. Adjust VAR TIME/DIV control for exactly 1 time marker/major division. (Time markers should fill the screen vertically. If not, reduce the VOLTS/DIV switch setting.)
- d. CHECK-Display for 0.1 division tilt or less, when compared to the center vertical graticule line.
- e. ADJUST-Y-Axis Alignment (R4072) to align to center time marker with the center vertical graticule line.
 - f. INTERACTION—TRACE ROTATION.

4. Check/Adjust Geometry (R4069)

a. CHECK-Display for 0.1 division or less, vertical curvature of the markers across the graticule area. (Readjust A VAR TIME/DIV as needed to maintain exactly 1 marker per division.)

- b. ADJUST-Geometry (R4069) for minimum curvature of the markers across the graticule area.
 - c. INTERACTION—Y-Axis Alignment.
 - d. Disconnect the test setup.
 - e. Return A VAR TIME/DIV to detent.

5. Check/Adjust Z-Axis Compensation (C4217)

- a. Set the A TIME/DIV switch to 0.05 μs.
- b. Connect the 10X probe from the test oscilloscope to TP4217.
- c. Adjust the 465B INTENSITY control for a 15 V display on the test oscilloscope.
- d. CHECK-Test oscilloscope display for optimum square corner on the unblanking gate (with minimum ringing).
- e. ADJUST-Z-Axis Compensation (C4217), with a low-capacitance screwdriver, for the best square corner on the unblanking pulse viewed on the test oscilloscope.
 - Disconnect the test setup.
- g. CHECK-Display for uniform intensity across the graticule area (especially the first 2 divisions of the trace).
 - h. READJUST-C4217, if necessary.

VERTICAL

Equipment Required

- 1. Calibration Generator
- 2. Test Oscilloscope (only if gain requires complete recalibration
- 3. Leveled Sine Wave Generator
- 4. Two 10X Probes (one should have Scale-factor Switching, however an 11 $k\Omega$ resistor may be substituted 11. 3-inch Slotted Screwdriver in Step 1, part a).
- 5. 50 Ω Bnc Cable (2 required)
- 6. Dual-input Coupler

- 7. 2X or 5X Bnc Attenuator
- 8. 10X Bnc Attenuator (2 required)
- 9. 50 Ω Bnc Termination (2 required)
- 10. Low-capacitance Screwdriver
- 12. Bnc-to-probe tip Adapter
- 13. Bnc-female-to-coaxial-cable-connector

Adapter.

See **ADJUSTMENT LOCATIONS 2** and

ADJUSTMENT LOCATIONS 3

in the Diagrams section for adjust-

ments and test points (TP).

465B Control Settings

POWER ON COUPLING

Trigger (A and B)

As needed for stable LEVEL

display

SLOPE

NORM A TRIGGER SOURCE INTENSITY As desired

B TRIGGER SOURCE STARTS AFTER DELAY For optimum definition **FOCUS**

AUTO TRIG MODE As desired SCALE ILLUM

NORM A TRIGGER HOLDOFF ASTIG Best defined trace

Vertical (CH 1 and CH 2)

Display

VERT MODE CH₁ **POSITION** Midrange VOLTS/DIV 5 mV

Calibrated detent VAR VOLTS/DIV

AC-GND-DC DC

INVERT Normal (button out) 20 MHz BW LIMIT Full bandwidth

(button out)

Sweep (A and B)

Α HORIZ DISPLAY A TIME/DIV 1 ms B TIME/DIV 1 ms

Calibrated detent VAR TIME/DIV

DELAY TIME POSITION Fully counterclockwise

Off (button out) X10 MAG

Midrange POSITION (Horizontal)

Calibration Procedure—465B Service Adjustment Procedure

1. Check Probe Indicator LED

- a. Connect a 10X probe with a Scale-factor Switching connector to CH 1 input (if no Scale-factor Switching probe is available, an 11 k Ω resistor may be used. Connect the resistor between ground and the metal coding ring on the input connector).
- b. CHECK—5 mV LED is extinguished and 50 mV LED is illuminated.
- c. Set VERT MODE switches to display CH 2 and move probe to CH 2 input.
- d. CHECK—5 mV LED is extinguished and 50 mV LED is illuminated.
 - e. Remove 10X probe.

2. Check Input Coupling (AC-GND-DC) Switches

- a. Connect output of calibration generator to CH 2 input via 50 Ω cable. Set the generator for 20 mV standard-amplitude output.
- b. Position bottom of display to center horizontal graticule line and set CH 2 AC-GND-DC switch to GND.
- c. CHECK—No vertical deflection; trace is at center horizontal graticule line.
 - d. Set CH 2 AC-GND-DC switch to AC.
- e. CHECK—Display is centered about center horizontal graticule line.
- f. Set VERT MODE switches to display CH 1 and move test signal to CH 1.
- g. Position bottom of display to center horizontal graticule line.
 - h. Set CH 1 AC-GND-DC switch to GND.
- i. CHECK—No vertical deflection; trace is at center horizontal graticule line.
 - i. Set CH 1 AC-GND-DC switch to AC.

- k. CHECK—Display is centered about center horizontal graticule line.
 - I. Disconnect square-wave signal.

3. Check ALT Mode

Set:

VERT MODE CH 1, CH 2, and

ALT: OUT

A TRIGGER LEVEL Fully clockwise

- b. Position traces about 2 divisions apart.
- c. CHECK—Sweeps alternate for all A TIME/DIV settings except X-Y.

4. Check CHOP Mode

a. Set:

A TIME/DIV $0.5 \mu s$

VERT MODE CH1, CH 2, and CHOP

AC-GND-DC (both) GND
A TRIGGER COUPLING HF REJ
A TRIGGER LEVEL As needed for stable display

- b. Position traces about 4 divisions apart and set A TRIGGER LEVEL control for a stable display.
- c. CHECK—Vertical switching transients are completely blanked between horizontal chopped segments.
- d. CHECK—Duration of each cycle is approximately 4 divisions.

5. Check BEAM FIND

- a. Push in BEAM FIND button and hold.
- b. CHECK—Trace remains entirely on screen, regardless of the setting of vertical or horizontal POSITION controls.
 - c. Release BEAM FIND button.

6. Check/Adjust CH 1 Var Volts/Div Balance And Var Indicator (R1484)

- a. Position trace to center horizontal graticule line.
- b. CHECK—CH 1 UNCAL LED is illuminated when VAR control is out of detent.
- c. CHECK—Trace shift of 0.2 division or less when rotating VAR control from one extreme to the other.
- d. ADJUST—CH 1 Var Bal (R1484) for minimum trace shift while rotating CH 1 VAR control from one extreme to the other.
 - e. Return CH 1 VAR control to detent position.

7. Check/Adjust CH 1 Position Centering (R1135)

a. Set:

CH 1 VOLTS/DIV .2 V
CH 1 AC-GND-DC AC
A TIME/DIV 1 ms

- b. Connect leveled sine-wave generator output to CH 1 input via 50 Ω bnc cable and 50 Ω termination. Set the generator for a vertical display of 2.4 divisions at 50 kHz.
- c. Set CH 1 VOLTS/DIV switch to 20 mV without moving the VAR control.
- d. CHECK—Top of display positions down to center horizontal graticule line or below, bottom of display positions up to center horizontal graticule line or above.
- e. ADJUST—CH 1 Position Center (R1135) so display positions same distance above and below graticule center line.
 - f. Disconnect generator.

8. Check/Adjust CH 2 Var Volts/Div Balance and Var Indicator (R1884)

- a. Set VERT MODE switches to display CH 2.
- b. CHECK—CH 2 UNCAL LED is illuminated when VAR control is out of detent.

- c. CHECK—Trace shift is 0.2 division or less when rotating VAR control from one extreme to the other.
- d. ADJUST—CH 2 Var Bal (R1884) for minimum trace shift while rotating CH 2 VAR control from one extreme to the other.
 - e. Return CH 2 VAR control to detent position.

9. Check/Adjust CH 2 Invert Balance (R1975)

- a. Set CH 2 AC-GND-DC to GND.
- b. Position trace to center horizontal graticule line and push INVERT button in.
- c. CHECK—Trace shift is 0.2 division or less when switching from normal to inverted.
- d. ADJUST—Invert Bal (R1975) for minimum trace shift.

10. Check/Adjust CH 2 Position Centering (R1735)

a. Set:

INVERT Normal (button out)

CH 2 VOLTS/DIV .2 V CH 2 AC-GND-DC AC

A TRIGGER LEVEL Fully clockwise

- b. Connect leveled sine-wave generator output to CH 2 input via 50 Ω bnc cable and 50 Ω bnc termination. Set the generator for a vertical display of 2.4 divisions at 50 kHz.
- c. Set CH 2 VOLTS/DIV switch to 20 mV without moving VAR control.
- d. CHECK—Top of display positions down to center horizontal graticule line or below, bottom of display positions up to center horizontal graticule line or above.
- e. ADJUST—CH 2 Position Center (R1735) so display positions same distance above and below graticule line.
 - f. Disconnect generator.

Calibration Procedure—465B Service Adjustment Procedure

11. Check CH 2 and CH 1 Gate Current

a. Set:

AC-GND-DC (both) GND VOLTS/DIV (both) 5 mV

- b. Position trace to graticule center and change AC-GND-DC switch to DC.
- c. CHECK—Trace shift is 0.1 division or less, when switching between GND and DC.
- d. Set VERT MODE switches to display CH 1. Position trace to graticule center and change AC-GND-DC switch to DC.
- e. CHECK—Trace shift is 0.1 division or less, when switching between GND and DC.
 - f. Set both AC-GND-DC switches to DC.

12. Check/Adjust Gain (R1482, R2025, R1882) (R1482, R2005, R1882 below SN B030000)

NOTE

It is not always necessary to do a complete readjustment to meet instrument gain specifications. Use following procedure to determine required adjustments. a. Set:

VERT MODE CH 2 CH 2 VOLTS/DIV 5 mV CH 2 AC-GND-DC DC

- b. Connect calibration generator standard-amplitude output to CH 2 input via 50 Ω bnc cable. Set the generator for 20 mV output.
- c. CHECK—Display is 4 divisions within 3% (4 divisions ± 0.12 division).
- d. Change CH 2 VOLTS/DIV and calibration generator settings as shown in Table 4-9 and check that deflection accuracy is within 3% for all VOLTS/DIV settings listed.
- e. Set VERT MODE Switches to display CH 1 and set the CH 1 AC-GND-DC switch to DC.
- f. Move the input signal from the CH 2 input connector to the CH 1 input connector.
- g. CHECK—Display is 4 divisions within 3% (4 divisions ± 0.12 division).
- h. Change CH 1 VOLTS/DIV and calibration generator settings as shown in Table 4-9 and check that deflection accuracy is within 3% for all VOLTS/DIV settings listed.

Table 4-9
VERTICAL DEFLECTION ACCURACY

Volts/Div	Calibration Generator		on in Div Accuracy	Reading
Setting	Amplitude	Divisions	Accuracy	In Div
10 mV	50 mV	5	±0.15 div	4.85 to 5.15
20 mV	0.1 V	5	±0.15 div	4.85 to 5.15
50 mV	0.2 V	4	±0.12 div	3.88 to 4.12
.1 V	0.5 V	5	±0.15 div	4.85 to 5.15
.2 V	1 V	5	±0.15 div	4.85 to 5.15
.5 V	2 V	4	±0.12 div	3.88 to 4.12
1 V	5 V	5	±0.15 div	4.85 to 5.15
2 V	10 V	5	±0.15 div	4.85 to 5.15
5 V	20 V	4	±0.12 div	3.88 to 4.12

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- i. If both channels check within 3%, no further vertical gain calibration is required. Proceed to step 13. If a check at any setting of the VOLTS/DIV switch falls outside the 3% accuracy limits, a complete gain recalibration is required. Continue with part j of this step.
- j. Set CH 1 VOLTS/DIV switch to 5 mV and set the output of the calibration generator to 20 mV.
 - k. Set the test oscilloscope controls as follows:

Vertical Mode Add

Invert On (button in)

Volts/Div (both) .1 V (with 10X probe)
Trlggering Auto (free-running sweep)

A Trigger Source Ext (no trigger

applied)

- I. Connect two 10X probes from the test oscilloscope to TP1519 and TP1319 on the 465B Vertical Preamplifier board. Connect the probe ground leads to chassis ground.
- m. CHECK—Signal between TP1519 and TP1319 is 400 mV p-p (4 divisions).
- n. ADJUST—CH 1 Gain Adjust (R1482) for 400 mV p-p.

NOTE

This is a nominal value for this adjustment. If may be reset to obtain correct CH 1 overall gain.

- o. Remove 10X probes from TP1519 and TP1319.
- p. CHECK—Display is 4 divisions within 3% (4 divisions ± 0.12 division).
- q. ADJUST—Output Gain Adjust R2025 (R2005 below SN B030000) on the Vertical Output board for a 4-division display.
- r. Set CH 2 VOLTS/DIV to 5 mV and move the input signal from CH 1 input to CH 2 input. Set the VERT MODE switches to display CH 2.
- s. ADJUST—CH 2 Gain Adjust (R1882) for a 4-division display.

t. Repeat parts e thorugh i to recheck the vertical deflection accuracy.

13. Check CH 1 and CH 2 Var Volts/Div Range

- a. Set VERT MODE switches to display CH 2 and set both VOLTS/DIV switches to 10 mV and amplitude calibrator for 50 mV signal.
- b. Rotate CH 2 VAR VOLTS/DIV control fully counterclockwise.
 - c. CHECK-Display reduces to 2 divisions or less.
- d. Move signal to CH 1 input connector and set VERT MODE switches to display CH 1.
- e. Rotate CH 1 VAR VOLTS/DIV control fully counterclockwise.
 - f. CHECK-Display reduces to 2 divisions or less.
- g. Return both VAR VOLTS/DIV controls to calibrated detent.

14. Check ADD Mode

a. Set:

VOLTS/DIV (both) 5 mV VERT MODE ADD

INVERT Normal (button out)

- b. Connect calibration generator standard-amplitude output to both inputs via 50 Ω cables and dual-input coupler. Set generator output for 10 mV.
- c. CHECK—Display of 4 divisions, within 3% (4 divisions ± 0.12 division).

15. Check Compression and Expansion

a. Set:

CH 2 AC-GND-DC GND VERT MODE CH 1

 Adjust CH 1 VAR control for a 2 divisions display, centered about center horizontal graticule line.

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Calibration Procedure—465B Service Adjustment Procedure

- c. Position top of display to top graticule line.
- d. CHECK—Display compression or expansion is 0.1 division or less.
 - e. Position bottom of display to bottom graticule line.
- CHECK—Display compression or expansion is 0.1 division or less.
- g. Set CH 1 VAR VOLTS/DIV control to calibrated detent.
- h. Disconnect generator standard-amplitude output and dual-input coupler.

16. Check/Adjust Low-Frequency Compensation

a. Set:

 A TIME/DIV
 0.2 ms

 VERT MODE
 CH 1

 AC-GND-DC (both)
 DC

 VOLTS/DIV (both)
 5 mV

A TRIGGER LEVEL As needed for stable

display.

- b. Connect calibration generator fast-rise + output to CH 1 input via a 50 Ω bnc cable, 10X attenuator, and 50 Ω bnc termination.
- c. Adjust calibration generator to maintain a 5-division display throughout step 16.
- d. CHECK—Display overshoot or rounding is within 3% (5 divisions ± 0.15 division) for each A TIME/DIV and generator setting given in Table 4-10.

Table 4-10

MAXIMUM OVERSHOOT OR ROUNDING

Calibration Generator Signal	A Time/Div Setting	Maximum Overshoot or Rounding in Div
1 kHz	.2 ms	4.85 to 5.15
10 kHz	20 μs	4.85 to 5.15
100 kHz	2 μs	4.85 to 5.15

e. If above checks are within 3%, proceed to step 17; if not, continue with part f.

f. Set:

A TIME/DIV 0.2 ms

VERT MODE CH 1, CH 2, and ALT

AC-GND-DC (both) DC VOLTS/DIV (both) 5 mV

A TRIGGER LEVEL As needed for stable

display

A TRIGGER SLOPE - (minus)

g. Unplug cable connector from J4387 (Vert Alt Sync pulse) and insert plug into bnc-to-cable-connector adapter. Connect the square-wave output of low-frequency generator to the bnc-to-cable-connector adapter via a 50 Ω bnc cable. Set the generator output frequency to 1 kHz and adjust CH 1 and CH 2 Vertical POSITION controls for a 6-division display. Adjust A TRIGGER LEVEL control for a stable display. Presentation will be a square wave when the CH 1 and CH 2 traces alternate at the generator frequency.

NOTE

As an alternate signal source, use the fast-rise — (minus) output of the calibration generator. Do not terminate the cable and adjust the output amplitude to maximum.

h. ADJUST—Use the settings and adjustments in Table 4-11 and adjust the Vertical Output for best flat top within $\pm 3\%$.

Table 4-11
VERTICAL OUTPUT LOW-FREQUENCY
COMPENSATION

Square-wave Frequency	465B A Time/Div	Adjustment
1 kHz	0.2 ms	R2448 (R2550)ª
10 kHz	20 μs	R2446 (R2540) ^a
100 kHz	2 μs	R2436 (R2535) ^a R2426 (R2520) ^a

a Below SN B030000.

INTERACTION—Repeat 1 kHz, 10 kHz, and 100 kHz until no further improvement is noted.

i. Unplug cable connector from bnc-to-cable-connector adapter and plug connector back into J4387.

j. Set:

A TIME/DIV HORIZ DISPLAY 2 μs ALT

k. CHECK—TRACE SEP control will move the B trace at least ± 4 vertical divisions from the A trace when rotating TRACE SEP control to fully clockwise and fully counterclockwise positions (A trace centered).

I. CHECK—B trace moves an equal distance above and below the A trace (\approx 4 divisions). Below SN B030000; ADJUST—Trace Sep Range Adjust R2035 for \pm 4 divisions of trace separation when rotating TRACE SEP control to fully clockwise and fully counterclockwise positions.

m. ADJUST—Trace Sep Centering R2117 so that the B trace moves an equal distance above and below the A Trace (≈4 divisions). Below SN B030000; ADJUST Trace Sep Comp adjust R2030 for minimum movement of the A Trace while rotating TRACE SEP control from fully clockwise to fully counterclockwise positions.

n. Set:

A TIME/DIV VERT MODE

0.2 ms CH 1

AC-GND-DC (both)

DC 5 mV

VOLTS/DIV (both) HORIZ DISPLAY

Δ

A TRIGGER LEVEL

As needed for stable

display

A TRIGGER SLOPE

+

o. Connect calibration generator fast-rise + output to CH 1 input connector via 50 Ω bnc cable, 10X attenuator, and 50 Ω termination. Set generator frequency to 1 kHz and adjust amplitude for a 6-division display. Adjust A TRIGGER LEVEL for a stable display.

p. ADJUST—Use the settings and adjustments in Table 4-12 to adjust the CH 1 low-frequency compensation for best flat top within $\pm 3\%$.

Table 4-12
CH 1 LOW-FREQUENCY COMPENSATION

Square-Wave Frequency	465B A Time/Div	Adjustment
1 kHz	0.2 ms	R1176
10 kHz	20 μs	R1185
100 kHz	2 μs	R2432 (R2530) ^a and R2426 (R2520) ^a on Vertical Output board if needed. (See Table 4-13.)

a Below SN B030000.

q. Move the input signal from CH 1 input connector to CH 2 input connector and set VERT MODE switches to display CH 2.

r. ADJUST—Use the settings and adjustments in Table 4-13 to adjust the CH 2 low-frequency compensation for best flat top within $\pm 3\%$.

Table 4-13
CH 2 LOW-FREQUENCY COMPENSATION

Square-Wave Frequency	465B A Time/Div	Adjustment
1 kHz	0.2 ms	R1580
10 kHz	20 μs	R1582
100 kHz	2 μs	R2432 (R2530) ^a and R2426 (R2520) ^a for best compromise between CH 1 and CH 2.

^{*} Below SN B030000.

s. Disconnect calibration generator fast-rise \pm output from CH 2 input connector.

17. Check/Adjust CH 1 Volts/Div Compensation

NOTE

C13010, in the CH 1 Preamplifier, is set at the factory to give C13010, in the CH 2 Preamplifier, enough range to match CH 2 input capacitance with CH 1 input capacitance. Unless there is a circuit malfunction, the CH 1 C13010 should not need readjustment. When adjusting either C13010, or other adjustments in this section, if the low-capacity screwdriver contains a metal bit, the metal may affect the adjustment. Check adjustment after the screwdriver is remove, and re-adjust as necessary.

a. Set:

VOLTS/DIV (both) 5 mV (see note

below)

VERT MODE CH 1

A TIME/DIV 0.2 ms (see note

below)

20 MHz BW LIMIT Limited bandwidth

(button in)

NOTE

In steps 17 and 18, all VOLTS/DIV Checks and Adjustments require the use of a 10X probe with Scale-Factor Switching (preferably the probe supplied as a standard accessory with the oscilloscope you are calibrating). If it is necessary to use a 10X probe without Scale-Factor Switching, set the VOLTS/DIV knob to indicate one-tenth of the setting listed (5 mV instead of 50 mV, etc). When adjusting compensation, one adjustment will affect the waveform front corner, and another will affect the flat top. Ignore the front corner when making the flat top adjustment and vice-versa. The A TIME/DIV switch should be set to 1 ms for the flat-top, and to 0.2 ms for front corner checks and adjustments.

- b. Connect a 10X probe to CH 1 input connector (note that the VOLTS/DIV Scale-Factor LED will now indicate 50 mV).
- c. Connect calibration generator high-amplitude output to tip of the 10X probe via a 2X, 5X, or 10X bnc attenuator (depending on generator amplitude) and bnc-to-probe-tip adapter.

- d. Set the calibration generator for a 5-division, 1 kHz display; add or remove attenuators or termination as needed to maintain a 5-division display throughout steps 17 and 18.
- e. Adjust probe compensation adjustment for best flattop waveform. Do not re-adjust probe compensation throughout the remainder of steps 18 and 19.
 - f. Set CH 1 VOLTS/DIV to 0.1 V.
- g. CHECK—Compensation for all VOLTS/DIV settings listed in Table 4-14 for display overshoot, rounding, and flat-top, is within 2% (5 divisions ± 0.1 division). If compensation setting is within 2%, skip part h; otherwise perform part h.
- h. ADJUST—Any adjustment pair (see Table 4-14) as necessary so compensation for all settings of the VOLTS/DIV switch is within 2%.

18. Adjust CH 2 Volts/Div Compensation

a. Set:

VERT MODE CH 2

- b. Move the 10X probe connector from the CH 1 input to the CH 2 input connector.
- c. Adjust calibration generator for a 5-division, 1 kHz display; add or remove attenuators or termination as needed to maintain a 5-division display throughout the remainder of this step.
- d. CHECK—Display for flat-top waveform within 3% $(\pm 0.15 \text{ division})$.
- e. ADJUST—C13010 in the CH 2 Preamplifier for best flat-top waveform using a low-capacitance screwdriver.
 - f. Repeat step 17, parts f through h for CH 2.
 - g. Disconnect test setup.

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Table 4-14 VOLTS/DIV COMPENSATION

Volts/Div Setting (10X Scale-Factor)	Adjust	
	Time/Div 1 ms Flat	Time/Div 0.2 ms Corner
.1 V	C37	C36
.2 V	C35	C34
.5 V	C33	C32
1 V	Check	Check
2 V	Check	Check
5 V	C31	C30

NOTE

If the oscilloscope is to be used primarily with a 50 Ω signal source, more accurate reproduction of the waveform front corner may be achieved by calibrating with a 50 Ω system. To accomplish this, substitute a properly terminated 50 Ω cable for the 10X probe while making the front corner adjustments listed in Table 4-14.

19. Check/Adjust CH 2 and Output High-Frequency Compensation

a. Set:

VOLTS/DIV (both) 5 mV A TRIGGER SLOPE +

20 MHz BW LIMIT Full bandwidth (button out)

b. Connect calibration generator fast-rise \pm (positive-going) output to CH 2 input connector via a 50 Ω bnc cable, 10X bnc attenuator, and 50 Ω termination.

NOTE

Adjustments in steps 19 through 25 interact. Perform all of the checks, but not the adjustments, in these steps before making any adjustments (unless calibration is being performed after repair or replacement of vertical components).

If all checks are within the given limits, proceed to step 26.

If any of the checks are not within the given limits, perform checks and adjustments in steps 19 through 25, using low-capacitance screwdriver.

If still not within the given limits—perform steps 6 through 25.

- Adjust calibration generator output for a 5-division, 100 kHz display.
 - d. Set A TIME/DIV to 0.2 μs.
- e. CHECK—Flat-top display aberrations are within 4% (±0.2 division). See Figure 4-1 for typical display.

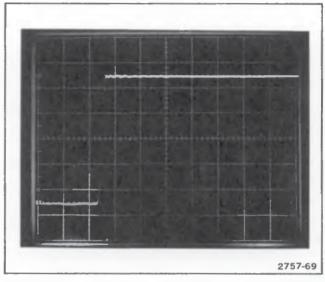


Figure 4-1. Typical display when high-frequency compensation is correctly adjusted.

- f. ADJUST—R1685, C1690, R1634, C1643, C2315 (C2308 below SN B030000), R2325 (R2312 below SN B030000), R2243 (R2245 below SN B030000), and C2346 (C2350 below SN B030000), for best flat-top waveform with fastest rise time.
- g. Connect test setup to fast-rise (negative-going) output of calibration generator.
 - h. Set A TRIGGER SLOPE to -.
- i. CHECK—Flat-bottom display aberrations are within 6% (± 0.3 division).

20. Check CH 2 Position Effect

- a. Position bottom of display to top graticule line.
- b. CHECK—Display aberrations are within 8% (± 0.4 division).
 - c. Set A TRIGGER SLOPE to +.

- d. Connect test setup to fast-rise + output of calibration generator.
 - e. Position top of display to bottom graticule line.
- f. CHECK—Display aberrations are within 6% (± 0.3 division).

21. Check/Adjust CH 1 High-Frequency Compensation

- a. Set VERT MODE switches to display CH 1.
- b. Move test signal from CH 2 input to CH 1 input connector.
- c. CHECK—Flat-top display aberrations are with 4% (±0.2 division). See Figure 4-1 for typical display.
- d. ADJUST—R1190, C1192, R1335, and C1342 for best flat-top display.

INTERACTION—It may be necessary to compromise Vertical Output adjustment and CH 2 adjustment for best high-frequency match between CH 1 and CH 2.

- e. Connect test setup to fast-rise output of calibration generator.
 - f. Set A TRIGGER SLOPE to -.
- g. CHECK—Flat-bottom display aberrations are within 6% (± 0.3 division).

22. Check CH 1 Position Effect

- a. Position bottom of display to top graticule line.
- b. CHECK—Display aberrations are within 8% (± 0.4 division).
 - c. Set A TRIGGER SLOPE to +.
- d. Connect test setup to fast-rise + output of calibration generator.
 - e. Position top of display to bottom graticule line.

f. CHECK—Display aberrations are within 6% (± 0.3 division).

23. Check CH 1 Transient Response

- a. Verify that A TRIGGER SLOPE is set to + and that the calibration generator fast-rise + output is connected to CH 1 input via a 50 Ω bnc cable, 10X bnc attenuator, and 50 Ω bnc termination.
- b. Adjust generator and add or remove attenuators as necessary to maintain a 5-division display throughout the checks of the 5 mV, 10 mV, 20 mV, and 50 mV positions of CH 1 VOLTS/DIV switch.
- c. CHECK—Display flat-top and aberrations are within 4% (\pm 0.2 division) for each position of the VOLTS/DIV switch given in part b.

24. Check CH 2 Transient Response

- a. Set VERT MODE switches to display CH 2.
- b. Move test setup to CH 2 input connector.
- c. Adjust generator and add or remove attenuators as necessary to maintain a 5-division display throughout the checks of the 5 mV, 10 mV, 20 mV and 50 mV positions of CH 2 VOLTS/DIV switch.
- d. CHECK—Display flat-top and aberrations are within 4% (± 0.2 division) for each position of the VOLTS/DIV switch given in part c.

25. Check Bandwidth

a. Set:

A TIME/DIV 0.2 ms CH 2 VOLTS/DIV 5 mV

- b. Connect leveled sine-wave generator reference signal to CH 2 input via a 50 Ω bnc cable, 10X attenuator, and 50 Ω termination.
 - c. Adjust generator for 5-division display.
 - d. Set generator for 100 MHz output frequency.
 - e. CHECK-Display amplitude is 3.5 divisions or more.

- f. Repeat step 25 parts c, d, and e, for 10 mV through 1 V positions of CH 2 VOLTS/DIV switch.
- g. Change VERT MODE switches to display CH 1. Move test setup to CH 1 input.
- h. Repeat step 25, parts c, d, and e, for 5 mV through 1 V positions of CH 1 VOLTS DIV switch.
 - i. Disconnect test setup.

26. Check Cascaded Gain and Bandwidth

a. Set:

VOLTS/DIV (both)	5 mV
AC-GND-DC (both)	AC
VERT MODE	CH 2
A TIME/DIV	1 ms

- b. Connect CH 1 VERT SIGNAL OUT (on 465B rear panel) to CH 2 input connector via 50 Ω bnc cable and 50 Ω termination.
- c. Connect calibration generator standard-amplitude output to CH 1 input connector via 50 Ω bnc cable. Set generator output to 5 mV.
 - d. CHECK—Display amplitude is 5 divisions or more.
 - e. Remove test setup from CH 1 input.
- f. Connect leveled sine-wave generator reference signal output to CH 1 input via 50 Ω bnc cable, 10X attenuator, and 50 Ω termination.
 - g. Adjust generator output for a 5-division display.
 - h. Set generator for 50 MHz output frequency.
 - i. CHECK—Display amplitude is 3.5 divisions or more.
 - i. Disconnect test setup.

27. Check Channel Isolation

a. Set:

CH 2 VOLTS/DIV	0.2 V
VERT MODE	CH 2
CH 1 AC-GND-DC	GND

- b. Connect leveled sine-wave generator output to CH 2 input via 50 Ω bnc cable, and 50 Ω termination.
- c. Set generator for 25 MHz and adjust output for a 2-division display.
 - d. Set:

VOLTS/DIV (both)	20 mV
VERT MODE	CH 1
A TRIGGER SOURCE	CH 2

A TRIGGER LEVEL As needed for a stable

display

- e. CHECK-Display amplitude is 0.2 division or less.
- f. Move test setup from CH 2 input to CH 1 input connector.
 - a. Set:

CH 1 AC-GND-DC	DC
CH 2 AC-GND-DC	GND
VERT MODE	CH 2
A TRIGGER SOURCE	CH 1

A TRIGGER LEVEL As needed for a stable

display

- h. CHECK—Display amplitude is 0.2 division or less.
- i. Disconnect test setup.

28. Check/Adjust Common-Mode Rejection Ratio (R1882)

a. Set:

VOLTS/DIV (both)	20 mV
AC-GND-DC (both)	DC
A TRIGGER SOURCE	NORM
VERT MODE	CH 1

CH 2 INVERT Inverted (button in)

- b. Connect leveled sine-wave generator output to CH 1 and CH 2 input connectors via 50 Ω bnc cable, 10X attenuator, 50 Ω termination, and dual-input coupler.
- c. Set generator frequency to 20 MHz and adjust output for a 6-division display.
- d. Set VERT MODE switches for ADD only (press CH 1 VERT MODE to remove CH 1 trace from crt display).
- e. CHECK—Display is 0.6 division or less (indicates CMRR of at least 10:1 at 20 MHz).
- f. Proceed to part m if the check in part e meets the requirements. If the CMRR is less than 10:1, continue with this procedure.
 - g. Set VERT MODE switches to display CH 1.
- h. Set generator frequency to 50 kHz and adjust output for a 6-division display.
 - i. Set VERT MODE switches to display ADD only.
- j. ADJUST—CH 2 Gain Adjust (R1882) for minimum display (best CMRR).
 - k. Set generator frequency to 20 MHz.
- I. CHECK—Display is 0.6 division or less (indicates CMRR of at least 10:1 at 20 MHz).
- m. Press CH 2 INVERT push button to release; disconnect test setup.

29. Check Bandwidth Limit Operation

a. Set:

20 MHz BW LIMIT Limited bandwidth

(button in)

CH 1 AC-GND-DC DC VERT MODE CH1

b. Connect leveled sine-wave generator reference signal output to CH 1 input connector via 50 Ω bnc cable and 50 Ω termination.

- c. Adjust generator output amplitude for a 6-division display.
- d. Increase generator frequency until display is 4.2 divisions.
- e. CHECK—Generator output frequency is 16 to 24 MHz.
 - f. Disconnect test setup.

30. Check/Adjust Trigger View Centering and Gain (R7526, R7439)

a. Set:

A TRIGGER COUPLING AC
A TRIGGER SOURCE EXT
A TRIGGER LEVEL 0
A TIME/DIV 0.2 ms

VERT MODE A TRIG VIEW

- b. Connect the calibration generator standard-amplitude signal to the A External Trigger input connector via a 50 Ω bnc cable. Set the generator for 0.5 V output.
- c. CHECK—Display amplitude is 5 divisions $\pm 5\%$ (5 divisions ± 0.25 division) and that display will trigger symmetrically within one division of the center horizontal graticule line when the A TRIGGER SLOPE is switched between \pm and \pm .
- d. ADJUST—Trig View Centering (R7526) to center the display about the center horizontal graticule line.
- e. ADJUST—Trig View Gain (R7439) for a 5-division display.
- f. INTERACTION—Between Trig View Centering and Trig View Gain adjustments. Repeat both for no visible interaction.
- g. Disconnect the calibration generator standardamplitude signal from the A External Trigger input.

31. Check/Adjust Trigger View Low-Frequency Compensation (C7505, C7506)

a. Connect the calibration generator high-amplitude output to the A External Trigger input connector via a 50 $\,\Omega$ bnc cable. (Check generator output to see if termination is required.)

- b. Set calibration generator for a 5-division display at 1 kHz.
- c. CHECK—Square wave has less than 10% overshoot or rounding $(\pm 0.5 \text{ division})$.
- d. ADJUST—C7505 for best flat top on square-wave display.
- e. Change A TRIGGER SOURCE to EXT/10 and adjust calibration generator output amplitude for a 5-division display.
- f. CHECK—Square wave has less than 10% overshoot or rounding $(\pm 0.5 \text{ division})$.
- g. ADJUST—C7506 for best flat top on square-wave display.
- h. Remove bnc cable from high-amplitude output on the calibration generator.

32. Check/Adjust Trigger View High-Frequency Compensation (C7425, C7529, and R7423)

a. Set:

A TIME/DIV 0.2 μ s A TRIGGER SOURCE EXT

- b. Connect fast-rise + output from calibration generator to the A External Trigger input connector via a 50 Ω bnc cable and a 50 Ω termination. Set the calibration generator to 100 kHz and adjust output amplitude for a 5-division display.
- c. CHECK—Square-wave front corner has less than $\pm 10\%$ aberration (± 0.5 division).
- d. ADJUST--C7425, R7423, and C7529 for best front corner and square-wave rise time of 5 ns or less.
 - e. Disconnect calibration generator.

33. Check/Adjust Zero Trigger View Delay (R6011 and R6152)

NOTE

For instruments equipped with DM44 Option, access to R6011 and R6152 is through a hole in the DM44 circuit board. See the DM44 Instruction manual, Test Points and Adjustment Location foldout, for the location of these adjustments.

a. Set:

VERT MODE CH 1 and A TRIG

VIEW

HORIZ DISPLAY A $0.02 \mu s$ X10 MAG On (button in)

A TRIGGER SOURCE EXT
A TRIGGER COUPLING AC
CH 1 VOLTS/DIV 0.1 V

- b. Connect output of sine-wave generator via bnc T, two 42-inch (equal length) 50 Ω bnc cables, and 50 Ω terminations; one to the CH 1 input connector, and one to the A External Trigger input connector. Set sine-wave generator frequency to 40 MHz and adjust output for a 6-division A TRIG VIEW display. Adjust CH 1 VAR and VOLTS/DIV to match CH 1 display amplitude to A TRIG VIEW display amplitude.
- c. CHECK—Time difference with displays superimposed is ≤ 0.15 horizontal graticule division.
- d. ADJUST—R6011 for zero time difference between CH 1 display and A TRIG VIEW display.
 - e. Set:

HORIZ DISPLAY B DLY'D A TIME/DIV 0.2 μ s B TIME/DIV 0.02 μ s

- f. CHECK—Time difference with displays superimposed is \leq 0.15 horizontal graticule division.
- g. ADJUST—R6152 for zero time difference between CH 1 display and A TRIG VIEW display.
 - h. Disconnect test setup.

TRIGGERS

Equipment Required

- 1. Leveled Sine-wave Generator
- 2. Low-frequency Generator
- 3. Time Mark Generator
- 4. Calibration Generator
- 5. 50 Ω Signal Pickoff Unit (Type CT-3)
- 6. 10X Probe
- 7. 42-inch Bnc Cable (2 required)

- 8. Gr-to-bnc-female Adapter
- 9. Gr-to-bnc-male Adapter
- 10. 10X Bnc Attenuator
- 11. 50 Ω BNC Termination (2 required)
- 12. Dual-input Coupler (2 required)
- 13. Bnc T Connector
- 14. 3-inch Slotted Screwdriver

See ADJUSTMENT LOCATIONS 2

and

ADJUSTMENT LOCATIONS 4

in the Diagrams section for adjust-

ments and test points (TP).

465B Control Settings

Regulating Range Selector Medium Line Voltage Selector 115 V

POWER

ON

(bo

Triggering Controls (both A and B if applicable)

LEVEL Adjust as needed for

a stable display

SLOPE +
COUPLING AC
SOURCE NORM
TRIG MODE AUTO

CRT Controls

INTENSITY As desired

FOCUS Best focused display

SCALE ILLUM As desired

Sweep Controls

HORIZ DISPLAY A

DELAY TIME POSITION Fully counterclockwise

A TIME/DIV $0.05 \mu s$ B TIME/DIV $0.05 \mu s$

VAR TIME/DIV Calibrated detent X10 MAG Off (button out)

POSITION Midrange
A TRIGGER HOLDOFF NORM

Vertical Controls (both channels if applicable)

VOLTS/DIV 10 mV

VAR Calibrated detent

POSITION Midrange
AC-GND-DC DC
VERT MODE CH 1

INVERT Off (button out)
20 MHz BW LIMIT Full bandwidth

(button out)

Check/Adjust A Trigger Sensitivity and TRIG LED (R7246)

a. Connect a 10 MHz signal from the leveled sine-wave generator to the A and B External Trigger inputs via a GR-to-bnc-male adapter, CT-3 through output, GR-to-bnc-female adapter, 50 Ω bnc cable, 10X attenuator, 50 Ω termination and dual-input coupler.

- b. Connect CT-3 Sig Out 10% signal to CH 1 and CH 2 inputs via a 50 Ω bnc cable, 50 Ω termination and a dualinput coupler.
- c. Adjust the leveled sine-wave generator for a 3-division display.
- d. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.3-division display).
- e. CHECK—Stable display can be obtained by rotating A TRIGGER LEVEL control in both + and slopes.
 - f. CHECK-TRIG LED is on when the display is stable.
- g. Set CH 1 VOLTS/DIV switch to 5 mV and adjust leveled sine-wave generator for a 2-division display.
- h. Set CH 1 VOLTS/DIV switch to 0.1 V (0.1-division display).
- i. CHECK—Stable display cannot be obtained by rotating A TRIGGER LEVEL control in both + and slopes. Return the A TRIGGER SLOPE control to +.
- j. If the checks in parts c through i meet the requirements, proceed to step 2. If not, make the following adjustments.
- k. Set the CH 1 VOLTS/DIV switch to 10 mV and adjust the leveled sine-wave generator for a 2.5-division display.
- I. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.25-division display).
- m. ADJUST—A Trigger Sensitivity (R7246) so display can just be triggered by rotating A TRIGGER LEVEL control (A TRIGGER SLOPE in +).
- n. Set CH1VOLTS/DIV switch to 10 mV and adjust the leveled sine-wave generator for a 2-division display.
- o. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.2-division display).

- p. CHECK—Stable display cannot be obtained by adjusting the A TRIGGER LEVEL control in + slope only (- slope is generally slightly more sensitive).
- q. If a stable display can be obtained, then the trigger is too sensitive. Adjust A Trigger Sensitivity (R7246) slightly so display will just barely not trigger by adjusting the A TRIGGER LEVEL control (in + slope only).
- r. Repeat parts k through puntil a stable display can be obtained on a 0.25-division display, but not on a 0.2-division display (+ slope only).
 - q. Repeat checks in parts c through i.

2. Check/Adjust B Trigger Sensitivity (R7045)

a. Set:

HORIZ DISPLAY B DLY'D CH 1 VOLTS/DIV 10 mV

A TRIGGER LEVEL Fully clockwise

B TRIGGER LEVEL As needed for a stable

display.

- b. Adjust leveled sine-wave generator for a 3-division display.
- c. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.3-division display).
- d. CHECK—Stable display can be obtained by rotating B TRIGGER LEVEL control in both $+\ {\rm and}\ -\ {\rm slopes}.$
- e. Set CH 1 VOLTS/DIV switch to 5 mV and adjust the sine-wave generator for a 2-division display.
- f. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.1-division display).
- g. CHECK—Stable display cannot be obtained by rotating the B TRIGGER LEVEL control in either + or slope. Return B TRIGGER SLOPE control to +.
- h. If check results in parts b through g meet requirements, proceed to step 3. If not, make the following adjustments.

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- i. Set CH 1 VOLTS/DIV switch to 10 mV and adjust leveled sine-wave generator for a 2.5-division display.
- j. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.25-division display).
- k. ADJUST—B Trigger Sensitivity (R7045) so display can be just triggered by adjusting B TRIGGER LEVEL control. (Adjust with B TRIGGER SLOPE in +).
- I. Set the CH 1 VOLTS/DIV switch to 10 mV and adjust the leveled sine-wave generator for a 2-division display.
- m. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.2-division display).
- n. CHECK—Stable display cannot be obtained by adjusting the B TRIGGER LEVEL control (+ slope only).
- o. If stable display can be obtained, then trigger is too sensitive. Adjust B Trigger Sensitivity (R7045), slightly so display will just barely not trigger by adjusting B TRIGGER LEVEL control (+ slope only).
- p. Repeat parts i through o until stable display can be obtained on a 0.25 division display but not on a 0.2 division display (+ slope only).
 - q. Repeat checks in parts c through g.

3. Check/Adjust B Trigger Slope Center and Level (R7042, R7026)

a. Set:

B TRIGGER SOURCE STARTS AFTER DELAY

TIME/DIV (both) 10 μ s B TRIGGER LEVEL 0 CH 1 VOLTS/DIV 10 mV CH 1 AC-GND-DC GND

NOTE

The B TRIGGER LEVEL control must remain at 0 throughout this step.

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

c. Set:

CH 1 AC-GND-DC DC
B TRIGGER SOURCE NORM

- d. Adjust the leveled sine-wave generator for approximately a 4-division display at 50 kHz.
- e. Switch the B TRIGGER SLOPE switch between \pm and \pm .
- f. CHECK—Display begins at about the same vertical point, within 1 division of graticule center, in both $+\ {\rm and}\ -\ {\rm slopes}.$
- g. ADJUST—B Slope Center (R7042) for the display to start at the same vertical point on the sine wave in both + and slopes (not necessarily the center horizontal graticule line). Return B TRIGGER SLOPE to +.
- h. ADJUST—B Trig Level (R7026) to move the starting point of the display to the center horizontal graticule line.
- i. INTERACTION—B Trig Level (R7026) B Slope Center (R7042), and B Trigger Sensitivity (R7045) will interact. Repeat these adjustments until no improvement is noted.

4. Check/Adjust A Trigger Slope Center and Level (R7242, R7224)

a. Set:

HORIZ DISPLAY A A TRIGGER LEVEL 0

NOTE

The A TRIGGER LEVEL control must remain at 0 throughout this step.

- b. Switch the A TRIGGER SLOPE switch between \pm and \pm .
- c. CHECK—Display begins at about the same vertical point, within 1 division of graticule center, in both + and slopes.
- d. ADJUST—A Slope Center (R7242) for the display to start at the same vertical point on the sine wave in both \pm and \pm slopes (not necessarily the graticule center). Return A TRIGGER SLOPE to \pm .

- e. ADJUST—A Trig Level (R7224) to move the starting point of the display to the center horizontal graticule line.
- f. INTERACTION—A Trig Level (R7224), A Trigger Sensitivity (R7246), and A Slope Center (R7242) will interact. Repeat these adjustments until no improvement is noted.

5. Check/Adjust A Trigger DC Levels (R1202, R1126, R1835)

a. Set the A TRIGGER COUPLING switch to DC.

NOTE

The A TRIGGER LEVEL control must remain at 0 throughout this step.

- b. CHECK—Start of the display is within 1 division of the center horizontal graticule line in both + and slopes. Return A TRIGGER SLOPE to +.
- c. ADJUST—Norm Trig DC Balance (R1202) to move the starting point of the display to the center horizontal graticule line.
- d. INTERACTION—A and B Trig Level (R7224 and R7026) interact with Norm Trig DC Balance (R1202). Repeat these adjustments until no improvement is noted.
 - e. Set the A TRIGGER SOURCE switch to CH 1.
- f. CHECK—Start of the display is within 1 division of the center horizontal graticule line in both + and slopes. Return A TRIGGER SLOPE to +.
- g. ADJUST—CH 1 Trig DC Balance (R1126) to move the starting point of the display to the center horizontal graticule line.
 - h. Set the A TRIGGER SOURCE Switch to CH 2.
- i. CHECK—Start of the display is within 1 division of the center horizontal graticule line in both + and slopes. Return A SLOPE to +.
- j. ADJUST—CH 2 Trig DC Balance (R1835) to move the starting point of the display to the center horizontal graticule line.

6. Check B Trigger DC Levels

a. Set:

HORIZ DISPLAY	B DLY'D
A TRIGGER LEVEL	Fully clockwise
B TRIGGER LEVEL	0
B TRIGGER COUPLING	DC
B TRIGGER SOURCE	NORM

NOTE

The B TRIGGER LEVEL control must remain at 0 during this step.

b. CHECK—Start of the display is within 1 division of the center horizontal graticule line for the following modes:

B TRIGGER SOURCE

NORM CH 1 CH 2

7. Check B Internal 10 MHz Triggering

a. Set:

TRIGGER COUPLING	AC
(both)	
CH 1 VOLTS/DIV	10 mV
CH 2 VOLTS/DIV	0.1 V
A TIME/DIV	$0.2~\mu s$
B TIME/DIV	$0.05 \mu s$
TRIGGER SOURCE (both)	NORM

- b. Adjust the leveled sine-wave generator for a 3-division (30 mV) display at 10 MHz.
- c. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.3-division display).
- d. Adjust the BTRIGGER LEVEL control as needed for a stable display.
- e. CHECK—For a stable display, with both \pm and \pm slopes for these modes:

B TRIGGER

SOURCE	COUPLING
NORM	AC, DC
CH 1	DC, AC
CH 2	AC, DC

f. Set:

CH 1 VOLTS/DIV 10 mV B TRIGGER COUPLING LF REJ

- g. Adjust the leveled sine-wave generator for a 5-division (50 mV) display at 10 MHz.
- h. Set the CH 1 VOLTS/DIV switch to .1 V (0.5-division display).
- Adjust B TRIGGER LEVEL control as needed for a stable display.
- j. CHECK—For a stable display, with both + and slopes for these modes:

B TRIGGER SOURCE

CH 2 CH 1 NORM

- k. Set the B TRIGGER COUPLING switch to HF REJ.
- I. CHECK—No stable display for these modes:

B TRIGGER SOURCE

NORM CH 1 CH 2

8. Check A Internal 10 MHz Triggering

a. Set:

HORIZ DISPLAY A A TIME/DIV 0.05 μ s

A TRIGGER LEVEL As needed for a stable

display

CH 1 VOLTS/DIV 10 mV

- b. Adjust the leveled sine-wave generator for a 3-division (30 mV) display at 10 MHz.
- c. Set the CH 1 VOLTS/DIV switch to .1 V (0.3-division display).
- d. Adjust the ATRIGGER LEVEL control as needed for a stable display.

e. CHECK—For a stable display, with both + and - slopes for these modes:

A TRIGGER

SOURCE	COUPLING
NORM	AC, DC
CH 1	DC, AC
CH 2	AC, DC

f. Set:

CH 1 VOLTS/DIV 10 mV A TRIGGER COUPLING LF REJ

- g. Adjust the leveled sine-wave generator for a 5-division (50 mV) display at 10 MHz.
- h. Set the CH 1 VOLTS/DIV switch to .1 V (0.5-division display).
- Adjust the A TRIGGER LEVEL control as needed for a stable display.
- j. CHECK—For a stable display, with both + and slopes for these modes:

A TRIGGER SOURCE

CH 2 CH 1 NORM

- k. Set the A TRIGGER COUPLING switch to HF REJ.
- I. CHECK—No stable display for these modes:

A TRIGGER SOURCE

NORM CH 1 CH 2

9. Check A External 10 MHz Triggering

a. Set:

VOLTS/DIV (both) 10 mV TRIGGER COUPLING

(both) AC

TRIGGER SOURCE
(both) EXT

- b. Adjust the leveled sine-wave generator to maintain a
 5-division display throughout steps 9 and 10. Adjust the A
 TRIGGER LEVEL control as needed for a stable display.
- c. CHECK—For a stable display, with both + and slopes fo these modes:

A TRIGGER COUPLING

AC, DC

d. Set:

CH 1 VOLTS/DIV 20 mV A TRIGGER COUPLING LF REJ

- e. Adjust the leveled sine-wave generator for a 5-division (100 mV) display at 10 MHz.
- f. Adjust the A TRIGGER LEVEL control as needed for a stable display.
- g. CHECK—For a stable display, with both + and slopes.
 - h. Set the A TRIGGER COUPLING switch to HF REJ.
 - i. CHECK-No stable display.
- j. Remove the 10X bnc attenuator from the external trigger setup and change the A TRIGGER SOURCE switch to EXT/10.
 - k. CHECK-No stable display.
 - I. Set the A TRIGGER COUPLING switch to LF REJ.
- m. CHECK—For a stable display, with both + and slopes.
 - n. Set:

CH 1 VOLTS/DIV 10 mV A TRIGGER COUPLING AC

o. Adjust the leveled sine-wave generator for a 5-division (50 mV) display at 10 MHz (0.5 volt at the external Trigger Input).

p. CHECK—For a stable display, with both + and - slopes for these modes:

A TRIGGER COUPLING

AC. DC

10. Check B External 10 MHz Triggering

a. Set:

HORIZ DISPLAY B DLY'D A TIME/DIV 0.2 μ s B TIME/DIV 0.05 μ s

- b. Reconnect the 10X bnc attenuator to the external trigger setup.
- c. CHECK—For a stable display, with both + and slopes for these modes:

B TRIGGERING COUPLING

AC, DC

- d. Set the CH 1 VOLTS/DIV switch to 20 mV.
- e. Adjust the leveled sine-wave generator for a 5-division (100 mV) display at 10 MHz.
- f. Set the B TRIGGER COUPLING switch to LF REJ and adjust the B TRIGGER LEVEL control as needed for a stable display.
- g. CHECK—For a stable display, with both + and slopes.
 - h. Set the B TRIGGER COUPLING switch to HF REJ.
 - i. CHECK-No stable display.

11. Check B and A External 100 MHz Triggering

a. Set:

TRIGGER COUPLING

(both) AC

TRIGGER SOURCE

(both) EXT CH 1 VOLTS/DIV 50 mV

- c. Adjust the leveled sine-wave generator for a 3division (150 mV) display at 10 MHz; then change the generator frequency to 100 MHz. Do not readjust signal amplitude.
- d. Press the X10 MAG push button in and use the A and B TRIGGER LEVEL controls as needed for a stable display.
- e. CHECK-For a stable display, with 0.1 division or less jitter, with + and - slopes for these modes:

B TRIGGER COUPLING

AC. DC

- f. Adjust the leveled sine-wave generator for a 6division (300 mV) display at 10 MHz; then change the generator frequency to 100 MHz. Do not readjust the signal amplitude.
- g. Set the B TRIGGER COUPLING switch to LF REJ and use the A and B TRIGGER LEVEL controls as needed.
- h. CHECK-For a stable display, with 0.1 division or less jitter, with both + and - slopes.
 - i. Set the B TRIGGER COUPLING switch to HF REJ.
 - j. CHECK-No stable display.
 - k. Set:

HORIZ DISPLAY Α A TIME/DIV $0.05 \mu s$ A TRIGGER SOURCE LF REJ A TRIGGER SOURCE FXT A TRIGGER LEVEL As needed.

- I. CHECK-For a stable display, with 0.1 division or less jitter, with both + and - slopes.
 - m. Set the A TRIGGER COUPLING switch to HF REJ.
 - n. CHECK-No stable display.
 - o. Set the A TRIGGER COUPLING switch to AC.

- p. Adjust the leveled sine-wave generator for a 3division (150 mV) display at 10 MHz; then change the generator frequency to 100 MHz. Do not readjust the signal amplitude.
- g. Use the A TRIGGER LEVEL control as needed for a stable display.
- r. CHECK-For a stable display, with 0.1 division or less jitter, with both + and - slopes:

A TRIGGER COUPLING

AC. DC

- t. Remove the 10X bnc attenuator from the external trigger setup and change the ATRIGGER SOURCE switch to EXT/10.
- u. Use the ATRIGGER LEVEL control as needed for a stable display.
- v. CHECK-For a stable display, with 0.1 division or less jitter, with both + and - slopes for these modes:

A TRIGGER COUPLING

DC, AC

- w. Adjust the leveled sine-wave generator for a 6division (300 mV) display at 10 MHz; then change the generator frequency to 100 MHz. Do not readjust the signal amplitude.
- x. Set the A TRIGGER COUPLING switch to LF REJ and use the A TRIGGER LEVEL control as needed for a stable display.
- y. CHECK-For a stable display, with 0.1 division or less jitter, with both + and - slopes.
 - z. Set the A TRIGGER COUPLING switch to HF REJ.
 - aa. CHECK-No stable display.

12. CHECK A Internal 100 MHz Triggering

a. Set:

VOLTS/DIV (both) 50 mV TRIGGER SOURCE (both) NORM TRIGGER COUPLING

(both) AC

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- b. Reconnect the 10X attenuator to the external trigger setup. Adjust the leveled sine-wave generator for a 1.5-division display at 100 MHz.
- c. CHECK—For a stable display, with 0.1 division or less iitter, with + and slopes for these modes:

A TRIGGER

SOURCE	COUPLING
NORM	AC, LF REJ, DC
CH 1	DC, LF REJ, AC
CH 2	AC, LF REJ, DC

- d. Set the A TRIGGER COUPLING switch to HF REJ.
- e. CHECK-No stable display.

13. Check B Internal 100 MHz Triggering

a. Set:

HORIZ DISPLAY	B DLY'd
A TIME/DIV	$0.2 \mu s$
B TIME/DIV	$0.05 \mu s$
A TRIGGER COUPLING	DC
A TRIGGER SOURCE	NORM

b. CHECK—For a stable display, with 0.1 division or less jitter, with + and - slopes, for these modes:

B TRIGGER

SOURCE	COUPLING	
NORM	AC, LF REJ, DC	
CH 1	DC, LF REJ, AC	
CH 2	AC, LF REJ, DC	

NOTE

It may be necessary to adjust both A and B TRIGGER LEVEL controls to obtain the most stable display at higher frequencies in B sweep.

- c. Set the B TRIGGER COUPLING switch to HF REJ.
- d. CHECK-No stable display.

14. Check A and B High Frequency Reject Triggering

a. Set:

HODIZ DICDLAY

HURIZ DISPLAT	A
TIME/DIV (both)	10 <i>μ</i> s
X/10 MAG	Off (button out)
TRIGGER COUPLING	
(both)	HF REJ
TRIGGER SOURCE (both)	NORM
CH 1 VOLTS/DIV	.1 V

- CH 1 VOLTS/DIV .1 V
 CH 2 VOLTS/DIV 10 mV
 VERT MODE CH 2
- b. Adjust leveled sine-wave generator for a 5-division (50 mV) display at 50 kHz.
- c. Set the CH 2 VOLTS/DIV switch to .1 V. Adjust A TRIGGER LEVEL control for stable display.
- d. Adjust leveled sine-wave generator for 1 MHz and press the X10 MAG push button in.
- e. CHECK—No stable display with the A TRIGGER SOURCE switch in NORM, CH 1, or CH 2.
 - g. Set:

A TRIGGER LEVEL	Fully clockwise
HORIZ DISPLAY	B DLY'D

h. CHECK—No stable display with the B TRIGGER SOURCE switch in NORM, CH 1, or CH 2.

15. Check Single Sweep

a. Set:

HORIZ DISPLAY	Α
CH 1 VOLTS/DIV	50 mV
VERT MODE	CH 1
X10 MAG	Off (button out)

A TRIGGER

COUPLING	AC
SOURCE	NORM
LEVEL	0
SLOPE	+

b. Adjust the leveled sine-wave generator for a 1-division display at 50 kHz and adjust the A TRIGGER LEVEL control so the display is just triggered.

c. Set:

TIME/DIV (both) 10 ms CH 1 AC-GND-DC GND

A TRIG MODE SINGL SWP (push in)

- d. CHECK-READY LED Illuminates.
- e. Set the CH 1 AC-GND-DC switch to DC.
- f. CHECK—A single sweep occurs and the READY LED goes out.
 - g. Press the SINGLE SWP push button in.
- h. CHECK-A single sweep occurs each time the SINGL SWP push button is depressed.
 - i. Remove the test setup.

16. Check 60 Hz Internal Triggering

a. Set:

TIME/DIV (both) 5 ms
TRIGGER MODE NORM
CH 1 VOLTS/DIV 10 mV

- b. Connect the low-frequency generator signal to the CH 1 input via a 50 Ω bnc cable, bnc T and 50 Ω bnc termination. From bnc T, connect a 50 Ω bnc cable and 50 Ω bnc termination to the B External Trigger input.
- c. Adjust the low-frequency generator for a 3-division (30 mV) display at 60 Hz.
- d. Set the CH 1 VOLTS/DIV switch to .1 V (0.3-division display).
- e. CHECK—For a stable display, with both + and slopes for these modes:

TRIGGER COUPLING

AC, DC

f. Set:

CH / VOLTS/DIV 10 mV A TRIGGER COUPLING HF REJ

- g. Set the low-frequency generator for a 5-division (50 mV) display at 60 Hz.
- h. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.5-division display).
- i. CHECK—For a stable display, with both $+\ \mathrm{and}\ -\ \mathrm{slopes}.$
 - j. Set the A TRIGGER COUPLING switch to LF REJ.
 - k. CHECK-No stable display.

I. Set:

A TRIG MODE AUTO

A TRIGGER LEVEL Fully clockwise

A TIME/DIV 10 ms
B TIME/DIV 5 ms
B TRIGGER SOURCE NORM
B TRIGGER COUPLING HF REJ
HORIZ DISPLAY B DLY'D
CH 1 VOLTS/DIV 0.1 V

- m. CHECK—For a stable display, with both + and slopes.
 - n. Set the B TRIGGER COUPLING switch to LF REJ.
 - o. CHECK-No stable display.

p. Set:

CH 1 VOLTS/DIV 10 mV B TRIGGER COUPLING AC

- q. Set the low-frequency generator for a 3-division (30 mV) display at 60 Hz.
- r. Set the CH 1 VOLTS/DIV switch to 0.1 V and use the BTRIGGER LEVEL control as needed for a stable display.
- s. CHECK—For a stable display, with both + and slopes for these modes:

B TRIGGER COUPLING

AC, DC

17. Check 60 Hz External Triggering

a. Set:

B TRIGGER COUPLING AC CH 1 VOLTS/DIV 10 mV

- b. Adjust the low-frequency generator for a 5-division (50 mV) display at 60 Hz.
 - c. Set the B TRIGGER SOURCE switch to EXT.
- d. CHECK—For a stable display, with both + and slopes for these modes:

B TRIGGER COUPLING

AC, HF REJ, DC

- e. Set the B TRIGGER COUPLING switch to LF REJ.
- f. CHECK-No stable display.
- g. Move the signal cable from the B External Trigger input to the A External Trigger input.
 - h. Set:

HORIZ DISPLAY A
A TIME/DIV 5 ms
A TRIGGER COUPLING AC
A TRIG MODE NORM
A TRIGGER SOURCE EXT
A TRIGGER LEVEL As needed

i. CHECK—For a stable display, with both + and - slopes for these modes:

A TRIGGER COUPLING

AC, HF REJ, DC

- j. Set the A TRIGGER COUPLING switch to LF REJ.
- k. CHECK-No stable display.

18. Check A and B External Trigger Level Ranges

a. Set:

TRIGGER COUPLING

(both) AC
TRIGGER SLOPE (both) +
CH 1 VOLTS/DIV 1 V
HORIZ/DISPLAY A
A TRIG MODE AUTO
A TIME/DIV 1 ms

- b. Remove the 50 Ω termination and adjust the low-frequency generator for a 4-division (4 V) display at 1 kHz.
- c. CHECK—Display is triggered along the positive slope of the waveform as the ATRIGGER LEVEL control is rotated.
- d. CHECK—Display is not triggered (free runs) at either extreme of rotation.
 - e. Set the A TRIGGER SLOPE switch to -.
- f. CHECK—Display is triggered along the negative slope of the waveform as the ATRIGGER LEVEL control is rotated.
- g. CHECK—Display is not triggered (free runs) at either extreme of rotation.
- h. Move the low-frequency generator signal from the A External Trigger input to the B External Trigger input.
 - i. Set:

A TRIGGER LEVEL Fully counterclockwise HORIZ DISPLAY B DLY'D

- j. CHECK—Display is triggered along the positive slope of the waveform as the BTRIGGER LEVEL control is rotated.
- k. CHECK—Display is not triggered (not visible) at either extreme of rotation.
 - I. Set the B TRIGGER SLOPE switch to -.

- m. CHECK—Display is triggered along the negative slope of the waveform as the BTRIGGER LEVEL control is rotated.
- n. CHECK—Display is not triggered (not visible) at either extreme of rotation.
 - o. Disconnect the test setup.

p. Set:

HORIZ DISPLAY A
A TRIGGER SOURCE EXT/10
CH 1 VOLTS/DIV 5 V

CH 1 VAR Fully counterclockwise

A TRIGGER COUPLING AC

q. Connect the calibration generator standard-amplitude output to the CH 1 input via a 50 Ω bnc cable and bnc T. Connect the bnc female connection to A External Trigger input via a 50 Ω bnc cable. Adjust the generator output to 50 volts.

NOTE

The range of the A LEVEL control with the A SOURCE switch in EXT/10 is ±20 volts (40 V peak-to-peak) or greater. The applied signal is 50 V peak-to-peak. Therefore, untriggered operation at both extremes of the A TRIGGER LEVEL control is not required.

- r. CHECK—Display is triggered along the negative slope of the waveform as the ATRIGGER LEVEL control is rotated.
 - s. Set the A TRIGGER SLOPE switch to +.
- t. CHECK—Display is triggered along the positive slope of the waveform as the A TRIGGER LEVEL control is rotated.
 - u. Disconnect the test setup.

19. Check Line Triggers

a. Set:

CH 1 VOLTS/DIV and VAR As required

A TRIGGER

MODE AUTO
COUPLING AC
SOURCE LINE
SLOPE +

- b. Connect a 10X probe from the CH 1 input to a line-frequency source.
- c. CHECK—For a stable display, starting on the positive-going slope.
 - d. Set the A TRIGGER SOURCE switch to -.
- e. CHECK—For a stable display, starting on the negative-going slope.
- f. Disconnect probe from the line-frequency source; then from the 465B.

20. Check NORM A Trigger Mode

a. Set:

A TIME/DIV 1 ms CH 1 VOLTS/DIV .5 V

CH 1 VAR Calibrated detent

A TRIGGER

SLOPE +
SOURCE NORM
COUPLING AC
MODE AUTO

b. Connect time-mark generator to the CH 1 input via a 50 Ω bnc cable and 50 Ω bnc termination. Adjust generator for 0.1 s time markers.

- c. CHECK—Display can be triggered by adjusting the A TRIGGER LEVEL control.
 - d. Set the A TRIG MODE switch to NORM.
 - e. CHECK-Display is triggered.
 - f. Set the CH 1 AC-GND-DC switch to GND.
 - g. CHECK-No display is visible.

21. Check AUTO Recovery Time

a. Set:

CH 1 AC-GND-DC DC A TRIG MODE AUTO

- b. CHECK-Display is triggered.
- c. Set the time-mark generator for 0.5 s time markers.
- d. CHECK-Display cannot be triggered (free runs).
- e. Disconnect the time-mark generator.

NOTE

OSCILLOSCOPES WITH DIGITAL MULTIMETERS ATTACHED, REFER TO THE CALIBRATION SECTION OF THE DIGITAL MULTIMETER MANUAL AT THIS POINT. ON COMPLETION OF THE CALIBRATION SECTION IN THE DM MANUAL RETURN TO THIS MANUAL AND COMPLETE STEPS 18 & 19 IN THE HORIZONTAL SECTION, THEN CONTINUE ON TO THE NEXT SECTION.

FOR CALIBRATION OF OSCILLOSCOPES WITHOUT DIGITAL MULTIMETERS, CONTINUE TO HORIZON-TAL SECTION OF THIS MANUAL.

HORIZONTAL

Equipment Required

1. Test Oscilloscope

2. Time-mark Generator

3. 50 Ω Bnc Cable

4. Leveled Sine-wave Generator

5. 50Ω Bnc Termination

6. 3-Inch Slotted Screwdriver

7. Low-capacitance Slotted Screwdriver

8. Dual-input Coupler

LEVEL

SLOPE

COUPLING

A SOURCE

B SOURCE

See ADJUSTMENT LOCATIONS 1

and ADJUSTMENT LOCATIONS 5

in the Diagrams section for ad-

Triggering Controls

(both A and B if applicable)

display

+

AC

EXT

As needed for a stable

Starts after delay

justments and test points (TP).

465B Control Settings

Power Controls

Regulating Range Selector Medium

Line Voltage Selector 115 V

POWER ON

CRT Controls

INTENSITY As desired

FOCUS Best focused display

SCALE ILLUM As desired B INTENSITY As desired

Sweep Controls

VAR Calibrated detent VAR TIME/DIV Calibrated detent
POSITION Midrange X10 MAG Off (button out)
AC-GND-DC DC POSITION Midrange

VERT MODE

CH 1

A TRIGGER HOLDOFF

INVERT

Off (button out)

POSITION

A TRIGGER HOLDOFF

NORM

As needed for ALT

Full bandwidth

(button out)

display trace sep-

aration.

VOLTS/DIV

20 MHz BW LIMIT

1. Check/Adjust Sweep Start and A Sweep Calibration (R4570, R6053)

- a. Connect 1 ms time markers to the CH 1 input from the time-mark generator via a 50 Ω bnc cable and a 50 Ω termination. Connect + Trigger Out from the time-mark generator to the A External Trigger input via a 50 Ω bnc cable and a 50 Ω termination.
- b. CHECK—Intensified portion of the sweep begins at the second time marker. (It may be necessary to readjust the INTENSITY and B INTENSITY controls, so that the intensified portion of the sweep is visible.)
- c. ADJUST—Sweep Start (R4570) so the intensified portion of the sweep begins at the start of the second time marker and the pulse displayed on B DLY'D trace starts at the beginning of the sweep.
 - d. Set the DELAY TIME POSITION dial to 9.00.
- e. CHECK—Intensified portion of the sweep begins at the tenth time marker.
- f. ADJUST—A Sweep Cal (R6053) so the intensified portion of the sweep begins at the start of the tenth time marker and the pulse displayed on B DLY'D trace starts at the beginning of the sweep.
- g. INTERACTION—Between Sweep Start and A Sweep Cal adjustments. Repeat both until no further improvement is noted.

2. Check Delay or Differential Time Linearity

- 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 difference in reading of: 1.00 \pm 0.01 (0.99 to 1.01), from +15°C to +35°C; 1.00 \pm 0.03 (0.99 to 1.03), from -15°C to -55°C, than the reading noted in part c.

NOTE

1 division of the DELAY TIME POSITION dial is one complete revolution of the inner knob. 0.01 division is one minor division of the inner knob.

- 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 difference in reading of: 1.00 \pm 0.01 (0.99 to 1.01) from +15° C to +35° C; 1.00 \pm 0.03 (0.99 to 1.03), from -15° C to +55° C, than the adjacent time marker.

3. Check/Adjust Horizontal Amplifier Gain (R4373, R4272)

a. Set:

HORIZ DISPLAY A
TIME/DIV (both) 1 ms

DELAY TIME POSITION Fully counterclockwise

- b. Select 1 ms time markers from the time-mark generator.
- c. CHECK—Display for 1 marker/division $\pm 2\%$ (± 0.2 division at the eleventh time marker).
- d. ADJUST—X1 Gain (R4274) for exactly 1 marker/division.
- e. Select 0.1 ms time markers from the time-mark generator.
 - f. Press X10 MAG push button in.
- g. CHECK—X10 MAG LED is on when the X10 MAG push button is in.
- h. CHECK—1 marker/division $\pm 3\%$ (± 1 1/2 minor divisions at the eleventh time marker).
- i. ADJUST—X10 Gain (R4373) for exactly 1 time marker/division.

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4. Check Sweep Linearity

- a. CHECK—Linearity over any 2 divisions of the magnified sweep to be within 0.1 division.
 - b. Release the X10 MAG push button.
- c. Select 1 ms time markers from the time-mark generator.
- d. CHECK—Linearity over any 2 divisions of the sweep to be within 0.1 division.

5. Check/Adjust R4253 Magnifier Centering (SN B011250—UP) and R4275 Registration

a. Push the X10 MAG push button in.

NOTE

Perform parts b through e for SN B011250—up. Below SN B011250, skip to part f.

- b. Press BEAM FIND push button in.
- c. CHECK-Display is centered horizontally.
- d. ADJUST—Horizontal DC Centering (R4253) to horizontally center the display.
 - e. Release BEAM FIND push button.
- f. Select 5 ms time markers from the time-mark generator.
- g. Position the middle time marker to the center vertical graticule line.
 - h. Release the X10 MAG push button.
- i. CHECK—Middle time marker is within 0.2 division of the center vertical graticule line.
- j. ADJUST-Magnifier Registration (R4275) to position the middle time marker to the center vertical graticule line.
- k. Repeat parts c through j (parts a and f through j for SN below B011250) until no horizontal shift is observed between X10 MAG in and X10 MAG out.

6. Check/Adjust B Sweep Calibration (R6052)

a. Set:

DELAY TIME POSITION Fully counterclockwise

HORIZ DISPLAY B DLY'D
A TIME/DIV 2 ms
B TIME/DIV 1 ms

X10 MAG Off (button out)

- b. Select 1 ms time markers from the time-mark generator.
- c. CHECK—Display for 1 time marker/division $\pm 2\%$ (1 minor division at the eleventh time marker).
- d. ADJUST—B Sweep Cal (R6052) for exactly 1 time marker/division.

7. Check A Sweep Length

a. Set:

TIME/DIV (both) 1 ms HORIZ DISPLAY A

- b. Select 5 ms time markers.
- c. Position the third time marker horizontally to the center vertical graticule line.
- d. CHECK—Display extends to the right of the center vertical graticule line 1 division (± 0.5 division).

8. Check Variable Time/Division

- a. Set the A TIME/DIV switch to 2 ms.
- b. Select 5 ms time markers from the time-mark generator.
- c. CHECK—At least 1 time marker/division can be obtained by adjusting the VAR TIME/DIV control.
- d. CHECK—UNCAL LED 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.

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9. Check Horizontal POSITION Range

- a. Turn the Horizontal POSITION control fully clockwise.
- b. CHECK—Start of sweep is to the right of the center vertical graticule line.
- c. Turn the Horizontal POSITION control fully counterclockwise.
- d. CHECK—End of sweep is to the left of the center vertical graticule line.

NOTE

Horizontal POSITION control is a combined Coarse and Fine position control mounted on the same shaft in a mechanical arrangement that allows the Fine position potentiometer to rotate approximately 1/4 turn (1/8 turn in either direction from midrange) before the Coarse position control potentiometer is engaged.

- e. Rotate the horizontal POSITION control through its Fine range.
- f. CHECK—Horizontal POSITION control Fine range will position the sweep approximately 0.5 divisions.

10. Check/Adjust A 10 μ s Timing (C6002)

a. Set:

DELAY TIME POSITION 1.00 A TIME/DIV 10 μ s B TIME/DIV 1 μ s

- b. Select 10 μs time markers from the time-mark generator.
- c. CHECK—Display for 1 time marker/division $\pm 2\%$ (1 minor division at the eleventh time marker).
- d. ADJUST—10 μ s timing (C6002), with a low capacitance screwdriver, for exactly 1 time marker/division.
- e. Set the HORIZ DISPLAY switch to B DLY'D and B TRIGGER SOURCE to STARTS AFTER DELAY.

- f. Horizontally position the displayed marker to align it with a vertial graticule line.
 - g. Set DELAY TIME POSITION to 9.00.
- h. ADJUST—10 μ s timing (C6002) with a low capacitance screwdriver, so the displayed marker is aligned with the same vertical graticule line as in part f.
- i. Repeat parts f through h until no error exists between a DELAY TIME POSITION dial setting of 1.00 and 9.00.

11. Check/Adjust A Sweep High Speed Timing (C6015)

a. Set:

DELAY TIME POSITION 1.50
B TRIGGER SOURCE STARTS AFTER DELAY
A TIME/DIV 0.5 μ s
HORIZ DISPLAY A

- b. Select 0.5 $\mu \rm s$ time markers from the time-mark generator.
- c. CHECK—Display for 1 time marker/dvision $\pm 2\%$ (1 minor division at the eleventh time marker).
- d. ADJUST—A High Speed Timing (C6015), with the low-capactiance screwdriver, for exactly 1 time marker/division.
 - e. Switch the HORIZ DISPLAY switch to B DLY'D.
- f. Use Horizontal POSITION control to position the displayed marker so it is aligned with the center vertical graticule line.
 - g. Set DELAY TIME POSITION to 8.50.
- h. CHECK—Displayed time marker aligns with the center vertical graticule line.
- i. ADJUST—A High Speed Timing (C6015), with a low-capacitance screwdriver, so the displayed marker is aligned with the center vertical graticule line.

j. INTERACTION—Between the two positions of the DELAY TIME POSITION dial when adjusting C6015. Compromise the adjustments as necessary to achieve correct timing.

12. Check/Adjust B Sweep High Speed Timing (C6042)

a. Set:

DELAY TIME POSITION	Fully counterclockwise
HORIZ DISPLAY	B DLY'D
B TRIGGER SOURCE	NORM
A TIME/DIV	1 μ s.
B TIME/DIV	0.5 <i>μ</i> s

- Adjust the A and B TRIGGER LEVEL controls for a stable display.
- c. CHECK—Display for 1 time marker/division $\pm 2\%$ (1 minor division at the eleventh time marker).
- d. ADJUST—B High Speed Timing (C6042), with a low capacitance screwdriver, for exactly 1 time marker/division.

13. Check A and B Time/Division Accuracy

a. CHECK—Using the B TIME/DIV switch and the time-mark generator settings given in Table 4-15, check B sweep timing is within 0.2 division, over the first 10 divisions of the display.

Table 4-15
A AND B TIMING ACCURACY

A and B Time/Div Switch Setting	Time-mark Generator Output	CRT Display (Markers/ Division)
0.02 μs	20 ns	1
$0.05 \ \mu s$	50 ns	1
0.1 μs	0.1 <i>μ</i> s	1
$0.2~\mu s$	0.2 <i>μ</i> s	, 1
0.5 <i>μ</i> s	0.5 μs	1
1 <i>μ</i> s	1 <i>μ</i> s	1
2 μs	2 μs	1
5 μs	5 μs	1
10 <i>μ</i> s	10 <i>μ</i> s	1
20 μs	20 <i>μ</i> s	1

Table 4-15 (cont)

A and B Time/Div Switch Setting	Time-mark Generator Output	CRT Display (Markers/ Division)
50 μs	50 μs	1
0.1 ms	0.1 ms	1
0.2 ms	0.2 ms	1
0.5 ms	0.5 ms	1
1 ms	1 ms	1
2 ms	2 ms	1
5 ms	5 ms	1
10 ms ^a	10 ms	1
20 ms ^a	20 ms	1
50 ms ^a	50 ms	1
	A SWEEP ONLY	
0.1 s ^a	0.1 s	1

*Switch A TRIG MODE to NORM below 5 ms/division.

0.1 s

0.5 s

1

b. Set the HORIZ DISPLAY switch to A.

c. CHECK—Using the A TIME/DIV switch and the time-mark generator settings given in Table 4-15 check A sweep timing within 0.2 division, over the first 10 divisions of the display.

14. Adjust High-Speed Magnified Timing (C4246, C4247)

a. Set:

0.2 s^a

 $0.5 s^a$

HORIZ DISPLAY	Α
X10 MAG	X10 (button in)
Horizontal POSITION	Midrange (as required)
A and B TIME/DIV	0.05 <i>μ</i> s

- b. Select 5 ns time markers from the time-mark generator.
- c. Set CH 1 VOLTS/DIV for at least a 4-division display.
- d. CHECK—Display for 1 time marker/division $\pm 3\%$ ($\pm 1.1/2$ minor divisions at the eleventh time marker).

10 divisions of the magnified display. Note the portions of the total magnified sweep length to be excluded from the measurement.

- d. Release the X10 MAG push button.

f. Set A and B TIME/DIV to 0.02 μs.

marker/division over the entire 10 divisions.

NOTE

e. ADJUST-C4246 and C4247 equally for 1 time

For SN B011250-up, perform parts g through j. For SN below B011250 skip to part k.

- g. Press BEAM FIND push button in.
- h. CHECK-Display is centered horizontally.
- i. ADJUST-Horizontal DC Centering R4253 to horizontally center the compressed display. (Recheck Magnifier Registration if this adjustment is made.)
 - j. Release BEAM FIND push button.
- k. ADJUST-C4246 for 2 time marker/5 divisions over the entire 10 divisions (adjust Horizontal POSITION control as necessary).
 - I. Set A and B TIME/DIV switch to 0.05 μ s.
- m. ADJUST-C4247 for 1 time marker/division over the entire 10 divisions.
- n. Repeat part f and parts k through m for best timing on 0.05 μ s and 0.02 μ s ranges until no further improvement is obtained.

15. Check A and B Magnified Timing Accuracy

- a. CHECK-Using the ATIME/DIV switch settings and the time-mark generator settings given in Table 4-16 check A magnified sweep timing is within 0.3 division over the center 10 divisions of the magnified display. Note the portions of the total magnified sweep length to be excluded from the measurement.
 - b. Set the HORIZ DISPLAY switch to B DLY'D.
- c. CHECK-Using the B TIME/DIV switch and the time-mark generator settings given in Table 4-16 check B magnified sweep timing, within 0.3 division over the center

Table 4-16 A AND B MAGNIFIED ACCURACY

A and B Time/ Div Switch Setting	Time- mark Generator Output	CRT Display (Markers/ Division)	Portions of Total Mag- nified Sweep Length to Exclude from Measurement
0.02 μs	2 ns	1	First and last 25 divisions
0.05 <i>μ</i> s	5 ns	1	First and last 10 divisions
0.1 <i>μ</i> s	10 ns	1	First and last 5 divisions
0.2 <i>μ</i> s	20 ns	1	First and last 2.5 divisions
0.5 μs	50 ns	1	
1 <i>μ</i> s	0.1 <i>μ</i> s	1	
2 μs	0.2 <i>μ</i> s	1	
5 μs	0.5 <i>μ</i> s	1	
10 μs	1 <i>μ</i> s	1	
20 μs	2 μs	1	
50 μs	5 <i>μ</i> s	1	
0.1 ms	10 <i>μ</i> s	1	
0.2 ms	20 <i>μ</i> s	1	
0.5 ms	50 μs	1	
1 ms	0.1 ms	1	
2 ms	0.2 ms	1	
5 ms	0.5 ms	1	
10 msª	1 ms	1	
20 ms ^a	2 ms	1	
50 ms ^a	5 ms	1	

A SWEEP ONLY

0.1 s ^a	10 ms	1	
0.2 s ^a	20 ms	1	
0.5 s ^a	50 ms	1	

^a Switch TRIG MODE to NORM below 5 ms/division.

16. Check Delay or Differential Time Accuracy

a. Set:

B TRIGGER SOURCE STARTS AFTER DELAY

A TRIG MODE AUTO

TIME/DIV (both) According to

Table 4-17

HORIZ DISPLAY ALT

b. CHECK—Using the A TIME/DIV switch, B TIME/DIV switch, and the time-mark generator settings given in Table 4-17, check differential time accuracy is within the given tolerance. First set the DELAY TIME POSITION dial to 1.00 and rotate the dial slightly until the sweep starts at the top of the second time marker. Note the control setting and then set the dial to 9.00 and rotate it slightly until the sweep starts at the top of the tenth time marker. Delay TIME POSITION dial setting must be 8.00 divisions higher, ±0.08 division.

Table 4-17
DIFFERENTIAL TIME ACCURACY

A Time/	B Time/	Time-	Allowable
Div	Div	mark	Error for
Switch	Switch	Generator	Given
Setting	Setting	Output	Accuracy
0.1 μs	0.02 μs	0.1 μs	
0.2 μs	0.05 μs	0.2 μs	
0.5 μs	0.05 μs	0.5 μs	
1 μs	0.1 μs	1 μs	
2 μs	0.2 μs	2 μs	
5 μs	0.5 μs	5 μs	
10 μs	1 μs	10 μs	
20 μs	2 μs	20 μs	±8 minor
50 μs	5 μs	50 μs	
0.1 ms	10 μs	0.1 ms	
0.2 ms 0.5 ms 1 ms	20 μs 50 μs 0.1 ms	0.2 ms 0.5 ms 1 ms	dial divisions
2 ms	0.2 ms	2 ms	
5 ms	0.5 ms	5 ms	
10 ms ^a	1 ms	10 ms	
20 ms ^a	2 ms	20 ms	
50 ms ^a	5 ms	50 ms	
0.1 s ^a	10 ms	0.1 s	
0.2 s ^a	20 ms	0.2 s	
0.5 s ^a	50 ms	0.5 s	

^a Below 5 ms/division, set HORIZ DISPLAY to B DLY'D and A TRIG MODE to NORM.

NOTE

Below 5 ms/division ALT HORIZ DISPLAY sweeps alternate too slowly to observe display with ease; therefore, set HORIZ DISPLAY TO B DLY'D. 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 marker is intensified.

17. Check Delay or Differential Time Jitter

a. Set:

DELAY TIME POSITION 1.00 HORIZ DISPLAY B DLY'D 1 ms B TIME/DIV 0.2 μ s A TRIG MODE AUTO

- b. Select 1 ms time markers from time-mark generator.
- c. Position the time marker near the center of the display area with the DELAY TIME POSITION dial.
- d. CHECK—Jitter on the leading edge of the time marker should not exceed 1 division (2.5 divisions if the instrument is being operated on a 50 Hz line voltage). Disregard the slow drift.
- e. Turn the DELAY TIME POSITION dial to 9.00 and slightly readjust so the time marker is displayed near the center of the display area.
- f. CHECK—Jitter on the leading edge of the time marker should not exceed 1 division (2.5 divisions if the instrument is being operated on a 50 Hz line voltage). Disregard the slow drift.
 - g. Disconnect test setup.

18. Check/Adjust X Gain (R4381)

a. Set:

TIME/DIV (both)	X-Y
VOLTS/DIV (both)	5 mV
CH 1 AC-GND-DC	AC
CH 2 AC-GND-DC	GND
HORIZ DISPLAY	Α
A TRIGGER SOURCE	NORM

NOTE

Setting a TIME/DIV switch to X-Y position disables all VERT MODE switches, and automatically selects CH 1 input for the X-Axis signal and CH 2 input for the Y-Axis signal.

- b. Connect standard-amplitude signal from the calibration generator to the CH 1 input via a 50 Ω unterminated bnc cable. Set the generator output amplitude to 20 mV.
- c. CHECK—Display for 4 divisions of horizontal deflection $\pm 4\%$ (4 divisions ± 0.16 division).
 - d. Switch the CH 1 AC-GND-DC switch to DC.
- e. CHECK—Display for 4 divisions of horizontal deflection $\pm 4\%$ (4 divisions ± 0.16 division). It is normal for this check to be slightly less than that observed in part c.
 - f. Set the CH 1 AC-GND-DC switch to AC.
- g. ADJUST—X Gain (R4381) for exactly 4 divisions of horizontal deflection.
 - h. Disconnect test setup.

19. Check X-Y Phasing and Bandwidth

- a. Connect the output of the leveled sine-wave generator to the CH 1 and CH 2 inputs via a 50 Ω bnc cable, 50 Ω termination, and a dual-input coupler.
- b. Adjust the leveled sine-wave generator for an 8-division horizontal display at 50 kHz.
 - c. Set the CH 2 AC-GND-DC switch to AC.
- d. Center the display vertically and horizontally with the Horizontal POSITION and CH 2 POSITION controls.
- e. CHECK—Display for an opening at the center horizontal graticule line of 0.4 division or less.
 - f. Set the CH 2 AC-GND-DC switch to GND.

- g. Adjust the leveled sine-wave generator for a 10-division horizontal display at 50 kHz.
- h. Increase the leveled sine-wave generator frequency until the display is reduced to 7 divisions.
- CHECK—Output frequency of the leveled sine-wave generator is at least 4 MHz.
 - j. Disconnect the test setup.

20. Check B Ends A

a. Set:

HORIZ DISPLAY A INTEN
A TIME/DIV 1 ms
B TIME/DIV 0.1 ms
A TRIGGER HOLDOFF B ENDS A
(in detent)

- b. Adjust the INTENSITY control so the A sweep portion of the display 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.

21. Check A Trigger Holdoff

a. Set:

HORIZ DISPLAY A
A TRIGGER HOLDOFF NORM
A TRIGGER LEVEL Fully clockwise

- b. Connect the A +GATE output signal (from 465B rear panel) to the test oscilloscope via a 50 Ω unterminated bnc cable.
- c. Set the test oscilloscope TIME/DIV switch and VAR TIME/DIV control so that the bottom portion of the waveform (holdoff time of the A +GATE) is exactly 1 division in length.

- d. Rotate the A TRIGGER HOLDOFF control clockwise.
- f. Set the A TRIGGER HOLDOFF control to NORM.
- e. CHECK—At least 10 times increase in the holdoff time of the A \pm GATE.
- g. Disconnect test equipment.

GATES, CALIBRATOR, AND EXT Z AXIS

Equipment Required

- 1. Test Oscilloscope
- 2. 42-inch, 50 Ω Bnc Cable (2 required)
- 3. Digital Voltmeter

- 4. Shorting Strap
- 5. Calibration Generator
- 6. Bnc T Connector
- 7. 3-inch Slotted Screwdriver

See

ADJUSTMENT LOCATIONS 1

in the Diagrams section for adjustments and test points (TP).

465B Control Settings

Power Controls

Regulating Range Selector Medium Line Voltage Selector 115 V **POWER** ON

CRT Controls

INTENSITY

As desired

FOCUS

Best focused display

SCALE ILLUM **B INTENSITY**

As desired As desired

Vertical Controls (both Channels if applicable)

VOLTS/DIV

5 mV

VAR

Calibrated detent

POSITION VERT MODE Midrange CH₁

INVERT

Off (button out)

20 MHz BW LIMIT

Full bandwidth

(button out)

Triggering Controls (both A and B if applicable)

LEVEL

Fully clockwise

SLOPE COUPLING

AC

A SOURCE

NORM

B SOURCE

STARTS AFTER DELAY

A TRIG MODE

AUTO

Sweep Controls

HORIZ DISPLAY

DELAY TIME POSITION

Fully counterclockwise

A TIME/DIV B TIME/DIV

50 us 50 µs

VAR TIME/DIV X10 MAG

Calibrated detent Off (button out)

POSITION A TRIGGER HOLDOFF Midrange NORM

1. Check A and B +Gates

a. Connect the B +GATE output (from the rear panel of the 465B) to the test oscilloscope via a 50 Ω unterminated bnc cable.

- b. CHECK-Test oscilloscope display for a positivegoing pulse of +5.5 V in amplitude (within 0.5 V).
- c. Disconnect the cable from the B+GATE output and connect it to the A + GATE output.
- d. CHECK-Test oscilloscope display for a positivegoing pulse of ± 5.5 V in amplitude (± 0.5 V).
 - e. Disconnect test equipment.

2. Check/Adjust Calibrator DC Level (R4293)

- a. Connect a shorting strap between TP4177 and TP4178.
- b. Connect digital voltmeter common lead to chassis ground and + lead to the CALIBRATOR current loop.

- c. CHECK—CALIBRATOR dc level is 300 mV $\pm 1\%$ (297 to 303 mV at 0°C to ± 40 °C).
- d. ADJUST-Amplitude Cal (R4293) for exactly 300 mV.
- e. Remove the shorting strap and the digital voltmeter connections.
- f. Connect a 10X probe from the test oscilloscope to the CALIBRATOR current loop.
- g. CHECK—Test oscilloscope display for a 0.3 V square wave with a duration of about 1 ms.
 - h. Disconnect the test setup.

3. Check External Z Axis

a. Set:

HORIZ DISPLAY A
A TIME/DIV 0.2 ms
A TRIGGER SOURCE EXT

- b. Set the INTENSITY control for a normal viewing level.
- c. Connect the calibration generator standard-amplitude signal to the A External Trigger input via a 50 Ω bnc cable and bnc T connector. Connect from the bnc T to the EXT Z-AXIS input (465B rear panel) via a 50 Ω bnc cable. Set the generator output for 5 V.
- d. Adjust A TRIGGER LEVEL for a stable display (TRIG LED on).
- e. CHECK—Display for noticeable intensity modulation.
 - f. Disconnect the test setup.

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MAINTENANCE

INTRODUCTION

This section of the manual contains information for use in preventive maintenance, troubleshooting and corrective maintenance. Procedures for removal and replacement of the standard instrument cabinet and the rack adapter are presented at the beginning of the section. Should the instrument require shipment to a Tektronix Service Center for repair, refer to the repackaging instructions at the end of this section.

CABINET AND RACK ADAPTER REMOVAL AND REPLACEMENT

The standard cabinet protects the interior of this instrument from accumulation of dust and also provides protection to personnel from the operating potentials present. In addition, the cabinet reduces the emi (electromagnetic interference) radiation from the instrument and interference to the display due to other equipment.

The front panel cover provides a dust-tight seal around the front panel and protects the front panel when storing or transporting the instrument.

The Rack Adapter cabinet for the 465B provides the proper electrical environment for the instrument, reduces dust accumulation, minimizes handling damage, and provides a means for mounting the instrument solidly to a surface such as a rack or console.

Standard Cabinet Removal

The standard instrument cabinet can be removed in the following manner:

- 1. Disconnect the instrument power cord from the power source.
- 2. Install the front panel cover and set the instrument face on a flat surface.
 - 3. Unwrap the power cord from the instrument feet.
- 4. Remove the six screws indicated in Figure 5-1 and remove the rear cabinet frame (with feet and screws) from the instrument as an intact assembly.

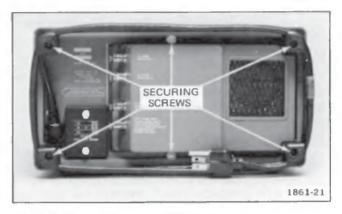


Figure 5-1. Removing the wrap-around cabinet.

Lift the cabinet up until it is separated from the instrument and power cord.

WARNING

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

Standard Cabinet Installation

The standard instrument cabinet should be installed in the following manner:

- 1. Disconnect the instrument power cord from the power source.
- 2. If parts were removed or replaced, check all sections of the instrument for proper assembly. It may be helpful to use the diagrams in Section 9, Replaceable Mechanical Parts List, for the location of parts.
- 3. 465B DM-series only—If the DM-series main circuitboard is not in place, install the board on the main chassis.
- Install the front panel cover and set the instrument face on a flat surface.

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- 5. Place the cabinet handle against the bottom of the cabinet (bottom of cabinet is nearest to the carrying handle pivot points).
- 6. Pull the power cable through the cabinet and carefully slide the cabinet over the instrument. Avoid pinching cables or damaging components that protrude from circuit boards.
- 7. Using both hands, press lightly on the top and bottom sides of the cabinet until the front edge of the cabinet is inserted into the braided gasket groove around the full periphery of the front cabinet frame.
- 8. Pull the power cord through the rear cabinet frame, align the cutout portion in the frame for proper fit at the regulating range selector cover, and work the frame into place.
- 9. Set the feet and screws in place and with one hand exert a light downward pressure on the rear cabinet frame. Press lightly on the top and bottom sides of cabinet with the other hand, checking that cabinet edge is properly seated in the gasket groove of both front and rear frames. Continue to exert a downward pressure and tighten the six screws of the rear frame to a snug fit. Do not over-tighten these screws.

Rack Adapter Removal

The Rack Adapter can be removed from the instrument in the following manner:

 Remove the hardware that fastens the Rack Adapter to the rack and pull the adapter partially out. Disconnect the instrument power cord from the power source and remove any interconnecting cables.

NOTE

It if is desired to tilt the Rack Adapter and instrument, remove a screw from the rear of each slide section mounted to the Rack Adapter. These securing screws are an important part of the mounting and should be installed when tilt operation is not necessary.

2. Remove the Rack Adapter, with instrument, from the rack and set the bottom of the complete assembly on a flat surface.

- 3. Remove two setscrews from the top front of Rack Adapter chassis, (0.125-inch Allen wrench is required to remove the setscrews). It may be helpful to use the diagrams in Section 9, Replaceable Mechanical Parts List, for the locations of parts.
- 4. Remove 10 screws that secure the rear support plate to an angle bracket on one side, to the Rack Adapter chassis on the opposite side, and to the rear of the instrument. Remove the rear support plate and blue plastic rear frame.
- 5. Slide the instrument forward through the adapter cabinet, using both hands (on front and rear) to lift and guide the instrument until separated from the Rack Adapter.

WARNING

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

Rack Adapter Installation

The Rack Adapter should be installed in the following manner:

- Disconnect the instrument power cord from the power source.
- 2. Verify proper assembly of all sections of the instrument if parts were removed or replaced. It may be helpful to use the diagrams in Section 9, Replaceable Mechanical Parts List, for the locations of parts.
- 3. Set the bottom of the Rack Adapter on a flat surface, pull the power cord through the cabinet portion of the Rack Adapter, and carefully slide the instrument rearward using both hands (on front and rear) to lift and guide the instrument until fully inserted. Avoid pinching cables or damaging components that protrude from circuit boards.
- 4. Check that the front edge of the cabinet portion of the Rack Adapter is inserted into the braided gasket groove around the full periphery of the instrument front frame. Pull the power cord through the blue plastic rear frame. Align the cutout portion in the plastic frame for proper fit at the regulating-range selector cover and work the frame into place.

- 5. Apply the rear support bracket to the rear of the Rack Adapter. Install, without tightening, six screws that secure the rear support bracket through the blue plastic frame to the rear of the instrument and four screws that secure the rear support bracket to an angle bracket and to the Rack Adapter chassis.
- 6. Check that all parts of the complete assembly are properly seated, then tighten the screws at the rear of the instrument and the screws at the adapter chassis to a snug fit. Do not overtighten these screws.
- 7. Install two setscrews at the top front of the Rack Adapter chassis (0.125-inch Allen wrench is required to install the setscrews).
- 8. Mount the Rack Adapter slide sections to the rack slide assemblies, connect the power cord, connect any interconnecting cables, push the Rack Adapter into final operating position, and install the adapter-to-rack hardware.

PREVENTIVE MAINTENANCE

Introduction

Preventive maintenance consists primarily of cleaning and visual inspection. When performed on a regular basis, preventive maintenance can prevent instrument breakdown and ensure the reliability of this instrument. The severity of the environment to which the 465B is subjected will determine the frequency of maintenance. A convenient time to perform preventive maintenance is just prior to recalibration of the instrument.

Cleaning

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

INTERIOR. Accumulation of dust and dirt should be removed as often as operating conditions require. Dirt can cause overheating and component breakdown. Dirt on components acts as an insulating blanket, preventing efficient heat dissipation. It also provides an electrical conduction path that can result in instrument failure, especially under high humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-pressure air (approximately 9 pounds per square inch). Remove any remaining dirt with a soft brush or a cloth dampened with a mild detergent and water

solution. A cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning ceramic terminal strips and circuit boards.



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

Most spray circuit coolants contain Freon 12 as a propellant. Because many Freons adversely affect switch contacts, check the contents and brand name before using a spray coolant. The following brand names are acceptable coolants: Artic Freeze, Quik-Freeze, and Can-O-Gas. Do not use Zero Mist brand of circuit coolant. The only recommended circuit coolants for the volts/division attenuators are dry ice (CO_2) or isopropyl alcohol.

SWITCH CONTACTS. Most of the switches in the 465B are circuit-board mounted, cam-actuated contacts. Care must be exercised to preserve the high-frequency characteristics of these switches. Switch maintenance is seldom necessary, but if it is required, observe the following precautions.

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

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

CRT. Two plastic light filters, one blue and one clear, are provided with the oscilloscope. Clean the light filter and the crt face with a soft lint-free cloth dampened with

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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 Number 7 soft 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.
- Rinse the filter thoroughly in clean water and allow to air dry.
- 4. If any lint or dirt remains, use clean low-pressure air (approximately 9 pounds per square inch) to remove it. 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.

AIR FILTER. The air filter should be visually checked every few weeks and cleaned or replaced if dirty. More frequent inspections are required under severe operating conditions. The following procedure is suggested for cleaning the filter. If the filter is to be replaced, order new air filters from your local Tektronix Field Office or representative. Refer to the Replaceable Mechanical Parts List for ordering information.

- 1. Remove the filter by pulling it out of the retaining frame on the rear panel. Be careful not to drop any of the accumulated dirt into the instrument.
- 2. Flush the loose dirt from the filter with a stream of hot water.
- 3. Place the filter in a solution of mild detergent and hot water and let it soak for several minutes.
 - 4. Squeeze the filter to wash out any remaining dirt.
 - 5. Rinse the filter in clear water and allow it to dry.
- 6. Coat the dry filter with an air-filter adhesive (available from an air conditioner supplier, or see Maintenance Aids information at the end of this section).

- 7. Let the adhesive dry thoroughly.
- 8. Re-install the filter in the retaining frame.

Visual Inspection

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

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

Lubrication

The fan motor and most of the potentiometers used in the 465B are permanently sealed and generally do not require periodic lubrication. The switches used in the 465B, both cam- and lever-type, are installed with proper lubrication applied where necessary and will rarely require any additional lubrication. A regular periodic lubrication program for the 465B is not recommended.

Semiconductor Checks

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

Readjustment

To ensure accurate measurements, check the adjustment of this instrument after each 1000 hours of operation or, if used infrequently, every six months. In addition, replacement of components may necessitate readjustment of the affected circuits. The adjustment procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed and/or corrected by readjustment. Complete adjustment instructions are given in the Calibration Procedure section. If only a partial adjustment is performed, see the interaction chart, Table 4-6, for possible interactions with circuits not adjusted.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is helpful in locating troubles, particularly where integrated circuits are used. See the Theory of Operation, Section 3, for this information.

Troubleshooting Aids

TROUBLESHOOTING CHARTS. As an aid in locating problem areas, troubleshooting charts have been provided for the low-voltage power supplies, the -2450-volt power supply, and for a no-visible-display condition. These can be found on foldout pages in the Diagrams section.

POWER DISTRIBUTION DIAGRAM. As an aid in troubleshooting the power supplies, a power distribution diagram is provided on Diagram 14 in the foldout pages at the rear of this manual. The diagram shows the distribution for each voltage from the low-voltage power supply. It also shows the service jumpers that can be used to aid in isolating the power supply from the various circuit boards. Excessive loading on the low-voltage power supply by a circuit board can rapidly be traced to the faulty circuit board with the aid of the service jumpers. The service jumpers associated with a specific schematic diagram are indicated on the respective schematic diagram. The power distribution diagram should be used in conjunction with the power supply isolation procedures adjacent to troubleshooting diagrams located in the Diagrams section of this manual.

GRID COORDINATE SYSTEM. Each schematic diagram and circuit board illustration is sectioned by a grid system. A table listing the grid coordinates of each component shown is located adjacent to the schematic diagram. The table lists the grid location of components on both the schematic diagram and on the circuit board illustration to aid in cross referencing components between the schematic diagram and the circuit board illustration.

DIAGRAMS. Complete circuit diagrams are given on foldout pages in the Diagrams section. The portions of the circuit mounted on circuit boards are enclosed within black lines. The component number and electrical value of each component in this instrument are shown on the diagrams (see the first page of the Diagrams section for definition of the reference designators used to identify components in this instrument). Important voltages and

waveforms are also shown on the diagrams. The physical locations of the waveform test points are shown on the Circuit Board illustrations.

CIRCUIT BOARD ILLUSTRATIONS. In conjunction with each circuit diagram is a circuit board illustration. These can be found on the back of a pullout page preceding the circuit diagram to which it relates. Each circuit component shown on the circuit diagram is identified on the circuit board illustration by its component number. In general, the component numbers increase from the left side of the circuit board to the right side, and from the top to the bottom. The lowest component numbers will be at the top left corner, and the highest component numbers will be at the bottom right corner of the circuit board.

ADJUSTMENT LOCATIONS ILLUSTRATIONS. To aid in locating test points and adjustable components, the adjustment locations pullout pages (normally used with the adjustment procedure) permit rapid location of test points and adjustments, because only these components are identified.

READ-ONLY MEMORY U1605 LOGIC TABLE. Refer to the Vertical Switching Logic diagram located in the Diagrams section of this manual for the following discussion. Input signals to U1605, a read-only memory (ROM), are as follows:

Input lines A_0 through A_2 — Logic levels from the Q_0 , Q_1 , and Q_2 outputs of U1705 used to indicate the present state of the switching. (Q_0 , Q_1 , and Q_2 outputs are active when LO.)

Input lines A_3 through A_6 — Logic levels selected by the VERT MODE switches (CH 1, CH 2, ADD, and A TRIG VIEW). A HI logic level present indicates that the Vertical Mode is selected.

Input line A₇ — Logic level controlled by the X-Y position of the A TIME/DIV switch. A LO logic level is present when X-Y Horizontal Display is selected.

After U1705 is clocked, ROM U1605 uses the present data on its input lines (A_0 through A_7) to select the next output switching state to be presented to U1705. There are four output lines from U1605, O_1 through O_4 . Output lines O_1 through O_3 carry the future data; the signal present on output line O_4 is the Chop Clock Oscillator enabling logic (HI enables).

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Maintenance-465B Service

In the partial table shown in Figure 5-2, no Vertical Modes are selected, and the present data from U1705 is an undefined column, (i.e., 000 is not a Vertical Mode selection). In the example given, the Chop Clock Oscillator will be enabled, and the next clock pulse to U1705 will switch U1705 output to 111. Table 5-1 shows that column 111 is the idle state of U1605 (the state switched to when no Vertical Modes are selected). In the Idle column, the future state of U1705 will remain 111, and the Chop Clock Oscillator will not be enabled. Each row across the table indicates the possible future states of U1705, while the column headings indicate the possible present state. The order of priority in switching (when multiple Vertical Modes are selected) is CH 1, CH 2, ADD, then A TRIG VIEW.

To use the table, determine the Vertical Mode(s) selected. Follow that row across the table. If the output of U1705 is at the present state indicated by a column heading, the data given in that column is the future state of 11705

Example 1. Assume CH 1 and CH 2 Vertical Modes are selected. The present data from the Vertical Mode Switch is 10011. Move across that row to the 000 column. The data given indicates that if the present state of U1705 is 000, the future state will be 110 (CH 1) and that the Chop Clock Oscillator will be enabled. Following across the row, each column, except 110 (CH 1), gives the same future state. If the present state is CH 1, the future state will be 101 (CH2). From there, it will switch back to CH 1 for the chopped display of the Channel 1 and Channel 2 input signals.

Example 2. Assume that X-Y Horizontal Display is selected. Go to any Vertical Mode selection in the bottom half of the table. All the columns indicate that regardless of the state of the U1705 output, the future state will be 101 (CH 2). When the output of U1705 goes to 101, the Chop Clock Oscillator will be turned off, and the Chop Clock to U1705 will cease.

Example 3. Assume ADD Vertical Mode is selected. In the Present Data from the Vertical Mode Switch column read 10100. Move across the row (adjacent to the data) to the 000 column and note that the future state of U1605 is 1100. The output state required to switch to the ADD display is 100. Trigger view is not selected, and both CH 1 and CH 2 are selected (LO logic level selects). The Chop Clock Oscillator will be enabled to clock U1705. After clocking, the Q₀ and Q₁ outputs (pins 3 and 6) of U1705 will be HI to gate U1805D and turn on transistor Q1636. This transistor supplies the extra current required to keep both CH 1 and CH 2 Diode Gates forward biased. In the case of the 000 state, it indicates that CH 1, CH 2, and A TRIG VIEW are selected for viewing together. While this output state exists, the Diode Gates will not be forward biased to allow this combination of signals to be displayed during the switching. If the ALT Vertical Mode is selected, the circuitry of the Vertical Mode Switch enables the Chop Clock Oscillator momentarily to switch U1605 to the selected state without waiting for the next Vert Alt Sync pulse from the Horizontal Display Logic circuit.

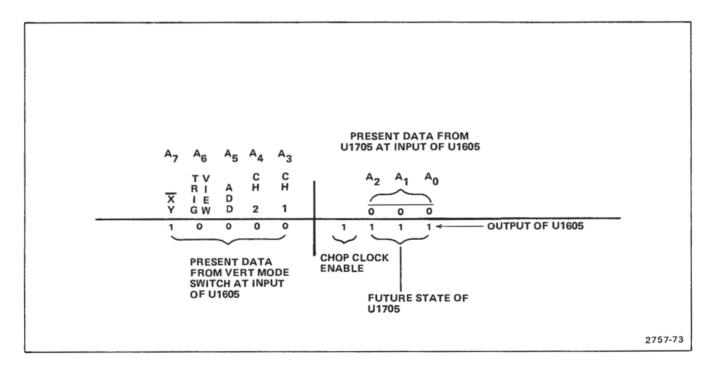


Figure 5-2. Partial Tabla 5-1.

Table 5-1
READ-ONLY MEMORY U1605 LOGIC

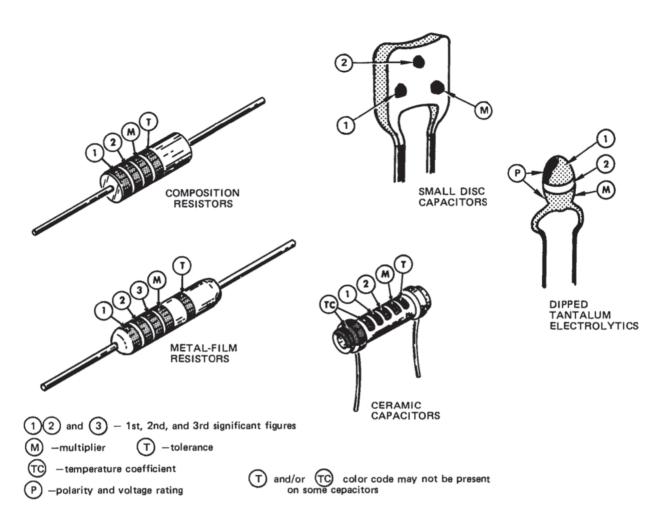
VERT MODE PRESENT DATA AT U1605					UNDEFINED			TRIG VIEW	ADD	CH 2	CH 1	IDLE
	T V		C	C								
X Y	ĞW	A D D	1	2	000	001	010	011	100	101	110	111
1	0	0	0	0	1111	1111	1111	1111	1111	1111	1111	0111
1	0	0	0	1	1110	1110	1110	1110	1110	1110	0110	1110
1	0	0	1	0	1101	1101	1101	1101	1101	0101	1101	1101
1	0	0	1	1_	1110_	1110	1110	1110	1110	1110	1101	1110
1	0	1	0	0	1100	1100	1100	1100	0100	1100	1100	1100
1	0	1	0	1	1110	1110	1110	1110	1110	1110	1100	1110
1	0	1	1	0	1101	1101	1101	1101	1101	1100	1101	1101
1	0	1	1	1	1110	1110	1110	1110	1110	1100	1101	1110
1	1	0	0	0	1011	1011	1011	0011	1011	1011	1011	1011
1	1	0	0	1	1110	1110	1110	1110	1110	1110	1011	1110
1	1	0	1	0	1101	1101	1101	1101	1101	1011	1101	1101
1	1	0	1	1	1110	1110	1110	1110	1110	1011	1101	1110
1	1	1	0	0	1100	1100	1100	1100	1011	1100	1100	1100
1	1	1	0	1	1110	1110	1110	1110	1011	1110	1100	1110
1	1 1	1	1	0	1101	1101	1101	1101	1011	1100	1101	1101
1	1	1	1	1	1110	1110	1110	1110	1011	1100	1101	1110
0	0	0	0	0	1101	1101	1101	1101	1101	0101	1101	1101
0	0	0	0	1	1101	1101	1101	1101	1101	0101	1101	1101
0	0	0	1	0	1101	1101	1101	1101	1101	0101	1101	1101
0	0	0_	1_	1	1101	1101	1101	1101	1101	0101	1101	1101
0	0	1	0	0	1101	1101	1101	1101	1101	0101	1101	1101
0	0	1	0	1	1101	1101	1101	1101	1101	0101	1101	1101
0	0	1	1	0	1101	1101	1101	1101	1101	0101	1101	1101
_0	0	1	1	1	1101	1101	1101	1101	1101	0101	1101	1101
0	1	0	0	0	1101	1101	1101	1101	1101	0101	1101	1101
0	1	0	0	1	1101	1101	1101	1101	1101	0101	1101	1101
0	1	0	1	0	1101	1101	1101	1101	1101	0101	1101	1101
0	1	0	1	1	1101	1101	1101	1101	1101	0101	1101	1101
0	1	1	0	0	1101	1101	1101	1101	1101	0101	1101	1101
0	1	1	0	1	1101	1101	1101	1101	1101	0101	1101	1101
0	1	1	1	0	1101	1101	1101	1101	1101	0101	1101	1101
_0	1	1	1	1	1101	1101	1101	1101	1101	0101	1101	1101

RESISTOR COLOR CODE. In addition to the brown composition resistors, some metal-film resistors and some wire-wound resistors are used in the 465B. The resistance values of wire-wound resistors are usually printed on the body of the component. The resistance values of composition resistors and metal-film resistors are color coded on the components with EIA color code (some metal-film resistors may have the value printed on the body). The color code is read starting with the stripe nearest the end of the resistor. Composition resistors have four stripes which consist of two significant figures, a

multiplier, and a tolerance value (see Figure 5-3). Metalfilm resistors have five stripes consisting of three significant figures, a multiplier, and a tolerance value.

CAPACITOR MARKINGS. The capacitance values of common disc capacitors and small electrolytics are marked on the side of the component body. The white ceramic capacitors used in the 465B are color coded in picofarads, using a modified EIA code (see Figure 5-3).

COLOR CODE 1881-20 A



COLOR	SIGNIFICANT	RESISTORS		CAPACITORS			DIPPED
	FIGURES	MULTIPLIER	TOLERANCE	MULTIPLIER	TOLE	TANTALUM VOLTAGE	
					over 10 pF	over 10 pF under 10 pF	
BLACK	0	1		1	±20%	±2 pF	4 VDC
BROWN	1	10	±1%	10	±1%	±0.1 pF	6 VDC
RED	2	10 ² or 100	±2%	10 ² or 100	±2%		10 VDC
ORANGE	3	10 ³ or 1 K	±3%	10 ³ or 1000	±3%		15 VDC
YELLOW	4	10 ⁴ or 10 K	±4%	10 ⁴ or 10,000	+100% -9%		20 VDC
GREEN	5	10 ⁵ or 100 K	±1/2%	10 ⁵ or 100,000	±5%	±0.5 pF	25 VDC
BLUE	6	10 ⁶ or 1 M	±1/4%	10 ⁶ or 1,000,000			35 VDC
VIOLET	7		±1/10%				50 VDC
GRAY	В			10 ⁻² or 0.01	+B0% -20%	±0,25 pF	
WHITE	9			10 ⁻¹ or 0.1	±10%	±1 pF	3 VDC
GOLD	_	10 ⁻¹ or 0.1	±5%				
SILVER	_	10 ⁻² or 0.01	±10%				
NONE	_		±20%		±10%	±1 pF	

Figure 5-3. Color codes.

The dipped tantalum capacitors used in the 465B are color coded in microfarads (see Figure 5-3). The color dot indicates the positive lead and voltage rating. Be careful to observe the polarity and voltage rating, as capacitors are easily destroyed by reverse or over voltage.

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

SEMICONDUCTOR LEAD CONFIGURATIONS. Typical semiconductor lead configurations are shown at the beginning of the diagrams section.

Troubleshooting Equipment

Refer to Table 5-2 in Maintenance Aid information at the end of this section for suggested test equipment.

Troubleshooting Techniques

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

- 1. CHECK CONTROL SETTINGS. Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, see the Operating Instructions section of this manual or the 465B Operators Manual.
- 2. CHECK ASSOCIATED EQUIPMENT. Before proceeding with troubleshooting, check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source.
- 3. CHECK INSTRUMENT CALIBRATION. Check the calibration of this instrument, or the affected circuit if the trouble exists in one circuit. The apparent trouble may

only be a result of misadjustment and may be corrected by adjustment. Complete adjustment instructions are given in the Calibration Procedure section of this manual.

- 4. VISUAL CHECK. Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visible indications such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.
- 5. ISOLATE TROUBLE TO A CIRCUIT. To isolate trouble to a particular circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. When trouble symptoms appear in more than one circuit, check the power supplies, then check the affected circuits. If the trouble has been isolated to a power supply, follow the Troubleshooting Chart for that supply. The power supplies are interdependent. All the low-voltage power supplies depend on +55 volts for reference. If more than one supply appears defective, repair them in the following order: +55 Volt, +110 Volt, +15 Volt, -8 Volt, and -2450 Volt.
- 6. CHECK CIRCUIT BOARD INTERCONNECTIONS. After the trouble has been isolated to a particular circuit, check for loose or broken connections, improperly seated transistors, and heat-damaged components.
- 7. CHECK VOLTAGES AND WAVEFORMS. Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages are given on the diagrams. Waveforms are shown at the left of the circuit diagram.

NOTE

Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the voltage and waveform setup procedures at the beginning of the Diagrams section for the preliminary equipment setup. Note the recommended test equipment, front panel control settings, voltage and waveform conditions, and test equipment cable connection instructions. The 465B Oscilloscope control settings required to obtain the given waveforms and voltages are located adjacent to the waveform diagrams. Changes to the control settings from the preliminary setup, other than those given, are not required.

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

WARNING

The Power switch must be turned off before removing or replacing components.

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

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

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

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

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



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

Resistors. Check the resistors with an ohmmeter. Check the Replaceable Electrical Parts List for tolerance of the resistors used in this instrument. Resistors normally do not require replacement unless the measured value varies widely from the specified value.

Inductors. Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit.

Capacitors. A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can be detected with a capacitance meter or by checking whether the capacitor passes ac signals.

Attenuators. The thick film attenuators are best checked by substitution. If only one channel of the 465B is not operating properly, and there is reason to believe an attenuator is defective, replace the suspected attenuator

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with the same attenuator from the other channel and check instrument operation. If proper operation results, order a new attenuator.

9. REPAIR AND READJUST THE CIRCUIT. If any defective parts are located, follow the replacement procedures given in this section. Be sure to check the performance of any circuit that was repaired or that had any electrical components replaced. Readjustment of the affected circuit may be necessary. Check Table 4-6 in the Calibration Procedure section of this manual for possible adjustment interaction.

CORRECTIVE MAINTENANCE

Introduction

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

Maintenance Precautions

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

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

Static-Sensitive Components

CAUTION

Static discharge can damage any semiconductor component in this instrument.

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

Observe the following precautions to avoid damage:

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

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RELATIVE SUSCEPTIBILITY TO STATIC DISCHARGE DAMAGE

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

*Voltage equivalent for levels:

(Voltage discharge from a 100 pF capacitor through a resistance of 100 ohms.)

Obtaining Replacement Parts

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

NOTE

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

SPECIAL PARTS. In addition to the standard electronic components, some special components are used in the 465B. 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 (see Cross Index-

Manufacturers Code Number to Manufacture in Replaceable Electrical Parts List for code numbers). Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative

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

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

Soldering Techniques

WARNING

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. 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.

The following technique should be used to replace a component on the circuit board. Most components can be replaced without removing the boards from the instrument.

- 1. Grip the component lead with long-nose pliers. Touch the soldering iron to the lead at the solder connection. Do not lay the iron directly on the board, since it may damage the board.
- 2. When the solder begins to melt, pull the lead out gently. This should leave a clean hole in the board, If not, the hole can be cleaned by reheating the solder and placing a sharp object such as a toothpick into the hole to clean it out. A vacuum-type desoldering tool can also be used for this purpose.
- 3. Bend the leads of the new component to fit the holes in the board. If the component is replaced while the board is mounted in the instrument, cut the leads so they will just protrude through the board. Insert the leads into the holes in the board so the component is firmly seated against the board (or as positioned originally). If it does not seat properly, heat the solder and gently press the component into place.
- 4. Touch the iron to the connection and apply a small amount of solder to make a firm solder joint. To protect heat-sensitive components, hold the lead between the component body and the solder joint with a pair of longnose pliers or other heat sink.
- 5. Clip the excess lead that protrudes through the board (if not clipped in step 3).
- 6. Clean the area around the solder connection with a flux-remover solvent. Be careful not to remove information printed on the 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 Switch Contacts paragraph in the Preventive Maintenance part of this section for recommended cleaners and procedures.

Component Removal and Replacement

WARNING

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

circuit boards. 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 and reassembly. 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 in this section.

VERTICAL PREAMPLIFIER ASSEMBLY. Remove and replace this assembly as follows:

- Remove instrument wrap-around cabinet in the manner given under Cabinet Removal at the beginning of this section.
- 2. Loosen front setscrews in the Vertical POSITION control shaft couplers (0.050" Allen wrench required) and the VAR VOLTS/DIV control shaft couplers. Slide shafts out of the couplers and remove them from the instrument.
- 3. Disconnect the INVERT and 20 MHz BW LIMIT push-button extension shafts from the switch shafts. Insert a scribe or similar tool between the end of the white plastic shaft and the inside of the black plastic extension shaft, then pry gently. Extension shafts will snap back into position when reassembling.
 - 4. Disconnect the following wires and cables:
 - a. Ten coaxial cables from the Preamplifier circuit board. Make a note of cable color codes to aid in proper installation during reassembly.
 - b. Unplug the delay-line connection from the end of the Preamplifier circuit board toward the rear of the instrument.
 - c. Locate the ground braid (near the High Voltage shield) connecting the Preamplifier circuit board to the Interface circuit board. Unsolder the end of the braid attached to the Preamplifier circuit board.
 - d. Unplug P1565, a three-wire connector near the middle of the Preamplifier circuit board.

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- e. Unplug P1505, an eight-wire connector near the rear of the Preamplifier circuit board.
- Remove 10 screws from attenuator covers (five in each cover) and lift covers from attenuator assemblies.
- 6. Unsolder two resistors that connect from the Vertical Preamplifier circuit board to the Attenuator boards.
- Remove six circuit board hold-down screws from the Preamplifier circuit board and remove board from the instrument.
- 8. To replace the Vertical Preamplifier circuit board, use the reverse of the removal steps.

VERTICAL MODE SWITCH AND ATTENUATORS.Remove and replace these assemblies as follows:

- 1. Loosen front setscrews in the Vertical POSITION control shaft couplers and the VAR VOLTS/DIV control shaft couplers. Slide shafts out of the couplers and remove them from the instrument.
- 2. Disconnect INVERT and 20 MHz BW LIMIT pushbutton extension shafts from the switch shafts. Insert a scribe or similar tool between the end of the white plastic shaft and the inside of the black plastic extension shaft, then pry gently. Extension shafts will snap back into position when reassembling.
- Loosen six Vertical Preamplifier board hold-down screws (do not remove).
- Remove knobs from the VOLTS/DIV switches.
 Loosen setscrews and pull to remove (requires a 1/16" Allen wrench).
- Remove the AC-GND-DC lever switch knobs by pulling them straight off.
- Unplug both input coupling capacitors from the board. Bend capacitors out of the way, leaving the soldered lead attached.
- 7. Remove four nuts securing the attenuator chassis to the instrument front casting (1/4" nutdriver required).

- 8. Disconnect the following wires and connectors:
- a. P5232, a three-wire connector (to the Interface circuit board).
- b. P5236 and P5235, two-wire connectors (to the VAR VOLTS/DIV potentiometers).
- c. P5036, a six-wire connector (to the CH 1 and CH 2 VOLTS/DIV UNCAL LED and the 20 MHz BW LIMIT LED).
- d. P5001, an eight-wire connector at rear of Vertical Mode Switch circuit board (to the Preamplifier circuit board).
- e. P5056 and P5265, three-wire connectors (to the Probe Coding boards).
- f. Single red lead near the stand-off post at the rear of the Vertical Mode Switch circuit board.
- Remove securing screw and hexagonal stand-off post from the rear of the Vertical Mode Switch circuit board.
- 10. Remove Vertical Mode Switch circuit board from the instrument.
- 11. To reinstall the Vertical Mode Switch and attenuators, use the reverse of the removal steps.

TRIGGER GENERATOR AND SWEEP LOGIC BOARD.

Remove and replace this board as follows:

- 1. Disconnect the following cables and wires:
- a. Eight coaxial cables from component side of the Trigger Generator and Sweep Logic circuit board. Make note of cable color codes to aid in proper installation when reassembling.
- b. P7010 and P7305, five-wire connectors (to the A and B TRIGGER SLOPE controls).
- c. P7204, a four-wire connector (to TRIG and READY LED). Guide the connector through the slotted hole when removing the circuit board.
 - d. P7105, a two-wire connector (to POWER LED).

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- e. P7052, a three-wire connector near top center of Trigger Generator and Sweep Logic circuit board.
- f. Unsolder the wires from the External Trigger Input connectors.
- 2. Remove POWER-switch-actuator rod from the plastic holder on the switch. Pry rod out of the holder with a small flat-bladed screwdriver and remove rod from the instrument.
- 3. Remove POWER switch bracket from the circuit board (3/16" wrench or nutdriver required). The white plastic circuit board support on back side of board may fall off when circuit board hold-down screws are removed; save it for reinstallation.
- 4. Remove five circuit board hold-down screws (Phillips screwdriver required) from the board (two at rear, two at front, and one in a post at top center of the board). Also remove post (3/16" wrench or nutdriver required).
- 5. Unplug Trigger Generator and Sweep Logic circuit board by prying Trigger board away from Interface board at the two white interboard connectors (at bottom edge of the Trigger board).
- 6. Move Trigger board to the rear until Trigger switches clear the front casting to remove the assembly from the instrument. Exercise caution to avoid damaging the connector pins on the Interface board.
- 7. To reinstall the Trigger Generator and Sweep Logic circuit board, reverse the order of the removal steps. If indexing of the Trigger switches was disturbed, a series of alignment steps will be required to return the indexing to its correct position. After each adjustment to the switch positioning, the board must be reinstalled to check out the switch operation.

SWEEP TIMING CIRCUIT BOARD. Remove and replace this board as follows:

- 1. Disconnect the following wires:
- a. P6014, a two-wire connector (to main cable harness).
- b. P6002, a three-wire connector (to DELAY TIME POSITION potentiometer).
- c. P6001, a four-wire connector (to X10 MAG and UNCAL LED).

- 2. Remove VAR TIME/DIV, A TIME/DIV, and B TIME/DIV knobs (1/16" and 5/64" Allen wrenches required). The VAR knob has one externally accessible Allen setscrew, and the large gray knob has two externally accessible Allen setscrews. The clear plastic skirt knob has two Allen setscrews which are accessible from behind the front panel casting. Black spacing rings may fall out; save them for reinstallation.
- 3. Remove the board hold-down screw and the hexagonal rod from the Sweep Timing circuit board (Phillips screwdriver and 3/16" wrench or nutdriver required).
- 4. Use a flat-blade screwdriver to pry the Timing board away from the Interface board. Gently pull away the corner of the Interface board near the B External Trigger input connector and simultaneously lift up on the Timing board near the rear to fully disengage connector pins from the Interface board.
- To reinstall Timing board, reverse the order of the removal steps.

VERTICAL OUTPUT BOARD REMOVAL. Remove and replace this board as follows:

- 1. Unplug P4295, a six-wire connector at the top front corner of Vertical Output board.
- 2. Disconnect two wires from the crt neck. (Use longnose pliers and gently pull connectors from the pins on the crt neck. Pull straight away from the crt neck to avoid putting a side strain on the metal-to-glass neck-pin seal.)
- 3. Unplug the delay-line terminal from the top right corner of the board.
- 4. Remove the integrated circuit mounting nut from main chassis. Use a 1/4" open-end wrench to loosen the nut.
- 5. Remove two circuit board hold-down screws along the top edge of the board and remove Vertical Output circuit board from the instrument. Save the nylon posts (located behind front edge of board) for reinstallation.
- 6. To reinstall Vertical Output circuit board, reverse the order of the removal steps.

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MAIN INTERFACE BOARD REMOVAL. If repair is necessary on reverse side of the Main Interface board, it is possible to gain access to that area by removal of one or two circuit boards as previously outlined. Consider this first before proceeding with Main Interface board removal procedure. (There is no reason to remove the Main Interface board except for exchange.)

CAUTION

If the Main Interface board becomes defective, it is recommended that your local Tektronix Field Office or representative be contacted to arrange instrument repair at a Tektronix Service Center.

The Main Interface board can be removed as follows:

- Remove Trigger Generator and Sweep Logic board as previously outlined.
- 2. Position the instrument with the front to your right and the Interface board facing you.
- 3. Remove the high-voltage shield from Interface board.
- 4. Remove BEAM FIND and X10 MAG push-button extension shafts. Insert a scribe or small screwdriver between the end of the white plastic switch shaft and the inside of the black plastic extension shaft, then pry gently.
- 5. Remove INTENSITY, FOCUS, SCALE ILLUM, ASTIG, and TRACE ROTATION control extension shafts. Loosen front setscrew in each coupling with a 0.050" Allen wrench.
- 6. Disconnect twelveribbon- or wire-cable connectors from Main Interface board and note the location, quantity, and color of wires for each plug for reassambly reference:
 - a. P4009, a three-wire connector at the top left corner of the board (to Q14009).
 - b. P4035, a four-wire connector near top center of the board (to crt socket).
 - c. P4069, a two-wire connector near the INTEN-SITY potentiometer at top center of the board (to the Fan board).
 - d. P4057, a three-wire connector near the INTEN-SITY potentiometer at top center of the board (to Vertical Mode Switch).

- e. P4061, a three-wire connector near the INTEN-SITY potentiometer at top center of the board (to Vertical Preamp board).
- f. P4058, a six-wire connector near the INTENSITY potentiometer at top center of the board (to Vertical Output board).
- g. P4086, a two-wire connector near Q4190 (to graticule lights).
- h. P4165, a two-wire connector near the front of the INTENSITY potentiometer (Y-Axis).
- i. P4176, a two-wire connector near the TRACE ROTATION potentiometer (to crt).
- j. P4398, a six-wire connector from the TRACE SEP and B INTENSITY potentiometers, at the front of the board.
- k. P4498, a six-wire connector from the TRACE SEP and HOLDOFF potentiometers, at the front of the board.
- I. P4561, a three-wire connector near the bottom center of the board (from the HOLDOFF control).
- Unsolder the CALIBRATOR loop from Main Interface board.
- 8. Unsolder five wires from Main Interface board and confirm each wire's color and location in the following list for reassembly reference (high-voltage wires to crt socket):
 - a. Wire to the one-notch ceramic strip is white with a yellow stripe.
 - b. Wire to the -2450 volts test point (TP4129) is white with a red stripe.
 - c. Wire to center notch on the three-notch ceramic strip is white with an orange stripe.
 - d. Lowest of a pair of wires between the large highvoltage capacitors is white with brown and yellow stripes.

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- e. Upper wire of a pair of wires between the large high-voltage capacitors is white with a brown stripe.
- 9. Disconnect horizontal deflection plate leads at the crt. This requires a pair of long-nose pliers for best removal or reinstallation (pull connectors straight out from pins to avoid strain on metal-to-glass neck-pin seal).
- 10. Unplug five connectors from Main Interface board. Confirm each wire's color and location in the following list for reassembly reference:
 - a. J4325, white with black and brown stripes, from near the rear middle of the board.
 - b. J4387, white with a red stripe, from near the front of the board.
 - c. J4385, white with black and red stripes, from near the front of the board.
 - d. J4388, white with a blue stripe, from near the front of the board.
 - e. J4475, white with an orange stripe, from between the interboard connectors (to the Sweep Timing circuit board).
- 11. Unsolder one wire from near the left middle of the board (under cable harness).
- 12. Remove power transistor mounting screw from Q4102, Q4301, and Q4401.
- 13. Remove mounting screw from transistor Q4312 near the lower rear corner of the board.
- 14. Remove mounting screw from transistor Q4190 near the top right corner of the board.
- 15. Remote four hexagonal posts that stand-off the high-voltage shield. Use a 3/16" nutdriver.
- 16. Remove seven Main Interface board mounting screws. A Phillips screwdriver is required.

WARNING

The crt anode and the output terminal of highvoltage multiplier may retain a high-voltage charge after the instrument is turned off. To avoid electrical shock, ground both the output terminal of the multiplier and the crt high-voltage anode lead to chassis ground.

- 17. Disconnect crt anode-lead plug from the highvoltage multiplier jack. Ground this lead to the instrument main chassis to remove any stored charge. Insert a medium-size screwdriver tip between the multiplier jack body and the hold down spring clip. Pry the multiplier jack out of the spring clip.
- 18. Separate Main Interface circuit board from the instrument chassis, using care to prevent damage to components or wiring. Carefully thread interconnecting cables through the board and chassis, as necessary, to avoid strain on any cable. Let the board pivot on power-transformer leads that are still connected to the board.

NOTE

You can now perform repairs on the reverse side of the Main Interface board, if repair is intended. To reinstall the board, reverse the order of the removal steps. If you intend to replace the Main Interface circuit board, continue with this procedure.

19. Unsolder power-transformer wires from Main Interface board. Confirm each wire's color and location in Figure 5-4. To facilitate reassembly, record any exceptions to this procedure.

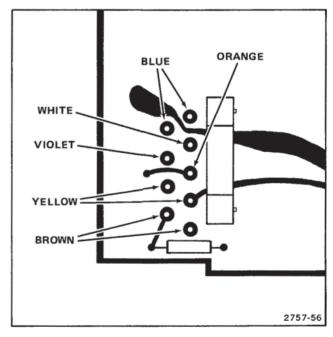


Figure 5-4. Locations of power trensformer secondary wires.

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- 20. Unsolder blue power-cord wire from the stand-off insulator near power transformer secondary wires. Feed wire through hole in the board.
- 21. Remove Main Interface board from the chassis, using care to prevent strain on any of the wires.
- 22. To facilitate reinstallation, remove solder from the holes in the circuit-board wire-terminal pads, if wires were removed in this procedure.

To reinstall the Main Interface circuit board, reverse the order of the removal steps.

NOTE

All of the mounted components are not supplied with a replacement Main Interface board. It will be necessary to exchange some components from the old board to the new board or new parts must be ordered.

POWER TRANSFORMER. If the power transformer becomes defective, be sure to replace only with a direct replacement Tektronix transformer. After the transformer is replaced, check the performance of the complete instrument. Remove the transformer as follows:

- Unsolder the power cord from the Interface board, the Regulating Range Selector Assembly, and the solder lug on the rear subpanel.
- 2. Remove small blue panel from the rear panel of the instrument (short screw is at the top, and the long screw is at the left side). It will be necessary to remove rear ring assembly, as for cabinet removal (see Figure 5-1) and the Regulating Range Selector cover to allow removal of the panel.
- 3. Disconnect actuating shaft from the POWER switch coupler and remove shaft from the instrument. Be careful not to damage switch coupler.
- 4. Remove POWER switch mounting bracket from the Trigger board (3/16" wrench or nutdriver required).
- 5. Unsolder transformer leads from the Interface board and the solder lug on the rear subpanel. Note the wire color codes to facilitate correct reinstallation (see Figure 5-4).

- 6. Remove transformer leads from the Regulating Range Selector Assembly. It will be necessary to use a special pin removing tool available from Tektronix, Inc. (refer to Maintenance Aids information at end of this section). 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 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 Trigger board, then lift the transformer assembly partially out until thermal cutoff retaining screws can be removed. Remove these retaining screws with a Phillips screwdriver and lift transformer assembly out of the instrument.
- Remove thermal cutout and POWER switch from old transformer and install on new transformer. Note wire color codes to facilitate correct installation.
- 10. Install new transformer assembly in the instrument reversing the order of removal steps.

CATHODE RAY TUBE (CRT). Remove and replace the crt as follows:

WARNING

Use care when handling a crt. Protective clothing and safety glasses should be worn. Avoid striking it on any object which might cause it to crack or implode. When storing a crt, place it in a protective carton or set it face down on a smooth surface in a protective location with a soft mat under the faceplate to protect it from scratches.

- Remove instrument wrap around cabinet in the manner given under Cabinet Removal at the beginning of this section.
- 2. Remove plastic bezel and filter from the front of the crt (held with four screws).
 - 3. Remove rear cover (held by two flat-head screws).
- 4. Remove bell-shaped cover to expose crt socket (held by two screws).

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- 5. Unplug crt socket.
- 6. Remove the two vertical deflection pin connectors from the left side of the crt neck. (Use long-nose pliers and pull connectors straight off the crt neck to avoid strain on the metal-to-glass neck-pin seal.)
- 7. Set the instrument on its left side (Vertical Preamp board side).
- 8. Remove horizontal deflection pin connectors from bottom of the crt neck (accessible through a hole in the Interface board). (Refer to step 6 for removal method.)
 - 9. Position the instrument so the top is accessible.

WARNING

The crt anode and the output terminal of high-voltage multiplier may retain a high-voltage charge after the instrument is turned off. To avoid electrical shock, ground both the output terminal of the multiplier and the crt high-voltage anode lead to chassis ground.

- 10. Locate anode lead connector that is held in place by a metal spring clip fastened to the chassis. Pull the top portion of the anode lead out of the connector (where the connector plugs together, just above the metal spring clip) and discharge the metal tip to the chassis.
- 11. Holding one hand on the crt face, push slowly on the crt base with the other hand. Guide the anode connector through the crt shield while slowly pulling the crt out of the instrument. The plastic corner pads may fall out during removal; save them for reinstallation.
- 12. Reverse the above procedure to install a crt. Observe the following precautions:
 - a. Be sure to guide anode lead through the hole in the crt shield while pushing crt into the instrument.
 - b. Be sure plastic corner pads are securely seated.
 - c. Be sure plastic centering ring firmly centers the crt neck. Reposition the ring as necessary.

HIGH VOLTAGE MULTIPLIER. Remove and replace the High Voltage Multiplier as follows:

- 1. Remove Vertical Preamplifier board and crt as previously described.
- 2. Slide the round part of the crt shield to the rear about two inches
- Remove high voltage shield (held on by four screws). Note position of the cabinet grounding clip for reassembly reference.
- 4. Remove four 3/16" stand-off posts to which the high voltage shield is secured.
- 5. Remove mounting screw from Q4102 and Q4301 at the rear of the Interface board.
- Remove circuit board hold-down screw just forward of P4165 on the Interface board.
- 7. Remove the shield from the high voltage transformer and high voltage multiplier (shield held by three screws).
- 8. Unsolder black wire (between the High Voltage Multiplier and the Interface board) from the Interface board.
- 9. Unsolder the diode and the wire from the post on the High Voltage Multiplier.
- 10. Remove two nylon nuts securing the High Voltage Multiplier to the Interface board.
- 11. Remove High Voltage Multiplier (carefully pry up on the Interface board as necessary to facilitate removal).
- 12. Reverse above procedure to install the High Voltage Multiplier.

TRANSISTORS AND INTEGRATED CIRCUITS.

Transistors and IC (integrated circuits) should not be replaced unless they are actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement or switching of semiconductor devices may affect the

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adjustment of the instrument. When a transistor is replaced, check the operation of the part of the instrument that may be affected.

Any replacement component should be of the original type or a direct replacement. Bend the leads to fit the socket and cut the leads to the same length as on the component being replaced. See Figure 8-1 for basing diagrams.

To remove the 14-, 16-, and 20-pin integrated circuits, pull slowly and evenly on both ends of the device. Try to avoid having one end of the integrated circuit disengage from the socket before the other, since this may damage the pins.

WARNING

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

WARNING

Voltages are present on the exterior surface of the chassis-mounted power supply transistors if power is applied to the instrument and the POWER switch in on.

The chassis-mounted power supply transistors and their mounting bolts are insulated from the chassis. In addition, silicone grease is used to increase heat transfer capabilities. Reinstall the insulators and replace the silicone grease when replacing these transistors. The grease should be applied to both sides of the mica insulators and should be applied to the bottom side of the transistor, where it comes in contact with the insulator.

NOTE

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

INTERCONNECTING PINS. Two methods of interconnection are used in this instrument to connect the circuit boards with other boards and components. When the interconnection is made with a coaxial cable, a special end-lead connector plugs into a socket on the board. Other interconnections are made with a pin soldered onto the board. Two types of mating connections are used for these interconnecting pins. If the mating connector is on the end of a lead, an end-lead pin connector is used which

mates with the interconnecting pin. The following information provides the replacement procedure for the various types of interconnecting methods:

Coaxiai-Type End-Lead Connectors. Replacement of the coaxial-type end-lead connectors requires special tools and techniques; only experienced maintenance personnel should attempt replacement of these connectors. It is recommended that the cable or wiring harness be replaced as a unit. For cable or wiring harness part numbers, see the Replaceable Mechanical Parts List. An alternative solution is to refer the replacement of the defective connector to your local Tektronix Field Office or representative.

NOTE

A circuit-board pin-replacement kit including necessary tools, instructions, and replacement pins is available from Tektronix, Inc. (see Maintenance Aids information at the end of this section).

Circuit Board Pins. To replace a pin which is mounted on a circuit board, first disconnect any pin connectors, then, unsolder the damaged pin and pull it out of the circuit board with a pair of pliers. Be careful not to damage the wiring on the board with too much heat. Ream out the hole in the circuit board with a 0.031" drill bit. Remove the ferrule from the new interconnecting pin and press the new pin into the hole in the circuit board. Position the pin in the same manner as the old pin. Then solder the pin on both sides of the circuit board. If the old pin was bent at an angle to mate with a connector, carefully bend the new pin to match the associated pins.

Circuit Board Pin Sockets. The pin sockets on the circuit boards are soldered to the rear of the board. To replace one of these sockets, first unsolder the pin (use a vacuum-type desoldering tool to remove excess solder). Then straighten the tabs on the socket and remove it from the hole in the board. Place the new socket in the circuit board hole and press the tabs down against the board. Solder the tabs of the socket to the circuit board; be careful not to get solder into the socket.

NOTE

The spring tension of the pin sockets ensures a good connection between the circuit board and the pin. This spring tension can be destroyed by using the pin sockets set as a connecting point for spring-loaded probe tips, alligator clips, or other devices.

End-Lead Pin Connectors. The pin connectors used to connect the wires to the interconnecting pins are factory assembled. They consist of machine-installed pin connec-

tors mounted in plastic holders. The plastic holders are easily replaced as individual items; but if the connectors are faulty, the entire cable assembly should be replaced. Individual pin connectors are listed in the parts list, but special tools are required for installation.

When pin connectors are grouped together and mounted in a plastic holder, these connectors are removed and installed as a multi-pin connector. To provide correct orientation of this multi-pin connector when it is replaced, an arrow is stamped on the circuit board, and a matching arrow is molded into the plastic housing of the multi-pin connector. Be sure these arrows are aligned when the multi-pin connector is reinstalled. If the individual end-lead pin connectors are removed from the plastic holder, note the color of the individual wires to facilitate replacement.

CERAMIC TERMINAL STRIPS. Replacement strips (including studs) and spacers are supplied under separate part numbers. However, the old spacers may be reused if they are not damaged. The applicable Tektronix part numbers for the ceramic strips and spacers used in this instrument are given in the Replaceable Mechanical Parts list.

Remove ceramic terminal strips as follows:

- Unsolder all components and connections on the strip. To aid in replacing the strip, it may be advisable to mark each lead or draw a sketch to show location of the components and connections.
 - 2. Pry or pull the damaged strip from the chassis.
- 3. If the spacers come out with the strip, remove them from the stud pins for use on the new strip (spacers should be replaced if they are damaged).

Replace ceramic terminal strips as follows:

- Place the spacers in the chassis holes.
- Carefully press the studs of the strip into the spacers until they are completely seated.
- If the stud extends through the spacers, cut off the excess.

 Replace all components and connections. Observe the soldering precautions under Soldering Techniques in this section.

Readjustment After Repair

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

Instrument Repackaging

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

- 1. Obtain a carton of corrugated cardboard having inside dimensions of no less than six inches more than the instrument dimensions; this will allow for cushioning. Use a carton having a test strength of at least 275 pounds.
- 2. Surround the instrument with polyethylene sheeting to protect the finish and prevent packing material from entering the instrument.
- Cushion the instrument on all sides by tightly packing dunnage or urethane foam between carton and instrument, allowing three inches on all sides.
 - 4. Seal carton with shipping tape or industrial stapler.

Required Reshipment Information

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

- 1. Owner's name and address, with the name of an individual at your firm who can be contacted.
 - Complete instrument serial number.
 - 3. Description of the services required.

MAINTENANCE AIDS

The following maintenance aids include items required for some maintenance procedures in this instrument. Equivalent products may be substituted for examples given providing characteristics are similar.

	Description	Specifications	Use	Example
1.	Soldering iron	15 Watt	General soldering and unsoldering	ANTEX PRECISION Model C
2.	Screwdriver	Phillips #1 tip	Assembly and Disassembly	Xcelite Model X108
3.	Screwdriver	Phillips #2 tip	Assembly and Disassembly	Xcelite Model X102
4.	Screwdriver	Three-inch shaft; 3/32" flat bit	General	Xcelite R3323
5.	Torque Screw- driver	1.5 inch-pounds	FUNCTION switch assembly	Sturtevant-Richmont Torque Products Model PM-5 Roto-Torq
6.	Nutdrivers	1/4", 5/16" 3/8", 7/16"	General	Xcelite #8, #10, #12, & #14
7.	Open End Wrench	1/4"	General	
8.	Allen Wrenches	1/16", 5/64", 0.050"	Assembly and Disassembly	
9.	Solder Wick		Unsoldering	Hex Wik #887-10
10.	Lubricant	Versilube	FUNCTION switch lubrication	Tektronix Part Number 006-1353-00
11.	Spray Cleaner	No Noise	FUNCTION switch pad cleaning	Tektronix Part Number 006-0442-02
12.	Air Filter Adhesive		Coat air filter after cleaning	Tektronix Part Number 006-0580-00
13.	Pin Removing Tool		Remove leads from Regulating Range Selector Assembly	Tektronix Part Number 003-0707-00
14.	Circuit Board Pin Replacement Kit		Replace Circuit board connector pins	Tektronix Part Number 040-0542-00

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Before using any test equipment to make measurements on static-sensitive components or assemblies, be certain that any voltage or current supplied by the test equipment does not exceed the limits of the component to be tested.

Table 5-2
SUGGESTED TROUBLESHOOTING EQUIPMENT

Equipment	Minimum Specification	Usage	Examples
1. Semiconductor Tester	Dynamic type tester. Measure reverse breakdown voltages up to at least 400 V.	Test Semiconductors.	a. TEKTRONIX 576 Curve Tracer, b. TEKTRONIX 577 (D1 or D2) Curve Tracer with 177 Test Fixture
Test Oscilloscope with 10X voltage probe	Frequency response, dc to at least 100 MHz; deflection factor, 5 mV to 5 V/div; input impedance, 1 M Ω , 20 pf; sweep rate, 0.5 s to 0.02 μ s/div.	Check operating wave- forms.	TEKTRONIX 465B Oscillo- scope with included 10X probe
3. Multimeter	Digital multimeter. Volt- meter input impedance, 10 MΩ range 0 to 150 volts; voltage accuracy, within 0.15%, display 4 1/2 digits. Ohmmeter, 0 to 20 MΩ.	Check voltages and general troubleshooting.	a. TEKTRONIX DM 501 Digital Multimeter ^a b. TEKTRONIX 465B Oscilloscope with DM44 Option
Variable Autotransformer	Variable from 0 to 140 V, 1.2 A. Equipped with 3-wire power cord, plug, and receptacle.	Vary input line voltage when troubleshooting the power supply.	General Radio W8MT3VM or W10MT3W Metered Variac Autotransformer

^{*}Requires a TM 500-Series power module.

OPTIONS

GENERAL OPTION INFORMATION

Your instrument may be equipped with one or more options. This section describes those options and provides required support documentation. Each Option part of this section is complete and supplies all the necessary information for operation and adjustment of the instrument. The Electrical and Mechanical Replaceable Parts list for each option are included at the end of the discussion of that option.

Index to Options Described in this section						
Option 04		6-3				
Option 05		6-5				
Option 07 ^a		6-23				
Option 78		6-39				

^aOption 07 is not available on instruments equipped with the DM44 Digital Multimeter.

OPTION 04 EMC ENVIRONMENTAL

INTRODUCTION

This section describes the features of Option 04 applicable to the 465B Oscilloscope. Circuitry in the instrument is modified to meet additional conducted and radiated interference requirements over the frequency range of 150 kHz to 25 MHz (conducted) and 150 kHz to 1 GHz (radiated).

The following changes are made to the standard instrument circuitry to meet the additional specification requirements. Figure 6-1 reflects the Option 04 instrument configuration.

EMI filter FL14500 is added in series with the input power cord.

A cathode-ray tube mesh filter is installed to minimize crt faceplate radiation.

Four signal-output bnc connectors on the rear plenum chamber are changed to a type that improves shielding of the connected signal leads.

Capacitors are added across the transformer secondary windings.

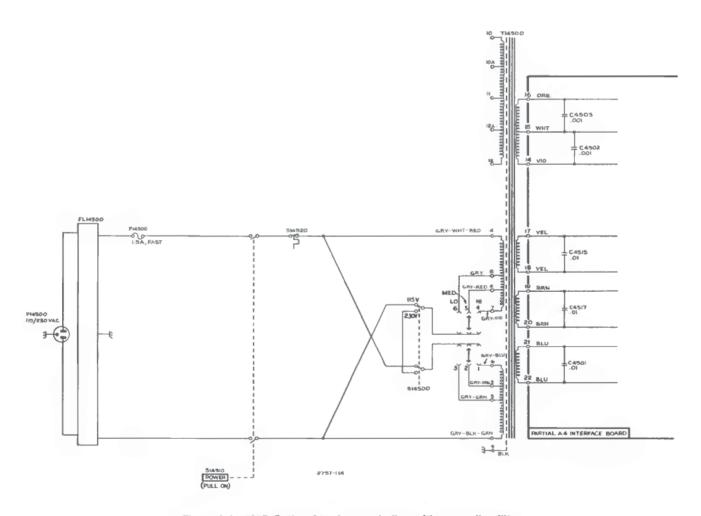


Figure 6-1. 465B Option 04 primary winding with power-line filter.

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Options—465B Service Option 04

ELECTRICAL

Component No.	Tektronix Part No.	Serial/N Eff	Model No. Dscont	Name & Description	Mfr Code	Mfr Part Number
				CHANGES FROM STANDARD 465B WHEN OPTION 04 IS ADDED		
(CHANGE TO):						
A4 A4	670-5996-01 670-5996-04	B010100 B030000	в029999	CKT BOARD ASSY:INTERFACE CKT BOARD ASSY:INTERFACE	80009 80009	670-5996-01 670-5996-04
A4C4501	283-0003-00	ВОЗОООО		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
A4C4513	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-558Z5U-103Z
A4C4517	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
(ADD):						
A4C4502	283-0000-00			CAP., FXD, CER DI:0.001UF, +100-0%,500V	72982	831-516E102P
A4C4503	283-0000-00			CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P

MECHANICAL

Fig. & Index No.	Tektronix Part No.	Serial/I	Model No. Dscont	Qty	12345	Name & Description	Mfr Code	Mfr Part Number
					CHANGES FROM S WHEN OPTION 04			
A4				1	CKT BOARD ASSY	: INTERFACE		
	131-0382-0	00		1	. TERMINAL, STU	D:0.812 L,INSULATED	71279	572-4822-01-05-1
	210-0586-0	00		1		T W:4-40 X 0.25 INCH, STL	78189	211-041800-00
					CHASSIS PARTS			
					OIRIODID TANTO			
	119-0376-0)1		1	FILTER, RAD INT	:2 X 3A,250V,400 HZ (ATTACHING PARTS)	80009	119-0376-01
	211-0038-0	00		1	SCREW.MACHINE:	4-40 X 0.314, FLH, 100 OEG	83385	OBD
	210-0586-0	00		1		W:4-40 X 0.25 INCH, STL	78189	211-041800-00
	131-0707-0	00		1	CONNECTOR, TERM	.:22-26 AWG, BRS& CU BE GOLD	22526	47439
	131-0708-0	00		1		.48"L,28-32 AWG WIRE	22526	47437
	131-1310-0	00		1		ESH FILTER GROUND	80009	131-1310-00
	131-1315-0)1		4	CONN, RCPT, ELEC	:BNC, FEMALE	24931	28JR 306-1
	210-0774-0	00		2	EYELET, METALLI	C:0.152 OD X 0.245 INCH L, BRS	80009	210-0774-00
	210-0775-0	00		2	EYELET, METALLI	C:0.126 OD X 0.23 INCH L, BRS	80009	210-0775-00
	378-0726-0	00		1	FILTER, MESH: EM	IT.	80009	378-0726-00
	334-3379-0	00		1	MARKER, IDENT: M	ARKED GROUNDSYMBOL	80009	334-3379-00
	348-0239-0	00		1	GROMMET, PLASTI	C:DK GRAY, U-SHAPE, 0.27 ID	80009	348-0239-00
	179-2739-0	00		1	WIRING HARNESS	:MAIN	80009	179-2739-00
	195-0529-0	00		1	LEAD, ELECTRICA	L:18 AWG,2.0 L,8-0	80009	195-0529-00

OPTION 05 TV SYNC SEPARATOR

INTRODUCTION

Option 05, when installed in the 465B Oscilloscope, adds a TV Sync Separator and other changes to provide stable sweep triggering from composite video waveforms. Two positions are added to the A TRIGGER COUPLING switch: TV FIELD and TV LINE. When these positions are selected, the A Sweep may be triggered at the field or line rate with the A TRIGGER LEVEL control. A TV LINE position is also added to the B TRIGGER SOURCE switch. In this position, the B Sweep may be triggered at the line rate. The Option 05 circuitry accepts sync-positive or sync-negative video from Channel 1, Channel 2, or external input. Recognition circuits accommodate 405-, 525-, and 625-line, 50 or 60 Hz field-rate broadcast systems and are compatible with closed-circuit systems with up to 1201-line, 60 Hz field rates.

Option 05 provides the instrument with front-panel selection of additional processing of trigger signals, to facilitate observation and measurement of composite video and related television waveforms. Added circuits provide amplification, selectable polarity inversion, clip-

ping, and vertical-sync recognition. Outputs of vertical and horizontal (field and line rate) triggers are connected to the A TRIGGER COUPLING switch, and horizontal (line rate) triggers are connected to the B TRIGGER SOURCE switch.

When the A TRIGGER COUPLING switch is set to either TV FIELD or TV LINE, the A TRIGGER SOURCE switch selects the source of signals to be processed in the Sync Separator. This includes NORM (composite vertical signal), CH 1, CH 2, EXT, or EXT/10 (LINE source is not a usable function with TV FIELD or TV LINE coupling).

The Option 05 circuitry may be operated from normal sync-negative composite video (with the A TRIGGER SLOPE switch at —) or from inverted video (SLOPE switch set to +). This applies to most standard broadcast systems using from 405 to 819 lines, 50 or 60 Hz field rates, or to closed-circuit systems using up to 1201 lines and 60 Hz field.

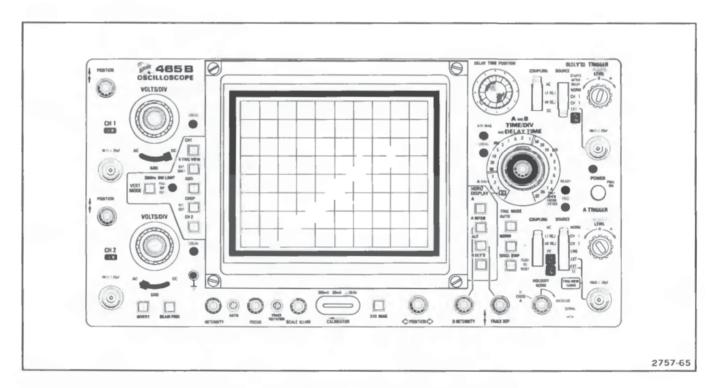


Figure 6-2. 465B Oscilloscope with Option 05.

Options—465B Service Option 05

When the A TRIGGER COUPLING switch is set to TV FIELD or TV LINE, the output of the Sync Separator is automatically applied to the A Sweep Trigger circuits, and only this signal may be used for triggering the A Sweep. For B Sweep, the horizontal sync signal (line-rate sync) from the Separator is fed only to the TV LINE position on the B TRIGGER SOURCE switch, which may be selected at the option of the user.

To optimize video measurements, the vertical amplifier ac input coupling capacitors are increased from 0.02 to 0.2 microfarad. The larger physical size of these capacitors increases the input shunt capacitance, which is normalized at 24 picofarads.

This following descriptive text includes the characteristics, operation, and maintenance of the added features of Option 05. For all other information concerning the 465B Oscilloscope, refer to appropriate sections of the Operators manual or this Service manual.

SPECIFICATION

Electrical characteristics and performance requirements listed in the Specification part of this manual are applicable to the 465B Option 05 oscilloscope with the following exceptions or additions.

Input

Resistance	1	$M\Omega$	$\pm 2\%$
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Capacitance Approximately 24 pF Time Constant Approximately 24 µs

AC Input Coupling

Low Frequency -3 dB point

Direct ≤1 Hz Via 10X Passive Probe 0.1 Hz

Tilt (10-ms pulse)

Direct ≤2.5% Via 10X Passive Probe ≤0.25%

Triggering

Sync Separation Stable video rejection and sync separation from sync-positive

or sync-negative composite video, 405- to 819-line, 50 or 60 Hz field rate, or for closed-circuit systems using up to 1201

lines, 60 Hz field rate.

Amplitude (p	Min	Max	
Internal	Composite video (nominal) ^a Composite sync	1.2 div 0.5 div	20 div 20 div
External	Composite video (nominal)	225 mV	4 V
Ext/10	Composite sync Composite video (nominal)	75 mV 2.25 V	4 V 40 V 40 V
	Composite sync	750 mV	40 V

[&]quot;Peak video ≈ 7/3 sync amplitude.

FURNISHED ACCESSORIES

- 1 Graticule, NTSC (CCIR System M): -40 to +100 units, with 7.5-unit setup line; horizontal divisions along line zero (see last page of Option 05 information for part number).
- 1 Graticule, CCIR (CCIR System B): zero to +100 units, 35-unit setup line; horizontal divisions along line 30 (see last page of Option 05 information for part number).

OPERATING INFORMATION

The following instructions and information pertain primarily to the use of the 465B Option 05 oscilloscope in TV applications. Refer to preceding sections of this manual for use and operation of the unmodified instrument.

Installation of Video Graticule

To install a video graticule, loosen (about sixturns) the four captive screws holding the crt bezel in place and remove the bezel. Remove the light filter from the two bosses on the bezel and install the desired graticule on these bosses, with the marking on the outside.

NOTE

The extended tab at the bottom of the graticule mates with the slightly wider (bottom) margin of the graticule cover.

The graticule can be moved slightly horizontally to align the external graticule and mask with the crt graticule and viewing area. Reinstall the bezel.

When the video graticule is installed, the 10 horizontal divisions along line zero correspond to the internal graticule divisions, and the TIME/DIV calibration of the

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oscilloscope is correct. However, the vertical divisions represent only proportions of the 100-unit (CCIR) or 140-unit (NTSC) video waveform, and the vertical VOLTS/DIV calibration is inapplicable.

To calibrate for a standard 1 volt (nominal) studio video signal, apply the 300 millivolt CALIBRATOR waveform to the Vertical input and adjust the VOLTS/DIV and VAR controls so that the displayed waveform occupies just 30 units (CCIR graticule) or 42 units (NTSC graticule). This adjustment may be performed with a free-running sweep.

Operation of the Sync Separator

To trigger the 465B on a video signal, perform the following three steps:

- 1. Set the A TRIGGER COUPLING switch to either TV FIELD or TV LINE.
- 2. Apply a suitable Composite Sync or Composite Video waveform to the A External Trigger input connector.

NOTE

Composite Sync is combined Vertical and Horizontal sync as a single waveform, but without video (picture) waveforms. Composite Video is the picture waveform complete with Vertical and Horizontal blanking and sync.

For special considerations in Dual Trace modes (ALT and CHOP), refer to Vertical Operating Modes—Special Considerations in this section. For internal triggering, the sync portion of the displayed waveform should be at least 10 units, or 0.5 division on the CCIR graticule; 14 units, or about 0.75 division on the NTSC graticule. For external triggering, the sync portion of the waveform should be at least 75 millivolts in amplitude, or 0.75 volt in the EXT/10 mode. Do not exceed the indicated maximum amplitudes (20 divisions for internal triggering, 40 volts for external triggering), to avoid circuit overloads and partial or complete loss of sync.

3. Select the proper polarity for the video waveform applied. For normal video with sync at the negative peak and positive-going picture information, the A TRIGGER SLOPE switch should be set to minus (–); for inverted video having sync at the positive peaks and peak video (white) at the negative peaks, the SLOPE switch should be set to plus (+). The A TRIGGER SLOPE switch controls an inverting/non-inverting signal preamplifier ahead of the sync separator.

Triggering the Sweep

The output of the Sync Separator is fed directly to the A Sweep Trigger circuit; all that is required for triggering is the proper setting of the A TRIGGER LEVEL control. To trigger the B Sweep from the Line-rate trigger output, perform the following steps:

1. Make sure the A Sweep is running.

NOTE

The B Sweep cannot be operated independently and cannot run more than once per operation of the A Sweep. For Composite line displays, refer to Special Measurements in this section.

- 2. Set the B TRIGGER SOURCE switch to TV LINE.
- 3. Set the B TRIGGER LEVEL control for a stable triggered sweep.

Vertical Operating Modes—Special Considerations

Sync Separator input must be taken from Channel 1, Channel 2, or an external source. (When only one trace is displayed, the NORM position of the A TRIGGER SOURCE switch may be used.) The Sync Separator is not capable of correct processing of switched (composite vertical deflection) waveforms present on the NORM bus in the ALT or CHOP modes; it is therefore not possible to obtain stable simultaneous displays of two independent video signals that are not time-related.

SINGLE CHANNEL TRIGGERING. When triggering from Channel 1 or Channel 2, the waveform fed to the Sync Separator is the same (except for positioning) as that displayed on-screen when the channel is turned on. If the VOLTS/DIV VAR control is used to reduce displayed amplitude, the signal to the Sync Separator is also reduced. When the CH 2 INVERT switch is pushed in, the Channel 2 signal to the A TRIGGER SOURCE switch is also inverted. Therefore, in selecting the position of the A TRIGGER SLOPE switch in internal triggering, it is only necessary to note the polarity of the displayed waveform, disregarding its actual polarity as applied to the Vertical INPUT connector. For external triggering, the actual applied polarity will determine the necessary A TRIGGER SLOPE setting.

It is not necessary to display Channel 1 or Channel 2 to obtain CH 1 or CH 2 triggering. Whenever the AC-GND-DC switch for the channel is not in GND, the input amplifier and trigger channel are active, regardless of the selection of VERT MODE push buttons.

Options—465B Service Option 05

ADD MODE. A single-channel trigger signal amplitude is not affected by the contribution of the other channel to an ADD mode display. When the ADD mode with Channel 2 inverted is used to compare two video waveforms by subtraction, the Channel 1 or Channel 2 signal to the Sync Separator will be adequate for stable triggering providing the individual channel signal (when displayed alone) meets the signal requirements.

When the ADD mode is used to display a signal from two sides of a balanced line, the A TRIGGER SOURCE switch NORM (composite vertical) position may be used if neither channel signal alone is of sufficient amplitude for stable sync separation and triggering.

Typical Operation

In a typical operating mode for the Option 05 instrument, the A Sweep establishes the basic frame and field presentation, and the B Sweep allows detailed observation and measurement of various portions of the video waveform.

To obtain stable displays free of interlace jitter (for systems which have 2:1 interlace), the A TIME/DIV switch should be set to display an odd number of fields, plus a fraction of a field, in the unmagnified display. For 50 and 60 Hz field rates, the 2 millisecond/division setting is usually selected. For some PAL system observations, a setting of 5 milliseconds/division (approximately 2 1/2 field display), with the A TRIGGER HOLDOFF control set to approximately the four o'clock position (additional onefield holdoff), may be desirable to maintain a stable display relationship to the four-field PAL burst-blanking sequence. All detail measurements are then made with B Sweep, using the B DLY'D or ALT Horizontal Display, with the B TRIGGER SOURCE switch set to either STARTS AFTER DELAY (continuously variable B Sweep start point) or to TV LINE (B Sweep starts after the leading edge of the next horizontal sync pulse following the delay interval set by the DELAY TIME POSITION control and the A TIME/DIV switch setting).

Because the leading edge of the sync pulse will not be displayed, the typical B TIME/DIV setting for width measurements on front porch, back porch and horizontal blanking intervals, horizontal sync, serration, and equalizing pulses will be 10 microseconds/division to allow display of two consecutive pulses. Use the X10 Magnifier to display the second pulse at 1 microsecond/division.

For rise and fall time measurements on blanking and sync waveforms, trigger the A or B Sweep directly from the displayed waveform (avoiding the processing delay of the sync separator). This permits viewing the triggering edge at sweep rates from 0.5 to 0.02 microsecond/division.

Selecting an Individual Line

NOTE

For field and line identification systems, refer to Identifying Fields, Frames & Lines in 525/60 and 625/50 TV Systems at the end of Option 05.

The Sync Separator circuit does not differentiate between the two fields of an interlaced frame or among the four fields of the PAL color frame sequence. However, if a 1.5- or 3.5-field basic A Sweep cycle is used, the sweep will remain stably locked to a given display until the signal is interrupted.

ONE FRAME CYCLE. To display an entire vertical blanking interval and locate a specific line (e.g., one of the lines containing a specific VIT waveform), set the A TIME/DIV switch to 2 milliseconds and the B TIME/DIV switch (pull to unlock from A) to 10 microseconds. Use the Horizontal POSITION control to center the second vertical blanking interval to center-screen and press the X10 MAG push button in. This will provide sufficient resolution to identify the field. Adjust the A TRIGGER HOLDOFF as necessary.

If the displayed field is not the desired one, first rotate the A TRIGGER SLOPE control momentarily to the opposite polarity then rotate back again until the start of the desired field is displayed.

Press A INTEN and use the DELAY TIME POSITION control to position the intensified zone (B Sweep) on the desired line. Pressing the B DLY'D button will then display the desired line. Select ALT Horizontal Display to view both A INTEN and B DLY'D traces together.

TWO FRAME CYCLE. If PAL Burst blanking is to be checked, an A Sweep 3.5-field cycle (5 milliseconds/division, with the A TRIGGER HOLDOFF at about four o'clock) is required, using B Sweep (ALT Horizontal Display recommended) to identify fields and lines. At 5 milliseconds/division, only two and a fraction fields will be displayed with a full field covered by the trigger holdoff interval. To put a specific field on-screen in a particular location will typically require several operations of the A TRIGGER SLOPE switch.

Special Measurements

OVERSCANNED DISPLAYS. For various video measurements, it may be desirable to magnify the video waveform vertically beyond the limits of the screen. Under these circumstances, the trigger amplifiers or Sync Separator may be overloaded, blocking out some sync

pulses in the vicinity of strong video transitions, or losing sync pulses altogether. To avoid overload problems, use external sync or use the other vertical channel to supply a constant amplitude signal to the Sync Separator while the overscanned observations are being made. Note, however, that transient-response aberrations in the main vertical amplifier will be increased when the signal is driven offscreen, becoming relatively serious if the amplifier is driven to saturation and cutoff.

HORIZONTAL SYNC PULSE MEASUREMENTS. Rise and fall times and width of horizontal sync pulses may be measured while using the Sync Separator to determine whether part or all of the lines or groups of lines appear to be abnormal. A bright display of all horizontal sync pulses is obtained when the ATRIGGER COUPLING switch is set to TV LINE.

RF INTERFERENCE. Operation in the vicinity of some FM and TV transmitters may show objectionable amounts of rf signal energy in the display, even when coaxial input connections are used. The front-panel 20 MHz BW LIMIT switch will usually eliminate such interference from the display, but will not affect the signal reaching the Sync Separator. Where the rf interferes with Sync Separator operation, external filters will be required. Use of probes designed for 10 to 30 MHz oscilloscopes will provide 6 to 10 dB attenuation in the 50 to 100 MHz range and may be beneficial in reducing interference.

IDENTIFYING FIELDS, FRAMES, AND LINES IN 525/60 AND 625/50 TV SYSTEMS

NTSC (CCIR System M)

Field 1 is defined as the field whose first equalizing pulse is one full H interval (63.5 microseconds) from the preceding horizontal sync pulse. The Field 1 picture starts with a full line of video. Field 1 lines are numbered 1 through 263, starting with the leading edge of the first equalizing pulse. The first regular horizontal sync pulse after the second equalizing interval is the start of line 10.

Field 2 starts with an equalizing pulse a half-line interval from the preceding horizontal sync pulse. The Field 2 picture starts with a half line of video. Field 2 lines are numbered 1 through 262, starting with the leading edge of the second equalizing pulse. After the second equalizing interval, the first full line is line 9.

CCIR System B and Similar 625/50 Systems (including PAL)

In most 625-line, 50 Hz field-rate systems, identification of parts of the picture relies primarily on continuous line numbering rather than on field-and-line identification, except for PAL systems.

The CCIR frame starts with the first (wide) vertical sync pulse following a field which ends with a half-line of video. The first line after the second equalizing interval is line 6; the first picture line is line 23 (half-line of video). The first field of the frame contains lines 1 through the first half of line 313, the picture ending with a full line of video (line 310).

The second field of the frame commences with the leading edge of the first (wide) vertical sync pulse (middle of line 313), and runs through line 625 (end of equalizing interval). The first full line after the equalizing interval is line 318; the picture starts on line 336 (full line).

The first field is referred to as "odd", the second field as "even". Note that the identification systems for System M and System B are reversed.

In the four-field PAL sequence with Bruch Sequence Color-burst blanking, the fields are identified as follows:

- Field 1: Field that follows a field ending in a half-line of video, when preceding field has color burst on the last full line. Field 1 lines are 1 through 312 and half of line 313. Color burst starts on line 7 of Field 1; a half-line of video appears on line 23.
- Field 2: Field that follows a field ending in a full line which does not carry color burst. Field 2 lines are the last half of line 313 through line 625. Color burst starts on line 319 (one line without burst following the last equalizing pulse); a full line of video appears at line 336.
- Field 3: Field that follows a field ending in a half line when preceding field has no color burst on its last full line. Field 3 lines are 1 through the first half of line 313. Burst starts on line 6 (immediately following the last equalizing pulse); a half-line of video appears on line 23.
- Field 4: Field that follows a field ending in a full line carrying color burst. Field 4 lines are the second half of line 313 through line 625. Color burst for Field 4 starts on line 320 (two full lines without burst follow the last equalizing pulse); video starts with a full line on line 336.

THEORY OF OPERATION

Introduction

This section describes circuitry unique to Option 05. Refer to the Theory of Operation section of this manual for information concerning those portions of the oscilloscope circuitry that are unchanged by Option 05.

Figure 6-3 shows the circuit stages for those circuits added or changed by Option 05. This discussion is limited to a general description of those stages. Refer to the schematic diagrams and component location figures at the end of this Option 05 description for a more detailed examination of individual components.

Switching

The added TV FIELD and TV LINE positions of the A TRIGGER COUPLING switch open the conventional signal path to the A Trigger circuitry. The TV FIELD and TV LINE positions also couple the appropriate output of the Sync Separator stage to the conventional A Trigger Generator circuitry.

The Option 05 TV LINE position on the B TRIGGER SOURCE switch couples line rate trigger signals from the Sync Separator output to the conventional B Trigger Generator circuitry.

With Option 05 the A TRIGGER SLOPE switch adds connections through P2834 to provide inverting or non-inverting control of the Trigger Amplifier and Inverter stage.

Trigger Pickoff

This stage consists of Q7512, a source follower, and Q7514, an emitter follower. The stage provides isolation, impedance match to the Trigger Amplifier and Inverter, and minimum loading to the input signal. Gain of the Trigger Pickoff stage is slightly less than unity. The video trigger signal (internal or external) from the A TRIGGER SOURCE switch is coupled to the input of Q7512, while the output of the Trigger Pickoff stage (Q7514 emitter) is fed through P7575 and P2810 to the Trigger Amplifier and Inverter stages (Q2802, Q2803, and U2810). CR7510 protects the input of Q7512 from damage when high amplitude negative signals are present.

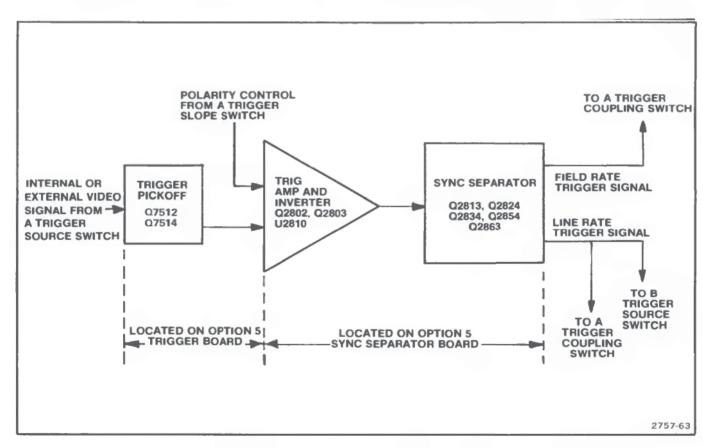


Figure 6-3. Option 05 simplified block diagram.

Trigger Amplifier and Inverter

This stage consists of Q2802, Q2803, and U2810, and is designed to provide adequate drive and correct polarity for the following Sync Separator stage, which accepts only negative sync (positive-going video). Signal is applied to the Trigger Amplifier and Inverter from the Trigger Pickoff via P2810. Polarity control is applied from the A TRIGGER SLOPE switch through P2834. Output from the stage is fed to Q2813, the Sync Separator input.

When the A TRIGGER SLOPE switch is set to +, this stage inverts the signal it receives from the Trigger Pickoff. If the switch is set to -, the signal is not inverted. Only one transistor, Q2802 or Q2803, conducts at a time. Feedback resistor R2807 controls Operational Amplifier U2810 gain for low amplitude signals, while R2809, CR2807, and CR2809 control the gain for higher amplitude signals.

Sync Separator

The Sync Separator strips off the video (picture) information from the incoming sync-negative video output of U2810, amplifies the resulting composite sync for use as horizontal (TV line) sync by A and B Sweep Triggers, and processes the composite sync to provide vertical (field rate) sync to the A Sweep Trigger circuits.

Video Stripper, Q2813 and Q2824, form a limited-swing feedback amplifier which amplifies only the negative peaks of the incoming waveform. The base of Q2813 rests at an equilibrium point of approximately +9.0 volts, which is affected slightly by Clipping Level adjustment R2826. The emitter of Q2824 is held at approximately +10.1 volts, and the collector rests at approximately +9 volts.

With sync-negative video applied to Q2813, the negative-going peaks (sync) are clamped at the +9 volt level. The positive-going portions of the input waveform generate increasing amounts of feedback current via R2818 until Q2824 reaches its negative-swing limit. Beyond this point, further positive input cuts off Q2813. and has negligible effect on the output. When Q2813 is driven positive, the negative excursion at the collector of Q2824 is stopped at approximately +7.6 volts. By not permitting Q2824 to be cut off when Q2813 is cut off the output to Q2834 is relatively unaffected by input video excursions. The maximum signal swing at the Q2824 collector for any magnitude of input signal above about 100 millivolts p-p is about 2 volts p-p, with active response confined to the most negative parts of the input signal. Divider R2824-R2825-R2826 sets the bias level for Q2824.

Diodes CR2824-CR2825 provide thermal compensation for Q2834, and have no other circuit function. Q2834 provides TV LINE (horizontal) composite sync output to the A and B TRIGGER SOURCE switches to serve as TV LINE sync, and drive to the Vertical Sync Recognizer Q2854-Q2863. In the quiescent state, Q2834 is cut off, its emitter held at +5.1 volts and its base below the turn-on level of +5.7 volts. The collector is at +10.1 volts, and is prevented from rising further above the +9.6 volts supply by CR2828. When negative-going sync pulses arrive at Q2813, they are inverted by Q2824 and provide sufficient base current to saturate Q2834. Q2834 is driven between saturation and cutoff, and generates approximately 4.9 volts p-p of sync signal, attenuated to approximately 0.1 volt, suitable for A and B Sweep triggering, and is ac coupled to the A and B Sweep Trigger circuitry.

The Vertical Sync Recognizer, Q2854 and Q2863, recognizes the various forms of TV Vertical (Field Rate) sync pulses by providing an output signal proportional in amplitude to the duration (width) of a preceding negativegoing pulse. The output signal occurs on the trailing edge of the input pulse. In most TV systems using sync-negative video, a vertical sync pulse consists of a train of negativegoing pulses about five times wider than horizontal sync pulses, and separated by narrow intervals (serrations) of about the same width as horizontal sync pulses. In these systems, the recognizer produces a train of narrow output pulses, one for each serration of the sync pulse. In some 405/50 and 819/50 broadcast systems and in many closed circuit TV systems, the vertical sync pulse is a single negative-going (sync-negative) pulse having a duration of several full horizontal lines. In these systems, the recognizer puts out a single narrow pulse at the end of the sync pulse.

Q2854 is driven by the Q2834 Sync Amplifier with a 4.9 volt signal, with the negative portion of the signal representing the sync portion of the incoming waveform. In the absence of sync pulses, the collector of Q2834 is high and CR2831 holds the base of Q2834 at about +9.6 volts. When the Q2834 collector steps negative with a sync pulse, Q2834 is cut off and its collector steps positive by about 350 millivolts. The output stage network sets the emitter of Q2863 near +10.2 volts and provides Q2854 with a collector voltage of around +12.2 volts. The 60 microamp collector current of Q2854 (set by approximately 9.0 volts drop across R2856) generates around a 0.35 volt drop in the equivalent 5.5 kilohm collector load. This sets the base voltage of Q2863 at +11.9 volts nominal, ensuring that Q2863 is cut off.

Options—465B Service Option 05

When Q2854 is cut off, C2856 discharges toward ground on a 30 microsecond time-constant, starting at a rate of about -300 millivolts per microsecond. The Q2854 emitter voltage decreases 0.5 to 2.0 volts for the duration of a 2- to 6-microsecond wide horizontal sync or vertical equalizing pulse. For the longer duration vertical sync pulses, the emitter voltage decreases 4 volts (typical for 819/50 system with serrations) to 5.5 volts (voltage decrease stops when the emitter reaches ± 4.2 volts since the base is held at ± 4.7 volts).

When the collector of the Q2834 Sync Amplifier steps positive at the end of the pulse, a negative-going output pulse is generated at the collector of Q2854 that is proportional to the amount of emitter voltage decrease. The exact magnitude of this output pulse is a complex function of the rate of rise of the positive transition from Q2834, the value of C2856, the collector-to-base capacitance of Q2854 (including C2854) and the collector-to-ground capacitance of Q2854. The output pulse at the Q2854 collector is approximately 80% of the amount of voltage decrease.

The positive-going trailing edge of the differentiated Q2854 collector output pulse, which is coupled back to the base by C2854 and the Q2854 collector capacitance, creates an overshoot at the base of Q2854. This drives the base about 1.5 volts above the quiescent level at the end of a vertical sync pulse (this overshoot does not appear on the Q2834 collector bus). The Q2854 collector waveform stays negative during the time the base is being driven positive; when the base stops at the quiescent level, the collector voltage rises rapidly, coupling an apparent overshoot into the base waveform. This condition tends to delay the start of the emitter voltage decrease for vertical serrations following the first one, but is otherwise insignificant.

The output stage bias network, keeping Q2863 cut off in the quiescent state, inhibits the output of Q2854 collector pulses of less than about 2 volts peak (negative) amplitude. The larger pulses corresponding to the trailing edge of vertical sync pulses are large enough to turn on Q2863, and provide output signals of 1 to 2.5 volts at the input end of C2865. Because of the short rise time of the generated pulses, the output stage responds a small amount, even during cutoff, due to base-emitter capacitance in Q2863; this is particularly noticeable when the load is removed.

With the load disconnected, the negative-going output pulses are 2 to 2.5 volts in amplitude (somewhat smaller in 819/50 systems with serrated sync pulses), with a rise time of about 25 nanoseconds and a width of about 150 nanoseconds. Because they are so narrow, with a low repetition rate, they are hard to locate in an oscilloscope

display. They are frequently misinterpreted as to their presence or absence, their amplitude, and even polarity (a small trailing-edge overshoot is often mistaken for the pulse itself).

The output stage is diode-connected to limit positivegoing peaks in the output. Output coupling capacitor C2865 attenuates the signal, providing a proper level to the A Trigger circuits, to permit correct A TRIGGER LEVEL control action.

ADJUSTMENT PROCEDURE

Introduction

This procedure ensures proper calibration and performance of the TV Sync Separator circuitry included in Option 05, and is based on the 525/60 line and field system. If your Option 05 instrument is calibrated with the equipment prescribed for the 525/60 system, it should perform satisfactorily with other line and field systems.

Before starting this procedure, make sure the rest of your instrument meets all the specifications covered by the Performance Check or Adjustment Procedure in the main portion of this manual. For Option 05 instruments, during the main Performance Check or Adjustment Procedure, use the 24 picofarad Normalizer for vertical attenuator input compensation. Refer to Table 6-1 for complete information on the Normalizer.

Preliminary Procedure for Sync Separator Calibration

- Refer to the instructions in the main portion of this manual and remove the front cover and cabinet from your Option 05 instrument.
- 2. Set the controls as stated under Preliminary Control Settings for Option 05 calibration.
- Connect the Option 05 instrument to a power source within the range of its overall voltage and frequency specifications.
- 4. Refer to the Performance Temperature Specifications in the Performance Check or Adjustment Procedure in the Specification section of this manual.
- Allow at least 20 minutes warm-up before proceeding.

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Table 6-1 **OPTION 05 TEST EQUIPMENT REQUIRED**

Description	Minimum Specifications	Examples		
Television Test Signal Generator	Composite Video Output with 525/60 and 1201/60 line and field rate; Output 350 mV to 1 V into 75 Ω termination.	Tektronix Part Number 067-0601-00 Calibration Fixture with 067-5002-00 (525/60) and 067-5010-00 (1201/60) plug-in units.		
Test Oscilloscope with 10X Probe	Bandwidth, dc to 20 MHz; minimum deflection factor, 5 mV/division at 20 MHz; Accuracy within 3%.	TEKTRONIX 465B Oscilloscope with included 10X probe.		
Termination	Impedance, 75 Ω; connectors, bnc.	Tektronix Part Number 011-0055-00.		
Cable, Coaxial (two required)	Impedance, 75 Ω (not critical, 50 Ω may be substituted); length, 42 inches; connectors, bnc.	Tektronix Part Number 012-0074-00.		
Input Normalizer	RC Time Constant, 24 pF times 1 MΩ (used during Vertical Input Compensation in main Performance Check and Adjustment Procedure).	Tektronix Part Number 067-0539-00.		

Preliminary Control Settings for Option 05 Calibration

(unlisted controls may be left at any position)

Power Controls

Regulating Range Selector

At center of range of available

power source.

Line Voltage Selector

As specified for available power

source.

POWER

ON (pull)

CRT Controls

INTENSITY **FOCUS**

Midrange (for viewable trace) Midrange (for focused trace)

SCALE ILLUM

Midrange

Vertical Controls

VERT MODE

CH₂

CH 2 VOLTS/DIV

.1 V

CH 2 Input Coupling

AC

INVERT

Out (Normal)

20 MHz BW LIMIT

Full bandwidth (button out)

Sweep Controls

HORIZ DISPLAY

A AND B TIME/DIV

20 μs

AUTO

Triggering Controls

TRIG MODE A LEVEL B LEVEL

A AND B SLOPE

0 (12 o'clock) Minus (-) TV FIELD

11 o'clock

A COUPLING B COUPLING A SOURCE

AC NORM

B SOURCE TV LINE

Procedure

1. Clipping Level Adjustment (R2826 on Sync Separator Board)

- a. Connect the Television Test Signal Generator (with the 525/60 plug-in installed) Composite Video Output to the CH 2 input via a 75 Ω cable and 75 Ω termination.
- b. Adjust the Average Picture Level fully counterclockwise and the Composite Video Amplitude for a 3-division display.

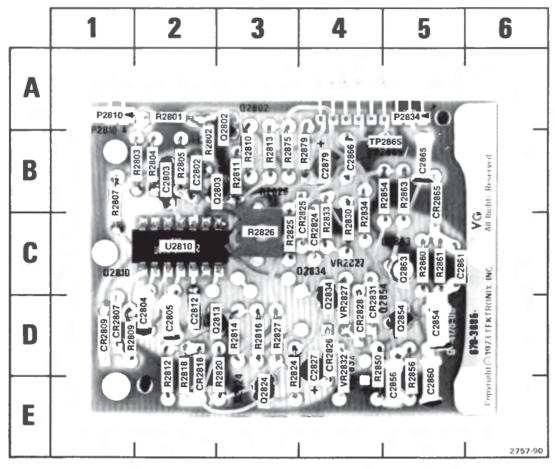
Options—465B Service Option 05

- c. Set the CH 2 VOLTS/DIV switch to 0.5 V.
- d. Adjust the Average Picture Level control for a 2-division display. Set CH 2 VOLTS/DIV switch to 2 V.
- e. Connect a 10X probe from the test oscilloscope (Vertical Volts/Division set for 0.2 V) to TP2865 (see Figure 6-1).
- f. Connect the generator rear panel Field Rate Trigger Output through a coaxial cable to the Test Oscilloscope External Trigger input. Set Test Oscilloscope Trigger Source to External, Time/Division to 1.0 ms, and Trigger Level for a stable triggered display.
- g. ADJUST—R2826. Starting at the counterclockwise stop, adjust in a clockwise direction until the test oscilloscope display consists of a sequence of 6 narrow—6 wide—6 narrow pulses (for systems other than 525/60 the number and shape of pulses will differ). Adjust until top of displayed pulses are clean and free of any distortion (disregard bottom of pulses). Set Test Oscilloscope Volts/Division to 0.5 V.
- h. Set the Option 05 instrument CH 2 VOLTS/DIV switch to 0.5 V, 0.2 V, 0.1 V, and 50 mV and check at each setting for a test oscilloscope display with top and bottom of waveform clean and free of distortion. If any distortion is noted, repeat parts a through h.
- i. Set the Option 05 A TRIGGER SLOPE switch to \pm and depress the INVERT button (in).
 - j. Repeat part h until no improvement is noted.
- k. Replace the Test Signal Generator 525/60 plug-in with the 1201/60 plug-in; set the Option 05 instrument A TRIGGER SLOPE switch to and release the INVERT button (out). Repeat parts h through j.
- Disconnect the Test Oscilloscope probe and external trigger cable.

2. A and B Sweep TV Line Trigger Check

- a. Replace the Television Test Signal Generator 1201/60 plug-in with the 525/60 plug-in.
- b. Set the Option 05 instrument CH 2 VOLTS/DIV switch to 1.0 V, A TIME/DIV switch to 20 μ s, and A TRIGGER COUPLING switch to TV LINE.
- c. CHECK—that stable TV line triggering can be achieved by adjusting A TRIGGER LEVEL control (disregard field pulses moving through the display).
- d. Set the Option 05 instrument A TRIGGER COUPLING switch to TV FIELD. Set A TIME/DIV switch to 2 ms and the B TIME/DIV switch to 0.1 ms. Adjust the A TRIGGER LEVEL control for a stable triggered display.
- e. Select ALT Horizontal Display and adjust B TRIGGER LEVEL control for a stable triggered intensified zone and B DLY'D trace. Adjust B INTENSITY and TRACE SEP controls as necessary.
- f. Rotate the DELAY TIME POSITION dial to position the start of the intensified portion of the trace just to the left of the second displayed field pulse.
- g. Rotate the DELAY TIME POSITION dial and check that a stable display can be obtained for any sync pulse that is positioned on top of the field pulse (intensified zone should jump from one sync pulse to the next as the DELAY TIME POSITION dial is rotated).
- h. Disconnect the test equipment, remove the power plug from the power source, and replace the cabinet on the Option 05 instrument.

This completes the Adjustment Procedure and check of the Option 05 portion of the instrument.



CKT NO	GRID	CKT GRID NO LOC	NO LOC	NO LOC	NO LOC	NO LOC	CKT GRID NO LOC	NO LO
C2802	2B	C2861 5C	CR2825 4C	Q2824 3E	R2801 2A	R2812 2E	R2827 3D	R2863 5E
C2803 C2804	2B 2D	C2865 5B C2866 4B	CR2826 4D CR2828 4D	Q2834 4D Q2854 5D	R2802 2B R2803 2B	R2813 3B R2814 3D	R2830 4C R2833 4C	R2875 3E R2879 4E
C2805	2D	C2879 4B	CR2831 4D	Q2863 5C	R2804 2B	R2816 3D	R2834 4C	TP2865 5E
C2812 C2827	2D 4D	CR2807 1D	CR2865 5B	P2810 1A	R2805 2B R2807 1B	R2818 2E R2820 3E	R2850 4D R2854 5B	U2810 2
C2854	5D	CR2809 1D	Q2802 3A	P2834 4A	R2809 1D	R2824 3E	R2856 5E	02010
C2856 C2880	5E 5E	CR2818 2E CR2824 4C	Q2803 3B Q2813 3D	P2833 4C P2863 1A	R2810 3B R2811 3B	R2825 3C R2826 3C	R2860 5C R2861 5C	VR2827 4 VR2832 4

Figure 6-4. A12 TV Sync Separator and Inverter Amplifier board component locations.

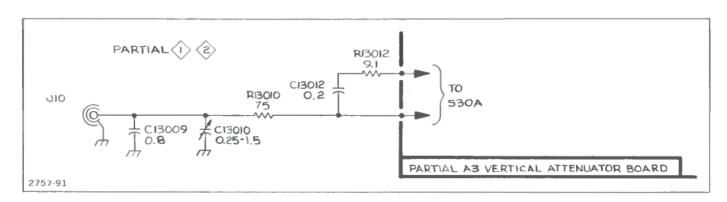
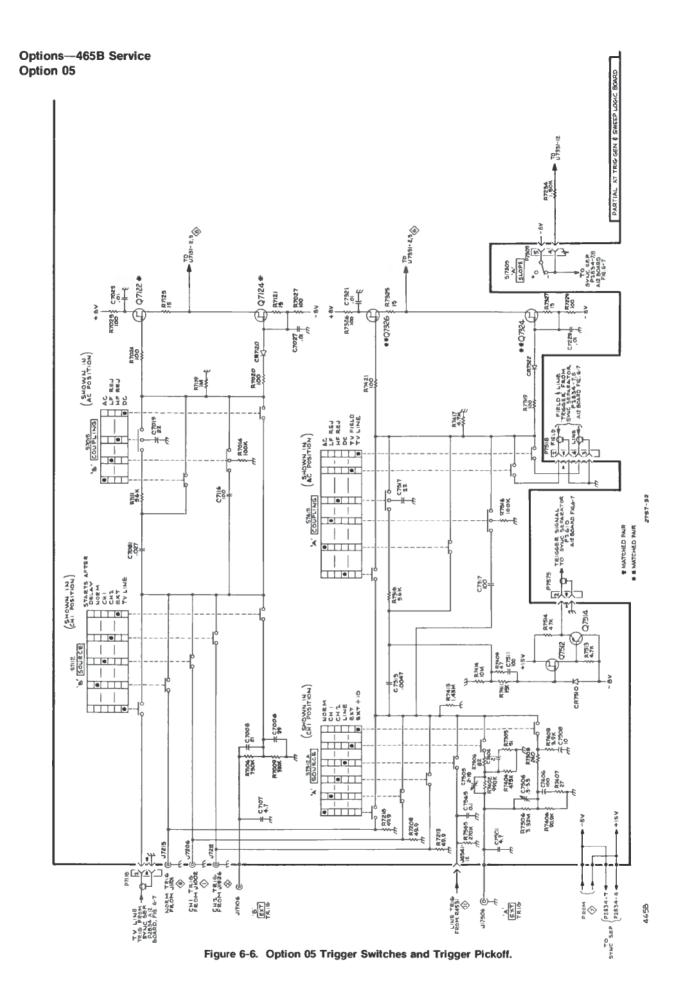


Figure 6-5. Option 05 465B Vertical Input changes.

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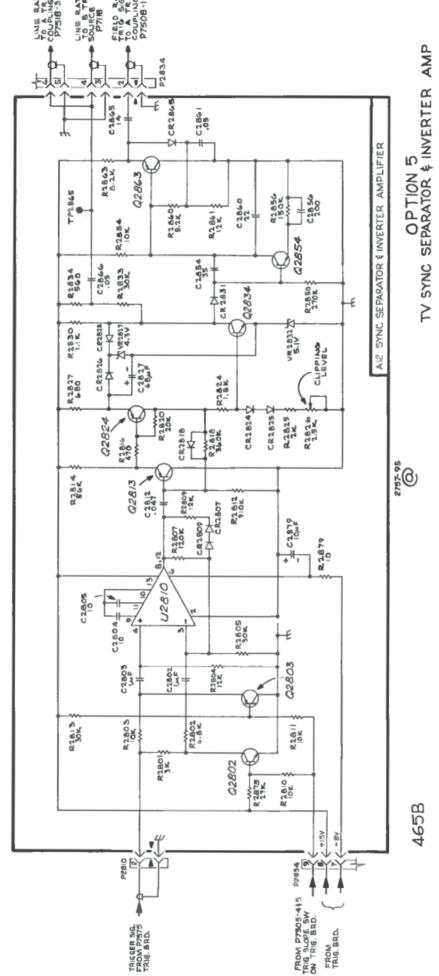


Figure 6-7. Option 05 TV Sync Separator and Inverter Amplifier.

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ELECTRICAL

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
			CHANGES FROM STANDARD 465B WHEN OPTION 05 IS ADDED		
(CHANGE TO):					
A7 A7C7313 A7R7417 A7S7112 A7S7415	670-6000-01 281-0772-00 315-0475-00 263-0070-00 263-0070-00		CKT BOARD ASSY:TRIGGER GEN & SWEEP LOGIC CAP.,FXD,CER DI:0.0047UF,10%,100V RES.,FXD,CMPSN:4.7M OHM,5%,0.25W SW SL ACTR ASSY:A COUPLING,6 OF 6 POSITION SW SL ACTR ASSY:A COUPLING,6 OF 6 POSITION	80009 72982 01121 80009 80009	670-6000-01 8005H9AADW5R472K CB4755 263-0070-00 263-0070-00
(ADD):					
A7C7107 A7C7501 A7C7511 A7CR7510 A7CR7512 A7Q7512 A7Q7514 A7R7409 A7R7411	281-0592-00 281-0592-00 281-0814-00 152-0264-00 151-1005-00 151-0220-03 315-0470-00 315-0153-00		CAP.,FXD,CER DI:4.7PF,+/-0.5PF,500V CAP.,FXD,CER DI:4.7PF,+/-0.5PF,500V CAP.,FXD,CER DI:100PF,10%,100V SEMICOND DEVICE:ZENER,3W,56V,5% TRANSISTOR:SILICON,JFE,N-CHANNEL TRANSISTOR:SILICON,PNP,SEL RES.,FXD,CMPSN:47 OHM,5%,0.25W RES.,FXD,CMPSN:15K OHM,5%,0.25W	72982 72982 72982 80009 80009 80009	301-023C0H0479D 301-023C0H0479D 8035D2AADC0G101K 152-0264-00 151-1005-00 151-0220-03 CB4705 CB1535
A7R7413 A7R7414 A7R7513 A7R7514	321-0496-00 315-0106-00 315-0472-00 315-0472-00		RES.,FXD,CMPSN:15K OHM,1%,0.125W RES.,FXD,CMPSN:10M OHM,5%,0.25W RES.,FXD,CMPSN:4.7K OHM,5%,0.25W RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	91637 01121 01121	HFF1813G14303F CB1065
			CHASSIS PARTS		
(CHANGE TO:)					
C13012 (ADD):	285-1055-00		CAP., FXD, PLSTC: 0.2UF, 10%, 400V	80009	285-1055-00
C13009	281-0661-00		CAP.,FXD,CER DI:0.8PF,+/-0.1PF,500V	72982	301-000C0K0808B
R13012	307-0116-00		RES.,FXD,CMPSN:9.1 OHM,5%,0.25W	01121	CB91G5
			A12 TV SYNC SEPARATOR		
A12 A12C2802 A12C2803 A12C2804 A12C2805 A12C2812	670-3685-00 283-0059-00 283-0059-00 281-0504-00 281-0504-00 283-0341-00		CKT BOARD ASSY:TV SYNC SEPARATOR CAP.,FXD,CER DI:1UF,+80-20%,25V CAP.,FXD,CER DI:1UF,+80-20%,25V CAP.,FXD,CER DI:10PF,+/-1PF,500V CAP.,FXD,CER DI:10PF,+/-1PF,500V CAP.,FXD,CER DI:0.047UF,10%,100V	80009 72982 72982 72982 72982 72982	8131N031Z5U0105Z 8131N031Z5U0105Z
A12C2827 A12C2854 A12C2856 A12C2860 A12C2861 A12C2865	290-0530-00 281-0632-00 281-0605-00 281-0511-00 283-0010-00 281-0577-00		CAP.,FXD,ELCTLT:68UF,20%,6V CAP.,FXD,CER DI:35PF,1%,500V CAP.,FXD,CER DI:200PF,10%,500V CAP.,FXD,CER DI:22PF,+/-2.2PF,500V CAP.,FXD,CER DI:0.05UF,+100-20%,50V CAP.,FXD,CER DI:14PF,5%,500V	90201 72982 04222 72982 56289 72982	TDC686M006NLF 308-000C0G0350F 7001-1375 301-000C0G0220K 273C20 301-050C0G0140J
A12C2866	283-0010-00		CAP., FXD, CER DI:0.05UF, +100-20%, 50V	56289	273C20

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Options—465B Service Option 05

	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A12C2879	290-0536-00		CAR PUR BY CONT. LOVID CON OFT	00001	
A12CR2807			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	
A12CR2809	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 50NA	01295	1N4152R
A12CR2818	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 50NA		1N4152R
	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 50NA		1N4152R
A12CR2824	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 50NA		1n4152R
A12CR2825	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 50NA	01295	1N4152R
A12CR2826	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 50NA	01295	1N4152R
A12CR2828	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 50NA		1N4152R
A12CR2831	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 50NA		1N4152R
A12CR2865	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 50NA		1N4152R
A12Q2802	151-0190-00		TRANSISTOR: SILICON, NPN	07263	
A12Q2803	151-0220-00		TRANSISTOR: SILICON, PNP	80009	151-0220-00
41202812	151 0100 00				
A12Q2813	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
A12Q2824	151-0188-00		TRANSISTOR: SILICON, PNP	80009	
A12Q2834	151-0192-00		TRANSISTOR: SILICON, NPN, SEL FROM MPS6521	04713	
A12Q2854	151-0192-00		TRANSISTOR: SILICON, NPN, SEL FROM MPS6521	04713	SPS8801
A12Q2863	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
A12R2801	315-0302-00		RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
A12R2802	315-0682-00		RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	СВ6825
A12R2803	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W		CB1035
A12R2804	315-0123-00		RES., FXD, CMPSN:12K OHM, 5%, 0.25W		CB1235
A12R2805	315-0303-00				CB3035
A12R2807	315-0124-00		RES.,FXD,CMPSN:30K OHM,5%,0.25W RES.,FXD,CMPSN:120K OHM,5%,0.25W		
A12R2809	315-0124-00				CB1245
R12R2009	313-0123-00		RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A12R2810	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A12R2811	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
A12R2812	315-0914-00		RES.,FXD,CMPSN:910K OHM,5%,0.25W	01121	CB9145
A12R2813	315-0303-00		RES.,FXD,CMPSN:30K OHM,5%,0.25W		CB3035
A12R2814	315-0563-00		RES., FXD, CMPSN: 56K OHM, 5%, 0.25W	01121	
A12R2816	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	
A12R2818	315-0364-00		DEC EVE ONDON 250V OUN 5% O 250	01101	on 277 E
A12R2820			RES.,FXD,CMPSN:360K OHM,5%,0.25W	01121	
A12R2824	315-0203-00		RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	
A12R2825	315-0182-00		RES., FXD, CMPSN:1.8K OHM, 5%, 0.25W		CB1825
A12R2826	315-0202-00		RES.,FXD,CMPSN:2K OHM,5%,0.25W		CB2025
	311-1226-00		RES., VAR, NONWIR: 2.5K OHM, 20%, 0.50W	32997	
A12R2827	315-0681-00		RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A12R2830	315-0112-00		RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
A12R2833	315-0303-00		RES., FXD, CMPSN: 30K OHM, 5%, 0.25W	01121	CB3035
A12R2834	315-0561-00		RES., FXD, CMPSN: 560 OHM, 5%, 0.25W		CB5615
A12R2850	315-0274-00		RES., FXD, CMPSN: 270K OHM, 5%, 0.25W	01121	
A12R2854	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W		CB1035
A12R2856	315-0154-00		RES., FXD, CMPSN: 150K OHM, 5%, 0.25W	01121	CB1545
A1202960	215 0000 00		Pro mun cunou a ou con fil a con-	01101	annone.
A12R2860	315-0822-00		RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
A12R2861	315-0123-00		RES., FXD, CMPSN: 12K OHM, 5%, 0.25W	01121	CB1235
A12R2863	315-0822-00		RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
A12R2875	315-0273-00		RES., FXD, CMPSN: 27K OHM, 5%, 0.25W	01121	CB2735
A12R2879	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A12U2810	156-0136-00		MICROCIRCUIT, LI: OPNL AMPL	02735	CA3030
A12VR2827	152-0395-00		SEMICOND DEVICE: ZENER, 0.4W, 4.3V, 5%	04713	1n749A
A12VR2832	152-0195-00		SEMICOND DEVICE: ZENER, 0.4W, 5.1V, 5%	80009	152-0195-00
	00			Ç500)	-92 01/9 00

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MECHANICAL

Fig. &					MECHANIC	AL		
Index No.	Tektronix Part No.	Serial/Mode Eff D:		/ 1	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
					CHANGES FROM STAND WHEN OPTION 05 IS			
CHANG	E TO:							
	672-0796-0 333-2524-0		1		CKT BOARD ASSY:ATT PANEL,FRONT:	PENUATOR	80009 80009	
A7	670-6000-0 131-0608-0 136-0252-0	00	1 8 6		TERMINAL, PIN: 0.3	GGER GEN & SWEEP LOGIC 165 L X 0.25 PH, BRZ, GOLD PI U/W 0.016-0.018 DIA PINS	80009 L 22526 22526	47357
				(CHASSIS PARTS			
	337-1762-0 105-0243-0 441-1150-0 211-0101-0 211-0244-0 179-2194-0 198-2318-0 131-0707-0 175-0828-0 352-0163-0	00 00 00 00 00 00 00		5	SCR,ASSEM WSHR:4-4 WIRING HARNESS:0PT WIRE SET,ELEC:	C,DC C SEPARATOR D X 0.25" 100 DEG,FLH STL SO X 0.312 INCH,PNH STL SION 5 22-26 AWG,BRS& CU BE GOLD 5 WIRE RIBBON	80009 80009 8338 78189 80009 80009 22526 0826	105-0243-00 441-1150-00 6 OBD 0 OBD 179-2194-00 198-2318-00 47439 OBD
					STAN	DARD ACCESSORIES		
	337-1674-0 337-1674-0	_	1		•	TER MARKED FOR NTSC TER MARKED FOR CCIR	80009	

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OPTION 07 EXTERNAL DC OPERATION

INTRODUCTION

Option 07 is a dc-to-ac inverter that permits Tektronix oscilloscopes to operate on either 12 or 24 volts dc with no performance deterioration. Circuitry is provided to protect against damage due to connection of 24 volts when in the 12-volt mode of operation. The 24-volt external input permits use with marine and aircraft conventional dc power.

Option 07 is an integral part of the oscilloscope. The modified oscilloscope has a three-position voltage input selection slide switch (visible through the right side panel) at the rear of the line voltage selector switch. A dc-input connector is located below the fan cover on the rear panel.

Option 07 is not provided with 465B oscilloscopes equipped with the DM44 Digital Multimeter.

SPECIFICATION

Electrical characteristics and performance requirements listed in the Specification part of this manual are applicable to the 465B Option 07 oscilloscope with the following exceptions or additions:

DC REQUIREMENTS. Either 11.5 to 14 volts or 22 to 28 volts. Operation with 11.5 to 14 volts will not allow use of the graticule lights or Option 05. Operating range may be extended to 15 volts or 30 volts with a series dropping resistor. Maximum elevation for + or - power lead is 50 volts with respect to oscilloscope chassis or ground.

CONTROLS AND CONNECTORS

Mode Switch	Three-position switch located adjacent to the Line Voltage Selector switch on the right side panel and used to select the proper input power to the 465B.
AC	Permits application of ac power

DC 12 Permits 12-volt operation of the instrument from an external 12-

volt source.

DC 24

Permits 24-volt operation of the instrument from either an external 24-volt power source or from the 1106 Battery Pack, which may be mechanically attached to the oscilloscope.

DC Input Connector

Used for connecting external dc power source to the 465B Option 07; located on rear panel.

OPERATION AND INSPECTION

To operate the 465B Option 07 oscilloscope:



Connect the oscilloscope frame to a ground (earth) reference before using.

Set the 465B Line Selector switch and the Option 07
Mode switch to the appropriate positions for the power
source to be used. Refer to the following table for proper
switch positions.

465B Line Selector Switch	Option 07 Mode Switch			
115	AC			
230	AC			
_	DC 12			
_	DC 24			
	DC 24			
	Selector Switch			

2. The 465B Option 07 oscilloscope may now be operated using the information, instructions, and procedures contained in preceding sections of this manual with the exception of DM44 digital multimeter operation.

THEORY OF OPERATION

Option 07 is a dc-to-ac inverter operating on 12 or 24 volts dc. The operating frequency of the inverter is approximately 400 Hz. The following circuit description is for 24-volt operation unless noted otherwise. Refer to the schematic diagrams (Figures 6-9 and 6-10) throughout the detailed circuit description.

General Description

The dc source is applied to the Turn-off Level circuit, the Start circuit, and the primary of T14500 (see Figure 6-8). If the dc source is above the level set by Turn-off Level Adjustment R1613, the Turn-off circuit does not operate.

The Start circuit provides a large current surgethrough T1631 secondary to the bases of Q1652, Q1662, Q1654 and Q1664. This starts the inverter.

The Turn-off circuit is activated in two ways. In 24 V operation, Q1622 is turned on by the source voltage dropping below 22 volts. In 12 V mode of operation, Q1626 is turned on by the accidental application of 24 volts dc.

Turn-Off Level Circuit

For the following description, refer to Figure 6-9.

The voltage reference for the base of Q1606 is set by R1604, VR1604, and VR1605 to approximately 9.1 volts. This establishes the junction of R1607 and the emitters of Q1606 and Q1608 at about 9.7 volts. Power transients that occur whenever the inverter is turned on are prevented from activating the Turn-off circuit by the filtering action of C1605. This filtering action helps hold the 9.1 volt supply base of Q1606 constant and prevents Q1608 from turning on, thereby allowing sufficient time for the power source to recover after providing the initial-start surge.

Source voltages higher than 22 volts dc cause increased current through R1607, Q1606, and R1609. Q1608 is kept cut off by the increased voltage across R1609 and the resulting change across the divider comprised of R1611, R1613, and R1614. This permits no current through R1617. Since R1617 furnishes bias to Q1622, the transistor is cut off. This permits the collector of Q1622 and the rest of the turn-off circuit to rise to a voltage determined by the inverter circuit and the dc source voltage. The collector of Q1622 may be about 24 volts (with respect to —dc) with a 12-volt dc source and about 36 volts with a 24-volt dc source

If the dc source voltage drops to less than 22 volts, the current through divider R1609, R1611, R1613 and R1614 is decreased. Q1608 conducts, taking current from Q1606, and causing less drop across R1609. This makes Q1608 conduct more, and Q1606 is cut off. Current flow through R1617 turns Q1622 on. Q1622 saturates, dropping its collector voltage to about 0.2 volt. The maximum base current of Q1622 is limited by R1618.

During 12-volt dc operation, there is no current flow through VR1604 and VR1605, since their series rating (about 18 volts) exceeds the applied voltage. The base current of Q1606, through R1605, turns Q1606 on enough to take all the current through R1607, which causes Q1608 to be cut off.

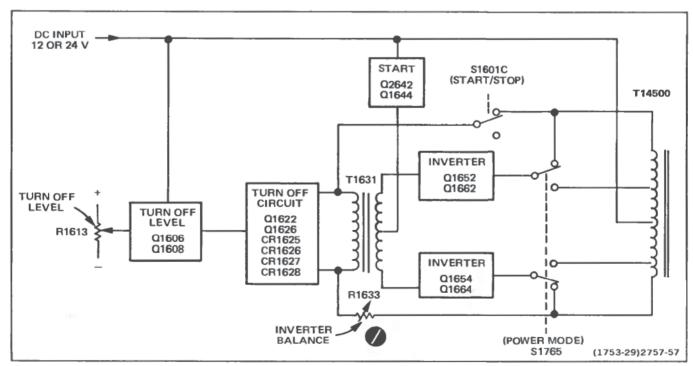


Figure 6-8. Option 07 simplified block diagram.

Turn-Off Circuit

Q1622 is off under normal operating conditions until the dc source drops below 22 volts and causes Q1622 to conduct. Q1622 does not conduct during 12-volt dc operation, since the Turn-off Level circuit is disabled. CR1625, CR1626, CR1627, and CR1628 form a bridge rectifier. The inverter waveform is rectified to provide operating power for the Turn-off circuit. The inverter spikes are filtered by C1626 to keep them from firing Q1626 (silicon-controlled rectifier). Resistor R1623 prevents C1626 from charging to the peak-to-peak level of the inverter spikes.

When Q1622 is turned on, it saturates. The high current path required for feedback current via CR1625 or CR1626 is provided by C1622. Whenever the inverter is shut down, C1622 discharges through R1622.

If 24 volts dc is accidentally applied when the mode switch is in the 12-volt position, transformer T14500 attempts to produce two times the correct feedback. This is sufficient to cause VR1622 to conduct. VR1622 provides the firing current for silicon-controlled rectifier Q1626. Scr Q1626 fires and shorts out the bridge rectifier and the

primary of T1631, stopping the inverter. R1625 prevents Q1626 from being fired by inverter noise. R1624 and C1626 provide holding current for Q1626, keeping it conducting until the surge created by the over-voltage conditions have terminated. Diode CR1624 permits rapid charging of C1626.

Start Circuit

When S1601 is closed, the external dc source is applied to C1614, VR1641, and R1645. The initial surge is coupled to Q1642 through C1614, VR1639, and R1641. Transistor Q1642 saturates until C1614 charges through R1639 to the value determined by VR1639 and the base-emitter junction of Q1642 (about 5.7 volts), then Q1642 is cut off. R1641 limits the base current in Q1642. Zener diode VR1639, once C1614 is charged, makes Q1642 insensitive to input variations. R1642 limits Q1642 collector current. Q1644, R1645, and VR1641 provide a constant current during the time Q1642 is saturated, regardless of the dc source voltage. CR1643 is reverse biased by this starting current. The starting current is applied to the inverter transistors through T1631.

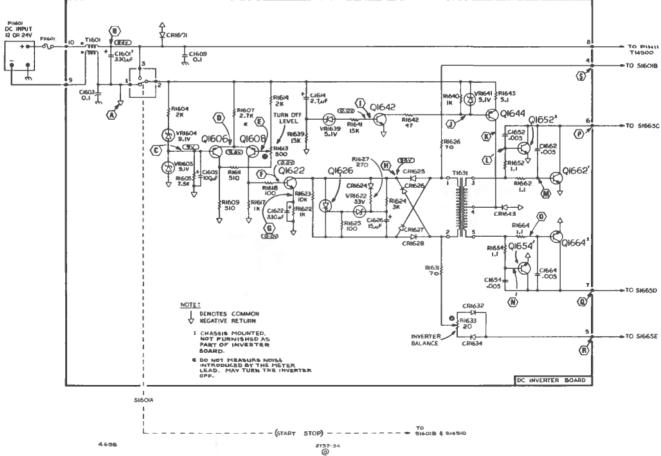


Figure 6-9. 465B Option 07 DC Inverter.

Options—465B Service Option 07

Inverter Circuit

The starting surge is applied to the bases of Q1652, Q1662, Q1654, and Q1664 through T1631, R1652, R1662, R1654, and R1664. Since the transistors do not have identical parameters, one pair will conduct before the other and will start the inverter. Operating base current is provided through CR1643.

The main frequency-determining components for the inverter are R1626, R1631, and T1631 primary and secondary windings. Four base resistors (R1652, R1662, R1654, and R1664) distribute the drive evenly between the four transistors. C1652, C1662, C1654 and C1664 degenerate the high frequency response and reduce transients.

Feedback to maintain inverter operation is provided from T14500 primary to T1631 primary through R1626, R1631, R1633, CR1632 and CR1634. R1626 and R1631 provide frequency stability and current limiting. R1633, CR1632, and CR1634 compensate for differences in

transistors and components. CR1632 and CR1634 conduct during different inverter half-cycles and permit R1633 to balance the drive to T14500.

Capacitors C4503, C4502, C4513, C4517, and C4501 are added to the secondary of T14500 with Option 07 to provide optimum reduction of transients during inverter operation.

DC Input

External power is applied through P11601. Diode CR1601 is normally reverse biased. If the wrong polarity external power is applied, CR1601 becomes forward biased and blows fuse F11601. A low-pass network comprised of T1601, C1601, C1603, and C1609 acts as a filter to reduce transients to the dc source.

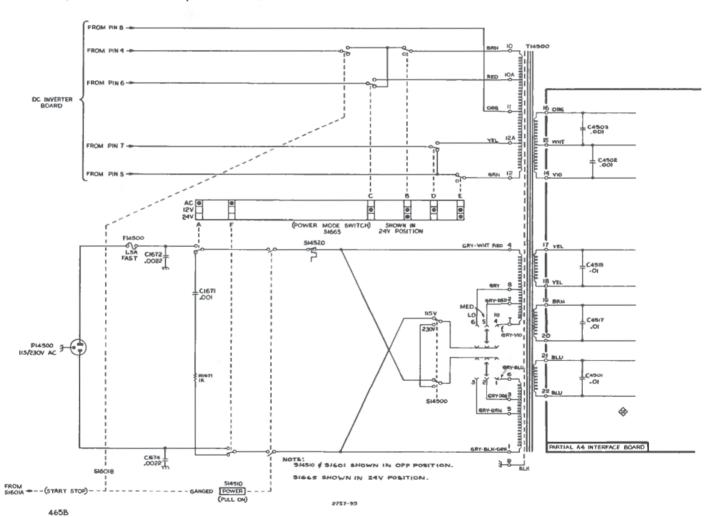


Figure 6-10. 465B Option 07 primary winding.

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Start-Stop Switch

The capacitors in the Turn-Off and Start circuits are discharged by section A of S1601 when the switch is set to the off (stop) position. This ensures the correct time constants when S1601 is changed to the on (start) position. In the start position, the dc input is applied to the inverter circuitry by S1601, section A. At the same time S1601 section B is closed, completing the feedback loop for the inverter transistors. S1601 section B stops the inverter in the off position by opening the feedback loop between T14500 and T1631.

Power-Mode Switch (S1665)

Sections A and F of S1665 connect filter C1671 and R1671 to T14500 during 12-volt or 24-volt operation to reduce converter transients (see Figure 6-10). Sections C and D of S1665 select either transformer terminals 10A and 12A or 10 and 12, to provide the same secondary output when operating on 12 or 24 volts. Sections B and E connect transformer terminals 10 and 12 to S1665 sections C and D and to the inverter feedback circuit during both 12-volt and 24-volt operation.

MAINTENANCE

Obtaining Replacement Parts

STANDARD PARTS. Most electrical and mechanical parts can be obtained through your local Tektronix field office or representative. However, you should be able to

obtain many of the standard electronic components from a local commercial source in your area. Before you purchase or order a part from a source other than Tektronix Inc., please check the Electrical Parts list for the proper value, rating, tolerance and description.

SPECIAL PARTS. In addition to the standard electronic components, some special components are used in Option 07. These components are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix in accordance with our specifications. 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., include the following information:

- 1. Instrument type.
- 2. Instrument serial number.
- A description of the part (if electrical, include the circuit number).
- 4. Tektronix part number.

Table 6-2
OPTION 07 TEST EQUIPMENT REQUIRED

Description	Minimum Specification	Usage	Examples
DC Voltmeter	22 V to 28 V, 1% accuracy.	Set input voltage.	a. Triplett Model 630-N/b. Simpson Model 262
Test Oscilloscope	Bandwidth, dc to 500 kHz; minimum deflection, 10 mV/division.	Verify inverter balance.	a. TEKTRONIX 212 oscilloscope. b. TEKTRONIX 465B oscilloscope*.
DC Power Source	22 V to 28 V and 11.5 V to 14 V. Handle starting surge of 4 to 10 A without dropping below 22 V. 12-volt starting surge is approximately 15 A.	Supply operating power for Option 07.	Any variable DC power supply that meets minimum specification.

^{*}If the instrument under test and Option 07 are operational and the power source used has a negative ground, the instrument under test may be used as the test oscilloscope.

Options—465B Service Option 07

Circuit Board Chassis Removal

The Option 07 circuit board is mounted on a small chassis located between the power transformer and the crt shield. To remove the chassis, first remove the two thread-forming screws located at the top of the chassis. Then remove one screw at the bottom right side of the chassis, just below the power transformer.

ADJUSTMENT

Option 07 may be calibrated without removing it from the oscilloscope.

In the following procedures the reference letters (A), (B), etc., refer to points indicated on the schematic diagram (Figure 6-9) and circuit board illustrations.

NOTE

Option 07 is calibrated at the factory using a power supply having the specifications given in Table 6-2, Equipment Required. This permits the most accurate setting of the turn-off volts and inverter balance adjustments. Because this type of power supply may not be available, several alternative possibilities are given. The alternate power supplies have drawbacks, including voltage stability vs. time with high discharge rates. See Figure 6-11.

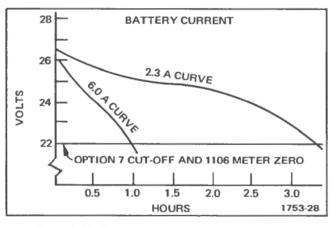


Figure 6-11. Typical battery pack discharge curves.

Power Supply Alternatives

- Variable power supply with the capabilities given in Table 6-2.
- Variable power supply with an adequate current rating, in series with the supply alternative in item 4 or item

- 3. TEKTRONIX 1106 Battery Pack.1
- Two 12-volt wet-cell storage batteries, in series, tapped at 20, 22, or 24 volts.²
- 5. 18 to 23 NiCd cells, 4.0 ampere-hour (D cells) or greater, furnishing 20 to 28 volts.²



This procedure is for an external dc source with the negative lead at ground potential (negative ground system).

Operating Range

a. Connect the dc source to the oscilloscope equipped with Option 07. Operate the oscilloscope in the 24 V mode. Connect the voltmeter between fuse F1601 (B) and the common negative return (A). Vary the dc source from 28 volts to 22 volts.

CHECK—that the oscilloscope operates over the voltage range.

 b. Change the dc source to 12 volts. Operate the oscilloscope in the 12 V mode. Vary the dc source from 14 volts to 11.5 volts.

CHECK—that the oscilloscope operates over the voltage range.

To set the turn-off level, the battery is charged above the cut-off point (22 V). An oscilloscope is connected and the battery allowed to discharge while its voltage is being monitored. As it reaches 22 V the turn-off point is set to cut off Option 07. The turn-off point on Option 07 approximately coincides with the meter zero on the 1106.

This does not permit accurate adjustment of the turn-off level. NiCd batteries can be used, following the technique used for item 3.

Inverter Balance

NOTE

If the major oscilloscope use is with a 12-volt source, perform this step while operating the oscilloscope with dc source on 12 volts.

Operate the oscilloscope in the 24 V mode. Set the do source to 24 volts. Attach the probe ground to the common negative terminal (A) and connect the test oscilloscope probe tip to C1601 (C).

CHECK-that the signal is flat. See Figure 6-12.

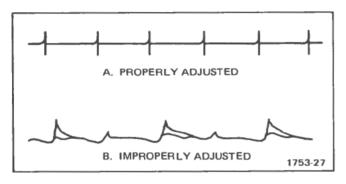


Figure 6-12. Option 07 Inverter balance.

ADJUST-Inverter Balance (R1633) for the flattest signal.

NOTE

There is a slow drift (about a second) after the Inverter Balance adjustment has been moved. This is due to transistor characteristics and will require a slight Inverter Balance readjustment.

A very close approximation of the preceding method can be obtained by setting the Inverter Balance control for the minimum sound coming from the Inverter.

Turn-Off Level

Set the dc source for 21.8 volts.

ADJUST—Turn-off Level (R1613) slowly until Option 07 turns off.

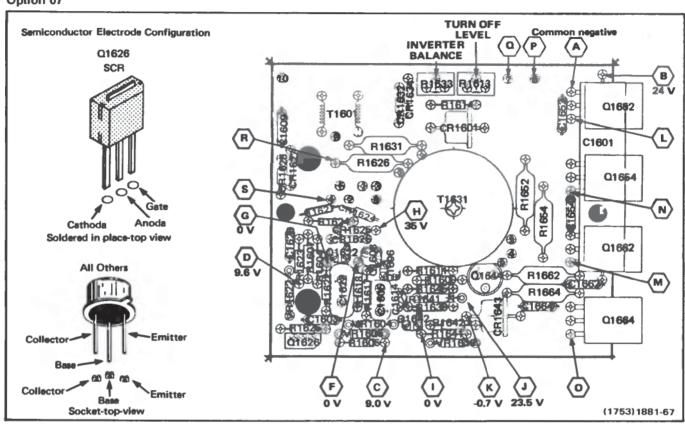


Figure 6-13. Option 07 DC Inverter circuit board adjustment and test point locations.

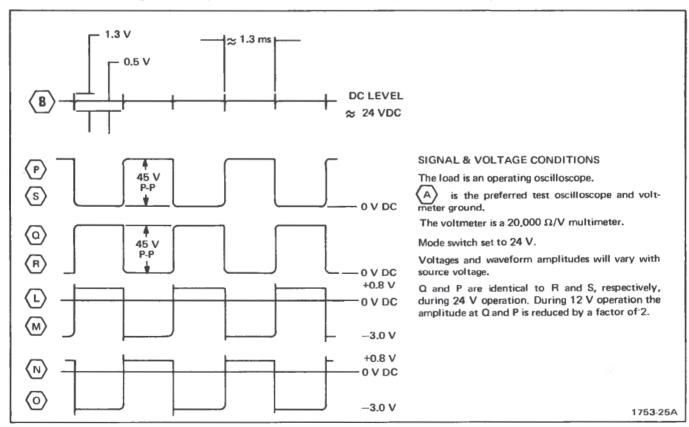
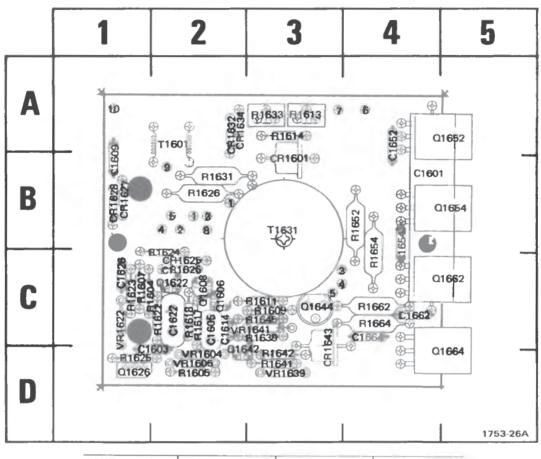


Figure 6-14. Option 07 DC Inverter idealized waveforms.



CKT NO	GRID LOC	CKT NO	GRID	CKT NO	GRID	CKT NO	GRID
C1601	4B	CR1628	1B	R1605	2D	R1641	3D
C1603	2D	CR1632	2A	R1607	1C	R1642	3D
C1605	2C	CR1634	2A	R1609	3C	R1645	3C
C1609	1B	CR1643	3D	R1611	3C	R1652	4B
C1614	2C			R1613	3A	R1654	4B
C1622	2C	Q1606	2C	R1614	3A	R1662	4C
C1626	1C	Q1608	2C	R1617	2C	R1664	4C
C1652	4A	Q1622	2C	R1618	2C		
C1654	4B	Q1626	1D	R1622	2C	T1601	2A
C1662	4C	Q1642	2D	R1623	1C	T1631	3B
C1664	4C	Q1644	3C	R1624	2C		
		Q1652	5A	R1625	1D	VR1604	2D
CR1601	3B	Q1654	5B	R1626	2B	VR1605	2D
CR1624	2B	Q1662	5C			VR1622	1C
CR1625	2C	Q1664	5D	R1631	2B	VR1639	3D
CR1626	2C			R1633	3A	VR1641	3C
CR1627	1B	R1604	1C	R1639	3C		

Figure 6-15. Option 07 DC Inverter circuit board component locations.

ELECTRICAL

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
			CHANGES FROM STANDARD 465B WHEN OPTION 07 IS ADDED		-
(CHANGE TO):					
A4 A4	670-5996-02 670-5996-05	B010100 B029999 B030000	CKT BOARD ASSY: INTERFACE CKT BOARD ASSY: INTERFACE	80009 80009	670-5996-02 670-5996-05
(ADD):					
A4C4501 A4C4502 A4C4503 A4C4513 A4C4517 A4R4262	283-0003-00 283-0000-00 283-0000-00 283-0003-00 283-0003-00 315-0223-00	хв011250	CAP.,FXD,CER DI:0.01UF,+80-20%,150V CAP.,FXD,CER DI:0.001UF,+100-0%,500V CAP.,FXD,CER DI:0.001UF,+100-0%,500V CAP.,FXD,CER DI:0.01UF,+80-20%,150V CAP.,FXD,CER DI:0.01UF,+80-20%,150V RES.,FXD,CMPSN:22K OHM,5%,0.25W	72982 72982 72982 72982 72982 01121	831-516E102P 831-516E102P 855-558Z5U-103Z 855-558Z5U-103Z
A14 A14C1601 A14C1603 A14C1605 A14C1609 A14C1614	670-2744-01 290-0667-00 283-0178-00 290-0531-00 283-0178-00 290-0573-00		CKT BOARD ASSY:INVERTER CAP.,FXD,ELCTLT:330UF,+75-10%,50V CAP.,FXD,CER DI:0.1UF,+80-20%,100V CAP.,FXD,ELCTLT:100UF,20%,10V CAP.,FXD,CER DI:0.1UF,+80-20%,100V CAP.,FXD,ELCTLT:2.7UF,20%,50V	80009 56289 72982 90201 72982 56289	670-2744-01 500D158 8131N145651 104Z TDC107M010WLC 8131N145651 104Z 196D275X0050JA1
A14C1622 A14C1626 A14C1652 A14C1654 A14C1662 A14C1664	290-0533-00 290-0528-00 283-0110-00 283-0110-00 283-0110-00 283-0110-00		CAP.,FXD,ELCTLT:330UF,20%,,6V CAP.,FXD,ELCTLT:15UF,20%,50V CAP.,FXD,CER DI:0.005UF,+80-20%,150V CAP.,FXD,CER DI:0.005UF,+80-20%,150V CAP.,FXD,CER DI:0.005UF,+80-20%,150V CAP.,FXD,CER DI:0.005UF,+80-20%,150V	90201 90201 56289 56289 56289 56289	TDC337M006WLD TDC156M050WLC 19C242B 19C242B 19C242B 19C242B
A14CR1601 A14CR1624 A14CR1625 A14CR1626 A14CR1627 A14CR1628	152-0198-00 152-0333-00 152-0107-00 152-0107-00 152-0107-00 152-0107-00		SEMICOND DEVICE:SILICON,200V,3A SEMICOND DEVICE:SILICON,55V,200MA SEMICOND DEVICE:SILICON,400V,400MA SEMICOND DEVICE:SILICON,400V,400MA SEMICOND DEVICE:SILICON,400V,400MA SEMICOND DEVICE:SILICON,400V,400MA	03508 80009 80009 80009 80009	1N5624 152-0333-00 152-0107-00 152-0107-00 152-0107-00 152-0107-00
A14CR1632 A14CR1634 A14CR1643 A14Q1606 A14Q1608 A14Q1622	152-0333-00 152-0333-00 152-0198-00 151-0301-00 151-0301-00 151-0302-00		SEMICOND DEVICE:SILICON,55V,200MA SEMICOND DEVICE:SILICON,55V,200MA SEMICOND DEVICE:SILICON,200V,3A TRANSISTOR:SILICON,PNP TRANSISTOR:SILICON,PNP TRANSISTOR:SILICON,NPN	80009 80009 03508 04713 04713	
A14Q1626 A14Q1642 A14Q1644 A14Q1652 A14Q1654 A14Q1662	151-0506-00 151-0302-00 151-0335-00 151-0436-00 151-0436-00 151-0436-00		SCR:SILICON TRANSISTOR:SILICON, NPN TRANSISTOR:SILICON, PNP TRANSISTOR:SILICON, NPN TRANSISTOR:SILICON, NPN TRANSISTOR:SILICON, NPN TRANSISTOR:SILICON, NPN	03508 07263 80009 80009 80009	C106B2X283 S038487 151-0335-00 151-0436-00 151-0436-00 151-0436-00
A14Q1664 A14R1604 A14R1605 A14R1607 A14R1609 A14R1611	151-0436-00 315-0202-00 315-0752-00 315-0272-00 315-0511-00 315-0511-00		TRANSISTOR:SILICON, NPN RES.,FXD,CMPSN:2K OHM,5%,0.25W RES.,FXD,CMPSN:7.5K OHM,5%,0.25W RES.,FXD,CMPSN:2.7K OHM,5%,0.25W RES.,FXD,CMPSN:510 OHM,5%,0.25W RES.,FXD,CMPSN:510 OHM,5%,0.25W	80009 01121 01121 01121 01121 01121	CB2725
A14R1613 A14R1614 A14R1617	311-1248-00 315-0202-00 315-0102-00		RES., VAR, NONWIR: 500 OHM, 10%, 0.50W RES., FXD, CMPSN: 2K OHM, 5%, 0.25W RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	73138 01121 01121	72X-23-0-501K CB2025 CB1025

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Options—465B Service Option 07

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A14R1622	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CP1025
A14R1623	315-0103-00		RES., FXD, CMPSN:1K OHM, 5%, 0.25W		CB1025
A14R1624	315-0302-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035 CB3025
A14R1625	316-0101-00				CB1011
A14R1626	308-0450-00		RES., FXD, CMPSN:100 OHM, 10%, 0.25W		
A14R1627	315-0271-00		RES.,FXD,WW:70 OHM,1%,3W RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	RS2B-B70R00F CB2715
***************************************	313 0271 00		RES., FAD, CHESN. 270 ORM, 3%, 0.23W	01121	CB2/13
A14R1631	308-0450-00		RES.,FXD,WW:70 OHM,1%,3W	91637	RS2B-B70R00F
A14R1633	311-1501-00		RES., VAR, NONWIR: 20 OHM, 10%, 0.50W		72-37-0
A14R1639	315-0153-00		RES., FXD, CMPSN:15K OHM, 5%, 0.25W		CB1535
A14R1640	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W		CB1025
A14R1641	315-0153-00		RES.,FXD,CMPSN:15K OHM,5%,0.25W		CB1535
A14R1642	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W		CB4705
A14R1645	307-0113-00		RES.,FXD,CMPSN:5.1 OHM,5%,0.25W	01121	CB51G5
A14R1652	308-0459-00		RES., FXD, WW:1.1 OHM, 5%, 3W	91637	CW2B-D1R100J
A14R1654	308-0459-00		RES.,FXD,WW:1.1 OHM,5%,3W	91637	CW2B-D1R100J
A14R1662	308-0459-00		RES.,FXD,WW:1.1 OHM,5%,3W	91637	CW2B-D1R100J
A14R1664	308-0459-00		RES.,FXD,WW:1.1 OHM,5%,3W	91637	CW2B-D1R100J
A14T1601	120-0637-00		XFMR, TOROID:5 TURNS BIFILAR	80009	120-0637-00
A1/m1/02	100 0				
A14T1631	120-0852-00		XFMR, TOROID: 2 WINDINGS	80009	120-0852-00
A14VR1604	152-0306-00		SEMICOND DEVICE: ZENER, 0.4W, 9.1V, 5%		152-0306-00
A14VR1605	152-0306-00		SEMICOND DEVICE: ZENER, 0.4W, 9.1V, 5%		152-0306-00
A14VR1622	152-0241-00		SEMICOND DEVICE:ZENER, 0.4W, 33V, 5%	80009	152-0241-00
A14VR1639	152-0279-00		SEMICOND DEVICE: ZENER, 0.4W, 5.1V, 5%	80009	152-0279-00
A14VR1641	152-0279-00		SEMICOND DEVICE:ZENER, 0.4W, 5.1V, 5%	80009	152-0279-00
			CHASSIS PARTS		
C1671	283-0000-00		CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P
C1672	283-0263-00		CAP., FXD, CER DI:0.0022UF, 20%, 3000V	56289	33C319
			(MOUNTED ON REAR PANEL. NOT USED WHEN		
			INSTR IS EQUIPPED WITH BOTH OPTION 4		
			AND OPTION 7)		
C1674	283-0263-00		CAP., FXD, CER DI:0.0022UF, 20%, 3000V	56289	33C319
			(SEE FOOTNOTE ON C1672)		
C1681	283-0000-00		CAD EVD CED DI-A AALIW -100 AF FAAU	70000	021 F1(F102D
01001	283-0000-00		CAP.,FXD,CER DI:0.001UF,+100-0%,500V (SEE FOOTNOTE ON C1672)	72982	831-516E102P
C1682	283-0000-00		CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P
01002			(WHEN EQUIPPED WITH BOTH OPTION 4 AND	12702	031-31061021
			OPTION 7, ONLY ONE SET OF THESE CAPS		
			IS USED)		
C1683	283-0003-00		CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-558Z5U-103Z
C1684	202 0002 00		(SEE FOOTNOTE ON C1682)	72000	OFF FEOREW 100-
C1004	283-0003-00		CAP.,FXD,CER DI:0.01UF,+80-20%,150V (SEE FOOTNOTE ON C1682)	72982	855-558Z5U-103Z
C1685	283-0003-00		CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-558Z5U-103Z
			(SEE FOOTNOTE ON C1682)		000 000000 2000
F1601	159-0038-00		FUSE, CARTRIDGE: 3AG, 15A, 32V, FAST-BLOW	71400	MDL 15A
m1/01					
P1601	131-1333-00		CONNECTOR, RCPT, : POWER	80009	131-1333-00
R1671	308-0077-00		RES., FXD, WW:1K OHM, 5%, 3W	14103	SA301001J
	300 0077-00		THE STATE OF THE S	14193	3K7010013
S1601	260-0834-00		SWITCH, TOGGLE: DPDT, 5A, 125VAC, 0.25-40 THD	09353	U21-SHZQE
S1665	105-0479-00		ACTUATOR, SWITCH: SLIDE, INVERTER	80009	105-0479-00
S1665A	260-0760-00		SWITCH, SENS: 10A, 250V, SPDT, SNAP ACTION	01963	
S1665B	260-0760-00		SWITCH, SENS: 10A, 250V, SPDT, SNAP ACTION		E62-10A
S1665C	260-0760-00		SWITCH, SENS: 10A, 250V, SPDT, SNAP ACTION	01963	
S1665D	260-0760-00		SWITCH, SENS:10A, 250V, SPDT, SNAP ACTION		E62-10A
S1665E	260-0760-00		SWITCH, SENS:10A,250V, SPDT, SNAP ACTION		E62-10A
S1665F	260-0760-00		SWITCH, SENS: 10A, 250V, SPDT, SNAP ACTION		E62-10A
_					

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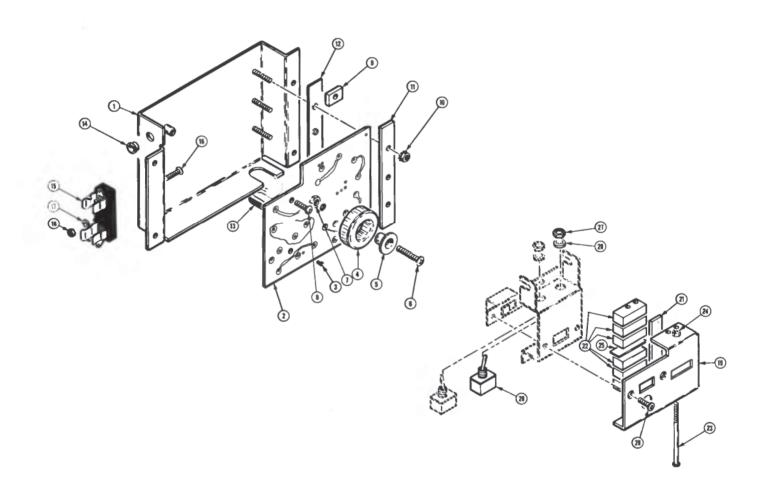
Options—465B Service Option 07

Fig. &			MECHANICAL	
Index	Tektronix	Serial/Model No.		

Fig. &				MEGIA	TOAL		
Index	Tektronix	Serial/Model No.				Mfr	
No.	Part No.	Eff Dscont	Qty	12345	Name & Description	Code	Mfr Part Number
-1	441-1171-00		1	CHASSIS,SCOPE: I	NVERTER ATTACHING PARTS)	80009	441-1171-00
	211-0008-00		2		-40 x 0.25 INCH, PNH STL	83385	OBD
	210-0938-00				09 ID X 0.25 INCH OD, STL		AN960-3
	210 0730 00		-	WASHER, FEAT. O. I.	*	7,54,77	ANJOU 3
-2			1	CKT BOARD ASSY:	INVERTER(SEE A14 EPL)		
-3	136-0252-04		15	. SOCKET, PIN TE	RM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-4				. XFMR, TOROID: (
-5	343-0443-00		1	. RETAINER, XFMR	:	80009	343-0443-00
-6	212-0011-00				:8-32 X 0.750 INCH, FLH STL	83385	OBD
-7	210-0409-00		1	. NUT, PLAIN, HEX	.:8-32 X 0.312 INCH, BRS	73743	3046-402
				(ATTACU	* ING PARTS FOR CKT BD)		
-8	211-0116-00		2	4	4-40 X 0.312 INCH, PNH BRS	83385	OBD
	212 0110 00		-	bon, abbut won.	*	0,70,7	000
-9			4		Q1652,Q1654,Q1662,1664 EPL) ATTACHING PARTS)		
-10	210-0586-00		3	NUT, PLAIN, EXT W	:4-40 X 0.25 INCH, STL	78189	211-041800-00
-11	343-0451-00		1	RETAINER, XSTR:		80009	343-0451-00
-12	342-0195-00		1	INSULATOR, PLATE	:0.70 X 3 INCHES LONG	08530	OBD
-13	348-0141-00		1	GROMMET, PLASTIC	:U-SHP,0.625 X0.658 INCH	80009	348-0141-00
-14	348-0055-00		1	GROMMET, PLASTIC	:0.25 INCH DIA	80009	348-0055-00
-15	352-0031-00		1	FUSEHOLDER: 3AG	FUSE ATTACHING PARTS)	75915	357001
-16	211-0507-00		1	SCREW, MACHINE: 6	-32 X 0.312 INCH, PNH STL	83385	OBD
-17	210-0006-00		1	WASHER, LOCK: #6	INTL, 0.018THK, STL CD PL	78189	1206-00-00-0541C
-18	210-0407-00				6-32 X 0.25 INCH, BRS	73743	3038-0228-402
	342-0228-00		1	INSULATOR, FILM:	0.70 X 1.150 INCH LONG	80009	342-0228-00
-19	407-1341-00		1	BRACKET, ELEC SW		80009	407-1341-00
-20	211-0101-00		2		-40 X 0.25" 100 DEG, FLH STL	83385	OBD
-21	105-0479-00		1	ACTUATOR, SWITCH		80009	105-0479-00
-22	260-0760-00		6	SWITCH, SENS: 10A	,250V,SPDT,SNAP ACTION ATTACHING PARTS)		E62-10A
-23	211-0212-00		2		-56 X 1.75 INCH, PNH STL	83385	OBD
-24	210-0405-00				2-56 X 0.188 INCH, BRS		2X12157-402
-25	386-2649-00		1	PL,ACTR GUIDE:I		80009	386-2649-00
	214-1925-00		1	SPRING, SW ACT: P			214-1925-00
-26				SWITCH, TOGGLE: (SEE S1665 EPL) ATTACHING PARTS)	00007	211 2727 00
-27	210-0562-00		1		0.25-40 X 0.312 INCH, BBS	73743	2X20224-402
-28	210-0046-00		î		L,0.26 ID X 0.40" OD,STL		1214-05-00-0541C
20	220 0040 00		•	midnen, book. Int	*	,0107	
	179-1962-00		1	WIRING HARNESS:	VARIABLE RESISTOR	80009	179-1962-00
	348-0005-00		1	GROMMET, RUBBER:	0.50 INCH DIA	70485	230
	200-1414-11			COVER, SCOPE: REA		80009	200-1414-11
	131-1333-00		1	CONNECTOR, RCPT,		80009	131-1333-00
	211_0101_00				ATTACHING PARTS)	83385	OBD
	211-0101-00		2	•	-40 X 0.25" 100 DEG, FLH STL	80009	
	348-0365-00		4	FOUL, CABINET: PL	ASTIC,W/LATCH GROOVE	00009	J-40-0107-00

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OPTION 07 EXPLODED VIEW



OPTION 78 TYPE P11 PHOSPHOR

This option adds a Type P11 phosphor crt to the instrument.

2. After completing crt installation, check Table 4-6 (Adjustment Interactions), in the Adjustment Procedure of this manual, for calibration adjustments which may require readjustment.

PARTS LIST CHANGES

If this option is being added to an instrument which is already equipped with a different phosphor, or if the cathode-ray tube requires replacement, use the following procedure:

1. Follow the crt removal and installation procedure in the Maintenance section of this manual.

Delete V14000

CRT, P31 Phosphor 154-0676-15

Add

CRT, P11 Phosphor V14000 154-0676-19

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REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

ABBREVIATIONS

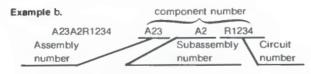
Abbreviations conform to American National Standard Y1.1

COMPONENT NUMBER (column one of the Electrical Parts List)

A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:



Read: Resistor 1234 of Assembly 23



Read: Resistor 1234 of Subassembly 2 of Assembly 23

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

NAME & DESCRIPTION (column five of the Electrical Parts List)

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

MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

MFR. PART NUMBER (column seven of the Electrical Parts List)

Indicates actual manufacturers part number.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00779	AMP, INC.	P 0 BOX 3608	HARRISBURG, PA 17105
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P 0 B0X 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR	P O BOX 5012, 13500 N CENTRAL	•
	GROUP	EXPRESSWAY	DALLAS, TX 75222
01963	CHERRY ELECTRICAL PRODUCTS CORPORATION	3600 SUNSET AVENUE	WAUKEGAN, IL 60085
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 9174
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR		
	PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD, PO BOX 20923	PHOENIX, AZ 85036
05397	UNION CARBIDE CORPORATION, MATERIALS	11001 WARROW ARRIVE	CLERKEL IND. OU 11101
07063	SYSTEMS DIVISION	11901 MADISON AVENUE	CLEVELAND, OH 44101
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF	/// FILLS CEDEEM	MOUNTAIN WIFE CA DADAS
07716	FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
07716	TRW ELECTRONIC COMPONENTS, IRC FIXED	2050 MT DIEACANT	BUDI INCTON IA 52601
08806	RESISTORS, BURLINGTON DIV.	2850 MT. PLEASANT	BURLINGTON, IA 52601
00000	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPARTMENT	NELA PARK	CLEVELAND, OH 44112
09353	C AND K COMPONENTS, INC.	103 MORSE STREET	WATERTOWN, MA 02172
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON STREET	DOVER, NH 03820
12954	SIEMENS CORPORATION, COMPONENTS GROUP	8700 E THOMAS RD, P O BOX 1390	SCOTTSDALE, AZ 85252
12969	UNITROOE CORPORATION	580 PLEASANT STREET	WATERTOWN, MA 02172
14193	CAL-R, INC.	1601 OLYMPIC BLVD.	SANTA MONICA, CA 90404
14298	AMERICAN COMPONENTS, INC., AN		,
	INSILCO COMPANY	8TH AVE. AT HARRY STREET	CONSHOHOCKEN, PA 19428
14433	ITT SEMICONDUCTORS	3301 ELECTRONICS WAY	•
		P O BOX 3049	WEST PALM BEACH, FL 33402
14552	MICRO SEMICONDUCTOR CORP.	2830 F FAIRVIEW ST.	SANTA ANA, CA 92704
15454	RODAN INDUSTRIES, INC.	2905 BLUE STAR ST.	ANAHEIM, CA 92806
16546	U.S. CAPACITOR CORP/CENTRALAB		
	ELECTRONICS DIV.	4561 COLORADO	LOS ANGELES, CA 90039
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
24546	CORNING GLASS WORKS, ELECTRONIC		
	COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
25088	SIEMENS CORP.	186 WOOD AVE. S	ISELIN, NJ 08830
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32293	INTERSIL, INC.	10900 N. TANTAU AVE.	CUPERTINO, CA 95014
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
34335	ADVANCED MICRO DEVICES	901 THOMPSON PL.	SUNNYVALE, CA 94086
50157	MIDWEST COMPONENTS INC.	P. O. BOX 787	WIGHTON W. 10113
50/3/	UPUR PETE DAOVADO COMPANY	1981 PORT CITY BLVD.	MUSKEGON, MI 49443
50434	HEWLETT-PACKARD COMPANY	640 PAGE MILL ROAD	PALO ALTO, CA 94304
50437	RELIANCE STEEL PRODUCTS COMPANY	3700 WALNUT STREET	MCKEESPORT, PA 15132
52306	HIGH VOLTAGE DEVICES, INC.	7485 AVENUE 304	VISALIA, CA 93277
52763	STETTNER-TRUSH, INC.	67 ALBANY STREET	CAZENOVIA, NY 13035
53184	XCITON CORPORATION	5 HEMLOCK STREET	LATHAM, NY 12110 SPRING MILLS, PA 16875
55210	GETTIG ENG. AND MFG. COMPANY	PO BOX 85, OFF ROUTE 45	CHICAGO, IL 60645
55680	NICHICON/AMERICA/CORP.	6435 N PROESEL AVENUE	NORTH ADAMS, MA 01247
56289 71400	SPRAGUE ELECTRIC CO. BUSSMAN MFG., DIVISION OF MCGRAW-		nonth nomin, in 01247
/1400	EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71590	CENTRALAB ELECTRONICS, DIV. OF	2330 W. UNIVERSITI OI.	311 20013, 770 03107
71330	GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, LA 50501
72619	DIALIGHT, DIV. AMPEREX ELECTRONIC	203 HARRISON PLACE	BROOKLYN, NY 11237
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
73899	JFD ELECTRONICS COMPONENTS CORP.	PINETREE ROAD	OXFORD, NC 27565
74276	SIGNALITE DIV., GENERAL INSTRUMENT CORP.	1933 HECK AVE.	NEPTUNE, NJ 07753
74970	JOHNSON, E. F., CO.	299 10TH AVE. S. W.	WASECA, MN 56093
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED		
. 7072	RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
76493	BELL INDUSTRIES, INC.,		
	MILLER, J. W., DIV.	19070 REYES AVE., P 0 BOX 5825	COMPTON, CA 90224
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80031	ELECTRA-MIDLAND CORP., MEPCO DIV.	22 COLUMBIA ROAD	MORRISTOWN, NJ 07960
	•		

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CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip	
82389 90201	SWITCHCRAFT, INC. MALLORY CAPACITOR CO., DIV. OF	5555 N. ELSTON AVE. 3029 E. WASHINGTON STREET	CHICAGO, IL 60630	
91637	P. R. MALLORY AND CO., INC. DALE ELECTRONICS, INC.	P. O. BOX 372 P. O. BOX 609	INDIANAPOLIS, IN 46206 COLUMBUS, NE 68601	
93410	ESSEX INTERNATIONAL, INC., CONTROLS DIV. LEXINGTON PLANT	P. O. BOX 1007	MANSFIELD, OH 44903	

Repleceable Electrical Parts-465B Service

	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description		Mfr Part Number
- Component Ito.	Turt ito.		Hame a besomption	0000	WITT CALL TROUTEDO
A1	670-5997-00	B010100 B045774	CKT BOARD ASSY: VERTICAL PREAMP	80009	670-5997-00
A1	670-5997-01	B045775	CKT BOARD ASSY: VERTICAL PREAMP	80009	670-5997-01
A2	670-5999-00	B010100 B029999	CKT BOARD ASSY: VERTICAL OUTPUT	80009	670-5999-00
A2	670-6385-00	B030000	CKT BOARD ASSY: VERTICAL OUTPUT	80009	670-6385-00
A3	670-6003-00		CKT BOARD ASSY: ATTENUATOR	80009	670-6003-00
A4	670-5996-00	B010100 B029999	CKT BOARD ASSY: INTERFACE	80009	670-5996-00
A4	670-5996-03	B030000	CKT BOARD ASSY: INTERFACE	80009	670-5996-03
			(SEE OPTION SECTION FOR OPT 4 & OPT 7)		
A5	670-5998-00		CKT BOARD ASSY: VERTICAL MODE SWITCH	80009	670-5998-00
A6	670-6001-00		CKT BOARD ASSY: TIMING	80009	670-6001-00
A7	670-6000-00		CKT BOARD ASSY:TRIGGER GEN & SWEEP LOGIC	80009	670-6000-00
A8	670-6002-01		CKT BOARD ASSY: FAN MOTOR	80009	670-6002-01
	470 4004			00000	170 1001 00
A9	670-6004-00		CKT BOARD ASSY: PROBE CODING	80009	670-6004-00
A10	670-2279-00		CKT BOARD ASSY: CRT SCALE ILLUMINATION	80009	670-2279-00
Al			CKT BOARD ASSY: VERTICAL PREAMP		
A1C1016		VP022260		72042	8035D9AADC1G470K
A1C1026	281-0763-00	XBUZZZGU	CAP., FXD, CER DI:47PF, 10%, 100V	72982 72982	
A1C1020	281-0815-00		CAP., FXD, CER DI:0.027UF, 20%, 50V	72982	
A1C1048	281-0815-00		CAP., FXD, CER DI:0.027UF, 20%, 50V	72982	
	281-0812-00		CAP., FXD, CER DI:1000PF, 10%, 100V CAP., FXD CER DI:0.047UF, 20%, 50V	04222	
A1C1071	281-0813-00		CAP., FAD CER DI:0.0470F, 20%, 50V	04222	GC/03-E-4/3M
A1C1072	281-0786-00		CAP., FXD, CER 01:150PF, 10%, 100V	72982	8035D2AADX5P151K
A1C1075	281-0773-00		CAP.,FXD,CER 01:0.01UF,10%,100V	72982	8005H9AADW5R103K
A1C1091	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	
A1C1095	281-0815-00		CAP.,FXD,CER D1:0.027UF,20%,50V	72982	
A1C1112	281-0798-00		CAP., FXD, CER D1:51PF, 1%, 100V	04222	
A1C1119	290-0517-00		CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KAI
AIOIII)	230-0317-00		CALL, FAD, DECIDITO. COL, 20%, 354	30207	1700007400774111
A1C1135	290-0517-00		CAP., FXD, ELCTLT: 6.8UF, 20%, 35V	56289	196D685X0035KA1
A1C1142	281-0823-00		CAP., FXD, CER DI:470PF, 10%, 50V	12969	
A1C1144	281-0763-00	B010100 B010239	CAP., FXD, CER D1:47PF, 10%, 100V	72982	
A1C1144	281-0819-00	B010240	CAP., FXD, CER DI: 33PF, 5%, 50V	72982	
A1C1152	281-0809-00	5010240	CAP., FXD, CER DI: 200PF, 5%, 100V	72982	
A1C1173	283-0114-00		CAP.,FXD,CER DI:0.0015UF,5%,200V	72982	
			,,		
A1C1192	281-0205-00		CAP., VAR, PLSTC: 4-65PF, 100V	80031	2810C5R565QJ02F0
A1C1287	281-0815-00		CAP., FXD, CER DI:0.027UF, 20%, 50V	72982	800509AA8W5R273M
A1C1306	281-0579-00		CAP., FXD, CER D1:21PF, 5%, 500V	72982	301-050C0G0210J
A1C1334	281-0773-00		CAP., FXD, CER D1:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A1C1342	281-0204-00		CAP., VAR, PLSTC: 2-22PF, 100V	80031	287C00222MJ02
A1C1353	281-0809-00		CAP., FXD, CER D1:200PF, 5%, 100V	72982	8013T2ADDC1G201J
A1C1384	281-0815-00		CAP., FXD, CER DI:0.027UF, 20%, 50V	72982	8005D9AABW5R273M
A1C1385	281-0815-00		CAP., FXD, CER DI:0.027UF, 20%, 50V	72982	8005D9AABW5R273M
A1C1396	290-0517-00		CAP., FXD, ELCTLT:6.8UF, 20%, 35V	56289	196D685X0035KA1
A1C1398	281-0547-00	B010100 B038899	CAP., FXD, CER D1:2.7PF, 10%, 500V	72982	301-000C0J0279C
A1C1398	281-0547-00	BO38900	CAP., FXD, CER DI:2.7PF, 10%, 500V	72982	301-000C0J0279C
			(NOMINAL VALUE, SELECTED)		
A1C1405	281-0589-00		CAP., FXD, CER D1:170PF, 5%, 500V	72982	30100025D0171J
A1C1422	281-0823-00		CAP., FXD, CER D1:470PF, 10%, 50V	12969	CGB471KDN
A1C1462	290-0517-00		CAP., FXD, ELCTLT: 6.8UF, 20%, 35V	56289	196D685X0035KA1
A1C1464	290-0517-00		CAP., FXD, ELCTLT: 6.8UF, 20%, 35V	56289	1960685X0035KA1
A1C1466	290-0517-00		CAP., FXD, ELCTLT: 6.8UF, 20%, 35V	56289	196D685X0035KA1
A1C1502	281-0773-00		CAP., FXD, CER D1:0.01UF, 10%, 100V	72982	8005H9AADW5K1U3K
.101517	001 000		CAR THE COLOR DATE OF THE COLOR	70000	tions to a series to the
A1C1517	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
AIC1521	281-0823-00		CAP., FXD, CER D1:470PF, 10%, 50V	12969	CGB471KDN
A1C1525	290-0527-00		CAP., FXD, ELCTLT: 15UF, 20%, 20V	90201	TDC156M020FL
A1C1586	283-0114-00		CAP., FXD, CER. D1:0.0015UF, 5%, 200V	72982	805-509B152J
A1C1587	281-0786-00		CAP., FXD, CER D1:150PF, 10%, 100V	72982	8035D2AADX5P151K
A1C1592	281-0773-00		CAP., FXD, CER D1:0.01UF, 10%, 100V	72982	8UO5H9AADW5R1O3K

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0	Tektronix	Serial/Model No.	N OB Set	Mfr	M/ B . N .
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A1C1597	281-0815-00		CAP., FXD, CER DI:0.027UF, 20%, 50V	72982	8005D9AABW5R273M
AlC1611	281~0814~00		CAP., FXD, CER DI:100PF, 10%, 100V	04222	
A1C1615	281-0814-00		CAP., FXD, CER DI:100PF, 10%, 100V	04222	
A1C1623	281-0814-00		CAP., FXD, CER DI:100PF, 10%, 100V	04222	GC70-1-A101K
A1C1643	281-0204-00		CAP., VAR, PLSTC: 2-22PF, 100V	80031	287C00222MJU2
A1C1647	281-0809-00		CAP., FXD, CER DI: 200PF, 5%, 100V	72982	8013T2ADDC1G201J
A1C1682	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A1C1683	281-0813-00		CAP.,FXD CER DI:0.047UF,20%,50V	04222	
A1C1690	281-0205-00		CAP., VAR, PLSTC: 4-65PF, 100V	80031	
A1C1714	281-0814-00		CAP., FXD, CER DI:100PF, 10%, 100V	04222	-
A1C1723	281-0814-00		CAP., FXD, CER DI:100PF, 10%, 100V	04222	GC70-1-A101K
A1C1726	281-0814-00		CAP.,FXD,CER DI:100PF,10%,100V	04222	GC70-1-A101K
A1C1734	290-0527-00		CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
A1C1787	281-0815-00		CAP., FXD, CER DI:0.027UF, 20%, 50V	72982	8005D9AABW5R273M
A1C1804	281-0630-00		CAP., FXD, CER DI:390PF, 5%, 500V	72982	630000Y5D391J
A1C1813	281-0809-00		CAP., FXD, CER DI:200PF, 5%, 100V	72982	8013T2ADDC1G201J
A1C1822	281-0763-00		CAP., FXD, CER D1:47PF, 10%, 100V	72982	8035D9AADC1G470K
A1C1827	281-0798-00		CAP.,FXD,CER D1:51PF,1%,100V	04222	MC101A510G
A1C1832	290-0517-00		CAP., FXD, ELCTLT:6.8UF, 20%, 35V	56289	196D685X0035KA1
A1C1837	281-0815-00		CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A1C1846	281-0812-00		CAP., FXD, CER DI:1000PF, 10%, 100V	72982	8035D9AADX7R102K
A1C1848	281-0759-00		CAP., FXD, CER DI:22PF, 10%, 100V	72982	8035D9AADC1G220K
A1C1854	281-0809-00		CAP., FXD, CER DI:200PF, 5%, 100V	72982	8013T2ADDC1G201J
A1C1885	281-0815-00		CAP.,FXD,CER D1:0.027UF,20%,50V	72982	8005D9AABW5R273M
A1C1886	281-0815-00		CAP., FXD, CER DI:0.027UF, 20%, 50V	72982	8005D9AABW5R273M
A1C1894	290-0517-00		CAP., FXD, ELCTLT: 6.8UF, 20%, 35V	56289	196D685X0035KA1
A1C1896	281-0547-00	B010100 B038899	CAP.,FXD,CER DI:2.7PF,10%,500V	72982	301-000C0J0279C
A1C1896	281-0547-00	B038900	CAP., FXD, CER DI:2.7PF, 10%, 500V	72982	301-000C0J0279C
			(NOMINAL VALUE, SELECTED)		0035004400405100
A1C1906	281-0799-00	XB045775	CAP., FXD, CER DI:62PF, 2%, 100V	72982	8035D2AADCIG510G
A1C1911	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
A1C1912	290-0517-00		CAP., FXD, ELCTLT:6.8UF, 20%, 35V	56289	196D685X0035KAI
A1C1943	281-0823-00		CAP., FXD, CER D1:470PF, 10%, 50V	12969	
A1CR1013	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A1CR1014	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
Alcr1015	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A1CR1023	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A1CR1024	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
AlCR1034	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
A1CR1193	152-0153-00		SEMICOND DEVICE: SILICON, 15V, 50MA		FD7003
AlCR1263	152-0612-00		SEMICOND DEVICE: V VAR CAP., 4V, 17.5PF	80009	
A1CR1264	152-0612-00		SEMICOND DEVICE:V VAR CAP.,4V,17.5PF	80009	152-0612-00
A1CR1298	152-0323-00		SEMICOND DEVICE: SILICON, 35V, 0.1A	80009	
A1CR1312	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
A1CR1327	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
A1CR1432	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672
A1CR1434	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672
A1CR1436	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672
A1CR1438	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672
A1CR1441	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672
A1CR1443	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672
A1CR1445	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672
Alcri447	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672
A1CR1529	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A1CRI541	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672
Alcri543	152-0322-00		SEMICOND DEVICE:SILICON, 15V, HOT CARRIER	50434	5082-2672
Alcris45	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672
AlCR1547	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672

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	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A1CR1693	152-0153-00		SEMICOND DEVICE: SILICON, 15V, 50MA	07263	FD7003
A1CR1727	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A1CR1763	152-0612-00		SEMICOND DEVICE: V VAR CAP., 4V, 17.5PF	80009	152-0612-00
Alcr1764	152-0612-00		SEMICOND DEVICE: V VAR CAP., 4V, 17.5PF	80009	152-0612-00
A1CR1796	152-0323-00		SEMICOND DEVICE: SILICON, 35V, 0.1A	80009	152-0323-00
A1CR1818	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	1N4152R
A1CR1918	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	1N4152R
Alcr1936	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A1L1245	108-0433-00		COIL, RF: 0.09UH	80009 80009	108-0433-00 108-0182-00
A1L1412 A1L1512	108-0182-00 108-0182-00		COIL, RF: 0.3UH COIL, RF: 0.3UH	80009	108-0182-00
A1L1642	108-0433-00		CO1L, RF: 0.09UH	80009	108-0433-00
A1Q1004	151-0190-00		TRANSISTOR: SILICON, NPN	07263	S032677
A1Q1028	151-0221-00	B010100 B022259	TRANSISTOR: SILICON, PNP	04713	SPS246
A1Q1028	151-0220-00	B022260 B045774	TRANSISTOR: SILICON, PNP	07263	S036228
A1Q1028	151-0438-00	B045775	TRANSISTOR: SILICON, PNP, SEL FROM SPS6927		151-0438-00
A1Q1038	151-0271-00		TRANSISTOR: SILICON, PNP		SPS5648
A1Q1045	151-0271-00		TRANSISTOR: SILICON, PNP	04713	SPS5648
A1Q1062	151-0190-00		TRANSISTOR: SILICON, NPN	07263	
A1Q1118	151-0221-00		TRANSISTOR: SILICON, PNP		SPS246
A1Q1125	151-0221-00		TRANSISTOR: SILICON, PNP	04713	SPS246 SPS5648
A1Q1145 A1Q1150	151-0271-00 151-0221-00		TRANSISTOR: SILICON, PNP TRANSISTOR: SILICON, PNP	04713	
A1Q1155	151-0434-00		TRANSISTOR: SILICON, PNP		SS7144
•				0/713	cnc+202_1
A1Q1175	151-0198-00		TRANSISTOR: SILICON, NPN, SEL FROM MPS918	04713	
A1Q1215 A1Q1225	151-0198-00 151-0221-00		TRANSISTOR:SILICON, NPN, SEL FROM MPS918 TRANSISTOR:SILICON, PNP	04713	
A1Q1235	151-0221-00		TRANSISTOR: SILICON, PNP	04713	
A1Q1250	151-0221-00		TRANSISTOR: SILICON, PNP	04713	SPS246
A1Q1297	151-1090-00		TRANSISTOR: SILICON, DUAL, N CHANNEL, FET	80009	151-1090-00
A1Q1344	151-0221-00		TRANSISTOR: SILICON, PNP	04713	SPS246
A1Q1346	151-0221-00		TRANSISTOR: SILICON, PNP	04713	SPS246
A1Q1355	151-0434-00		TRANSISTOR: SILICON, PNP		SS7144
A1Q1375	151-0198-00		TRANSISTOR: SILICON, NPN, SEL FROM MPS918	04713	
A1Q1426	151-0472-00		TRANSISTOR: SILICON, NPN	80009	
A1Q1428	151-0472-00		TRANSISTOR: SILICON, NPN	80009	151-0472-00
A1Q1555	151-0190-00		TRANSISTOR: SILICON, NPN		S032677
A1Q1617	151-0188-00		TRANSISTOR: SILICON, PNP	04713	
A1Q1619	151-0188-00		TRANSISTOR: SILICON, PNP	04713	
A1Q1636	151-0367-00		TRANSISTOR: SILICON, NPN, SEL FROM 3571TP	01295	SKA6516
A1Q1644 A1Q1646	151-0221-00 151-0221-00		TRANSISTOR: SILICON, PNP TRANSISTOR: SILICON, PNP	04713 04713	
•			•		
A1Q1655	151-0434-00		TRANSISTOR: SILICON, PNP		SS7144
A1Q1675	151-0198-00		TRANSISTOR: SILICON, NPN, SEL FROM MPS918		SPS8802-1 151-1090-00
A1Q1698 A1Q1719	151-1090-00 151-0188-00		TRANSISTOR:SILICON, DUAL, N CHANNEL, FET TRANSISTOR:SILICON. PNP	04713	
A101746	151-0168-00		TRANSISTOR: SILICON, PNP	04713	
A1Q1812	151-0188-00		TRANSISTOR: SILICON, PNP	04713	
A1Q1833	151-0221-00		TRANSISTOR: SILICON, PNP	04713	SPS246
A1Q1845	151-0271-00		TRANSISTOR: SILICON, PNP	04713	
A1Q1855	151-0434-00		TRANSISTOR: SILICON, PNP	04713	
A1Q1875	151-0198-00		TRANSISTOR:SILICON, NPN, SEL FROM MPS918	04713	SPS8802-1
A1Q1938	151-0271-00		TRANSISTOR: SILICON, PNP	04713	
A1Q1948	151-0271-00		TRANSISTOR: SILICON, PNP	04713	SPS5648
A1Q1954	151-0221-00		TRANSISTOR: SILICON, PNP		SPS246
A1R1015	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	
A1R1016 A1R1032	321-0064-00	8010100 8033350	RES.,FXD,F1LM:45.3 OHM,1%,0.125W RES.,FXD,F1LM:1.21K OHM,1%,0.125W		MFF1816G45R30F MFF1816G12100F
ALDIUJZ	321-0201-00	B010100 B022259	RES., FAU, FILM.I.ZIR UMM, IA, U.IZJW	11037	III 1010012100F

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Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A1R1032	321-0204-00	B022260	RES., FXD, FILM: 1.3K OHM, 1%, 0.125W		MFF1816G13000F
A1R1033	315-0331-00		RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	CB3315 CB4705
A1R1035 A1R1042	315-0470-00 315-0431-00		RES., FXD, CMPSN: 47 OHM, 5%, 0.25W		CB4315
A1R1052	315-0431-00		RES., FXD, CMPSN: 430 OHM, 5%, 0.25W RES., FXD, CMPSN: 100 OHM, 5%, 0.25W		CB1015
A1R1055	311-1311-00		RES., VAR, NONWIR: 1K OHM, 20%, 1W	01121	73M4G048L102M
MINIOSS	311 1311 00		RED., VAR, WHATKIR OIL, 20%, IW	01121	751140040210211
A1R1064	321-0190-00		RES., FXD, FILM: 931 OHM, 1%, 0.125W	91637	MFF1816G931R0F
A1R1072	315-0112-00		RES., FXD, CMPSN: 1.1K OHM, 5%, 0.25W		CB1125
A1R1081	321-0229-00		RES., FXD, FILM: 2.37K OHM, 1%, 0.125W		MFF1816G23700F
A1R1082	321-0229-00		RES., FXD, FILM: 2.37K OHM, 1%, 0.125W		MFF1816G23700F
A1R1087	315-0470-00		RES., FXD, CMPSN: 47 OHM, 5%, 0.25W		CB4705 MFF1816G20R00F
A1R1095	321-0030-00		RES., FXD, FILM: 20 OHM, 1%, 0.125W	31037	MFF1010G2URUUF
A1R1106	321-0064-00		RES., FXD, FILM: 45.3 OHM, 1%, 0.125W	91637	MFF1816G45R30F
A1R1107	321-0068-00		RES., FXD, FILM: 49.9 OHM, 1%, 0.125W	91637	MFF1816G49R90F
A1R1108	321-0126-00		RES., FXD, FILM: 200 OHM, 1%, 0.125W		MFF1816G200R0F
A1R1116	315-0751-00		RES., FXD, CMPSN: 750 OHM, 5%, 0.25W		CB7515
A1R1117	315-0331-00		RES., FXD, CMPSN: 330 OHM, 5%, 0.25W		CB3315
A1R1126	311-1564-00		RES., VAR, NONWIR: TRMR, 500 OHM, 0.5W	73138	91-86-0
A1R1135	311-1558-00		RES., VAR, NONWIR: 20K OHM, 20%, 0.50W	73138	91-80-0
A1R1136	315-0331-00		RES.,FXD,CMPSN:330 OHM,5%,0.25W		CB3315
A1R1143	321-0195-00	B010100 B010239	RES.,FXD,FILM:1.05K OHM,1%,0.125W	91637	MFF1816G10500F
A1R1143	321-0192-00	B010240	RES.,FXD,FILM:976 OHM,1%,0.125W	91637	MFF1816G976R0F
A1R1144	321-0087-00	B010100 B010239	RES., FXD, FILM: 78.7 OHM, 1%, 0.125W	91637	MFF1816G78R70F
A1R1144	321-0126-00	B010240	RES., FXD, FILM: 200 OHM, 1%, 0.125W	91637	MFF1816G200R0F
41011/7	215 2222 22		DEG. THE CHARLES OF STATE OF STATE	01121	CP300E
A1R1147	315-0390-00		RES., FXD, CMPSN: 39 OHM, 5%, 0.25W		CB3905 CB2225
A1R1148 A1R1152	315-0222-00 315-0241-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W RES., FXD, CMPSN: 240 OHM, 5%, 0.25W		CB2415
A1R1159	321-0126-00		RES., FXD, FILM: 200 OHM, 1%, 0.125W		MFF1816G200R0F
A1R1168	315-0183-00		RES., FXD, CMPSN: 18K OHM, 5%, 0.25W		CB1835
A1R1173	315-0241-00		RES., FXD, CMPSN: 240 OHM, 5%, 0.25W		CB2415
A1R1176	311-1560-00		RES., VAR, NONWIR: 5K OHM, 20%, 0.50W		91-82-0
A1R1185 A1R1186	311-1560-00		RES., VAR, NONWIR: 5K OHM, 20%, 0.50W RES., FXD, CMPSN: 47 OHM, 5%, 0.25W		91-82-0 CB4705
A1R1188	315-0470-00 315-0470-00		RES., FXD, CMPSN: 47 OHM, 5%, 0.25W	01121	
A1R1190	311-1567-00		RES., VAR, NONWIR: TRMR, 100 OHM, 0.50W		91-89-0
A1R1202	311-1564-00		RES., VAR, NONWIR: TRMR, 500 OHM, 0.5W		91-86-0
A1R1205	321-0206-00		RES.,FXD,FILM:1.37K OHM,1%,0.125W		MFF1816G13700F
A1R1206	321-0177-00		RES.,FXD,FILM:681 OHM,1%,0.125W	91637	
A1R1207	315-0271-00		RES., FXD, CMPSN: 270 OHM, 5%, 0.25W	75042	CB2715 CECTO-4120F
A1R1208 A1R1216	323-0156-00 315-0511-00		RES., FXD, FILM:412 OHM, 1%, 0.50W RES., FXD, CMPSN:510 OHM, 5%, 0.25W		CB5115
A1R1232	315-0430-00		RES., FXD, CMPSN: 43 OHM, 5%, 0.25W	01121	CB4305
	3.5 0.50				
A1R1233	315-0512-00		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W		CB5125
A1R1234	321-0149-00	B010100 B010239	RES.,FXD,FILM:348 OHM,1%,0.125W		MFF1816G348R0F
A1R1234	321-0196-00	B010240	RES., FXD, FILM: 1.07K OHM, 1%, 0.125W		MFF1816G10700F
A1R1242	321-0195-00	B010100 B010239	RES., FXD, FILM: 1.05K OHM, 1%, 0.125W		MFF1816G10500F
A1R1242	321-0192-00	B010240	RES., FXD, FILM: 976 OHM, 1%, 0.125W	91637 01121	MFF1816G976R0F CB3925
A1R1243	315-0392-00		RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W	01121	505747
A1R1244	315-0392-00		RES.,FXD,CMPSN: 3.9K OHM,5%,0.25W	01121	CB3925
A1R1246	315-0390-00		RES., FXD, CMPSN: 39 OHM, 5%, 0.25W		CB3905
A1R1247	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	
A1R1252	321-0170-00		RES., FXD, FILM: 576 OHM, 1%, 0.125W		MFF1816G576R0F
A1R1253	321-0170-00		RES.,FXD,FILM:576 OHM,1%,0.125W	91637	
A1R1254	321-0089-00		RES., FXD, FILM: 82.5 OHM, 1%, 0.125W	91637	MFF1816G82R50F
A1R1256	315-0100-00		RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
A1R1258	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A1R1274	315-0301-00		RES., FXD, CMPSN: 300 OHM, 5%, 0.25W	01121	CB3015

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_	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A1R1275	321-0181-00		BEC EVD EILM, JEO OUR 18 O 1050	01/07	MEET DISCOTTON
A1R1276	321-0181-00		RES.,FXD,FILM:750 OHM,1%,0.125W RES.,FXD,FILM:750 OHM,1%,0.125W		MFF1816G750R0F MFF1816G750R0F
A1R1278	315-0270-00		RES., FXD, CMPSN: 27 OHM, 5%, 0.25W		CB2705
A1R1285	311-1403-00		RES., VAR, NONWIR:5K OHM, 20%, 0.50W		10M922
A1R1296	321-0030-00		RES., FXD, FILM: 20 OHM, 1%, 0.125W		MFF1816G20R00F
A1R1299	315-0621-00	B010100 B038899	RES., FXD, CMPSN:620 OHM, 5%, 0.25W	01121	
			- and the first of	01111	020213
A1R1299	315-0621-00	B038900	RES., FXD, CMPSN: 620 OHM, 5%, 0.25W	01121	CB6215
			(NOMINAL VALUE, SELECTED)		
A1R1311	321-0049-00		RES., FXD, FILM: 31.6 OHM, 1%, 0.125W	91637	MFF1816G31R60F
A1R1314	321-0065-00		RES.,FXD,FILM:46.4 OHM,1%,0.125W		MFF1816G46R40F
A1R1326	315-0430-00		RES., FXD, CMPSN: 43 OHM, 5%, 0.25W	01121	
A1R1328	321-0126-00		RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A1R1333	315-0821-00		DEC EVE CMBCN. 920 OUM ET A 250	01121	CRROIS
A1R1334	315-0821-00		RES., FXD, CMPSN: 820 OHM, 5%, 0.25W	01121 01121	
A1R1335	311-1563-00		RES.,FXD,CMPSN:820 OHM,5%,0.25W RES.,VAR,NONWIR:1K OHM,20%,0.50W		91-85-0
A1R1353	315-0241-00		RES., FXD, CMPSN: 240 OHM, 5%, 0.25W		CB2415
A1R1358	321-0126-00		RES.,FXD,FILM:200 OHM,1%,0.125W		MFF1816G200R0F
A1R1376	315-0301-00		RES., FXD, CMPSN: 300 OHM, 5%, 0.25W		CB3015
	313 0301 00		KES., FAD, OH SH. 500 OH, 5%, 0.25%	01121	003013
A1R1382	315-0470-00		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
A1R1384	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W		CB1015
A1R1385	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W		CB1015
A1R1391	315-0151-00		RES., FXD, CMPSN: 150 OHM, 5%, 0.25W	01121	CB1515
A1R1392	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W		CB1035
A1R1422	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A1R1438	315-0302-00		RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
A1R1439	315-0302-00		RES., FXD, CMPSN: 3K OHM, 5%, 0.25W	01121	CB3025
A1R1448	315-0511-00		RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A1R1449	315-0751-00		RES., FXD, CMPSN: 750 OHM, 5%, 0.25W		CB7515
A1R1482	311-1561-00		RES., VAR, NONWIR: 2.5K OHM, 20%, 0.50W		91-83-0
A1R1484	311-1559-00		RES., VAR, NONWIR: 10K OHM, 20%, 0.50W	73138	91-81-0
A1R1486	321-0307-00		BEC EVE ELLM-15 AV OUM 17 O 1250	01627	MEE: 1016015401E
A1R1487	321-0307-00		RES.,FXD,F1LM:15.4K OHM,1%,0.125W RES.,FXD,F1LM:3.01K OHM,1%,0.125W		MFF1816G15401F MFF1816G30100F
A1R1488	321-0277-00		RES.,FXD,FILM:7.5K OHM,1%,0.125W		MFF1816G75000F
A1R1504	315-0331-00		RES., FXD, CMPSN: 330 OHM, 5%, 0.25W		CB3315
A1R1514	321-0065-00		RES., FXD, F1LM: 46.4 OHM, 17, 0.125W		MFF1816G46R40F
A1R1516	323-0161-00		RES., FXD, FILM: 464 OHM, 17, 0.50W		CECTO-4640F
A1R1521	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A1R1522	321-0126-00		RES., FXD, FILM: 200 OHM, 1%, 0.125W	91637	MFF1816G200R0F
A1R1532	321-0186-00		RES., FXD, FILM: 845 OHM, 1%, 0.125W	91637	MFF1816G845R0F
A1R1534	321-0186-00		RES., FXD, FILM: 845 OHM, 1%, 0.125W	91637	MFF1816G845R0F
A1R1536	321-0133-00		RES.,FXD,FILM:237 OHM,1%,0.125W	91637	
A1R1538	321-0133-00		RES.,FXD,FILM:237 OHM,1%,0.125W	91637	MFF1816G237R0F
A1015/.0	315_0751_00		DEC. DUD ONDON, TEO ONLY FO O OFFI	01121	CP7515
A1R1548 A1R1549	315-0751-00		RES., FXD, CMPSN: 750 OHM, 5%, 0.25W	01121	CB7515
A1R1558	315-0511-00		RES., FXD, CMPSN: 510 OHM, 5%, 0.25W	01121	CB5115
A1R1562	311-1311-00 321-0190-00		RES., VAR, NONWIR: 1K OHM, 20%, 1W	01121	73M4G048L102M MFF1816G931R0F
A1R1579	321-0190-00		RES.,FXD,FILM:931 OHM,1%,0.125W RES.,FXD,FILM:2.37K OHM,1%,0.125W	91637	
A1R1580	311-1560-00		RES., VAR, NONWIR: 5K OHM, 20%, 0.50W	73138	
	311 1300 00		ALLO : \$ VIA \$ HOLIWIKE JAC OILLI \$ 20% \$ 0 : 30#	75150	71 02 0
A1R1582	311-1560-00		RES., VAR, NONWIR: 5K OHM, 20%, 0.50W	73138	91-82-0
A1R1586	315-0241-00		RES., FXD, CMPSN: 240 OHM, 5%, 0.25W	01121	CB2415
A1R1587	315-0112-00		RES., FXD, CMPSN:1.1K OHM, 5%, 0.25W	01121	
A1R1589	315-0470-00		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
A1R1590	321-0229-00		RES., FXD, FILM: 2.37K OHM, 1%, 0.125W	91637	MFF1816G23700F
A1R1612	315-0752-00		RES., FXD, CMPSN: 7.5K OHM, 5%, 0.25W	01121	CB7525
A1R1613	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A1R1616	315-0752-00		RES., FXD, CMPSN: 7.5K OHM, 5%, 0.25W	01121	CB7525

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	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A1R1624	331_01/5_00		DEC. EVD ETIM. 214 OUN 19 O 125U	91637	MEET 014021400E
A1R1625	321-0145-00 321-0151-00		RES.,FXD,FILM:316 OHM,1%,0.125W RES.,FXD,FILM:365 OHM,1%,0.125W	91637	
A1R1626	321-0131-00		RES., FXD, FILM: 316 OHM, 1%, 0.125W	91637	
A1R1632	323-0106-00		RES., FXD, FILM: 124 OHM, 1%, 0.50W	91637	
A1R1634	311-1563-00		RES., VAR, NONWIR: 1K OHM, 20%, 0.50W		91-85-0
A1R1645	315-0392-00		RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W	01121	
			,,		
A1R1647	315-0241-00		RES., FXD, CMPSN: 240 OHM, 5%, 0.25W	01121	CB2415
A1R1661	321-0126-00		RES., FXD, F1LM: 200 OHM, 1%, 0.125W	91637	MFF1816G200R0F
A1R1683	315-0470-00		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	
A1R1684	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	
A1R1685 A1R1687	311-1567-00		RES., VAR, NONWIR: TRMR, 100 OHM, 0.50W		91-89-0
AIRIOO/	315-0270-00		RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A1R1695	321-0030-00		RES., FXD, FILM: 20 OHM, 1%, 0.125W	91637	MFF1816G20R00F
A1R1712	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	
A1R1714	315-0752-00		RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	
A1R1716	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	
A1R1724	321-0145-00		RES., FXD, FILM: 316 OHM, 1%, 0.125W	91637	MFF1816G316ROF
A1R1725	321-0151-00		RES., FXD, FILM: 365 OHM, 1%, 0.125W	91637	MFF1816G365R0F
4101705					
A1R1735	311-1558-00		RES., VAR, NONWIR: 20K OHM, 20%, 0.50W	73138	
A1R1742	315-0392-00		RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	
A1R1744	315-0390-00		RES.,FXD,CMPSN:39 OHM,5%,0.25W	01121	
A1R1752 A1R1753	321-0170-00 321-0170-00		RES., FXD, FILM: 576 OHM, 1%, 0.125W	91637	MFF1816G576R0F MFF1816G576R0F
A1R1754	321-0170-00		RES., FXD, FILM: 576 OHM, 1%, 0.125W RES., FXD, FILM: 82.5 OHM, 1%, 0.125W	91637	
*********	321 0009 00		RES., PAD, PIEM. 02.5 Our, 1%, 0.125%	71037	III I TOTOGOZROGI
A1R1756	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A1R1758	315-0100-00		RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
A1R1774	315-0301-00		RES., FXD, CMPSN: 300 OHM, 5%, 0.25W	01121	CB3015
A1R1775	321-0181-00		RES., FXD, FILM: 750 OHM, 1%, 0.125W	91637	MFF1816G750R0F
A1R1776	321-0181-00		RES., FXD, FILM: 750 OHM, 1%, 0.125W		MFF1816G750R0F
A1R1782	311-1403-00		RES., VAR, NONWIR: 5K OHM, 20%, 0.50W	01121	10M922
A1p170/	221 0020 00		DEC. TWD TYLK-OO OIN 18 O 10EU	01627	MENI OI COODOOR
A1R1794 A1R1798	321-0030-00 315-0621-00	B010100 B038899	RES.,FXD,FILM:20 OHM,1%,0.125W RES.,FXD,CMPSN:620 OHM,5%,0.25W	91637 01121	MFF1816G20R00F CB6215
A1R1798	315-0621-00	B038900	RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
		2030700	(NOMIMAL VALUE, SELECTED)	01121	000213
A1R1815	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A1R1816	315-0302-00		RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	
A1R1817	315-0302-00		RES., FXD, CMPSN: 3K OHM, 5%, 0.25W	01121	
A1R1818	315-0103-00	XB010965	RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	
A1R1825	315-0102-00		RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	
A1R1828	321-0064-00	PO10100 P00000	RES., FXD, F1LM: 45.3 OHM, 1%, 0.125W	91637	MFF1816G45R30F
A1R1834 A1R1834	321-0201-00	B010100 B022259	RES., FXD, FILM:1.21K OHM, 1%, 0.125W	91637 91637	MFF1816G12100F MFF1816G13000F
WI WI 074	321-0204-00	B022260	RES., FXD, FILM:1.3K OHM, 1%, 0.125W	7103/	*** F 1010013000f
A1R1835	311-1564-00		RES., VAR, NONWIR: TRMR, 500 OHM, 0.5W	73138	91-86-0
A1R1838	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
A1R1839	315-0431-00		RES., FXD, CMPSN: 430 OHM, 5%, 0.25W	01121	CB4315
A1R1842	321-0195-00	B010100 B010239	RES., FXD, FILM: 1.05K OHM, 1%, 0.125W	91637	
A1R1842	321-0192-00	B010240	RES., FXD, FILM: 976 OHM, 1%, 0.125W	91637	
A1R1843	321-0195-00	B010100 B010239	RES., FXD, FILM: 1.05K OHM, 1%, 0.125W	91637	MFF1816G10500F
A1010/.2	221_0102_00	P010240	DEC EVE ETTH. 074 OFF 19 0 10EH	01627	MEE10160076000
A1R1843	321-0192-00	B010240	RES., FXD, FILM: 976 OHM, 1%, 0.125W		MFF1816G976R0F CB2225
A1R1849 A1R1854	315-0222-00 315-0241-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W RES., FXD, CMPSN: 240 OHM, 5%, 0.25W	01121	
A1R1858	321-0126-00		RES.,FXD,FILM:200 OHM,1%,0.125W	91637	
A1R1868	315-0183-00		RES., FXD, CMPSN: 18K OHM, 5%, 0.25W	01121	CB1835
A1R1876	315-0301-00		RES., FXD, CMPSN: 300 OHM, 5%, 0.25W	01121	CB3015
A1R1881	315-0470-00		RES., FXD, CMPSN: 47 OHM, 5%, 0.25W	01121	СВ4705
A1R1882	311-1561-00		RES., VAR, NONWIR: 2.5K OHM, 20%, 0.50W	73138	91-83-0

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Replaceable Electrical Parts-465B Service

Commonant NI	Tektronix	Serial/Model No.	N. O.B. CHI	Mfr	
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A1R1885	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
A1R1886	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	
A1R1889	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	
A1R1891	315-0151-00		RES., FXD, CMPSN: 150 OHM, 5%, 0.25W	01121	
A1R1893	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	
A1R1903	315-0112-00		RES., FXD, CMPSN:1.1K OHM, 5%, 0.25W	01121	
A1R1904	315-0221-00		RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A1R1906	315-0203-00		RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	
A1R1914	315-0122-00		RES., FXD, CMPSN: 1.2K OHM, 5%, 0.25W	01121	
A1R1916	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	
A1R1922	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	
A1R1924	315-0122-00		RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	
	317 0122 00		RES., FAD, OHF SH. 1.2K OHN, JA, U.23W	01121	CB1223
A1R1932 A1R1934	315-0751-00	P010100 P010020	RES., FXD, CMPSN: 750 OHM, 5%, 0.25W		CB7515
	321-0149-00	B010100 B010239	RES., FXD, FILM: 348 OHM, 1%, 0.125W	91637	
A1R1934	321-0196-00	B010240	RES., FXD, FILM: 1.07K OHM, 1%, 0.125W	91637	
A1R1944	315-0331-00		RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	
A1R1946	321-0087-00	B010100 B010239	RES., FXD, FILM: 78.7 OHM, 1%, 0.125W	91637	
A1R1946	321-0126-00	B010240	RES., FXD, FILM: 200 OHM, 1%, 0.125W	91637	MFF1816G200R0F
A1R1952	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A1R1956	315-0390-00		RES., FXD, CMPSN: 39 OHM, 5%, 0.25W	01121	
A1R1958	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	
A1R1975	311-1559-00		RES., VAR, NONWIR: 10K OHM, 20%, 0.50W	73138	
A1R1981	321-0307-00		RES., FXD, FILM: 15.4K OHM, 1%, 0.125W	91637	
AlR19B3	321-0307-00			91637	
AIRI7D3	321-0307-00		RES., FXD, FILM: 15.4K OHM, 1%, 0.125W	91037	MFF1816G134U1F
A1R1986	321-0277-00		RES., FXD, FILM: 7.5K OHM, 1%, 0.125W	91637	MFF1816G75000F
A1R1987	321-0277-00		RES., FXD, FILM: 7.5K OHM, 1%, 0.125W	91637	MFF1816G75000F
A1R1988	321-0253-00	B010100 B010964	RES., FXD, FILM: 4.22K OHM, 1%, 0.125W	91637	
A1R1988	321-0260-00	B010965	RES., FXD, FILM: 4.99K OHM, 1%, 0.125W	91637	
A1R1989	321-0253-00	B010100 B010964	RES.,FXD,FILM:4.22K OHM,1%,0.125W	91637	
A1R1989	321-0260-00	B010965	RES., FXD, FILM: 4.99K OHM, 1%, 0.125W	91637	
A1RT1267	307-0181-00		RES., THERMAL: 100K OHM, 10%, 4MW/DEG C	15454	1DE104-K-220EC
A1RT1767	307-0181-00		RES., THERMAL: 100K OHM, 10%, 4MW/DEG C	15454	1DE104-K-220EC
A1S1414	260~1486-00		SWITCH, PUSH: 1 BUTTON, PB1, 4P, PUSH-PUSH	80009	260-1486-00
A1S1995	260-1208-00		SWITCH, PUSH: DPDT, 28VDC, PUSH-PUSH	80009	
A1U1290	155-0078-10		MICROCIRCUIT, LI:ML, VERTICAL AMPLIFIER	80009	155-007B-10
A1U1605	160-0204-00	B010100 B010959		B0009	160-0204-00
K101007	100-0204-00	B010100 B010939	MICROCIRCUIT, DI: 256 X 4 ROM, CUSTOM MASK	ВОООЭ	160-0204-00
Alu1605	160-0204-01	B010960	MICROCIRCUIT, DI: 256 X 4 ROM, SCRN	80009	160-0204-01
A1U1705	156-0392-00		MICROCIRCUIT, DI: QUAD LATCH	34335	SN74LS175N OR J
A1U1790	155-0078-10		MICROCIRCUIT, LI: ML, VERTICAL AMPLIFIER	80009	155-0078-10
A1U1805	156-0480-00		MICROCIRCUIT, DI: QUAD 2-INPUT AND GATE	01295	
A1U1905	156-0382-00		MICROCIRCUIT, DI: QUAD 2-INPUT NAND GATE	01295	
A1VR1096	152-0166-00		SEMICOND DEVICE: ZENER, 0.4W, 6.2V, 5%	04713	
A1VR1356	152-0166-00		SEMICOND DEVICE: ZENER, 0.4W, 6.2V, 5%	04713	SZ11738
A1VR1597	152-0166-00		SEMICOND DEVICE:ZENER, 0.4W, 6.2V, 5%	04713	
A1VR1662	152-0166-00		SEMICOND DEVICE: ZENER, 0.4W, 6.2V, 5%	04713	
A1VR1824	152-0306-00		SEMICOND DEVICE: ZENER, 0.4W, 9.1V, 5%	14433	
A1W1527	131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG		L-2007-1
A1W1732	131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG		L-2007-1
	131-0300-00		DOS CONDUCTOR DUMNIT RES, 2.3/3, 22 AWG	JJ210	L-2007-1

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	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description		Mfr Part Number
A2			CKT BOARD ASSY: VERTICAL OUTPUT		
A2C2016		B010100 B029999X	CAP.,FXD,CER DI:0.1UF,20%,50V	72982	9005D044B75III0/M
A2C2O38	281-0768-00		CAP., FXD, CER DI:470PF, 20%, 100V	72982	
A2C2047	281-0775-00		CAP.,FXD,CER DI:470FF,20%,100V		
A2C2112		B010100 B029999X		72982	
A2C2112			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	
M202120	281-0773-00	XB030000	CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A2C2133	281-0771-00	B010100 B029999X	CAP., FXD, CER DI:0.0022UF, 20%, 200V	72982	314-0222Z5U0222M
A2C2172	281-0775-00	XB030000	CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	
A2C2174	281-0775-00	B010100 B029999X	CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	
A2C2196	281-0783-00	XB030000	CAP., FXD, CER DI:0.1UF, 20%, 100V	72982	
A2C2293	281-0783-00	B010100 B029999X	CAP., FXD, CER DI:0.1UF, 20%, 100V	72982	
A2C2308	281-0089-00	B010100 B029999X	CAP., VAR, CER DI: 2-8PF, 350V	72982	
A2C2215	201 0000 00	**P03000	615 W. 10 G.		
A2C2315	281-0089-00		CAP., VAR, CER DI: 2-8PF, 350V	72982	
A2C2334	281-0772-00		CAP., FXD, CER DI:0.0047UF, 10%, 100V	72982	
A2C2335	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	
A2C2336	281-0812-00		CAP., FXD, CER DI: 1000PF, 10%, 100V	72982	
A2C2337	281-0797-00		CAP., FXD, CER DI:15PF, 10%, 100V	72982	
A2C2338	281-0797-00	B010100 B029999X	CAP.,FXD,CER DI:15PF,10%,100V	72982	8035D9AADCOG150K
A2C2339	281-0773-00	хво 30000	CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A2C2346	281-0096-00		CAP., VAR, AIR DI:5.5-18PF, 350V	72982	
A2C2350	281-0096-00	B010100 B029999X	CAP., VAR, AIR DI:5.5-18PF, 350V	72982	
A2C2412	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	
A2C2415	281-0812-00		CAP., FXD, CER DI: 1000PF, 10%, 100V	72982	
A2C2417	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	
		11000000	on tyrnoyour briding 20%, 304	, 2,02	000 50 512102 50 10411
A2C2421	281-0788-00	B010100 B029999X	CAP., FXD, CER DI:470PF, 10%, 100V	72982	8005H9AADW5R471K
A2C2422	281-0812-00	XB030000	CAP., FXD, CER DI: 1000PF, 10%, 100V	72982	8035D9AADX7R102K
A2C2424	281-0788-00	XB042675	CAP., FXD, CER DI:470PF, 10%, 100V	72982	8005H9AADW5R471K
A2C2428	281-0773-00	B010100 B029999X	CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	
A2C2436	281-0812-00	B010100 B029999X	CAP., FXD, CER DI: 1000PF, 10%, 100V	72982	
A2C2438	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	
A2004.20	201 0772 00	DO10100 D000000			
A2C2439	281-0772-00		CAP., FXD, CER DI:0.0047UF, 10%, 100V	72982	
A2C2481	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	
A2C2483	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	
A2C2486	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	
A2C2488	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	
A2L2264	108-0328-00	XB030000	COIL, RF: 0.3UH	80009	108-0328-00
A2L2267	108-0328-00	XB030000	COIL, RF: 0.3UH	80009	108-0328-00
A2L2296	108-0538-00	XB030000	COIL, RF: 2.7UH	76493	70F276A1
A2L2393	108-0538-00	B010100 B029999X	COIL, RF: 2.7UH	76493	
A2L2419	108-0760-00	B010100 B029999X	COIL, RF: FIXED, 57NH	80009	108-0760-00
A2L2485		B010100 B029999X	COIL, RF: 2.7UH	76493	
A2L2487		B010100 B029999X	COIL, RF: 2.7UH		70F276A1
A21 24 02	100-0530 00	¥8020000	COLL BD-0 3HH	76100	70027641
A2L2492	108-0538-00		COIL, RF: 2.7UH	76493	
A2L2494	108-0538-00		COIL, RF: 2.7UH	76493	
A2LR2264	108-0328-00		COIL, RF: 0.3UH	80009	108-0328-00
A2LR2265	108-0328-00		COIL, RF: 0.3UH	80009	108-0328-00
A2LR2267	108-0328-00		COIL, RF: 0.3UH	80009	108-0328-00
A2LR2268	108-0328-00	B010100 B029999X	COIL, RF: 0.3UH	80009	108-0328-00
A2LR2366	108-0328-00	B010100 B029999X	COIL, RF: 0.3UH	80009	108-0328-00
A2Q2105	151-0190-00	XB030000	TRANSISTOR: SILICON, NPN	07263	S032677
A2Q2115	151-0190-00	XB030000	TRANSISTOR: SILICON, NPN	07263	S032677
A2Q2130	151-0190-00	B010100 B029999X	TRANSISTOR: SILICON, NPN	07263	S032677
A2Q2140	151-0190-00	B010100 B029999X	TRANSISTOR: SILICON, NPN	07263	S032677
A2Q2306	151-0190-00		TRANSISTOR: SILICON, NPN	07263	
			-		
A2Q2308	151-0190-00		TRANSISTOR: SILICON, NPN	07263	
A2R2005	311-1238-00	B010100 B029999X	RES., VAR, NONWIR: 5K OHM, 10%, 0.50W	73138	72X~27-O-502K

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	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A2R2016	321-0251-00	XB030000	RES., FXD, FILM: 4.02K OHM, 1%, 0.125W	91637	MFF1816G40200F
A2R2017	321-0250-00	XB030000	RES., FXD, FILM: 3.92K OHM, 1%, 0.125W	91637	MFF1816G39200F
A2R2025	321-0160-00	B010100 B029999	RES., FXD, FILM: 453 OHM, 1%, 0.125W	91637	MFF1816G453R0F
A2R2025	311-1238-00	B030000	RES., VAR, NONWIR: 5K OHM, 10%, 0.50W	73138	72X-27-0-502K
A2R2029	315-0470-00	B010100 B029999	RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
A2R2030	311-1245-00	B010100 B029999	RES., VAR, NONWIR: 10K OHM, 10%, 0.50W	73138	72-28-0
A2R2035		B010100 B029999		32997	
A2R2045	315-0133-00		RES., FXD, CMPSN: 13K OHM, 5%, 0.25W	01121	
A2R2054	321-0080-00		RES., FXD, F1LM:66.5 OHM, 1%, 0.125W		MFF1816G66R50F
A2R2055	321-0175-00		RES., FXD, FILM: 649 OHM, 1%, 0.125W		MFF1816G649R0F
A2R2057	323-0127-00		RES., FXD, FILM: 205 OHM, 1%, 0.50W		MFF1226G205R0F
A2R2058	323-0155-00	XB030000	RES.,FXD,FILM:402 OHM,1%,0.50W	75042	CECTO-4020F
A200062	303 0107 00	PO10100 P000000		0160-	
A2R2063		B010100 B029999X			MFF1226G205R0F
A2R2073	315-0473-00		RES., FXD, CMPSN:47K OHM,5%,0.25W		CB4735
A2R2074	323-0055-00		RES., FXD, FILM: 36.5 OHM, 1%, 0.5W		CECTO-35R50F
A2R2075	315-0473-00		RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	
A2R2103	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	
A2R2104	315-0392-00	XB030000	RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
A2R2105	321_0100_00	B010100 B029999x	DEC EVE ETIM.007 ONL 1% O 10511	01627	MEE10160007000
A2R2105		B010100 B029999X		91637 91637	
A2R2107			,,,, -, ,		MFF1816G11300F
A2R2108	321-0198-00	B010100 B029999X			MFF1816G75R00F
A2R2113		B010100 B029999X	RES., FXD, FILM: 75 OHM, 1%, 0.125W	01121	
A2R2115		B010100 B0299998		75042	CECTO-2800F
RENETTY	323-0140-00	BUIUIUU BUZ99997	RES., FXD, F1LM: 280 OHM, 1%, 0.50W	73042	CEC10-2600F
A2R2117	311-1236-00	XB030000	RES., VAR, NONWIR: 250 OHM, 10%, 0.50W	73138	72X-22-0-251K
A2R2119	321-0193-00		RES.,FXD,FILM:1K OHM,1%,0.125W		MFF1816G10000F
A2R2123	321-0183-00		RES., FXD, FILM: 787 OHM, 1%, 0.125W		MFF1816G787ROF
A2R2124	321-0223-00		RES., FXD, FILM: 2.05K OHM, 1%, 0.125W	91637	
A2R2125	321-0198-00		RES., FXD, FILM: 1.13K OHM, 1%, 0.125W	91637	
A2R2127	315-0270-00		RES., FXD, CMPSN:27 OHM, 5%, 0.25W	01121	CB2705
			,,		
A2R2134	315-0561-00	B010100 B029999X	RES., FXD, CMPSN: 560 OHM, 5%, 0.25W	01121	CB5615
A2R2135	323-0140-00	XB030000	RES., FXD, FILM: 280 OHM, 1%, 0.50W	75042	CECTO-2800F
A2R2136	315-0121-00	B010100 B029999X	RES., FXD, CMPSN: 120 OHM, 5%, 0.25W	01121	CB1215
A2R2137	323-0140-00	XB030000	RES., FXD, FILM: 280 OHM, 1%, 0.50W	75042	CECTO-2800F
A2R2138	321-0061-00	B010100 B029999X	RES., FXD, FILM: 42.2 OHM, 1%, 0.125W	91637	MFF1816G42R20F
A2R2142	315-0561-00	XB030000	RES., FXD, CMPSN: 560 OHM, 5%, 0.25W	01121	CB5615
40D01/2	201 0041 00				
A2R2143	321-0061-00		RES., FXD, FILM: 42.2 OHM, 1%, 0.125W		MFF1816G42R20F
A2R2144	315-0152-00			01121	
A2R2146 A2R2151	321-0160-00				MFF1816G453R0F
	315-0202-00			01121	
A2R2153		B010100 B029999X			MFF1816G66R50F
A2R2154	323-0155-00	VD030000	RES.,FXD,FILM:402 OHM,1%,0.50W	75042	CECT0-4020F
A2R2155	321-0175-00	B010100 B029999X	RES.,FXD,FILM:649 OHM,1%,0.125W	91637	MFF1816G649R0F
A2R2156	321-0175-00		RES.,FXD,FILM:34 OHM,1%,0.125W	91637	
A2R2164		B010100 B029999X		75042	
A2R2165	321-0155-00				MFF1816G402R0F
A2R2166	321-0155-00		,	91637	
A2R2168	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	
	313 0101-00		ministration our 100 our 1 10, 0.27	01121	001017
A2R2172	323-0055-00	B010100 B029999X	RES.,FXD,FILM:36.5 OHM,1%,0.5W	75042	CECTO-35R50F
A2R2173		B010100 B029999X		01121	CB4735
A2R2185	308-0758-00		RES., FXD, WW: 430 OHM, 1%, 7W	14193	
A2R2202		B010100 B029999X		91637	
A2R2206		B010100 B029999X		91637	
A2R2207	321-0001-00		RES., FXD, FILM: 10 OHM, 1%, 0.125W	75042	
			* * * * · · · ·		
A2R2208	321-0001-00		RES.,FXD,FILM:10 OHM,1%,0.125W	75042	CEATO-1 OROOF
A2R2212	321-0193-00		RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
A2R2214	321-0068-00	XB030000	RES., FXD, FILM: 49.9 OHM, 1%, 0.125W	91637	MFF1816G49R90F

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On an annual No.	Tektronix	Serial/Model No.	Name & Description	Mfr	Mfr. Doub Number
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A2R2218	321-0068-00	YB030000	RES.,FXD,FILM:49.9 OHM,1%,0.125W	91637	MFF1816G49R90F
A2R2232		B010100 B029999X	RES., FXD, CMPSN: 120 OHM, 5%, 0.25W	01121	
A2R2242		B010100 B029999X	RES.,FXD,CMPSN:27 OHM,5%,0.25W		CB2705
A2R2243	311-1236-00		RES., VAR, NONWIR: 250 OHM, 10%, 0.50W		72X-22-0-251K
A2R2244	315-0270-00		RES., FXD, CMPSN: 27 OHM, 5%, 0.25W		CB2705
A2R2245		B010100 B029999X	RES., VAR, NONWIR: 250 OHM, 10%, 0.50W		72X-22-0-251K
	311 1230 00	D010100 D02/////	naor, the, normality of orange to a govern	.5250	
A2R2246	315-0270-00	XB030000	RES.,FXD,CMPSN:27 OHM,5%,0.25W		CB2705
A2R2247	321-0147-00	B010100 B029999	RES., FXD, FILM: 332 OHM, 1%, 0.125W	91637	MFF1816G332R0F
A2R2247	321-0139-00	B030000	RES., FXD, FILM: 274 OHM, 1%, 0.125W	91637	MFF1816G274R0F
A2R2262	315-0100-00	XB030000	RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
A2R2267	315-0100-00	B010100 B029999X	RES., FXD, CMPSN: 10 OHM, 5%, 0.25W		CB1005
A2R2268	315-0100-00	XB030000	RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
				1/100	OD11510 /20D0D
A2R2284	308-0758-00		RES.,FXD,WW:430 OHM,1%,7W		SP1151S-430R0F
A2R2285		B010100 B029999X	RES.,FXD,WW:430 OHM,1%,7W		SP1151S-430R0F
A2R2304	321-0147-00		RES., FXD, FILM: 332 OHM, 1%, 0.125W		MFF1816G332R0F
A2R2305	321-0147-00		RES., FXD, FILM: 332 OHM, 1%, 0.125W		MFF1816G332R0F
A2R2306		B010100 B029999X	RES., FXD, CMPSN: 75 OHM, 5%, 0.25W	01121	
A2R2308	315-0470-00	B010100 B029999X	RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
A2R2311	323-0140-00	B010100 B029999X	RES.,FXD,FILM:280 OHM,1%,0.50W	75042	CECTO-2800F
A2R2311 A2R2312		B010100 B029999X B010100 B029999X	RES., FXD, FILM: 280 OHM, 17, 0.30W RES., VAR, NONWIR: 250 OHM, 10%, 0.50W		72X-22-0-251K
A2R2312 A2R2318		B010100 B029999 B010100 B029999	RES., FXD, CMPSN:620 OHM, 5%, 0.25W		CB6215
A2R2318	315-0321-00		RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	
A2R2318 A2R2323	315-0331-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	
A2R2325 A2R2325	311-1236-00		RES., VAR, NONWIR: 250 OHM, 10%, 0.50W	73138	72X-22-0-251K
M2R2323	311-1236-00	XB030000	RES., VAR, NORWIK: 230 OHM, 10%, 0.30W	73130	72K-22-0-271K
A2R2326	315-0470-00	XB030000	RES., FXD, CMPSN: 47 OHM, 5%, 0.25W	01121	CB4705
A2R2328	315-0470-00		RES., FXD, CMPSN: 47 OHM, 5%, 0.25W	01121	CB4705
A2R2331		B010100 B029999X	RES., FXD, FILM: 42.2 OHM, 1%, 0.125W	91637	MFF1816G42R20F
A2R2333		B010100 B029999X	RES., FXD, CMPSN: 560 OHM, 5%, 0.25W	01121	CB5615
A2R2335	315-0561-00		RES., FXD, CMPSN: 560 OHM, 5%, 0.25W	01121	CB5615
A2R2336	315-0270-00	B010100 B029999X	RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A2R2337	321-0061-00		RES., FXD, FILM: 42.2 OHM, 1%, 0.125W		MFF1816G42R20F
A2R2344	315-0470-00		RES., FXD, CMPSN: 47 OHM, 5%, 0.25W		CB4705
A2R2352		B010100 B029999X	RES., FXD, CMPSN: 47 OHM, 5%, 0.25W		CB4705
A2R2354	315-0470-00		RES., FXD, CMPSN: 47 OHM, 5%, 0.25W		CB4705
A2R2356	321-0052-00		RES., FXD, FILM: 34 OHM, 1%, 0.125W		MFF1816G34R00F
A2R2357	323-0155-00	XB030000	RES., FXD, FILM: 402 OHM, 1%, 0.50W	75042	CECT0-4020F
A2R2358	323-0155-00	VB030000	RES.,FXD,FILM:402 OHM,1%,0.50W	75042	CECT0-4020F
A2R2361		B010100 B029999X	RES.,FXD,FILM:34 OHM,1%,0.125W		MFF1816G34R00F
A2R2363	323-0155-00		RES.,FXD,FILM:402 OHM,1%,0.50W		CECTO-4020F
A2R2367		B010100 B029999X	RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	
A2R2385		B010100 B029999X	RES., FXD, WW: 430 OHM, 1%, 7W		SP1151S-430R0F
			RES., FXD, CMPSN: 620 OHM, 5%, 0.25W	01121	CB6215
A2R2413	315-0621-00	B010100 B029999X	NGO., FAD, OFFE BH. OZU UNT, J/6, U. ZJW	01161	
A2R2414	321-0147-00	B010100 B029999X	RES.,FXD,FILM:332 OHM,1%,0.125W	91637	MFF1816G332R0F
A2R2422		B010100 B029999X	RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
A2R2425	321-0147-00	B010100 B011167	RES., FXD, FILM: 332 OHM, 1%, 0.125W	91637	MFF1816G332R0F
A2R2425		B011168 B029999X	RES., FXD, FILM: 374 OHM, 1%, 0.125W	91637	MFF1816G374R0F
A2R2426	311-1564-00	XB030000	RES., VAR, NONWIR: TRMR, 500 OHM, 0.5W	73138	91-86-0
A2R2432	311-1560-00	XB030000	RES., VAR, NONWIR: 5K OHM, 20%, 0.50W	73138	91-82-0
A2R2436	311-1559-00		RES., VAR, NONWIR: 10K OHM, 20%, 0.50W		91-81-0
A2R2445		B010100 B02999X	RES., FXD, CMPSN: 47 OHM, 5%, 0.25W	01121	
A2R2446	311-1559-00		RES., VAR, NONWIR: 10K OHM, 20%, 0.50W		91-81-0
A2R2447	321-0178-00		RES., FXD, FILM: 698 OHM, 1%, 0.125W	91637	
A2R2448		B010100 B029999	RES., VAR, NONWIR: 20K OHM, 20%, 0.50W	73138	
A2R2448	311-1556-00	B030000	RES., VAR, NONWIR: 50K OHM, 20%, 0.50W	73138	91-78-0
A2D2/,51	321_0170_00	B010100 B029999X	RES.,FXD,FILM:698 OHM,1%,0.125W	91637	MFF1816G698R0F
A2R2451 A2R2455	321-0178-00		RES.,FXD,FILM:698 OHM,1%,0.125W		MFF1816G698R0F
A2R2461		B010100 B029999X	RES.,FXD,FILM:402 OHM,1%,0.50W		CECTO-4020F
	32.7 0133-00	- DOIOIOO DO677777	smos janaja amis ton Utuijanjus 2011	. 30 12	

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Replaceable Electrical Parts-465B Service

Component No.	Tektronix Part No.	Serial/I	Model No. Dscont	Name & Description	Mfr Code	Mfr Part Number
1200//2	201 0170 00	2010100			01/07	
A2R2463 A2R2465	321-0178-00		B029999X	RES., FXD, FILM: 698 OHM, 1%, 0.125W	91637	
A2R2466	315-0473-00			RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
A2R2467	315-0473-00			RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	
	315-0473-00		B029999X	RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
A2R2468	315-0473-00		B029999X	RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
A2R2472	315-0202-00	XB030000		RES., FXD, CMPSN: 2K OHM, 5%, 0.25W	01121	CB2025
A2R2475	315-0202-00	B010100	B029999X	RES., FXD, CMPSN: 2K OHM, 5%, 0.25W	01121	CB2025
A2R2476	315-0821-00	XB030000		RES., FXD, CMPSN: 820 OHM, 5%, 0.25W	01121	CB8215
A2R2520	311-1564-00	B010100	B029999X	RES., VAR, NONWIR: TRMR, 500 OHM, 0.5W	73138	91-86-0
A2R2530	311-1560-00	B010100	B029999X	RES., VAR, NONWIR: 5K OHM, 20%, 0.50W	73138	91-82-0
A2R2535	311-1559-00	B010100	B029999X	RES., VAR, NONWIR: 10K OHM, 20%, 0.50W	73138	91-81-0
A2R2540	311-1559-00	B010100	B029999X	RES., VAR, NONWIR: 10K OHM, 20%, 0.50W	73138	91-81-0
A2R2550	311-1558-00	B010100	B029999X	RESVAR.NONWIR:20K OHM.20%,0.50W	73138	91-80-0
A2RT2304	307-0125-00		B029999X	RES., THERMAL: 500 OHM, 10%, 25 DEG C	50157	2D1595
A2RT2333	307-0125-00		-0-7771	RES., THERMAL: 500 OHM, 10%, 25 DEG C	50157	2D1595
A2U2005	156-0067-00			MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	02735	85145
A2U2210	155-0078-10		B029999X	MICROCIRCUIT, LI:ML, VERTICAL AMPLIFIER	80009	155-0078-10
A2U2225	155-0078-10			MICROCIRCUIT, LI:ML, VERTICAL AMPLIFIER	80009	155-0078-10
A2U2255	155-0115-00	VB030000		MICROCIRCUIT, LI: CRT VERT DEFLECTION DRIVER	80009	155-0115-00
A2U2260	155-0115-00		B029999X	MICROCIRCUIT, LI: CRT VERT DEFLECTION DRIVER	80009	155-0115-00
A2U2385	156-0067-00		DO27777K	MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	02735	85145
A2U2480	156-0067-00		B029999X	MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	02735	85145
A2VR2211	152-0195-00		B029999X	SEMICOND DEVICE: ZENER, 0.4W, 5.1V, 5%	04713	
A2VR2212	152-0278-00		B029999X	SEMICOND DEVICE:ZENER, 0.4W, 31.17, 3% SEMICOND DEVICE:ZENER, 0.4W, 3V, 5%	04713	SZG35009K20
AZVIIZZ1Z	132-0278-00	вотогоо	B029999X	SEMICOND DEVICE:ZENER, U. 4w, 5v, 5%	04/13	52033007R20
A2VR2215	152-0195-00	B010100	B029999X	SEMICOND DEVICE: ZENER, 0.4W, 5.1V, 5%	04713	SZ11755
A2VR2232	152-0195-00	XB030000		SEMICOND DEVICE: ZENER, 0.4W, 5.1V, 5%	04713	SZ11755
A2VR2234	152-0278-00	XB030000		SEMICOND DEVICE: ZENER, 0.4W, 3V, 5%	04713	SZG35009K20
A2VR2238	152-0195-00	XB030000		SEMICOND DEVICE: ZENER, 0.4W, 5.1V, 5%	04713	SZ11755
A2W2472	131-0566-00	B010100	B029999X	BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG	55210	L-2007-1

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Replaceable Electrical Parts—465B Service

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A3			CKT BOARD ASSY: ATTENUATOR		
A3C30			(SEE CHASSIS PARTS)		
A3C31			(SEE CHASSIS PARTS)		
A3C32			(SEE CHASSIS PARTS)		
A3C33			(SEE CHASSIS PARTS)		
A3C34			(SEE CHASSIS PARTS)		
A3C35			(SEE CHASSIS PARTS)		
A3C36			(SEE CHASSIS PARTS)		
A3C37			(SEE CHASSIS PARTS)		
A3C3042	283-0156-00		CAP., FXD, CER DI:1000PF,+100-0%,200V	72982	8111A208Z5U0102Z
A3R3014	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
A3R3015	315-0220-00		RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A3R3030	317-0100-00	B010100 B010239	RES.,FXD,CMPSN:10 OHM,5%,0.125W	01121	BB1005
A3R3030	317-0220-00	B010240	RES., FXD, CMPSN: 22 OHM, 5%, 0.125W	01121	BB2205
A3R3032	315-0360-00		RES.,FXD,CMPSN:36 OHM,5%,0.25W	01121	CB3605
A3R3033	317-0220-00	B010100 B010872	RES., FXD, CMPSN: 22 OHM, 5%, 0.125W	01121	BB2205
A3R3033	317-0100-00	B010873	RES., FXD, CMPSN: 10 OHM, 5%, 0.125W	01121	BB1005
A3R3036	317-0100-00		RES., FXD, CMPSN: 10 OHM, 5%, 0.125W	01121	BB1005
A3R3039	321-0481-00		RES., FXD, FILM: IM OHM, 1%, 0.125W	24546	NA4D1004F
A3R3042	317-0474-00		RES., FXD, CMPSN: 470K OHM, 5%, 0.125W	01121	BB4745
A3R3045	315-0300-00		RES., FXD, CMPSN: 30 OHM, 5%, 0.25W	01121	CB3005

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O A No	Tektronix	Serial/Model No.	Name & Description	Mfr	Mr. Deat New Law
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A4			CKT BOARD ASSY: INTERFACE		
A4C4003	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
A4C4005	283-0002-00		CAP., FXD, CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
A4C4006	290-0316-00		CAP., FXD, ELCTLT: 47UF, 20%, 35V	56289	150D476X0035S2
A4C4010	281-0622-00		CAP., FXD, CER DI:47PF, 1%, 500V	72982	308-000C0G0470F
A4C4012	283-0203-00		CAP., FXD, CER DI:0.47UF, 20%, 50V	72982	8131N075 E474M
A4C4016	285-0509-01		CAP., FXD, PLSTC:0.0068UF, 20%, 5000V	56289	430P507
A4C4020	285-0509-01		CAP.,FXD,PLSTC:0.0068UF,20%,5000V	56289	430P507
A4C4025	285-0509-01		CAP.,FXD,PLSTC:0.0068UF,20%,5000V	56289	
A4C4036	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	
A4C4037	283-0003-00		CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	
A4C4038	285-1040-00		CAP., FXD, PLSTC: 0.0012UF, 10%, 4000V	56289	430P522
A4C4039	283-0003-00		CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-558Z5U-103Z
A4C4043	281-0773-00		CAP., FXD, CER DI:0.010F, 10%, 100V	72982	8005H9AADW5R103K
A4C4104	290-0164-00		CAP., FXD, ELCTLT: 1UF, +50-10%, 150V	56289	500D105F150BA7
A4C4107	283-0178-00		CAP., FXD, CER DI:0.1UF, +80-20%, 100V	72982	8131N145651 104Z
A4C4113	283-0002-00		CAP., FXD, CER DI:0.01UF, +80-20%, 500V	72982	811-546E103Z
A4C4114	283-0057-00		CAP., FXD, CER DI:0.1UF, +80-20%, 200V	56289	274C10
	200 0037 00		on the form of the first the second		
A4C4116	283-0057-00		CAP., FXD, CER DI:0.1UF, +80-20%, 200V	56289	274C10
A4C4117	285-1040-00		CAP., FXD, PLSTC:0.0012UF, 10%, 4000V	56289	430P522
A4C4118	285-0507-01		CAP., FXD, PPR DI:0.0047UF, 20%, 6000V	56289	430P472060
A4C4126	285-1040-00		CAP., FXD, PLSTC: 0.0012UF, 10%, 4000V	56289	430P522
A4C4150	283-0328-00		CAP., FXD, CER DI:0.03UF, +80-20%, 200V	72982	8131N225Z5U0303Z
A4C4153	283-0003-00		CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-558Z5U-103Z
A4C4159	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A4C4164	281-0816-00		CAP., FXD, CER DI:82PF, 5%, 100V	16546	C40A820J
A4C4175	281-0812-00		CAP., FXD, CER DI:1000PF, 10%, 100V	72982	8035D9AADX7R102K
A4C4187	285-0686-00		CAP., FXD, PLSTC:0.068UF, 10%, 100V	56289	410P68391
A4C4192	281-0767-00		CAP., FXD, CER DI: 330PF, 20%, 100V	12969	CGB331MEX
A4C4203	290-0535-00		CAP., FXD, ELCTLT: 33UF, 20%, 10V	56289	196D336X0010KA1
A4C4204	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
A4C4216	283-0002-00		CAP.,FXD,CER DI:0.01UF,20%,500V	72982	811-546E103Z
A4C4217	281-0064-00		CAP., VAR, PLSTC: 0.25-1.5PF, 600V	72982	530-002
A4C4226	281-0788-00		CAP., FXD, CER DI:470PF, 10%, 100V	72982	8005H9AADW5R471K
A4C4229	283-0198-00		CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8121N083Z5U0224M
A4C4246	281-0168-00		CAP., VAR, AIR DI:1.3-5.4PF, 250V	74970	187-0103-035
			,		
A4C4247	281-0168-00		CAP., VAR, AIR DI:1.3-5.4PF, 250V	74970	187-0103-035
A4C4262	283-0024-00		CAP., FXD, CER DI:0.1UF, +80-20%, 50V	72982	8121N083Z5U0104Z
A4C4271	281-0812-00		CAP., FXD, CER DI:1000PF, 10%, 100V	72982	8035D9AADX7R102K
A4C4283	283-0004-00		CAP., FXD, CER DI:0.02UF, +80-20%, 150V	72982	855-558Z5V0203Z
A4C4285	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
A4C4288	283-0004-00		CAP., FXD, CER DI:0.02UF, +80-20%, 150V	72982	855-558Z5V0203Z
A4C4291	281-0762-00		CAP., FXD, CER DI:27PF, 20%, 100V	72982	8035D9AADCOG270M
A4C4292	290-0532-00		CAP., FXD, ELCTLT: 150UF, 20%, 6V	90201	TDC157M006WLC
A4C4303	290-0305-00		CAP., FXD, ELCTLT: 3UF, 20%, 150V	56289	109D305X0150C2
A4C4305	281-0814-00		CAP., FXD, CER DI:100PF, 10%, 100V	04222	GC70-1-A101K
A4C4306 A4C4307	281-0783-00		CAP., FXD, CER DI:0.1UF, 20%, 100V	72982 72982	8045-D-Z5U104M 8045A9ABDZ5U223M
A404307	281-0774-00		CAP., FXD, CER DI:0.022UF, 20%, 100V	72902	004 JAYADDZ JUZZ SRI
A4C4311	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A4C4326	290-0535-00		CAP., FXD, ELCTLT: 33UF, 20%, 10V	56289	196D336X0010KA1
A4C4327	290-0149-00		CAP., FXD, ELCTLT: 5UF, +75-10%, 150V	56289	30D505G150DD4
A4C4331	290-0149-00		CAP., FXD, ELCTLT: 47UF, 20%, 20V	05397	T368C476M020AZ
A4C4341	283-0328-00		CAP., FXD, CER DI:0.03UF, +80-20%, 200V	72982	8131N225Z5U0303Z
A4C4351	281-0773-00		CAP., FXD, CER DI:0.030F, +80-20%, 200V	72982	8005H9AADW5R103K
	201 0773 00			, 2,02	o o o su riano mana do su
A4C4352	283-0003-00		CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-558Z5U-103Z
A4C4361	281-0816-00		CAP., FXD, CER DI:82PF, 5%, 100V	16546	C40A820J
A4C4362	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M

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Replaceable Electrical Parts—465B Service

	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description		Mfr Part Number
	1 471 110.	LII DOCUM	Hame a bescription		THIT T GIT THUITIDG
A4C4375	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
A4C4391	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A4C4398	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	
A4C4407	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
A4C4419	290-0571-00		CAP., FXD, ELCTLT:5000UF,+100-0%,25V	90201	PFP2U-36043
A4C4429	290-0638-00		CAP., FXD, ELCTLT: 1200UF, +75-10%, 100V	56289	68D10529
A4C4439	290-0670-00		CAP., FXD, ELCTLT: 550UF, +75-10%, 100V	56289	68D10512
A4C4441	290-0527-00		CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
A4C4442	283-0178-00		CAP., FXD, CER DI:0.1UF, +80-20%, 100V	72982	
A4C4461	290-0807-00		CAP., FXD, ELCTLT: 1000UF, +100-10%, 10VDC	90201	TT102N010E1C3P
A4C4472	281-0774-00		CAP., FXD, CER DI:0.022UF, 20%, 100V	72982	
A4C4473	281-0767-00		CAP., FXD, CER DI: 330PF, 20%, 100V	12969	CGB331MEX
A4C4476	290-0527-00		CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
A4C4477	281-0756-00		CAP., FXD, CER DI:2.2PF, 0.5%, 200V	72982	0314022C0K0229D
A4C4487	281-0788-00		CAP., FXD, CER DI: 470PF, 10%, 100V	72982	8005H9AADW5R471K
A4C4497	281-0774-00		CAP., FXD, CER DI:0.022UF, 20%, 100V	72982	
A4C4521	290-0584-00		CAP., FXD, ELCTLT: 5500UF, +100-10%, 30V	90201	
A4C4531	290-0571-00		CAP., FXD, ELCTLT: 5000UF, +100-0%, 25V	90201	PFP20-36043
A4C4532	281-0580-00		CAP., FXD, CER DI:470PF, 10%, 500V	04222	7001-1374
A4C4533	281-0775-00		CAP.,FXD,CER DI:470FF,10%,500V	72982	
A4C4554	281-0760-00		CAP., FXD, CER DI:22PF, 10%, 500V	72982	
A4C4563	281-0785-00		CAP.,FXD,CER DI:68PF,10%,100V	72982	
A4C4567	281-0774-00		CAP., FXD, CER DI:0.022UF, 20%, 100V	72982	8045A9ABDZ5U223M
A4C4568	281-0787-00		CAP., FXD, CER DI:15PF, 5%, 500V	72982	0314021C0G0150J
1101510	001 07/0 00		017 7W 070 07 0707 00% 100W	72002	9035D04AD000370M
A4C4569	281-0762-00		CAP., FXD, CER DI:27PF, 20%, 100V	72982 56289	8035D9AADC0G270M 196D226X0015KA1
A4C4571 A4C4572	290-0512-00 290-0527-00		CAP.,FXD,ELCTLT:22UF,20%,15V CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
A4C4575	283-0178-00		CAP.,FXD,CER DI:0.1UF,+80-20%,100V	72982	8131N145651 104Z
A4C4585	281-0759-00		CAP., FXD, CER D1:22PF, 10%, 100V	72982	8035D9AADC1G220K
A4C4592	281-0814-00		CAP., FXD, CER DI:100PF, 10%, 100V	04222	
A404503	201 001/ 00		CAR TWO CER RE-100RE 10% 1000	04222	GC70-1-A101K
A4C4593 A4C4594	281-0814-00		CAP., FXD, CER DI:100PF, 10%, 100V CAP., FXD, CER DI:0.022UF, 20%, 100V	72982	8045A9ABDZ5U223M
A4C4597	281-0774-00 281-0771-00		CAP., FXD, CER DI:0.0220F, 20%, 100V	72982	314-0222Z5U0222M
A4C4598	281-0760-00		CAP.,FXD,CER DI:0.00220F,200,200V	72982	
A4CR4002	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	1N4152R
A4CR4004	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	
A4CR4005	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4010	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4021	152-0409-00		SEMICOND DEVICE:SILICON, 12,000V, 5MA	80009 01295	152-0409-00 1N4152R
A4CR4104	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA SEMICOND DEVICE:SILICON, 30V, 150MA	01295	
A4CR4105 A4CR4108	152-0141-02 152-0107-00		SEMICOND DEVICE: SILICON, 30V, 130MA SEMICOND DEVICE: SILICON, 400V, 400MA		G727
A4CR4111	152-0061-00		SEMICOND DEVICE: SILICON, 175V, 100MA		FDH2161
A4CR4112	152-0061-00		SEMICOND DEVICE:SILICON, 175V, 100MA		FDH2161
A4CR4115	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA		1N4152R
A4CR4122	152-0242-00		SEMICOND DEVICE: SILICON, 225V, 200MA		FDH5004
A4CR4123	152-0242-00		SEMICOND DEVICE:SILICON, 225V, 200MA	07263	
A4CR4144	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4159	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
A4CR4216	152-0061-00		SEMICOND DEVICE: SILICON, 175V, 100MA	07263	
A4CR4218	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	
A4CR4261A,B	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
A4CR4266	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	
A4CR4267	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672
A4CR4285	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4287	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4291	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R

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	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A4CR4302	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	1N4152R
A4CR4303	152-0066-00		SEMICOND DEVICE:SILICON, 400V, 750MA		LG4016
A4CR4304	152-0061-00		SEMICOND DEVICE: SILICON, 175V, 100MA	07263	FDH2161
A4CR4311	152-0061-00		SEMICOND DEVICE: SILICON, 175V, 100MA	07263	FDH2161
A4CR4312	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4318	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4 CD4 201	150 01/1 00			01005	111/1505
A4CR4321	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	1N4152R
A4CR4322	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4326 A4CR4328	152-0304-00 152-0061-00		SEMICOND DEVICE:ZENER,0.4W,20V,5% SEMICOND DEVICE:SILICON,175V,100MA	07263	1N968B FDH2161
A4CR4329	152-0333-00		SEMICOND DEVICE: SILICON, 175V, 100MA SEMICOND DEVICE: SILICON, 55V, 200MA		FDH-6012
A4CR4342	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA		1N4152R
	***		0211200112 02112121011,001,1011		
A4CR4381	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4396	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	1N4152R
A4CR4405	152-0066-00		SEMICOND DEVICE:SILICON,400V,750MA		LG4016
A4CR4406	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA		1N4152R
A4CR4411	152-0556-00		SEMICOND DEVICE: BRIDGE, 50V, 2.5A		SDA10271K
A4CR4423	152-0107-00		SEMICOND DEVICE: SILICON, 400V, 400MA	01295	G727
14004405	150 0066 00			14422	101016
A4CR4425	152-0066-00		SEMICOND DEVICE: SILICON, 400V, 750MA	14433	LG4016
A4CR4426	152-0066-00		SEMICOND DEVICE:SILICON, 400V, 750MA		LG4016
A4CR4431 A4CR4441	152-0107-00		SEMICOND DEVICE:SILICON, 400V, 400MA	01295 01295	
A4CR4441 A4CR4442	152-0141-02 152-0153-00		SEMICOND DEVICE: SILICON, 30V, 150MA		FD7003
A4CR4442 A4CR4465	152-0153-00		SEMICOND DEVICE:SILICON,15V,50MA SEMICOND DEVICE:SILICON,30V,150MA	01295	
ATCATTO	132-0141-02		SEMICOND DEVICE: SILICON, 30V, 130MA	01293	1041720
A4CR4466	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4467	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4471	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4472	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
A4CR4515	152-0066-00		SEMICOND DEVICE: SILICON, 400V, 750MA		LG4016
A4CR4516	152-0556-00		SEMICOND DEVICE:BRIDGE,50V,2.5A	04713	SDA10271K
A4CR4528	152-0556-00		SEMICOND DEVICE: BRIDGE, 50V, 2.5A	04713	SDA10271K
A4CR4531	152-0488-00		SEMICOND DEVICE: SILICON, 200V, 1500MA	04713	
A4CR4546	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	
A4CR4551	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	
A4CR4552	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
A4CR4567	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4577	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4581	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4582	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4592	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4CR4597	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A4DS4124	150-0002-00		LAMP,GLOW:0.5 MA 60/125V	74276	NE-2T(T2)
A4DS4125	150-0002-00		LAMP,GLOW:0.5 MA 60/125V	74276	NE-2T(T2)
A4F4501	159-0059-00		FUSE.WIRE LEAD:5A, FAST-BLOW	71400	
A4F4507	159-0059-00		FUSE, WIRE LEAD: 5A, FAST-BLOW	71400	
A4F4508	159-0016-00		FUSE . CARTRIDGE: 3AG, 1.5A, 250V, FAST-BLOW	71400	AGC 1 1/2
A4J4463	136-0499-12		CONNECTOR, RCPT, :12 CONTACT	00779	4-380949-2
A4J4487	136-0499-14		CONNECTOR, RCPT, :14 CONTACT	00779	4-380949-4
1/1/00/	100 0100 10			00000	100 0/00 00
A4L4006	108-0422-00		COIL, RF: FIXED, 82UH	80009	
A4L4292	108-0245-00		COIL, RF: 3.9UH	76493	
A4L4593 A4Q4002	108-0328-00		COIL, RF: 0. 3UH	80009	108-0328-00 SPS6868K
A4Q4002 A4Q4008	151-0188-00 151-0136-00		TRANSISTOR:SILICON, PNP TRANSISTOR:SILICON, NPN		35495
A4Q4102	131-0136-00		(SEE CHASSIS PARTS)	02133	23473
			(ODD SHRUUTU TRATE)		
A4Q4103	151-0190-00		TRANSISTOR: SILICON, NPN	07263	S032677
A4Q4105	151-0302-00		TRANSISTOR: SILICON, NPN	07263	
A4Q4106	151-0302-00		TRANSISTOR: SILICON, NPN	07263	S038487

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Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A404146	151-0406-00		TO ANCICTOR.CITICON DND	01205	0007202
A4Q4150	151-0407-00		TRANSISTOR: SILICON, PNP	01295	
A4Q4161	151-0302-00		TRANSISTOR: SILICON, NPN	04713	
A4Q4161 A4Q4169	151-0302-00		TRANSISTOR: SILICON, NPN	07263	S038487 S032677
A4Q4182	151-0342-00		TRANSISTOR:SILICON,NPN TRANSISTOR:SILICON,PNP		S035928
A4Q4190	131-0342-00			07203	3033920
A4Q4170			(SEE CHASSIS PARTS)		
A4Q4196	151-0342-00		TRANSISTOR: SILICON, PNP	07263	S035928
A4Q4213	151-0406-00		TRANSISTOR: SILICON, PNP	01295	
A4Q4217	151-0407-00		TRANSISTOR: SILICON, NPN		SS2456
A4Q4222	151-0188-00		TRANSISTOR: SILICON, PNP	04713	
A4Q4223	151-0223-00		TRANSISTOR: SILICON, NPN	04713	
A4Q4228	151-0126-00		TRANSISTOR: SILICON, NPN	04713	
A4Q4233	151-0301-00		TRANSISTOR: SILICON, PNP	04713	2N2907A
A4Q4273	151-0188-00		TRANSISTOR: SILICON, PNP	04713	SPS6868K
A4Q4274	151-0188-00		TRANSISTOR: SILICON, PNP	04713	SPS6868K
A4Q4284	151-0220-00		TRANSISTOR: SILICON, PNP	07263	S036228
A4Q4285	151-0216-00		TRANSISTOR: SILICON, PNP	04713	SPS8803
A4Q4291	151-0164-00		TRANSISTOR: SILICON, PNP	01295	SKB3334
A4Q4301			(SEE CHASSIS PARTS)		
A4Q4302	151 02/7 00		MUTHUR SALES OF THE SALES OF TH	04712	CDC7051
A4Q4302 A4Q4303	151-0347-00		TRANSISTOR: SILICON, NPN	04713	
*	151-0347-00		TRANSISTOR: SILICON, NPN	04713	SPS7951
A4Q4311	151-0302-00		TRANSISTOR: SILICON, NPN	07263	S038487
A4Q4312	151 0/0/ 00		(SEE CHASSIS PARTS)	01005	0007000
A4Q4341	151-0406-00		TRANSISTOR: SILICON, PNP	01295	SGC7282
A4Q4342	151-0407-00		TRANSISTOR: SILICON, NPN	04713	SS2456
A4Q4361	151-0301-00		TRANSISTOR: SILICON, PNP	04713	2N2907A
A4Q4362	151-0188-00		TRANSISTOR: SILICON, PNP	04713	SPS6868K
A4Q4398	151-0190-00	B010100 B029999X	TRANSISTOR: SILICON, NPN	07263	
A4Q4401			(SEE CHASSIS PARTS)		
A4Q4403	151-0302-00		TRANSISTOR: SILICON, NPN	07263	S038487
A4Q4404	151-0302-00		TRANSISTOR: SILICON, NPN	07263	S038487
4/0//05	151 0011 01				
A4Q4425	151-0311-01		TRANSISTOR: SILICON, NPN	80009	151-0311-01
A4Q4431	151-0347-00		TRANSISTOR: SILICON, NPN	04713	
A4Q4465	151-0188-00		TRANSISTOR: SILICON, PNP	04713	
A4Q4475	151-0188-00		TRANSISTOR: SILICON, PNP	04713	
A4Q4481	151-0190-00		TRANSISTOR: SILICON, NPN	07263	S032677
A4Q4482	151-0190-00		TRANSISTOR: SILICON, NPN	07263	S032677
A4Q4491	151-0190-00		TRANSISTOR: SILICON, NPN	07263	S032677
A404492	151-0190-00		TRANSISTOR: SILICON, NPN	07263	S032677
A4Q4497	151-0283-00		TRANSISTOR: SILICON, NPN	07263	S032790
A4Q4498	151-1025-00		TRANSISTOR: SILICON, JFE, N-CHANNEL	01295	
A404545	151-0188-00		TRANSISTOR: SILICON, PNP	04713	
A4Q4554	151-0220-00		TRANSISTOR: SILICON, PNP	07263	
1101510					007/000
A4Q4562	151-0220-00		TRANSISTOR: SILICON, PNP		S036228
A4Q4563	151-0188-00		TRANSISTOR: SILICON, PNP		SPS6868K
A4Q4564	151-0188-00		TRANSISTOR: SILICON, PNP	04713	
A4Q4565	151-0283-00		TRANSISTOR: SILICON, NPN		S032790
A4Q4566	151-1025-00		TRANSISTOR: SILICON, JFE, N-CHANNEL	01295	
A4Q4570	151-0127-00		TRANSISTOR: SILICON, NPN	07263	S006075
A4Q4581	151-0220-00		TRANSISTOR: SILICON, PNP	07263	S036228
A404582	151-0220-00		TRANSISTOR: SILICON, PNP	07263	
A4Q4588	151-0354-00		TRANSISTOR: SILICON, PNP, DUAL	32293	
A4Q4598	151-0127-00		TRANSISTOR: SILICON, NPN	07263	
A4R4001	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	
A4R4001	315-0472-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB4725
	313 0472-00		Mass, tras, oriestica. / N. Offin, JA, U. 23W	01121	054123
A4R4003	315-0392-00		RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
A4R4004	321-0327-00		RES., FXD, FILM: 24.9K OHM, 1%, 0.125W	91637	MFF1816G24901F

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	Taldonalio	Coming / Mandal Ma		144	
Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
Component No.	rail No.	EII DSCOIL	Name & Description	Coue	WIII FAIT NUITIDE
A4R4005	321-0329-00		RES., FXD, FILM: 26.1K OHM, 1%, 0.125W	91637	MFF1816G26101F
A4R4006	315-0106-00		RES.,FXD,CMPSN:10M OHM,5%,0.25W	01121	
A4R4008	315-0182-00		RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	
A4R4013	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W		CB1045
A4R4041	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W		CB1015
A4R4042	315-0223-00		RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
A4R4048	315-0183-00		RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
A4R4059	311-1538-00		RES., VAR, NONWIR: 5K OHM X 2.5M OHM, 10%	01121	18M683
A4R4069	311-1555-00		RES., VAR, NONWIR: 100K OHM, 20%, 0.5W		91-77-0
A4R4072	311-1560-00		RES., VAR, NONWIR: 5K OHM, 20%, 0.50W	73138	91-82-0
A4R4075	315-0302-00		RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
A4R4107	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A4R4108	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
A4R4109	311-1557-00		RES., VAR, NONWIR: 25K OHM, 20%, 0.50W	73138	91-79-00
A4R4110	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	
A4R4111	315-0102-03		RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	
A4R4112	315-0394-00		RES., FXD, CMPSN: 390K OHM, 5%, 0.25W		CB3945
A4R4113	315-0102-03		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W		CB1025
A4R4114	315-0911-00		RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	
A4R4119	315-0221-03		RES., FXD, CMPSN: 220 OHM, 5%, 0.25W		CB2215
A4R4124	315-0226-00		RES.,FXD,CMPSN:22M OHM,5%,0.25W	01121	
A4R4123	315-0103-03		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W		CB1035
A4R4126	315-0103-03		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	
A4R4127A,B,C,D	307-0290-04		RES., FXD, FILM: MULTIPLE SECTION	80009	307-0290-04
A4R4128	315-0103-03		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
A4R4132	311-0075-00		RES., VAR, NONWIR: 5M OHM, 20%	12697	381-CM16993
A4R4142	315-0470-00		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
A4R4144	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A4R4145	321-0189-00		RES., FXD, FILM: 909 OHM, 1%, 0.125W	91637	MFF1816G909R0F
A4R4146	301-0393-00		RES.,FXD,CMPSN:39K OHM,5%,0.50W	01121	EB3935
A4R4158	315-0475-00		RES.,FXD,CMPSN:4.7M OHM,5%,0.25W	01121	CB4755
A4R4161	315-0681-00		RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A4R4163	315-0182-00		RES., FXD, CMPSN: 1.8K OHM, 5%, 0.25W	01121	CB1825
A4R4165	315-0330-00		RES., FXD, CMPSN: 33 OHM, 5%, 0.25W	01121	CB3305
			(NOMINAL VALUE, SELECTED)		
A4R4167	321-0247-00	B010100 B011249	RES.,FXD,FILM:3.65K OHM,1%,0.125W	91637	MFF1816G36500F
A4R4167	321-0245-00	B011250	RES.,FXD,FILM:3.48K OHM,1%,0.125W	91637	MFF1816G34800F
A4R4169	315-0221-00		RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A4R4172	321-0287-00		RES.,FXD,FILM:9.53K OHM,1%,0.125W	91637	MFF1816G95300F
A4R4173	321-0138-00		RES.,FXD,FILM:267 OHM,1%,0.125W	91637	MFF1816G267R0F
A4R4174	321-0138-00		RES.,FXD,FILM:267 OHM,1%,0.125W	91637	MFF1816G267R0F
A4R4175	315-0621-00		RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
A4R4178	311-1372-00		RES., VAR, NONWIR: 100K OHM, 20%, 1W	01121	73M1G040L104M
A4R4179	311-1313-00		RES., VAR, NONWIR: 2K OHM, 20%, 1W	01121	73M4G048L202M
A4R4184	315-0822-00		RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
A4R4185	315-0912-00		RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
A4R4186	315-0473-00		RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
A4R4191	315-0513-00		RES., FXD, CMPSN:51K OHM, 5%, 0.25W	01121	CB5135
A4R4193	315-0302-00		RES., FXD, CMPSN: 3K OHM, 5%, 0.25W	01121	CB3025
A4R4195	311-1373-00		RES., VAR, NONWIR: 5K OHM, 20%, 1W	01121	73U4G040L502M
A4R4202	308-0459-00		RES., FXD, WW:1.1 OHM, 5%, 3W	91637	
A4R4204	315-0242-00		RES., FXD, CMPSN: 2.4K OHM, 5%, 0.25W	01121	CB2425
A4R4205	321-0274-00		RES., FXD, FILM: 6.98K OHM, 1%, 0.125W	91637	MFF1816G69800F
A4R4206	321-0775-03		RES., FXD, FILM: 45K OHM, 0.25%, 0.125W	91637	MFF1816D45001C
A/P/207	321-0374-03		DEC EVO BILLY, SV OUN O 25% O 125"	01627	MFF1816D45000C
A4R4207 A4R4208	321-0774-03 315-0563-00		RES.,FXD,FILM:4.5K OHM,0.25%,0.125W RES.,FXD,CMPSN:56K OHM,5%,0.25W	91637 01121	CB5635
TK7400	317-0303-00		Made grady out on Jon Othing Jague 278	01141	

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0 N-	Tektronix	Serial/Model No.	Name & Barriella	Mfr	AAC- Door No boo
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A4R4216	315-0273-00		RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
A4R4217	302-0393-00		RES., FXD, CMPSN: 39K OHM, 10%, 0.50W	01121	EB3931
A4R4218	323-0322-00		RES., FXD, F1LM:22.1K OHM, 1%, 0.50W	75042	CECTO-2212F
A4R4219	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	
A4R4220	315-0391-00		RES., FXD, CMPSN: 390 OHM, 5%, 0.25W	01121	
A4R4221	321-0249-00		RES.,FXD,F1LM:3.83K OHM,1%,0.125W	91637	MFF1816G38300F
A4R4224	321-0168-00		RES.,FXD,FILM:549 OHM,1%,0.125W	91637	MFF1816G549R0F
A4R4225	315-0201-00		RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	
A4R4226	315-0475-00		RES.,FXD,CMPSN:4.7M OHM,5%,0.25W	01121	
A4R4227	315-0221-00		RES., FXD, CMPSN: 220 OHM, 5%, 0.25W	01121	CB2215
A4R4228	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
A4R4230	315-0242-00		RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
A4R4231	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A4R4235	315-0683-00		RES., FXD, CMPSN: 68K OHM, 5%, 0.25W	01121	
A4R4242	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	
A4R4244	322-0289-00		RES.,FXD,F1LM:10K OHM,1%,0.25W	75042	
A4R4245	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A4R4250	322-0289-00		RES.,FXD,FILM:10K OHM,1%,0.25W	75042	CEBT0-1002F
A4R4253	211-1556-00	VP011250	BEG HAD MONUTO SON OUR CON O SON	73138	91-78-0
A4R4254	311-1556-00 322-0289-00	XDUI123U	RES.,VAR,NONWIR:50K OHM,20%,0.50W RES.,FXD,FILM:10K OHM,1%,0.25W	75042	
A4R4260	315-0622-00	B010100 B011249	RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
		2010100 2011249	(NOMINAL VALUE, SELECTED)	01121	050227
A4R4260	315-0223-00	B011250	RES., FXD, CMPSN: 22K OHM, 5%, 0.25W	01121	CB2235
A4R4262	315-0562-00	B010100 B011249	RES., FXD, CMPSN: 5.6K OHM, 5%, 0.25W	01121	CB5625
			(NOMINAL VALUE, SELECTED)		
A4R4262	315-0223-00	B011250	RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
A4R4263	301-0181-00		RES.,FXD,CMPSN:180 OHM,5%,0.50W	01121	
A4R4265	321-0142-00		RES.,FXD,FILM:294 OHM,1%,0.125W	91637	
A4R4266	321-0126-00		RES.,FXD,F1LM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A4R4267	321-0126-00		RES.,FXD,FILM:200 OHM,1%,0.125W	91637	
A4R4268	321-0300-00		RES., FXD, FILM: 13K OHM, 1%, 0.125W	91637	MFF1816G13001F
			(NOMINAL VALUE, SELECTED)		
A4R4270	321-0206-00		RES.,FXD,FILM:1.37K OHM,1%,0.125W	91637	MFF1816G13700F
A4R4272	315-0621-00		RES., FXD, CMPSN: 620 OHM, 5%, 0.25W	01121	CB6215
A4R4273	323-0289-00		RES.,FXD,FILM: 10K OHM, 1%, 0.50W	75042	CECT0-1002F
A4R4274	311-1563-00		RES., VAR, NONWIR: 1K OHM, 20%, 0.50W	73138	
A4R4275	311-1561-00		RES., VAR, NONWIR: 2.5K OHM, 20%, 0.50W	73138	
A4R4276	321-0210-00		RES.,FXD,FILM:1.5K OHM,1%,0.125W	91637	MFF1816G15000F
A4R4277	323-0289-00		RES.,FXD,FILM:10K OHM,1%,0.50W	75042	CECTO-1002F
A4R4279	321-0110-00		RES.,FXD,FILM:137 OHM,1%,0.125W	91637	MFF1816G137R0F
A4R4280	321-0205-00		RES.,FXD,F1LM:1.33K OHM,1%,0.125W	91637	MFF1816G13300F
A4R4281	321-0164-00		RES.,FXD,FILM:499 OHM,1%,0.125W	91637	
A4R4282	321-0248-00	B010100 B022259	RES.,FXD,FILM:3.74K OHM,1%,0.125W	91637	
A4R4282	321-0253-00	B022260	RES.,FXD,FILM:4.22K OHM,1%,0.125W	91637	MFF1816G42200F
A4R4283	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A4R4284	315-0333-00		RES., FXD, CMPSN: 33K OHM, 5%, 0.25W	01121	CB3335
A4R4285	321-0174-00		RES.,FXD,F1LM:634 OHM,1%,0.125W	91637	
A4R4286	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	
A4R4287	315-0152-00		RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
A4R4288	315-0202-00		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A4R4289	315-0203-00		RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
A4R4291	315-0512-00		RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A4R4293	311-1568-00		RES., VAR, NONWIR:50 OHM, 20%, 0.50W	73138	91-90-0
A4R4294	321-0107-00		RES.,FXD,FILM:127 OHM,1%,0.125W	91637	
A4R4295	321-0001-00		RES.,FXD,FILM:10 OHM,1%,0.125W	75042	
A4R4302	315-0122-00		RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225

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Replaceable Electrical Parts-465B Service

	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A4R4305	321-0366-00		RES., FXD, FILM: 63.4K OHM, 1%, 0.125W	91637	
A4R4306 A4R4311	315-0102-00		RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	CB1025
A4R4311 A4R4312	321-0962-03 321-0967-03		RES.,FXD,FILM:8K OHM,0.25%,0.125W RES.,FXD,FILM:55K OHM,0.25%,0.125W	91637 91637	
A4R4313	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	
A4R4314	321-0201-00		RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	
	011 0101 00		and the state of t	,100,	
A4R4315	315-0512-00		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	
A4R4316	315-0183-00		RES.,FXD,CMPSN:18K OHM,5%,0.25W		CB1835
A4R4318	311-1226-00		RES., VAR, NONWIR: 2.5K OHM, 20%, 0.50W	32997	
A4R4319 A4R4321	321-0292-00		RES.,FXD,FILM:10.7K OHM,1%,0.125W		MFF1816G10701F
A4R4321 A4R4322	321-0307-00 321-0220-00		RES.,FXD,FILM:15.4K OHM,1%,0.125W RES.,FXD,FILM:1.91K OHM,1%,0.125W		MFF1816G15401F MFF1816G19100F
1144322	321-0220-00		RES., FAD, FILM: 1.91K OHM, 1%, 0.125W	91037	MFF1010G19100F
A4R4323	301-0243-00		RES., FXD, CMPSN: 24K OHM, 5%, 0.50W	01121	EB2435
A4R4324	315-0242-00		RES., FXD, CMPSN: 2.4K OHM, 5%, 0.25W	01121	
A4R4325	307-0093-00		RES.,FXD,CMPSN:1.2 OHM,5%,0.50W		EB12G5
A4R4326	303-0223-00		RES., FXD, CMPSN: 22K OHM, 5%, 1W	01121	
A4R4327	315-0153-00		RES., FXD, CMPSN: 15K OHM, 5%, 0.25W		CB1535
A4R4331	315-0273-00		RES., FXD, CMPSN: 27K OHM, 5%, 0.25W	01121	CB2735
A4R4332	315-0224-00		RES., FXD, CMPSN: 220K OHM, 5%, 0.25W	01121	CB2245
A4R4341	322-0289-00		RES., FXD, FILM: 10K OHM, 1%, 0.25W	75042	
A4R4342	301-0393-00		RES., FXD, CMPSN: 39K OHM, 5%, 0.50W	01121	EB3935
A4R4343	315-0470-00		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
A4R4344	302-0273-00		RES., FXD, CMPSN: 27K OHM, 10%, 0.50W	01121	EB2731
A4R4345	321-0268-00		RES.,FXD,FILM:6.04K OHM,1%,0.125W	91637	MFF1816G60400F
A4R4346	321-0189-00		RES.,FXD,FILM:909 OHM,1%,0.125W	91637	MFF1816G909R0F
A4R4347	321-0139-00		RES.,FXD,FILM:22.1 OHM,1%,0.125W	91637	
A4R4351	315-0273-00		RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	
A4R4352	321-0222-00		RES., FXD, FILM: 2K OHM, 1%, 0.125W	91637	
A4R4360	321-0142-00		RES., FXD, FILM: 294 OHM, 1%, 0.125W	91637	
A4R4361	321-0247-00	B010100 B011249	RES., FXD, FILM: 3.65K OHM, 1%, 0.125W	91637	MFF1816G36500F
A4R4361	321-0245-00	B011250	RES., FXD, FILM: 3.48K OHM, 1%, 0.125W	91637	MFF1816G34800F
A4R4362	315-0391-00	D011230	RES., FXD, CMPSN: 390 OHM, 5%, 0.25W	01121	
A4R4363	315-0121-00		RES., FXD, CMPSN: 120 OHM, 5%, 0.25W		CB1215
			(NOMINAL VALUE, SELECTED)	01121	
A4R4364	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
A4R4365	321-0222-00		RES., FXD, FILM: 2K OHM, 1%, 0.125W	91637	MFF1816G20000F
A4R4366	321-0173-00		DEC DUD EXTRACTO OUR 18 O 1050	01627	WEE1 01 4 04 1 00 0 F
A4R4367	321-0173-00		RES.,FXD,FILM:619 OHM,1%,0.125W RES.,FXD,FILM:806 OHM,1%,0.125W	91637 91637	
A4R4368	323-0248-00		RES.,FXD,F1LM:3.74K OHM,1%,0.50W	75042	
A4R4369	323-0248-00		RES.,FXD,FILM:3.74K OHM,1%,0.50W		CECTO-3741F
A4R4371	321-0184-00		RES., FXD, FILM: 806 OHM, 1%, 0.125W		MFF1816G806R0F
A4R4372	321-0173-00		RES., FXD, FILM: 619 OHM, 1%, 0.125W	91637	MFF1816G619R0F
A/D/2-2				*****	01 00 0
A4R4373	311-1567-00		RES., VAR, NONWIR: TRMR, 100 OHM, 0.50W		91-89-0
A4R4374	315-0270-00		RES., FXD, CMPSN: 27 OHM, 5%, 0.25W	01121	CB2705
A4R4375 A4R4376	315-0331-00 323-0191-00		RES.,FXD,CMPSN:330 OHM,5%,0.25W RES.,FXD,FILM:953 OHM,1%,0.50W	01121 75042	CB3315 CECTO-9530F
A4R4381	311-1567-00		RES., VAR, NONWIR: TRMR, 100 OHM, 0.50W	73138	
A4R4382	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
	4		,,		
A4R4383	321-0147-00		RES., FXD, FILM: 332 OHM, 1%, 0.125W	91637	
A4R4384	321-0116-00		RES., FXD, FILM: 158 OHM, 1%, 0.125W	91637	
A4R4392	315-0512-00		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
A4R4393	315-0472-00	B010100 B029999X	, ,	01121	
A4R4394 A4R4395	315-0122-00 315-0821-00		RES., FXD, CMPSN: 1.2K OHM, 5%, 0.25W	01121	CB1225
	313-0021-00		RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
A4R4396	315-0122-00		RES., FXD, CMPSN: 1.2K OHM, 5%, 0.25W	01121	CB1225
A4R4397	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	
A4R4403	308-0459-00		RES.,FXD,WW:1.1 OHM,5%,3W	91637	CW2B-D1R100J

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Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
					THE PART HOLLDON
A4R4404	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A4R4405	315-0153-00		RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A4R4406	321-0296-00		RES., FXD, FILM: 11.8K OHM, 1%, 0.125W	91637	MFF1816G11801F
A4R4407	321-0603-00		RES., FXD, FILM: 15K OHM, 0.25%, 0.125W	91637	
A4R4411	321-0966-03		RES., FXD, FILM: 40K OHM, 0.25%, 0.125W		MFF1816D40001C
A4R4412	303-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 1W	01121	GB4725
A4R4421	323-0269-00		RES.,FXD,FILM:6.19K OHM,1%,0.50W	75042	CECTO-6191F
A4R4422	308-0644-00		RES., FXD, WW:25 OHM, 1%, 5W	91637	
A4R4432	315-0200-02		RES., FXD, CMPSN: 20 OHM, 5%, 0.25W	01121	
A4R4433	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W		CB1015
A4R4434	303-0203-00		RES., FXD, CMPSN: 20K OHM, 5%, 1W	01121	
A4R4441	315-0302-00		RES., FXD, CMPSN: 3K OHM, 5%, 0.25W		CB3025
A4R4451	315-0101-00		DEC. EVE CARON, 100 OUR ES O OFF	01101	CDIOIS
A4R4461	321-0229-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W RES., FXD, FILM: 2.37K OHM, 1%, 0.125W	01121	CB1015 MFF1816G23700F
A4R4462	321-0223-00		RES.,FXD,FILM:2.37K OHM,1%,U.125W	91637	
A4R4466	321-0418-00		RES.,FXD,FILM:4:02K OHM,0.3%,0.125W		MFF1816G22102F
A4R4467	315-0822-00		RES., FXD, CMPSN: 8.2K OHM, 5%, 0.25W	01121	
A4R4469	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
4404471					
A4R4471	321-0463-00		RES., FXD, FILM: 649K OHM, 1%, 0.125W	91637	
A4R4472	315-0822-00		RES., FXD, CMPSN: 8.2K OHM, 5%, 0.25W	01121	
A4R4473	315-0221-00		RES., FXD, CMPSN: 220 OHM, 5%, 0.25W	01121	
A4R4474 A4R4475	321-0228-00		RES., FXD, FILM: 2.32K OHM, 1%, 0.125W	91637 91637	
A4R4476	321-0251-01 315-0184-00		RES., FXD, FILM: 4.02K OHM, 0.5%, 0.125W	01121	MFF1816G40200D CB1845
N4N4470	313-0164-00		RES., FXD, CMPSN: 180K OHM, 5%, 0.25W	01121	CB1043
A4R4477	315-0470-00		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
A4R4479	315-0470-00		RES., FXD, CMPSN: 47 OHM, 5%, 0.25W	01121	CB4705
A4R4482	315-0512-02		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
A4R4483	315-0512-02		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	
A4R4484	315-0512-02		RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A4R4485	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
A4R4486	315-0512-00		RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A4R4487	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
A4R4488	315-0512-00		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
A4R4491	315-0122-00		RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
A4R4492	315-0821-00		RES., FXD, CMPSN: 820 OHM, 5%, 0.25W	01121	
A4R4493	315-0122-00		RES., FXD, CMPSN: 1.2K OHM, 5%, 0.25W	01121	CB1225
A4R4494	315-0821-00		RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
A4R4495	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A4R9996	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
A4R4497	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A4R4498	315-0470-00		RES., FXD, CMPSN: 47 OHM, 5%, 0.25W	01121	CB4705
A4R4526	308-0363-00		RES.,FXD,WW:3K OHM,5%,8W	91637	RS8-B30000J
A4R4527	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A4R4531	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
A4R4545	301-0432-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	EB4325
A4R4546	321-0228-00		RES., FXD, FILM: 2.32K OHM, 1%, 0.125W		MFF1816G23200F
A4R4547	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
A4R4548	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
AAD4551	308-0631-00		DEC EVE LEI-2V AIM E% 211	01627	CU_28 820000 1
A4R4551 A4R4552	308-0421-00		RES., FXD, WW: 3K OHM, 5%, 3W	91637	
A4R4553	315-0360-00 321-0250-00		RES., FXD, CMPSN: 36 OHM, 5%, 0.25W RES., FXD, FILM: 3.92K OHM, 1%, 0.125W	01121 91637	CB3605 MFF1816G39200F
A4R4554	321-0250-00		RES.,FXD,FILM:3.92k OHM,1%,0.125W	91637	
A4R4561	315-0360-00		RES.,FXD,CMPSN:36 OHM,5%,0.25W	01121	CB3605
A4R4562	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
A4R4563	321-0165-00		RES.,FXD,FILM:511 OHM,1%,0.125W	91637	MFF1816G511R0F
A4R4564	315-0330-00		RES., FXD, CMPSN: 33 OHM, 5%, 0.25W	01121	CB3305
A4R4565	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015

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Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A4R4566	321-0193-00		RES.,FXD,FILM:1K OHM,1%,0.125W	01637	MFF1816G10000F
A4R4568	315-0330-00		RES., FXD, CMPSN: 33 OHM, 5%, 0.25W	01121	CB3305
			RES., VAR, NONWIR: TRMR, 100 OHM, 0.50W		91-89-0
4R4570	311-1567-00				
14R4571	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	
4R4572	321-0256-00		RES., FXD, F1LM: 4.53K OHM, 1%, 0.125W		MFF1816G45300F
4R4573	321-0154-00		RES.,FXD,FILM:392 OHM,1%,0.125W	91637	MFF1816G392ROF
A4R4574	321-0231-00		RES., FXD, FILM: 2.49K OHM, 1%, 0.125W	91637	
A4R4575	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
A4R4576	303-0432-00		RES., FXD, CMPSN: 4.3K OHM, 5%, 1W	01121	GB4325
A4R4577	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
44R4578	321-0228-00		RES., FXD, FILM: 2.32K OHM, 1%, 0.125W	91637	MFF1816G23200F
A4R4579	321-0193-00		RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
A4R4581	308-0421-00		RES., FXD, WW: 3K OHM, 5%, 3W	91637	CW-2B B30000J
A4R4583	315-0360-00		RES., FXD, CMPSN: 36 OHM, 5%, 0.25W	01121	CB3605
A4R4584	321-0250-00		RES., FXD, FILM: 3.92K OHM, 1%, 0.125W	91637	MFF1816G39200F
A4R4585	321-0195-00		RES., FXD, FILM: 1.05K OHM, 1%, 0.125W	91637	MFF1816G10500F
A4R4586	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W		MFF1816G10000F
4R4587	321-0165-00		RES., FXD, FILM: 511 OHM, 1%, 0.125W	91637	
1,04,500	015 0040 00			01101	CP26C5
A4R4592	315-0360-00		RES., FXD, CMPSN: 36 OHM, 5%, 0.25W	01121	
A4R4593	315-0273-00		RES., FXD, CMPSN: 27K OHM, 5%, 0.25W	01121	
A4R4595	321-0256-00		RES., FXD, FILM: 4.53K OHM, 1%, 0.125W		MFF1816G45300F
A4R4596	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W		CB1015
A4R4597	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W		MFF1816G10000F
A4R4598	315-0181-00		RES., FXD, CMPSN: 180 OHM, 5%, 0.25W	01121	CB1815
A4R4599	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
A4RT4373	307-0122-00		RES., THERMAL: 50 OHM, 10%	50157	3D1515
A4S4075	260-1310-01		SWITCH, PUSH: 4PDT MOMENTARY, NON-SHORTING	80009	260-1310-01
A4S4371	260-1208-00		SWITCH, PUSH: DPDT, 28VDC, PUSH-PUSH	80009	260-1208-00
A4T4015	120-0800-01		XFMR, PWR, SDN&SU: MOLDED	80009	120-0800-01
A4U4032	152-0552-00		SEMICOND DEVICE: V MULTR, 5KV IN, 15KV OUT	52306	CMX234
A4U4206	156-0158-00		MICROCIRCUIT, LI: DUAL OPERATIONAL AMPLIFIER	18324	MC1458V
A4U4269	156-0197-00	B010100 B039319	MICROCIRCUIT, LI:5 TRANSISTOR ARRAY	80009	156-0197-00
A4U4269	156-0048-03	B039320	MICROCIRCUIT, LI:5 TRANSISTOR ARRAY		156-0048-03
A4U4391	156-0383-00	6037320	MICROCIRCUIT, DI: QUAD 2-INPUT NOR GATE	80009	156-0383-00
A4U4411	156-0158-00		MICROCIRCUIT, LI: DUAL OPERATIONAL AMPLIFIER	18324	MC1458V
A4U4491	156-0388-00		MICROCIRCUIT, DI: DUAL D-TYPE FLIP-FLOP	80009	156-0388-00
A 6 UD 6 O O 7	152 0220 00		COMPONE DESIGNED OF THE 1904 F	0/712	0710/0/201
A4VR4007	152-0289-00		SEMICOND DEVICE: ZENER, 0.4W, 180V, 5%	04713	SZ12484KRL
A4VR4108	152-0286-00		SEMICOND DEVICE: ZENER, 0.4W, 75V, 5%		152-0286-00
A4VR4194	152-0127-00		SEMICOND DEVICE: ZENER, 0.4W, 7.5V, 5%	04713	
A4VR4215	152-0166-00		SEMICOND DEVICE: ZENER, 0.4W, 6.2V, 5%		SZ11738
A4VR4304	152-0283-00		SEMICOND DEVICE: ZENER, 0.4W, 43V, 5%		DZ750903B1N976
A4VR4326	152-0304-00		SEMICOND DEVICE: ZENER, 0.4W, 20V, 5%	14433	1N968B
A4VR4341	152-0166-00		SEMICOND DEVICE: ZENER, 0.4W, 6.2V, 5%	04713	SZ11738
A4VR4394	152-0306-00		SEMICOND DEVICE: ZENER, 0.4W, 9.1V, 5%	14433	1N960B
A4VR4408	152-0281-00		SEMICOND DEVICE: ZENER, 0.4W, 22V, 5%	80009	152-0281-00
A4VR4421	152-0411-00		SEMICOND DEVICE: ZENER, 0.25W, 9V, 5%	04713	SZ12483K
A4VR4422	152-0268-00		SEMICOND DEVICE: ZENER, 0.4W, 56V, 5%	80009	152-0268-00
A4VR4495	152-0306-00		SEMICOND DEVICE: ZENER, 0.4W, 9.1V, 5%	14433	1N960B
A4VR4496	152-0306-00		SEMICOND DEVICE:ZENER, 0.4W, 9.1V, 5%	14433	1N960B
A4VR4497	152-0278-00		SEMICOND DEVICE: ZENER, 0.4W, 3V, 5%	04713	
4W4032	131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG		L-2007-1
4W4183	131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG		L-2007-1
4W4259					L-2007-1
14W4239 14W4348	131-0566-00 131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG		L-2007-1 L-2007-1
0.17.17.4				EFOLO	1 2007 1
A4W4440	131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG		L-2007-1
14W4468	131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG		L-2007-1
44W4 481	131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG		L-2007-1
14W448 3	131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG		L-2007-1
4W4544			BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG		L-2007-1

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	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A5			CKT BOARD ASSY: VERTICAL MODE SW		
A5C5018	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103H
A5C5135	290-0246-00		CAP.,FXD,ELCTLT:3.3UF,10%,15V	56289	
A5C5145	290-0246-00		CAP., FXD, ELCTLT: 3.3UF, 10%, 15V	56289	
A5C5214	290-0804-00		CAP., FXD, ELCTLT: 10UF, +50-10%, 25V	55680	
A5C5235	290-0304-00		CAP., FXD, ELCTLT: 3.3UF, 10%, 15V	56289	
NJ0J2JJ	290-0240-00		CAF., FAD, ELCILI. 3. 30F, 10%, 134	30207	1020333117013002
A5C5245	290-0246-00		CAP., FXD, ELCTLT: 3.3UF, 10%, 15V	56289	162D335X9015CD2
A5CR5115	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
A5CR5116	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A5CR5118	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	
A5CR5211	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA		1N4152R
A5CR5214	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA		1N4152R
1150115214	132-0141-02		DEFICORD DEVICE DELECTION, SOV, 1 SOLET	01277	211727411
A5Q5017	151-0301-00		TRANSISTOR: SILICON, PNP	04713	2N2907A
A5Q5056	151-0302-00		TRANSISTOR: SILICON, NPN	07263	S038487
A5Q5057	151-0281-00		TRANSISTOR: SILICON, NPN	03508	X16P4039
A5Q5241	151-0301-00		TRANSISTOR: SILICON, PNP	04713	2N2907A
A505257	151-0281-00		TRANSISTOR:SILICON, NPN	03508	X16P4039
A5Q5258	151-0302-00		TRANSISTOR: SILICON, NPN	07263	S038487
•			•		
A5R5005	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A5R5006	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A5R5007	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A5R5015	315-0103-00		RES., FXD, CMPSN:10K OHM, 5%, 0.25W	01121	CB1035
A5R5018	315-0331-00		RES.,FXD,CMPSN:330 OHM,5%,D.25W	01121	CB3315
A5R5041	315-0161-00		RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
A5R5042	215 0222 00		RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
	315-0332-00		RES., FXD, CMPSN: 240 OHM, 5%, 0.25W		CB2415
A5R5051	315-0241-00				CB1625
A5R5052	315-0162-00		RES., FXD, CMPSN:1.6K OHM, 5%, 0.25W	01121	
A5R5053	315-0821-00		RES., FXD, CMPSN: 820 OHM, 5%, 0.25W	01121	
A5R5055	315-0473-00		RES., FXD, CMPSN:47K OHM, 5%, 0.25W	01121	
A5R5111	315-0102-00		RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	CBIUZS
A5R5114	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A5R5117	315-0331-00		RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	CB3315
A5R5135	315-0621-00		RES., FXD, CMPSN: 620 OHM, 5%, 0.25W	01121	CB6215
A5R5145	315-0621-00		RES., FXD, CMPSN:620 OHM, 5%, 0.25W		CB6215
A5R5211	315-0302-00		RES., FXD, CMPSN: 3K OHM, 5%, 0.25W	01121	
A5R5212	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
A5R5213	315-0362-00		RES.,FXD,CMPSN:3.6K OHM,5%,0.25W		CB3625
A5R5214	315-0751-00		RES., FXD, CMPSN: 750 OHM, 5%, 0.25W	01121	
A5R5235	315-0621-00		RES.,FXD,CMPSN:620 OHM,5%,0.25W		CB6215
A5R5236	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W		CB1035
A5R5237	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	
A5R5238	315-0821-00		RES., FXD, CMPSN: 820 OHM, 5%, 0.25W	01121	CB8215
	***			01121	СВ6215
A5R5245	315-0621-00		RES., FXD, CMPSN: 620 OHM, 5%, 0.25W	01121	
A5R5251	315-0241-00		RES., FXD, CMPSN: 240 OHM, 5%, 0.25W	01121	CB2415
A5R5252	315-0162-00		RES., FXD, CMPSN: 1.6K OHM, 5%, 0.25W	01121	CB1625
A5R5253	315-0161-00		RES., FXD, CMPSN:160 OHM, 5%, 0.25W	01121	
A5R5254	315-0332-00		RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W	01121	CB3325
A5R5255	315-0473-00		RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
A595210	260-1944-00		SWITCH, PUSH: 5 BTN, 2 POLE, VERTICAL MODE	80009	260-1944-00
A5S5210	260-1944-00		MICROCIRCUIT, DI:QUAD 2-INPUT EXCL NOR GATE	01295	
A5U5235	156-0652-00		HIGHOUTHOUTH, DI. QUAD 2-THEUT EACH HOR GATE	01273	-117 12020011

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Replaceable Electrical Parts—465B Service

	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A6			CKT BOARD ASSY:TIMING		
A6C6001	281-0763-00		CAP., FXD, CER DI:47PF, 10%, 100V	72982	8035D9AADC1G470K
A6C6002	281-0096-00		CAP., VAR, AIR DI:5.5-18PF, 350V	72982	538-006-A5.5-18
A6C6015	281-0089-00		CAP., VAR, CER DI:2-8PF, 350V	72982	
A6C6016	283-0331-00		CAP., FXD, CER DI:43PF, 2%, 100V	72982	
A6C6020	203-0331-00		(MATCHED SET WITH A6C6105)	12702	007-707A4300
			(Introdies out with hoods)		
A6C6033	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R1U3K
A6C6041	281-0089-00		CAP., VAR, CER DI:2-8PF, 350V	72982	538-006-A2-8
A6C6043	283-0331-00		CAP., FXD, CER DI: 43PF, 2%, 100V	72982	805-505A430G
A6C6105	295-0175-00		CAP.,SET,MTCHD:0.luF,9.95UF,985UF,0.2%	80009	295-0175-00
A6C6110			(MATCHED SET WITH A6C6105)		
A6C6112	283-0645-00		CAP., FXD, MICA D:790PF, 1%, 100V	00853	D151E791F0
A6C6121	290-0245-00		CAP., FXD, ELCTLT: 1.50F, 10%, 10V	56289	150D155X9010A2
A6C6122	281-0707-00	B010100 B011099	CAP., FXD, CER D1:15000PF, 20%, 100V	72982	8003W5R 153K
A6C6122	283-0239-00	B011100	CAP., FXD, CER DI:0.022UF, 10%, 50V	72982	6121N083X7R0223K
A6C6135)					
A6C6140}	295-0157-00		CAP., SET, MTCHD: 0.1UF, 1UF, 998PF	80009	295-0157-00
A6C6225)					
A6CR6113	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A6CR6218	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	1N4152R
A6CR6219	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152K
A6Q6032	151-0190-00		TRANSISTOR: SILICON, NPN	07263	S032677
A6Q6034	151-0302-00		TRANSISTOR: SILICON, NPN	07263	S038487
A6Q6036	151-0302-00		TRANSISTOR: SILICON, NPN	07263	S038487
A6Q6215	151-0188-00		TRANSISTOR: SILICON, PNP	04713	SPS6868K
A6R6001	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W		CB1015
A6R6002	323-0498-04		RES., FXD, FILM: 1.5M OHM, 0.1%, 0.50W	91637	
A6R6004	323-0481-04		RES., FXD, FILM: 1M OHM, 0.1%, 0.50W	91637	
A6R6006	321-0648-04		RES., FXD, FILM: 500K OHM, 0.1%, 0.125W	91637	
A6R6008	321-0618-04		RES., FXD, FILM: 250K OHM, 0.1%, 0.125W	07716	
A6R6010	321-0414-04		RES., FXD, FILM: 200K OHM, 0.1%, 0.125W	91637	
A6R6011	311-1915-00		RES., VAR, NONWIR: 20K OHM, 10%, 0.50W	73138	72-196-0
A6R6012	321-0265-00		RES.,FXD,FILM:5.62k OHM,1%,0.125W		MFF1816G56200F
A6R6013	321-0385-04		RES., FXD, FILM: 100K OHM, 0.1%, 0.125W		MFF1816D10002B MFF1816D50001B
A6R6014 A6R6017	321-0756-04		RES., FXD, F1LM: 50K OHM, 0.1%, 0.125W	91637	MFF1816C25UUIB
AOKOO17	321-0986-07		RES.,FXD,FILM:25K OHM,0.1%,0.125W	91037	MFF 1010C25001B
A6R6018	321-0380-00		RES., FXD, FILM:88.7K OHM, 1%, 0.125W	91637	
A6R6019	321-0252-00		RES., FXD, FILM: 4.12K OHM, 1%, 0.125W	91637	
A6R6020	321-0790-00		RES., FXD, FILM: 990K OHM, 1%, 0.125W	14298	
A6R6021	321-0983-00		RES., FXD, FILM: 4.5M OHM, 1%, 0.125W	91637	
A6R6022	321-0296-00		RES., FXD, FILM: 11.8K OHM, 1%, 0.125W	91637	
A6R6026	323-0498-04		RES., FXD, FILM:1.5M OHM, 0.1%, 0.50W	91637	HFF129D15003B
A6R6027	323-0481-04		RES.,FXD,FILM:1M OHM,O.1%,O.50W	91637	MFF1226D10003B
A6R6032	321-0648-04		RES., FXD, FILM:500K OHM, 0.1%, 0.125W	91637	CMF110216D5002B
A6R6033	321-0618-04		RES., FXD, FILM: 250K OHM, 0.1%, U.125W	07716	OBD
A6R6034	321-0414-04		RES., FXD, FILM: 200K OHM, 0.1%, 0.125W	91637	MFF1816D20002B
A6R6035	321-0385-04		RES.,FXD,FILM:100K OHM,0.1%,0.125W	91637	MFF1816D10002B
A6R6036	321-0756-04		RES., FXD, FILM:50K OHM, 0.1%, 0.125W	91637	MFF1816D50001B
A6R6037	321-0986-07		RES.,FXD,FILM:25K OHM,0.1%,0.125W	91637	MFF1816C25001B
A6R6038	321-0383-00		RES.,FXD,F1LM:95.3K OHM,1%,0.125W	91637	MFF1816G95301F
A6R6044	315-0473-00		RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
A6R6045	321-0262-00		RES., FXD, FILM: 5.23K OHM, 1%, 0.125W	91637	MFF1816G52300F
A6R6046	321-0496-00		RES., FXD, FILM: 1.43M OHM, 1%, 0.125W	91637	HFF1813G14303F
A6R6047	321-0431-00		RES., FXD, FILM: 301K OHM, 1%, 0.125W	91637	MFF1816G30102F
A6R6052	311-1245-00		RES., VAR, NONWIR: 10K OHM, 10%, 0.50W	73138	72-28-0
A6R6053	311-1245-00		RES., VAR, NONWIR: 10K OHM, 10%, 0.50W	73138	72-28-0
A6R6054	321-0458-00		RES., FXD, FILM: 576K OHM, 1%, 0.125W		MFF1816G57602F

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Replaceable Electrical Parts-465B Service

Component No.	Tektronix	nix Serial/Model No.			Mfr	
	Part No.	Eff	Dscont	Name & Description	Code	Mfr Part Number
A6R6056	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A6R6060	315-0331-00			RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	CB3315
A6R6114	321-0338-00			RES., FXD, FILM: 32.4K OHM, 1%, 0.125W	91637	MFF1816G32401F
A6R6115	321-0429-00			RES., FXD, FILM: 287K OHM, 1%, 0.125W	91637	MFF1816G28702F
A6R6123	321-0481-00			RES., FXD, FILM: 1M OHM, 1%, 0.125W	24546	NA4D1004F
A6R6152	311-1238-00			RES., VAR, NONWIR: 5K OHM, 10%, 0.50W	73138	72X-27-0-502K
A6R6155				(SEE CHASSIS PARTS)		
A6R6212	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
A6R6213	315-0302-00			RES., FXD, CMPSN: 3K OHM, 5%, 0.25W	01121	CB3025
A6R6217	315-0682-00			RES., FXD, CMPSN: 6.8K OHM, 5%, 0.25W	01121	CB6825
A6S6111				(SEE CHASSIS PARTS)		
A6S6155				(SEE CHASSIS PARTS)		
A6S6205	260-1422-00			SWITCH, PUSH: 3 STA, INTERLOCK	80009	260-1422-00
A6S6260	260-1945-00			SWITCH, PUSH: 3 BTN, 2 POLE, 1 BTN BLANK	80009	260-1945-00
A6VR6057	152-0395-00			SEMICOND DEVICE: ZENER, 0.4W, 4.3V, 5%	14552	TD332317
A6VR6058	152-0166-00			SEMICOND DEVICE: ZENER, 0.4W, 6.2V, 5%	04713	SZ11738

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Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
oumponent ito.	1 011 110.	EII DOCOTIL	Haine a bescription		mii Tart Humbor
A7			CKT BOARD ASSY:TRIGGER GEN & SWEEP LOGIC		
A7C7006	281-0603-00		CAP., FXD, CER DI:39PF, 5%, 500V	72982	308-000C0G0390J
A7C7008	281-0579-00		CAP., FXD, CER DI:21PF, 5%, 500V	72982	301-050C0G0210J
A7C7018	281-0815-00		CAP., FXD, CER DI:0.027UF, 20%, 50V	72982	8005D9AABW5R273M
A7C7019	281-0759-00		CAP., FXD, CER DI: 22PF, 10%, 100V	72982	8035D9AADC1G220K
A7C7025	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A707007	001 0772 00		040 DVD 000 DV-0 01110 109 1001	70000	00051104477571571007
A7C7027	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A7C7028 A7C7052	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V CAP.,FXD,ELCTLT:1UF,10%,35V	72982 90201	8005H9AADW5R103K
A7C7108	290-0183-00 281-0813-00		CAP., FXD CER DI:0.047UF, 20%, 100V	04222	TAE105K035P1A GC705-E-473M
A7C7116	281-0814-00		CAP.,FXD,CER DI:100PF,10%,100V	04222	
A7C7127	290-0808-00		CAP., FXD, ELCTLT: 2.7UF, 10%, 20V	56289	162D275X9020CD2
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A7C7128	281-0759-00		CAP., FXD, CER DI:22PF, 10%, 100V	72982	8035D9AADC1G220K
A7C7134	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A7C7158	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
A7C7165	281-0814-00		CAP., FXD, CER DI:100PF, 10%, 100V	04222	
A7C7174	281-0786-00		CAP., FXD, CER DI:150PF, 10%, 100V	72982	
A7C7182	281-0547-00		CAP.,FXD,CER DI:2.7PF,10%,500V	72982	301-000C0J0279C
A707107	001 05/7 00		0.7 PVD 000 DV 0 300 108 5000	70000	201 00000 100700
A7C7187 A7C7188	281-0547-00 281-0775-00		CAP., FXD, CER DI:2.7PF, 10%, 500V CAP., FXD, CER DI:0.1UF, 20%, 50V	72982 72982	301-000C0J0279C
A7C7192					8005D9AABZ5U104M 8005H9AADW5R103K
A7C7196	281-0773-00 290-0527-00		CAP.,FXD,CER DI:0.01UF,10%,100V CAP.,FXD,ELCTLT:15UF,20%,20V	72982 90201	TDC156M020FL
A7C7197	290-0527-00		CAP., FXD, ELCTLT: 150F, 20%, 20V	90201	TDC156M020FL
A7C7227	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	
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A7C7229	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A7C7244	290-0808-00		CAP., FXD, ELCTLT: 2.7UF, 10%, 20V	56289	162D275X9020CD2
A7C7247	290-0808-00		CAP., FXD, ELCTLT: 2.7UF, 10%, 20V	56289	162D275X9020CD2
A7C7263	290-0808-00		CAP.,FXD,ELCTLT:2.7UF,10%,20V	56289	162D275X9020CD2
A7C7265	290-0808-00		CAP., FXD, ELCTLT: 2.7UF, 10%, 20V	56289	162D275X9020CD2
A7C7273	290-0183-00		CAP., FXD, ELCTLT: 1UF, 10%, 35V	90201	TAE105K035P1A
A707007	001 0775 00		010 PV 000 T 0 141 00# 504	70000	0005-0117-51110111
A7C7286 A7C7288	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
A7C7297	290-0527-00 281-0775-00		CAP., FXD, ELCTLT: 15UF, 20%, 20V	90201 72982	TDC156M020FL
A7C7303	290-0808-00		CAP.,FXD,CER DI:0.1UF,20%,50V CAP.,FXD,ELCTLT:2.7UF,10%,20V	56289	8005D9AABZ5U104M 162D275X9020CD2
A7C7313	281-0815-00		CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A7C7317	281-0814-00		CAP.,FXD,CER DI:100PF,10%,100V	04222	
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A7C7321	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A7C7329	281-0759-00		CAP., FXD, CER DI:22PF, 10%, 100V	72982	8035D9AADC1G220K
A7C7371	281-0797-00		CAP., FXD, CER DI:15PF, 10%, 100V	72982	8035D9AADC0G150K
A7C7376	281-0786-00		CAP., FXD, CER DI:150PF, 10%, 100V	72982	
A7C7377	290-0808-00		CAP., FXD, ELCTLT: 2.7UF, 10%, 20V		162D275X9020CD2
A7C7404	281-0579-00		CAP., FXD, CER DI:21PF, 5%, 500V	72982	301-050C0G0210J
A7C7406	281-0814-00		CAR EVE CER DI-100RE 109 1000	04222	GC70-1-A101K
A7C7406 A7C7425	281-0158-00		CAP.,FXD,CER DI:100PF,10%,100V CAP.,VAR,CER D1:7-45PF,50V	73899	DVJ-5006
A7C7435	283-0116-00		CAP., FXD, CER DI:820PF, 5%, 500V	72982	
A7C7442	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
A7C7443	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A7C7447	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
A7C7449	281-0814-00		CAP., FXD, CER DI: 100PF, 10%, 100V	04222	GC70-1-A101K
A7C7453	281-0797-00	XB011240	CAP., FXD, CER DI:15PF, 10%, 100V	72982	8035D9AADC0G150K
A7C7458	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	_
A7C7461	281-0814-00		CAP., FXD, CER DI: 100PF, 10%, 100V	04222	
A7C7471	290-0301-00		CAP., FXD, ELCTLT: 10UF, 10%, 20V	56289	
A7C7505	281-0207-00		CAP., VAR, PLSTC: 2-18PF, 100V	80031	2807C00218MH02F0
A7C7506	281-0217-00		CAP., VAR, CER DI:0.5-3.5PF, 400V	52763	RT202-08SB.6/3.5
A7C7507	290-0808-00		CAP., FXD, ELCTLT: 2.7UF, 10%, 20V	56289	162D275X9020CD2
A7C7508	281-0811-00		CAP., FXD, CER DI: 10PF, 10%, 100V	72982	
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	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A7C7517	281-0759-00		CAP., FXD, CER DI: 22PF, 10%, 100V	72982	8035D9AADC1G220K
A7C7519	281-0812-00		CAP., FXD, CER DI:1000PF, 10%, 100V	72982	
A7C7529	281-0122-00		CAP., VAR, CER DI:2.5-9PF, 100V	72982	
A7C7536	281-0775-00		CAP., FXD, CER D1:0.1UF, 20%, 50V	72982	
A7C7565	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	
A7CR7046	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	
A7CR7072	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	U1295	1N4152R
A7CR7073	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	
A7CR7078	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	
A7CR7084	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
A7CR7085	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	
A7CR7097	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
A7CR7098	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7099	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	1N4152R
A7CR7120	152-0246-00		SEMICOND DEVICE: SW, SI, 40V, 200MA	03508	
A7CR7146	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7147	152-0125-01		SEMICOND DEVICE: TUNNEL, 4.7MA, 18PF	03508	STD704
A7CR7148	152-0125-01		SEMICOND DEVICE: TUNNEL, 4.7MA, 18PF	03508	STD704
R/CK/140	172-0123-01		SERICORD DEVICE. TORREE, 4. /PIA, TO: 1	03300	515704
A7CR7149	152-0322-00		SEMICOND DEVICE: SILICON, 15V, HOT CARRIER	50434	5082-2672
A7CR7154	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7184	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7272	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7277	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7281	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	1N4152R
A7CR7322	152-0246-00		SEMICOND DEVICE:SW,SI,40V,200MA	03508	DE140
A7CR7349	152-0125-01		SEMICOND DEVICE: TUNNEL, 4.7MA, 18PF	03508	STD704
A7CR7350	152-0125-01		SEMICOND DEVICE: TUNNEL, 4.7MA, 18PF	03508	STD704
A7CR7362	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7381	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7382	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7383	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	1N4152R
A7CR7385	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
A7CR7386	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7387	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7449	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7463	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7464	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A7CR7521	152-0141-02		SEMICOND DEVICE:SILICON, 30V, 150MA	01295	
A7CR7536	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	01295	
A7J4541	136-0499-14		CONNECTOR, RCPT,:14 CONTACT		4-380949-4
A7J4571	136-0499-10		CONNECTOR, RCPT, : 10 CONTACT		4-380949-0
A7L7043	108-0370-00		COIL, RF: 0.14UH	80009	108-0370-00
A7L7137	108-0370-00		COIL.RF:0.14UH	80009	108-0370-00
A7L7278				76493	70F276Al
A7L7341	108-0538-00		COLL, RF: 2.7UH	80009	108-0370-00
	108-0370-00		COLL, RF: 0.14UH	80009	108-0370-00
A7L7441 A7L7525	108-0370-00		COIL, RF: 0.14UH COIL, RF: FIXED, 75NH	80009	108-0655-00
	108-0655-00		TRANSISTOR: SILICON, PNP, SEL	80009	151-0220-03
A7Q7053	151-0220-03		TRANSISTOR: SILICON, FNF, SEL	80003	191 0220 03
A7Q7055	151-0220-03		TRANSISTOR: SILICON, PNP, SEL	80009	151-0220-03
A7Q7067	151-0232-00		TRANSISTOR: SILICON, NPN, DUAL	80009	151-0232-00
A7Q7074	151-0220-03		TRANSISTOR: SILICON, PNP, SEL	80009	151-0220-03
A7Q7075	151-0220-03		TRANSISTOR: SILICON, PNP, SEL	80009	151-0220-03
A7Q7076	151-0190-00		TRANSISTOR: SILICON, NPN	07263	S032677
A7Q7083	151-0220-03		TRANSISTOR: SILICON, PNP, SEL	80009	151-0220-03
A7Q7092	151-0220-03		TRANSISTOR: SILICON, PNP, SEL	80009	151-0220-03
A7Q7093	151-0190-00		TRANS1STOR: SILICON, NPN	07263	
A7Q7095	151-0190-00		TRANSISTOR: SILICON, NPN	U7263	
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Replaceable Electrical Parts-465B Service

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A7Q7124A,B	151-1042-00		SEMICOND DVC SE:MATCHED PAIR FET	27016	SF50D31
A7Q7142	151-0221-00		TRANSISTOR:SILICON, PNP		SPS246
A7Q7143	151-0221-00		TRANSISTOR: SILICON, PNP		SPS246
A7Q7155	151-0220-03		TRANSISTOR: SILICON, PNP, SEL		151-0220-03
A7Q7174	151-0190-00		TRANSISTOR: SILICON, NPN		S032677
A7Q7181	151-0190-00		TRANSISTOR: SILICON, NPN		S032677
K/Q/101	131-0130-00		TRANSIBIUR: SILICON, NPN	07203	3032077
A7Q7182	151-0190-00		TRANSISTOR: SILICON, NPN	07263	S032677
A7Q7195	151-0190-00		TRANSISTOR: SILICON, NPN	07263	
A7Q7254	151-0220-03		TRANSISTOR: SILICON, PNP, SEL		151-0220-03
A7Q7256	151-0220-03		TRANSISTOR: SILICON, PNP, SEL		151-0220-03
A7Q7324A,B	151-1042-00		SEMICOND DVC SE: MATCHED PAIR FET	27014	
A7Q7344	151-0221-00		TRANSISTOR: SILICON, PNP	04713	SPS246
A7Q7345	151-0221-00		TRANSISTOR: SILICON, PNP	04713	SPS246
A7Q7422	151-0441-00		TRANSISTOR: SILICON, NPN	04713	SRF501
A7Q7424	151-0441-00		TRANSISTOR: SILICON, NPN	04713	SRF501
A7Q7460	151-0220-03		TRANSISTOR: SILICON, PNP, SEL	80009	151-0220-03
A7Q7465	151-0190-00		TRANSISTOR: SILICON, NPN	07263	S032677
A7R7009	315-0334-00		RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
A7R7014	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
A7R7020	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W		CB1015
A7R7024	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	
A7R7025	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	
A7R7026	311-1558-00		RES., VAR, NONWIR: 20K OHM, 20%, 0.50W		91-80-0
A7R7027	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	
A7R7028	215-0691-00		DEC PUR CHRON. COO DIN 5% O 250	01121	CB6815
A7R7029	315-0681-00 321-0209-00		RES.,FXD,CMPSN:680 OHM,5%,0.25W RES.,FXD,FILM:1.47K OHM,1%,0.125W		MFF1816G14700F
A7R7032	315-0202-00		RES., FXD, CMPSN: 2K OHM, 5%, 0.25W		CB2025
A7R7033	315-0560-00		RES.,FXD,CMPSN: 56 OHM, 5%, 0.25W		CB5605
A7R7034	315-0222-00		RES., FXD, CMPSN: 36 OHM, 5%, 0.25W	01121	CB2225
A7R7035	315-0682-00		RES., FXD, CMPSN: 6.8K OHM, 5%, 0.25W	01121	
A7R7036	315-0182-00		RES., FXD, CMPSN: 1.8K OHM, 5%, 0.25W	01121	CB1825
A7R7037	315-0182-00		RES., FXD, CMPSN: 1.8K OHM, 5%, 0.25W		CB1825
A7R7038	315-D103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W		CB1035
A7R7042	311-1558-00		RES., VAR, NONWIR: 20K OHM, 20%, 0.50W		91-80-0
A7R7043	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W		CB1015
A7R7044	315-0274-00		RES., FXD, CMPSN: 270K OHM, 5%, 0.25W		CB2745
A7R7045	311-1558-00		RES., VAR, NONWIR: 20K OHM, 20%, 0.50W	73138	91-80-D
A7R7046	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
A7R7047	315-0330-00		RES., FXD, CMPSN: 100K 0HM, 5%, 0.25W	01121	
A7R7048	315-0562-00		RES., FXD, CMPSN: 33 OHM, 5%, 0.25W	01121	CB5625
A7R7049	315-0390-00		RES., FXD, CMPSN: 39 OHM, 5%, 0.25W	01121	CB3905
A7R7052	321-0200-00		RES.,FXD,FILM:1.18K OHM,1%,0.125W	91637	MFF1816G11800F
A707056	215 0151 00		DEG. TWD GMDGN, 150 OWN 50 O SELL	01121	CR1515
A7R7056 A7R7057	315-0151-00		RES., FXD, CMPSN: 150 OHM, 5%, 0.25W	01121	CB1515
	315-0332-00		RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W	01121 01121	CB3325
A7R7062	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W		CB1015
A7R7063 A7R7064	315-0681-00 315-0752-00		RES., FXD, CMPSN: 680 OHM, 5%, 0.25W	01121 01121	CB6815 CB7525
A7R7065	315-0681-00		RES., FXD, CMPSN: 7.5K OHM, 5%, 0.25W RES., FXD, CMPSN: 680 OHM, 5%, 0.25W	01121	CB6815
			grangers our out Othing yang or a su	01121	
A7R7066	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	
A7R7068	315-0562-00		RES., FXD, CMPSN: 5.6K OHM, 5%, 0.25W	01121	CB5625
A7R7069	301-0622-00		RES., FXD, CMPSN: 6.2K OHM, 5%, 0.50W	01121	EB6225
A7R7070	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
A7R7077	301-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.50W	01121	EB4715
A7R7078	301-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.50W	01121	EB4715
A7R7079	321-0155-00		RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402R0F
A7R7084	315-0911-00		RES., FXD, CMPSN: 910 OHM, 5%, 0.25W	01121	CB9115
A7R7085	315-0221-00		RES., FXD, CMPSN: 220 OHM, 5%, 0.25W	01121	CB2215

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Commence No.	Tektronix	Serial/Model No.	Name & Bassistian	Mfr	
Component No.	Part No.	Eff Dscont	Name & Description	Code	Mfr Part Number
A7R7086	315-0221-00		RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A7R7087	321-0155-00		RES., FXD, FILM: 402 OHM, 1%, 0.125W	91637	
A7R7088	321-0215-00		RES.,FXD,FILM:1.69K OHM,1%,0.125W	91637	
A7R7097	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	
A7R7098	315-0911-00		RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
A7R7106	315-0754-00		RES.,FXD,CMPSN:750K OHM,5%,0.25W	01121	CB7545
A7R7108	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A7R7111	315-0563-00		RES., FXD, CMPSN: 56K OHM, 5%, 0.25W	01121	CB5635
A7R7119	321-0481-00		RES.,FXD,FILM:1M OHM.1%.0.125W	24546	
A7R7121	315-0150-00		RES., FXD, CMPSN: 15 OHM, 5%, 0.25W	01121	
A7R7125	315-0150-00		RES., FXD, CMPSN: 15 OHM, 5%, 0.25W	01121	
A7R7126	321-0209-00		RES.,FXD,FILM:1.47K OHM,1%,0.125W	91637	MFF1816G14700F
A7R7128	315-0390-00		RES., FXD, CMPSN: 39 OHM, 5%, 0.25W	01121	CB3905
A7R7132	315-0362-00		RES., FXD, CMPSN: 3.6K OHM, 5%, 0.25W		CB3625
A7R7133	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
A7R7134	315-0331-00		RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	CB3315
A7R7135	315-0153-00		RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
A7R7142	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A7R7143	315-0274-00		RES.,FXD,CMPSN:270K OHM,5%,0.25W	01121	CB2745
A7R7145	315-0330-00		RES., FXD, CMPSN: 33 OHM, 5%, 0.25W		CB3305
A7R7147	321-0097-00		RES., FXD, FILM: 100 OHM, 1%, 0.125W		MFF1816G100R0F
A7R7149	321-0258-00		RES., FXD, FILM: 4.75K OHM, 1%, 0.125W		MFF1816G47500F
A7R7150	323-0310-00		RES., FXD, FILM: 16.5K OHM, 1%, 0.50W	75042	
A7R7152	315-0331-00		RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	CB3315
A7R7154	315-0681-00		RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A7R7155	315-0681-00		RES., FXD, CMPSN: 680 OHM, 5%, 0.25W	01121	
A7R7157	321-0186-00		RES.,FXD,FILM:845 OHM,1%,0.125W		MFF1816G845R0F
A7R7159	315-0270-00		RES., FXD, CMPSN: 27 OHM, 5%, 0.25W		CB2705
A7R7162	315-0132-00		RES., FXD, CMPSN: 1.3K OHM, 5%, 0.25W		CB1 325
A7R7164	301-0562-00		RES.,FXD,CMPSN:5.6K OHM,5%,0.50W	01121	EB5625
A7R7165	315-0561-00		RES., FXD, CMPSN: 560 OHM, 5%, 0.25W	01121	CB5615
A7R7166	321-0206-00		RES., FXD, FILM: 1.37K OHM, 1%, 0.125W		MFF1816G13700F
A7R7167	321-0243-00		RES., FXD, FILM: 3.32K OHM, 1%, 0.125W		MFF1816G33200F
A7R7171	315-0752-00		RES., FXD, CMPSN: 7.5K OHM, 5%, 0.25W		CB7525
A7R7173	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A7R7175	321-0155-00		RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402R0F
A7R7176	321-0209-00		RES., FXD, FILM: 1.47K OHM, 1%, 0.125W	91637	MFF1816G14700F
A7R7177	321-0171-00		RES.,FXD,F1LM:590 OHM,1%,0.125W	91637	MFF1816G590R0F
A7R7178	321-0192-00		RES., FXD, FILM: 976 OHM, 1%, 0.125W		MFF1816G976R0F
A7R7179	321-0227-00		RES.,FXD,FILM:2.26K OHM,1%,0.125W	91637	MFF1816G22600F
A7R7184	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
A7R7186	321-0192-00		RES.,FXD,FILM:976 OHM,1%,0.125W	91637	MFF1816G976R0F
A7R7187	321-0171-00		RES.,FXD,FILM:590 OHM,1%,0.125W	91637	MFF1816G590R0F
A7R7188	315-0220-00		RES., FXD, CMPSN: 22 OHM, 5%, 0.25W	01121	CB2205
A7R7192	321-0231-00		RES., FXD, FILM: 2.49K OHM, 1%, 0.125W		MFF1816G24900F
A7R7194	321-0264-00		RES., FXD, FILM: 5.49K OHM, 1%, 0.125W	91637	MFF1816G54900F
A7R7196	315-0182-00		RES., FXD, CMPSN: 1.8K OHM, 5%, 0.25W	01121	CB1825
A7R7197	321-0155-00		RES., FXD, FILM: 402 OHM, 1%, 0.125W	91637	MFF1816G402R0F
A7R7208	321-0068-00		RES., FXD, FILM: 49.9 OHM, 1%, 0.125W	91637	MFF1816G49R90F
A7R7213	321-0068-00		RES., FXD, FILM:49.9 OHM, 1%, 0.125W	91637	
A7R7218	321-0068-00		RES., FXD, FILM: 49.9 OHM, 1%, 0.125W		MFF1816G49R90F
A7R7224	311-1558-00		RES., VAR, NONWIR: 20K OHM, 20%, 0.50W	73138	91-80-0
A7R7226	315-0202-00		RES., FXD, CMPSN: 2K OHM, 5%, 0.25W	01121	CB2025
A7R7228	315-0681-00		RES., FXD, CMPSN: 680 OHM, 5%, 0.25W	01121	CB6815
A7R7229	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
A7R7232	321-0209-00		RES., FXD, FILM: 1.47K OHM, 1%, 0.125W	91637	MFF1816G14700F
A7R7233	315-0560-00		RES., FXD, CMPSN: 56 OHM, 5%, 0.25W	01121	CB5605
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	Tektronix	Serial/Model No.		Mfr	
Component No.	Part No.	Eff Dscont	Name & Description		Mfr Part Number
170700/	215 2122 22				
A7R7234	315-0182-00		RES., FXD, CMPSN:1.8K OHM, 5%, 0.25W		CB1825
A7R7235	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
A7R7236	315-0682-00		RES., FXD, CMPSN: 6.8K OHM, 5%, 0.25W		CB6825
A7R7237	315-0182-00		RES., FXD, CMPSN: 1.8K OHM, 5%, 0.25W		CB1825
A7R7238	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W		CB1035
A7R7242	311-1558-00		RES., VAR, NONWIR: 20K OHM, 20%, 0.50W	73138	91-80-0
A7R7243	315-0274-00		RES.,FXD,CMPSN:270K OHM,5%,0.25W		CB2745
A7R7246	311-1558-00		RES., VAR, NONWIR: 20K OHM, 20%, 0.50W	73138	91-80-0
A7R7248	315-0562-00		RES.,FXD,CMPSN:5.6K OHM,5%,0.25W		CB5625
A7R7253	321-0196-00		RES., FXD, FILM: 1.07K OHM, 1%, 0.125W		MFF1816G10700F
A7R7264	315-0331-00		RES., FXD, CMPSN: 330 OHM, 5%, 0.25W		CB3315
A7R7267	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A7R7269	315-0331-00		RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	CB3315
A7R7272	315-0334-00		RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
A7R7275	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
A7R7276	315-0241-00		RES., FXD, CMPSN: 240 OHM, 5%, 0.25W	01121	CB2415
A7R7277	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A7R7281	315-0112-00		RES., FXD, CMPSN:1.1K OHM, 5%, 0.25W	01121	CB1125
A7R7283	315-0112-00		RES., FXD, CMPSN: 1.1K OHM, 5%, 0.25W	01121	CB1125
A7R7284	315-0162-00		RES.,FXD,CMPSN:1.6K OHM,5%,0.25W		CB1625
A7R7287	315-0220-00		RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	
A7R7297	315-0220-00		RES., FXD, CMPSN: 22 OHM, 5%, 0.25W		CB2205
A7R7305	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W		CB5105
A7R7306	315082000		RES.,FXD,CMPSN:82 OHM,5%,0.25W	01121	CB8205
A7R7308	315-02/1-00		DEC EVD CMDCN, 2/O OIM 5% O 250	01121	CB2415
A7R7316	315-0241-00		RES.,FXD,CMPSN:240 OHM,5%,0.25W RES.,FXD,CMPSN:56K OHM,5%,0.25W		CB5635
A7R7319	315-0563-00 315-0101-00		RES., FXD, CMPSN: 36K OHM, 5%, 0.25W	01121	
A7R7319	315-0150-00		RES., FXD, CMPSN: 15 OHM, 5%, 0.25W		CB1505
A7R7325	315-0101-00		RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1015
A7R7327	315-0151-00		RES., FXD, CMPSN: 15 OHM, 5%, 0.25W	01121	
	313 0170 00		Adde gardy out of the gray of a same	01121	001707
A7R7328	315-0270-00		RES., FXD, CMPSN: 27 OHM, 5%, 0.25W	01121	CB2705
A7R7329	315-0390-00		RES., FXD, CMPSN: 39 OHM, 5%, 0.25W	01121	CB3905
A7R7342	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
A7R7343	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A7R7346	315~0330~00		RES., FXD, CMPSN: 33 OHM, 5%, 0.25W	01121	CB3305
A7R7347	315-0330-00		RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
A7R7348	315-0390-00		RES.,FXD,CMPSN:39 OHM,5%,0.25W	01121	CB3905
A7R7349	321-0097-00		RES., FXD, FILM: 100 OHM, 1%, 0.125W	91637	
A7R7355	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
A7R7356	321-0258-00		RES., FXD, FILM: 4.75K OHM, 1%, 0.125W		MFF1816G47500F
A7R7357	315-0332-00		RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W	01121	CB3325
A7R7358	315-0151-00		RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
A7R7361	315-0132-00		RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
A7R7365	315-0102-00		RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	CB1025
A7R7402			RES., FXD, FILM: 990K OHM, 1%, 0.125W	14298	
A7R7402	321-0790-00 321-0450-00		RES.,FXD,FILM:475K OHM,1%,0.125W	91637	
A7R7404	321-0430-00		RES.,FXD,FILM:90.9K OHM,1%,0.125W	91637	
A7R7407	315-0270-00		RES., FXD, CMPSN: 27 OHM, 5%, 0.25W	01121	CB2705
11/11/4-//	317-0270-00		RES., FAD, GRESH-21 (MIII, 16, 0.2)	01121	652703
A7R7408	315-0392-00		RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W	01121	CB3925
A7R7417	321-0481-00		RES., FXD, FILM: IM OHM, 1%, 0.125W	24546	NA4D1004F
A7R7421	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
A7R7423	311-1260-00		RES., VAR, NONWIR: 250 OHM, 10%, 0.50W	32997	3329P-L58-251
A7R7432	315-0270-00		RES., FXD, CMPSN: 27 OHM, 5%, 0.25W	01121	CB2705
A7R7434	315-0200-00		RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A7R7435	315-0162-00		RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
A7R7436	321-0209-00		RES., FXD, FILM: 1.47K OHM, 1%, 0.125W	91637	MFF1816G14700F
A7R7437	315-0362-00		RES., FXD, CMPSN: 3.6K OHM, 5%, 0.25W	01121	CB3625
			- 3 3		

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Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A7R7439	311-1567-00		RES., VAR, NONWIR: TRMR, 100 OHM, 0.50W	73138	91-89-0
A7R7441	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
A7R7444	315-0331-00		RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	CB3315
A7R7445	315-0274-00		RES., FXD, CMPSN: 270K OHM, 5%, 0.25W	01121	CB2745
A7R7453	315-0103-00		RES., FXD, CMPSN:10K OHM, 5%, 0.25W	01121	CB1035
A7R7455	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A7R7456	321-0200-00		RES.,FXD,FILM:1.18K OHM,1%,0.125W	91637	MFF1816G11800F
A7R7457	315-0270-00		RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A7R7458	321-0243-00		RES.,FXD,FILM:3.32K OHM,1%,0.125W	91637	MFF1816G33200F
A7R7461	321-0201-00		RES., FXD, FILM: 1.21K OHM, 1%, 0.125W		MFF1816G12100F
A7R7465	315-0822-00		RES., FXD, CMPSN: 8.2K OHM, 5%, 0.25W		CB8225
A7R7471	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A7R7503	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	
A7R7506	325-0245-00		RES.,FXD,FILM:3.32M OHM,1%,0.125W	01121	CC3324FZ
A7R7516	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	
A7R7519	321-0175-00		RES.,FXD,FILM:649 OHM,1%,0.125W	91637	
A7R7521	321-0198-00		RES.,FXD,FILM:1.13K OHM,1%,0.125W	91637	
A7R7522	315-0430-00		RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	СВ4305
A7R7525	315-0124-00		RES., FXD, CMPSN: 120K OHM, 5%, 0.25W	01121	CB1245
A7R7526	311-0622-00		RES., VAR, NONWIR: 100 OHM, 10%, 0.50W	32997	3326H-G48-101
A7R7533	321-0198-00		RES.,FXD,FILM:1.13K OHM,1%,0.125W	91637	
A7R7534	315-0430-00		RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	
A7R7545	323-0310-00		RES., FXD, FILM: 16.5K OHM, 1%, 0.50W	75042	
A7R7565	315-0274-00		RES., FXD, CMPSN: 270K OHM, 5%, 0.25W	01121	CB2745
A7RT7147	307-0124-00		RES., THERMAL: 5K OHM, 10%	50157	1D1618
A7RT7349	307-0124-00		RES.,THERMAL:5K OHM,10%	50157	1D1618
A7S7015	263-0065-00		SW SL ACTR ASSY: B COUPLING, 4 OF 5 POSITION	80009	263-0065-00
A7S7112	263-0066-00		SW SL ACTR ASSY: B SOURCE, 5 OF6 POSITION	80009	263-0066-00
A7S7312	263-0068-00		SW SL ACTR ASSY: A SOURCE, 6 OF6 POSITION	80009	263-0068-00
A7S7415	263-0067-00		SW SL ACTR ASSY: A COUPLING, 4 OF 6 POSITION	80009	263-0067-00
A7U7131	155-0032-00		MICROCIRCUIT, LI: ML, PRE-AMPLIFIER	80009	155-0032-00
A7U7331	155-0032-00		MICROCIRCUIT, LI: ML, PRE-AMPLIFIER	80009	155-0032-00
A7U7375	155-0049-00		MICROCIRCUIT, DI: SWEEP CONTROL	80009	155-0049-00
A7VR7047	152-0175-00		SEMICOND DEVICE: ZENER, 0.4W, 5.6V, 5%	04713	
A7VR7145	152-0175-00		SEMICOND DEVICE: ZENER, 0.4W, 5.6V, 5%	04713	SZG35008
A7VR7256	152-0227-00		SEMICOND DEVICE: ZENER, 0.4w, 6.2v, 5%	04713	SZ13903
A7VR7275	152-0278-00		SEMICOND DEVICE: ZENER, 0.4W, 3V, 5%	04713	SZG35009K20
A7VR7346	152-0175-00		SEMICOND DEVICE: ZENER, 0.4w, 5.6v, 5%	04713	
A7VR7446	152-0175-00		SEMICOND DEVICE: ZENER, 0.4W, 5.6V, 5%	04713	
A7VR7520	152-0195-00		SEMICOND DEVICE: ZENER, 0.4w, 5.1v, 5%	04713	
A7W7291	131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG	55210	L-2007-1
A7W7292	131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG	55210	L-2007-1
A7W7293	131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG	55210	L-2007-1

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	Tektronix	Serial/Model No.			Mfr	
Component No.	Part No.	Eff	Dscont	Name & Description		Mfr Part Number
A8				CKT BOARD ASSY: FAN MOTOR		
A8B8045	147-0035-00			MOTOR, DC: BRUSHLESS, 10-15VDC, 145MA	25088	1AD3001-0A
A8C8064	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
A8CR8042	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A8CR8044	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A8CR8046	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A8CR8048	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A8CR8066	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 150MA	01295	1N4152R
A8Q8067	151-0301-00			TRANSISTOR: SILICON, PNP	04713	2N29O7A
A8R8033	321-0228-00			RES., FXD, FILM: 2.32K OHM, 1%, 0.125W	91637	MFF1816G23200F
A8R8D35	321-0201-00			RES., FXD, FILM: 1.21K OHM, 1%, 0.125W	91637	MFF1816G12100F
A8R8036	315-0363-00			RES.,FXD,CMPSN:36K OHM,5%,0.25W	01121	CB3635
A8R8054	323-0140-00			RES.,FXD,FILM:280 OHM,1%,0.50W	75042	CECTO-280UF
A8R8056	323-0140-00			RES., FXD, FILM: 280 OHM, 1%, 0.50W	75042	CECTO-2800F
A8R8058	303-0150-00			RES., FXD, CMPSN: 15 OHM, 5%, IW	01121	GB1505
A8R8065	321-0062-00			RES., FXD, FILM: 43.2 OHM, 1%, 0.125W	91637	MFF1816G43R20F
A8RT8038	307-0124-00			RES., THERMAL: 5K OHM, 10%	50157	1D1618
A8U8061	156-0281-00			MICROCIRCUIT, LI: 4 TRANSISTOR ARRAY	02735	CA 3725

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Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A9 A9DS9040	150-1063-00		CKT BOARD ASSY: PROBE CODING LT EMITTING DIO: YELLOW, 585 NM, 40 MA	72619	550-0305-804
A9DS9060	150-1063-00		LT EMITTING DIO:YELLOW,585 NM,40 MA	72619	550-0305-804
A10			CKT BOARD ASSY: CRT SCALE ILLUMINATION	00001	
A10DS14086 A10DS14087	150-0129-00 150-0129-00		LAMP, INCAND: 6.3V, 200MA LAMP, INCAND: 6.3V, 200MA	08806 08806	2112D 2112D
			CHASSIS PARTS		
C30	307-1014-01		ATTENUATOR, FXD: 100X	80009	307-1014-01
C31	307-1014-01		ATTENUATOR, FXD: 100X	80009	307-1014-01
C32	307-1013-01		ATTENUATOR, FXD: LOX	80009	
C33	307-1013-01		ATTENUATOR, FXD: LOX	80009	
C34 C35	307-1011-00 307-1011-00		ATTENUATOR, FXD:4X ATTENUATOR, FXD:4X	80009 80009	307-1011-00 307-1011-00
C35	307-1011-00		ALLEWALOK, FAU. 44	00007	307 1011 00
C36	307-1010-01		ATTENUATOR, FXD: 2X	80009	307-1010-01
C37	307-1010-01		ATTENUATOR, FXD: 2X	80009	307-1010-01
C13010	281-0064-00		CAP., VAR, PLSTC: 0.25-1.5PF, 600V	72982	530-002 285-0816-01
C13012 C15101(2)	285-0816-01 283-0000-00		CAP., FXD, PLSTC:0.019UF, 10%, 600V CAP., FXD, CER DI:0.001UF, +100-0%, 500V	80009 72982	
C15101(2)	283-0000-00		CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P
CR14498	152-0333-00		SEMICOND DEVICE:SILICON,55V,200MA	07263	FDH-6012
DL11405	119-0387-00		DELAY LINE, ELEC: 120NS, 100 OHM	80009	119-0387-00
DS15034	150-1001-02		LT EMITTING DIO: RED, 660NM, 50MA MAX	80009	150-1001-02
DS15036	150-1001-02		LT EMITTING DIO:RED,660NM,50MA MAX	80009	
DS15038	150-1001-02		LT EMITTING DIO: RED, 660NM, 50MA MAX	80009	150-1001-02
DS16001	150-1001-02		LT EMITTING DIO:RED,660NM,50MA MAX	80009	
DS16002	150-1001-02		LT EMITTING DIO: RED, 660NM, 50MA MAX	80009	
DS17105	150-1017-00		LT EMITTING DIO:GREEN,550NM,55MA MAX	50437	LSM-16L-100
DS17127 DS17206	150-1032-00 150-1001-02		LT EMITTING DIO:YELLOW,580NM,40MA,MAX LT EMITTING DIO:RED,660NM,50MA MAX	53184 80009	XC5566Y 150-1001-02
F14500	159-0016-00		FUSE, CARTRIDGE: 3AG, 1.5A, 250V, FAST-BLOW	71400	AGC 1 1/2
L14165	108-0714-00		COIL, TUBE DEFLE: Y AXIS ALIGNMENT	80009	108-0714-00
L14176	108-0713-00		COIL, TUBE DEFLE: TRACE ROTATION	80009	
Q4102	151-0349-00		TRANSISTOR: SILICON, NPN, SEL FROM MJE2801	04713	
Q4190	151-0390-00		TRANSISTOR: SILICON, NPN	04713	
Q4301	151-0436-00		TRANSISTOR: SILICON, NPN	80009	
Q4312	151-0390-00		TRANSISTOR:SILICON, NPN TRANSISTOR:SILICON, NPN, SEL FROM MJE28D1	04713	
Q4401 Q14009	151-0349-00 151-0140-00		TRANSISTOR: SILICON, NPN	80009	
•				01101	124212
R6155	311-1701-D0		RES., VAR, NONWIR: PNL, 50K OHM, IW, W/SW	01121	
R13010	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W RES.,VAR NONWIR:PNL,5DK/5K OHM,20%,1W	D1121 12697	
R14288 R14398	311-2047-00 311-1482-00		RES., VAR, NONWIR: 5K OHM, 20%, 0.50W	01121	
R14498	311-0608-00		RES., VAR, NONWIR: 2K OHM, 10%, 0.75W	01121	
R14518	311-1482-00		RES., VAR, NONWIR: 5K OHM, 20%, 0.50W	01121	W-8070
D15100/03	215 0100 00		DEC TWO CMOCN-low only E% O OFU	D1121	CB1035
R15102(2) R16002	315-0103-03 311-1464-00		RES.,FXD,CMPSN:1DK OHM,5%,0.25W RES.,VAR,WW:2K OHM,5%,2W	D1121 O2111	CB1035 534-264
R17010	311-1192-00		RES., VAR, WW. 2R OHH, 3%, 2W	71590	
R17305	311-1192-00		RES., VAR, NONWIR: LOK OHM, 20%, LW	71590	

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Component No.	Tektronix Part No.	Serial/I Eff	Model No. Dscont	Name & Description	Mfr Code	Mfr Part Number
S6111	263-1176-00			SW CAM ACTR AS:TIME/CM	80009	263-1176-00
S6155				(SEE R6155)		
S14398				(SEE R14398)		
S14500	260-1300-01			SWITCH, SLIDE: DPDT, 3A, 125V	82389	11A-1354
S14510	260-0834-00	1		SWITCH, TOGGLE: DPDT, 5A, 125VAC, 0.25-40 THD	09353	U21-SHZQE
S14520	260-0638-00			SW, THERMOSTATIC: 10A, 240V, OPEN 75 DEG C	93410	430-364
S17010				(SEE R17010)		
S17305				(SEE R17305)		
T14500	120-0798-01			XFMR, PWR, STPDN:	80009	120-0798-01
V14000	154-0731-00			ELECTRON TUBE: W/ANODE LEAD	80009	154-0731-00

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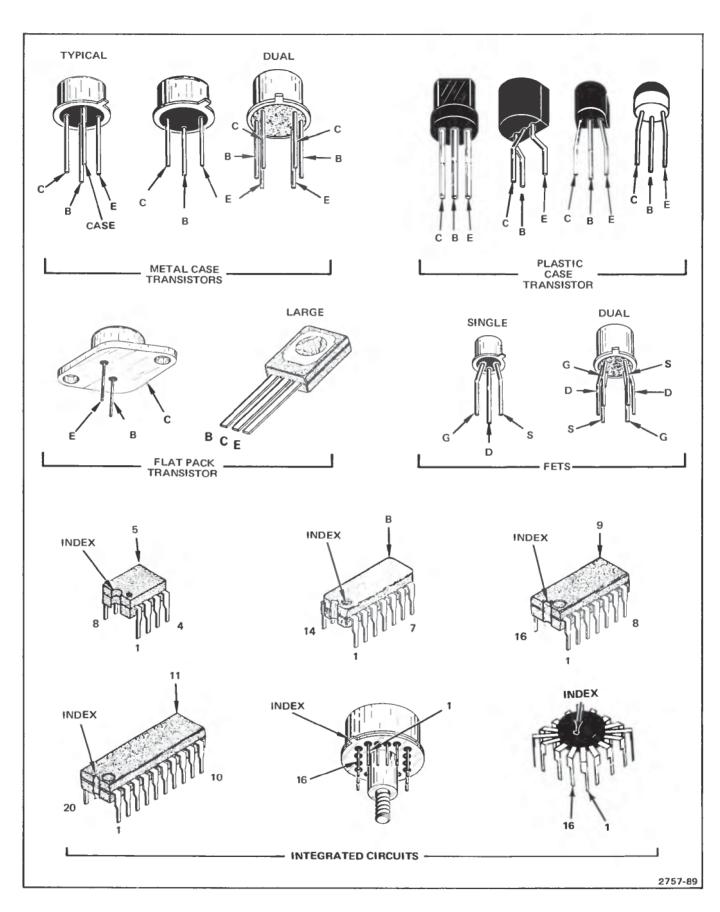


Figure 8-1. Semiconductor lead configurations.

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it is in the low state.

Abbreviations are based on ANSI Y1.1-1972.

Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966 Drafting Practices.

Y14.2, 1973 Line Conventions and Lettering.

Y10.5, 1968 Letter Symbols for Quantities Used in Electrical Science and Electrical

Engineering.

American National Standard Institute 1430 Broadway New York, New York 10018

Component Values

Electrical components shown on the diagrams are in the following units unless noted otherwise:

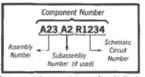
Capacitors = Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF) .

Resistors = Ohms (Ω) .

Assembly Numbers and Grid Coordinates

Each assembly in the instrument is assigned an assembly number (e.g., A20). The assembly number appears on the circuit board outline on the diagram, in the title for the circuit board component location illustration, and in the lookup table for the schematic diagram and corresponding component locator illustration. The Replaceable Electrical Parts list is arranged by assemblies in numerical sequence; the components are listed by component number (see following illustration for constructing a component number).

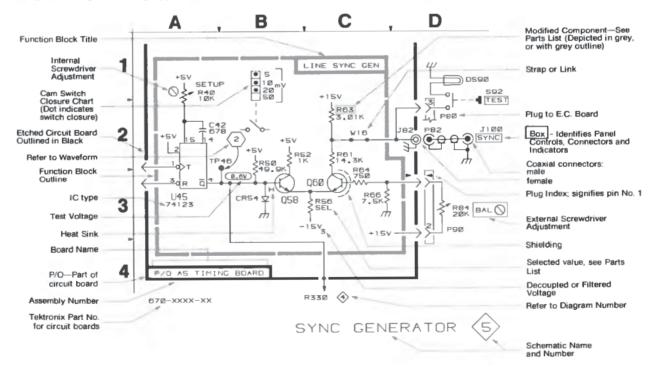
COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Numbe prefix—see end of Replaceable Electrical Parts List

The schematic diagram and circuit board component location illustration have grids. A lookup table with the grid coordinates is provided for ease of locating the component. Only the components illustrated on the facing diagram are listed in the lookup table. When more than one schematic diagram is used to illustrate the circuitry on a circuit board, the circuit board illustration may only appear opposite the first diagram on which it was illustrated; the lookup table will list the diagram number of other diagrams that the circuitry of the circuit board appears on.

The following special symbols may eppear on the diagrams:



AC WAVEFORMS

The waveforms adjacent to the circuit diagrams were obtained using the recommended test equipment and setup given below unless otherwise noted.

RECOMMENDED TEST EQUIPMENT

Item **Specifications** Example Test Oscilloscope Frequency response: DC-100 MHz. TEKTRONIX 465B or equivalent. Deflection factor: 5 mV/div to 5 V/div (to 50 V/div with 10X probe). Input impedance: 1 M Ω , 20 pf. Sweep rate: 5 ms to $0.5 \,\mu\text{s/div}$. Probe Fast-rise 10X probe compatible TEKTRONIX P6065 or equivalent. with the vertical amplifier of the test oscilloscope.

465B CONTROL SETTINGS

CRT Controls

INTENSITY As desired FOCUS As desired SCALE ILLUM As desired

Vertical Controls (both A and B if applicable)

VOLTS/DIV 5 mV

VAR Calibrated detent

POSITION Midrange AC-GND-DC DC

VERT MODE CH 1 and CHOP
INVERT Off (button out)
20 MHz BW LIMIT Full bandwidth (button

out)

Sweep Controls

TIME/DIV (both) 1 ms

VAR Calibrated detent

HORIZ DISPLAY A

X10 MAG Off (button out)
POSITION Midrange

DELAY TIME POSITION Fully counterclockwise

Trigger Controls (both A and B unless otherwise noted)

COUPLING AC
SOURCE NORM
TRIG MODE AUTO
SLOPE +

A TRIGGER LEVEL As needed for a stable

display (locked on positive transition of square-wave

input).

A TRIGGER HOLDOFF NORM

TEST OSCILLOSCOPE SETUP

Test Oscilloscope Control Settings

Apply a 20 mV p-p, positive-going square wave from the Calibration Generator to the CH 1 or X input connector. noted below: Connect the 465B A +GATE (from the 465B rear panel) to the test oscilloscope external trigger input connector. Use no terminations.

465B Oscilloscope control settings required to obtain valid waveforms are given with each set of waveforms. Changes from the preliminary control settings for the other controls is not required.

All controls as needed for the best display except as

Vert Mode Ch 1

Volts/Div

Ac-Gnd-Dc As required for the

measurement to be made
As needed for each wave-

form

Trigger Source Ext (465B A +GATE)

Trigger Coupling Ac Trigger Mode Auto

Time/Div As needed for each wave-

form

Connect a 10X probe to the Channel 1 input of the test oscilloscope. Apply the probe tip to the test point or component lead as indicated on the schematic and the component board layout Figure associated with that schematic.

DC VOLTAGES

Typical voltage measurements were obtained with the instrument operating under the conditions noted in the control settings adjacent to each schematic diagram. Voltage measurements were taken with no signal applied to the vertical or trigger inputs. All voltages measured with reference to chassis ground. Voltages rounded to the nearest tenth of a volt.

RECOMMENDED TEST EQUIPMENT

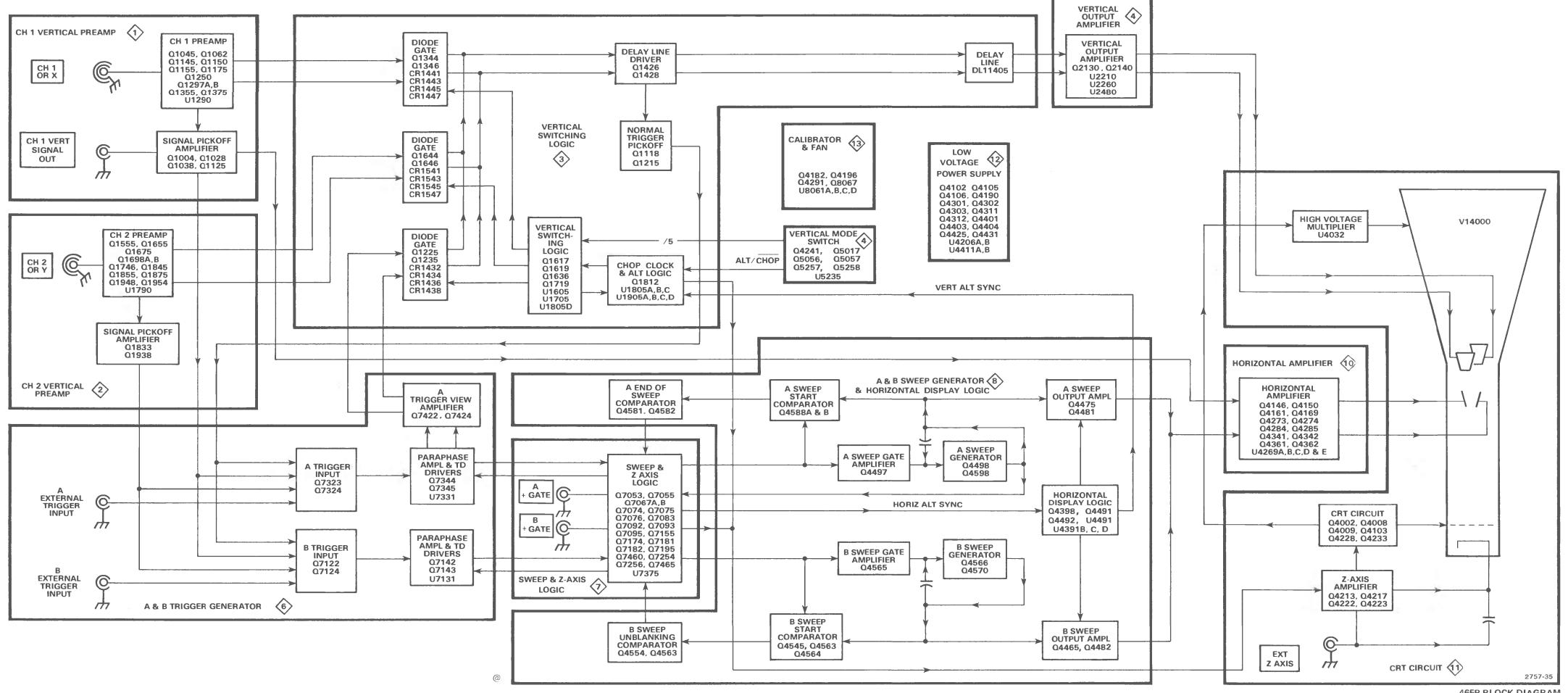
Item Specifications Example

Digital Multimeter (for Range: 0 to 1 kV. TEKTRONIX DM 501 Digital Multimeter.

voltages up to 1 kV Input Impedance: 10 MΩ. TEKTRONIX Oscilloscope with DM 44 Option.

DC Voltmeter (for voltages Range: 0 to 3 kV. Triplett Model 630NA.

above 1 kV) Input Impedance: 20 k Ω /V.



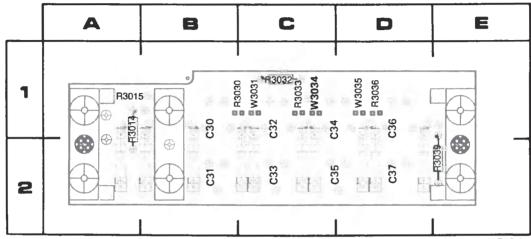
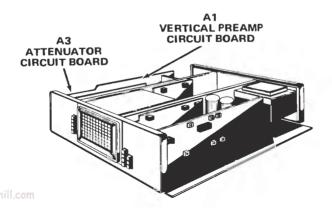
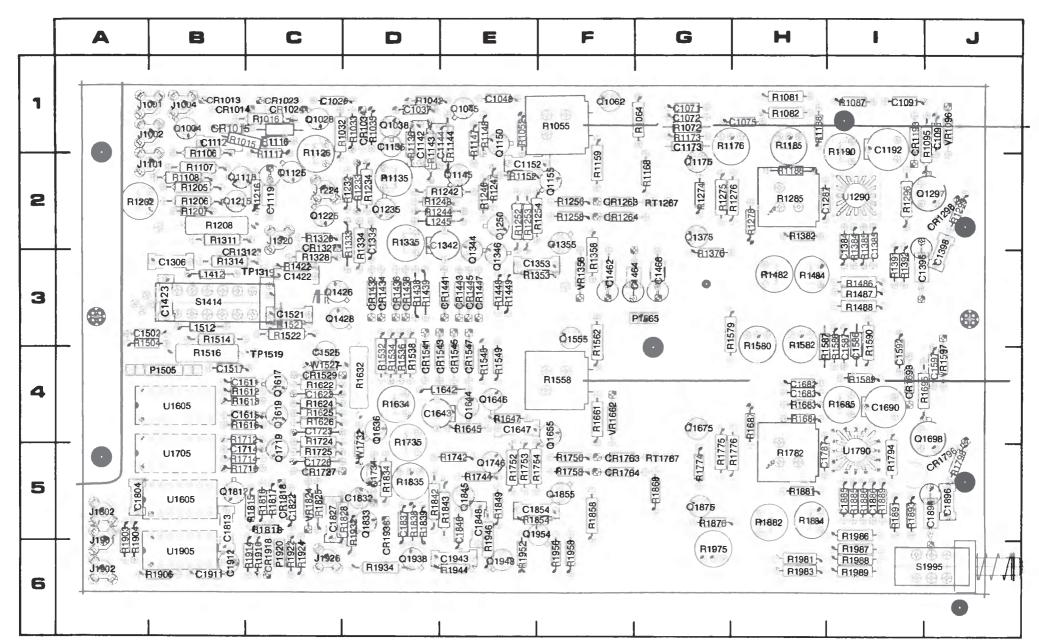


Figure 8-2. A3-Attenuator circuit board.

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465B CONTROL SETTINGS

DC Voltages

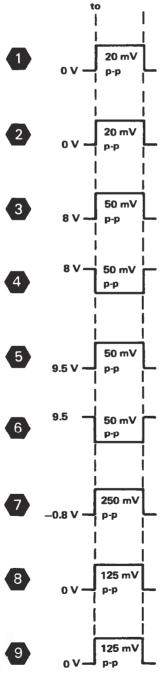
VERT MODE	CH 1
AC-GND-DC (both)	GND

AC Waveforms

VERT MODE CH 1 CH 1 AC-GND-DC DC VOLTS/DIV 5 mV

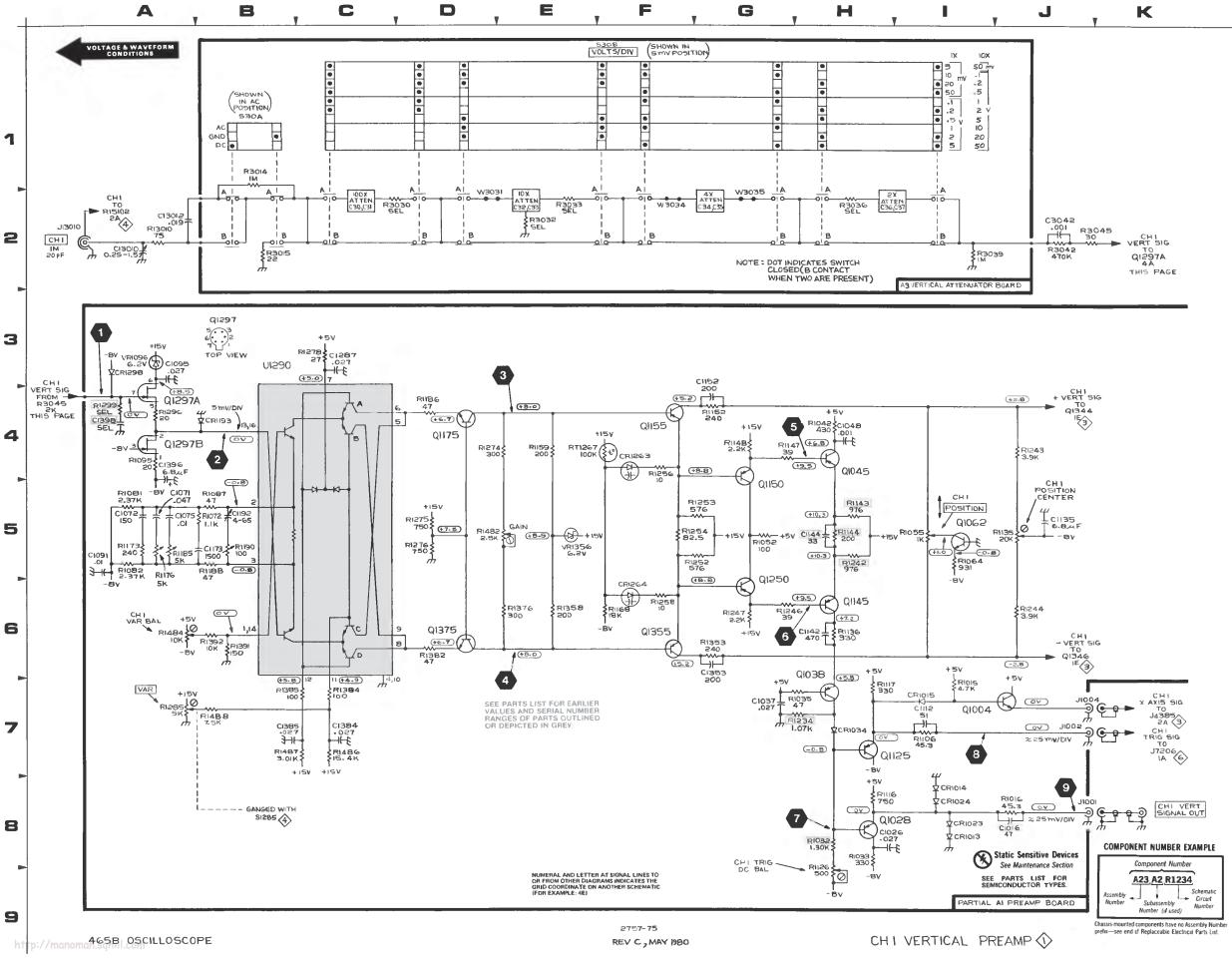
Input 20 mV positive-going

square wave



CH 1 VERTICAL PREAMP DIAGRAM (1)

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C1016*	8J	1C	Q1125	7 H	2C	R1188	5B	1H
C1026	BH	1C	Q1145	6H	2E	R1190	58	11
C1037	7G	1D	Q1150	5G	1E	R1234	7 H	2 D
C104B	4H	1E	Q1155	4F	2F	R1242	5H	2E
C1071	5A	1G	Q1175	4D	2G	R1243	4J	2D
C1072	5A	1G	Q1250	5G	2E	R1244	6 J	2E
C1075	5B	1H	Q1297A	4A	2 J	R1246	6G	2E
C1091	5A	11	Q1297D	4A	2J	R1247	6G	2E
C1095	3A	1J	Q1355	6F	2F	R1252	5G	2E
C1112	7I	18	Q1375	6D	2G	R1253	5G	2E
C1135	5J	1D	4.070	02		R1254	5G	2F
C1142	6H	1D	R1015	61	18	R1256	4F	2F
C1144	5H	1E	R1016	8J	1C	R125B	6F	2F
C1152	4G	2E	R1032	BH	1D	R1274	4D	2G
C1173	5A	1G	R1033	8H	1D	R1275	5D	2G
			R1035	7H	1D	R1276	5D	2H
C1192	5B	11				1		2H
C1287	3C	21	R1042	4H	1D	R127B	3C 7A	2H 2H
C1335	2D	2D	R1052	5G	1E	R1285		2H 2l
C1353	6G	3F	R1055	51	1F	R1296	4A	
C13B4	7C	21	R1064	51	1G	R1299	4A	2J 3F
C1385	78	21	R1072	5A	1G	R1353	6G	
C1396	4A	31	R10B1	5A	1H	R135B	6E	3F
C139B	4A	2J	R1082	5A	1H	R1376	6E	3G
CR1013	BI	18	R1087	5B	11	R13B2	6D	2H
CR1014	BI	18	R1095	4A	1J	R13B4	7C	21
CR1015	71	1B	R1106	71	28	R1385	7B	21
CR1023	BI	1C	R1116	BH	1C	R1391	6B	31
CR1024	ВІ	1C	R1117	7H	2C	R1392	6B	31
CR1034	7 H	1D	R1126	9G	2C	R1482	5D	ЗН
CR1193	4B	11	R1135	5 J	2 D	R14B4	6A	3H
CR1263	4F	2F	R1136	6H	1D	R1486	7C	31
CR1264	6F	2F	R1143	5H	1D	R1487	7B	31
CR129B	3A	2 J	R1144	5H	1E	R148B	7B	31
J1001	8J	18	R1147	4G	1E			
J1001	∞ 7J	18	R114B	4G	1E	RT1267	4E	2G
J1004	7J	18	R1152	4G	2E			
31004	73	10	R1159	4E	2F	U1290	3D	21
Q1004	71	18	R116B	6F	2G			
Q102B	вн	1C	R1173	5A	1G	VR1096	3A	1J
Q103B	6H	1D	R1176	5A	1H	VR1356	5E	3F
Q1045	4H	1E	R1185	5B	1H			
Q1043	51	1F	R1186	4D	2H			
·						umber ranges		
		on diagram(s) 2	and 3	"See Parts L	ist for serial n	umber ranges	·•	
P/O A3 AS	SY							
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C30	2C	18	C37	21	2 D	R3036	2H	1D
C31	2C	2B				R3039	21	2E
C32	2E	1C	R3014	18	1A			
C33	2E	2C	R3015	2B	1A	W3031	2D	1C
C34	2G	1C	R3030	2C	1C	W3034	2F	1C
C35	2G	2C	R3032	2E	1C	W3035	2G	1D
C36	2H	1D	R3033	2E	1C	,,,,,,,		
P/O A3 AS:	SY also shown	on diagram 2						
CHASSIS M	OUNTED PAR	RTS						
	SCHEM LOCATION	BOARD LOCATION	CIRCUIT	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
CIRCUIT NUMBER	LOCATION							
NUMBER C3042	2J	CHASSIS	J13010	2A	CHASSIS	R3045	2 J	CHASSIS
NUMBER		· · · · · · · · · · · · · · · · · · ·	J13010 R3042	2A 2J	CHASSIS CHASSIS	R3045	2 J	CHASSIS



465B CONTROL SETTINGS

DC Voltages

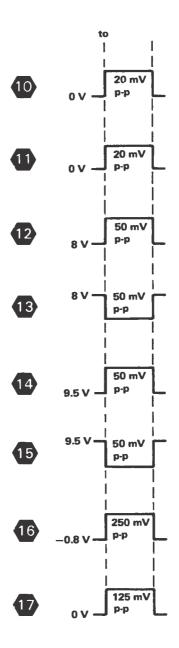
VERT MODE	CH 2
AC-GND-DC (both)	GND

AC Waveforms

VERT MODE CH 2 CH 2 AC-GND-DC DC VOLTS/DIV 5 mV

Input 20 mV positive-going

square wave



CH 2 VERTICAL PREAMP DIAGRAM ②

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C1586	5A	31	Q1948	6H	6E	R1842	5H	5D
C15B7	5A	31	Q1954	6G	5F	R1843	5H	5E
C1592	5A	41	R155B	51	4F	R1849	4G	5E
C1597	3A	4 J	R1562	51	3F	R1B54	6G	5F
C1647	3G	4E	R1579	5A	3H	R1B5B	6E	5F
C16B2	5B	4H	R1580	5A	3H	R1B6B	6F	5G
C16B3	5A	4H	R15B2	5B	3H	R1B76	6E	5G
C1690	5B	41	R15B6	5A	31	R18B1	6D	5H
C17B7	3C	5H	R15B7	5A	3H	R1BB2	5E	5H
C1B27	71	5C	R15B9	5B	41	R1BB4	6A	5H
C1837	7 G	50	R1590	5A	31	R1BB5	7C	51
C1846	4H	5E	R1645	4 J	4E	R18B6	7 B	51
C184B	5H	5E	R1647	4G	4E	R1BB9	6B	51
C1854	6G	5F	R1661	4E	4F	R1891	6B	51
C18B5	7C	51	R16B3	5B	4H	R1B93	6A	51
C1BB6	7B	51	R1684	4D	4H	R1932	7 H	5D
C1B94	4A	5J	R16B5	5B	41	R1934	7H	6D
C1B96	4A	5 J	R16B7	3C	4H	R1944	6H	6E
C1943	6H	6E	R1695	4A	4 J	R1946	5H	5E
CR1693	4B	41	R1735	5J	4D	R1952	5G	6E
CR1763	4F	5F	R1742	6J	5E	R1956	6H	6F
CR1764	6F	5F	R1744	4H	5E	R195B	6G	6F
CR1796	3A	5J	R1752	5G	5E	R1975	6A	6G
CR1936	7H	5D	R1753	5G	5E	R19B1	7 B	6H
			R1754	5F	5F	R19B3	7C	6H
J1926	7 J	6C	R1756	4F	5F	R19B6	7B	51
			R175B	6F	5F	R1987	7B	61
Q1555	51	3F	R1774	4E	5G	R1988	7 B	61
Q1556	4F	4F	R1775	5D	5G	R19B9	7A	61
Q1675	4D	4G	R1776	5D	5H			
Q1698A	4A	4 J	R17B2	7A	5H	RT1767	4F	5G
Q169BB	4A	4 J	R1794	4A	51			
Q1746	4G	5E	R179B	4A	5J	S1995	6A	6J
Q1833	ВІ	5D	R1B2B	71	5D			
Q1845	4H	5E	R1B34	BH	5D	U1790	3B	51
Q1B55	6F	5F	R1B35	8H	5D			
Q1B75	6D	5G	R1B38	7H	5D	VR1597	3A	4 J
Q193B	6H	6D	R1B39	4H	50	VR1662	5E	4F

P/O A1 ASSY also shown on diagram(s) 1, and 3

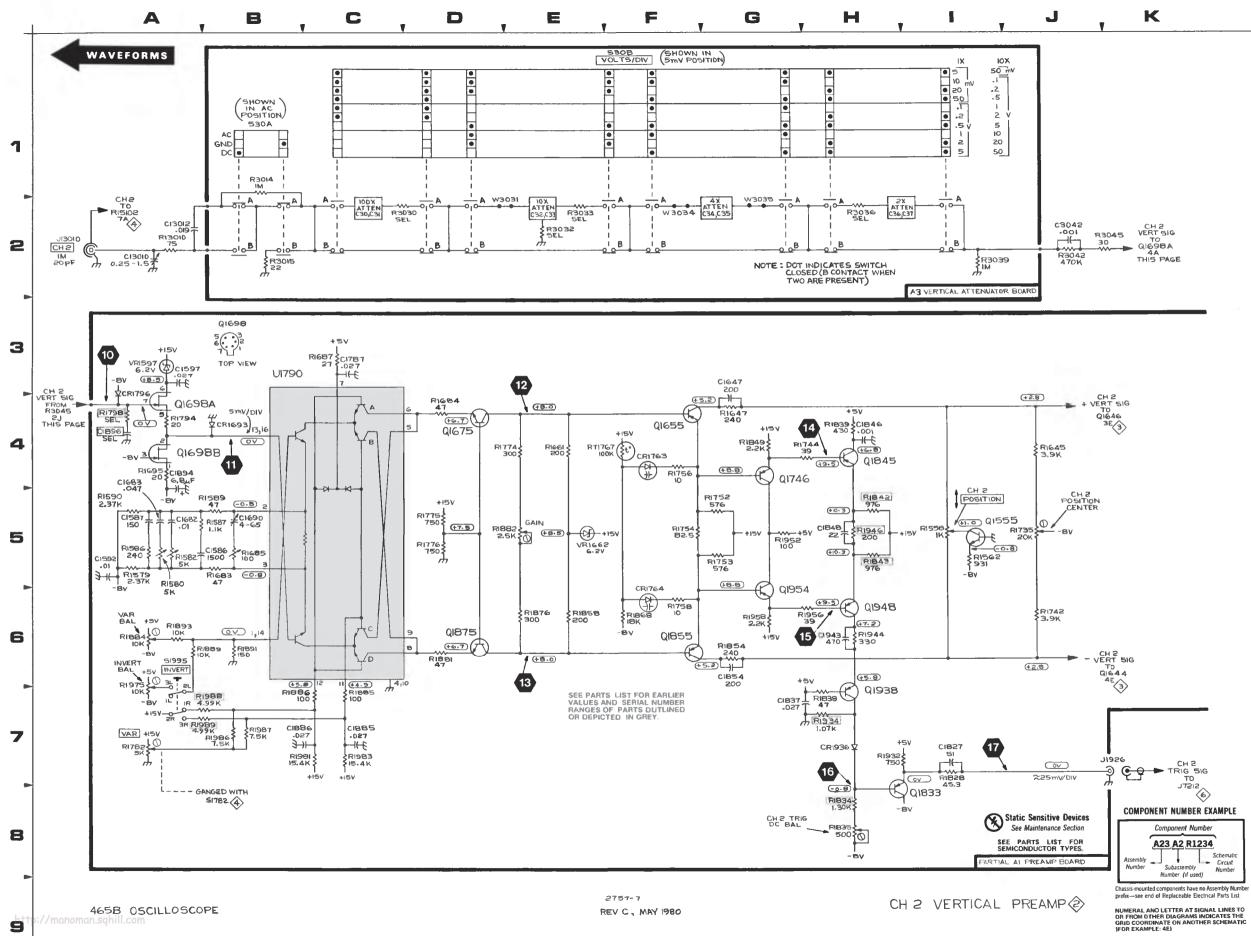
P/O A3 ASSY

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARO LOCATION
C30	2C	1B	C37	21	2D	R3036	2H	1D
C31	2C	2B				R3039	21	2E
C32	2E	1C	R3014	1B	1A			
C33	2E	2C	R3015	2B	1A	W3031	20	1C
C34	2G	1C	R3030	2C	1C	W3034	2F	1C
C35	2G	2C	R3032	2E	1C	W3035	2G	1D
C36	2H	1D	R3033	2E	1C			

P/O A3 ASSY also shown on diagram 1

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C3042	2 J	CHASSIS	J13010	2A	CHASSIS	R3045	2K	CHASSIS
C13010	2A	CHASSIS						
C13012	2A	CHASSIS	R3042	2J	CHASSIS			



465B CONTROL SETTINGS

DC Voltages

A TRIG MODE

NORM (sweep not running)

VERT MODE

AC-GND-DC (both)

CH 1 POSITION

NORM (sweep not running)

CH 1 and CHOP

GND

Midrange

AC Waveforms

VERT MODE

CH 1, ADD, A TRIG
VIEW, and CHOP

A TRIG MODE

A AND B TIME/DIV

HORIZ DISPLAY

CH 1, ADD, A TRIG
VIEW, and CHOP

A UTO (no trigger signal)

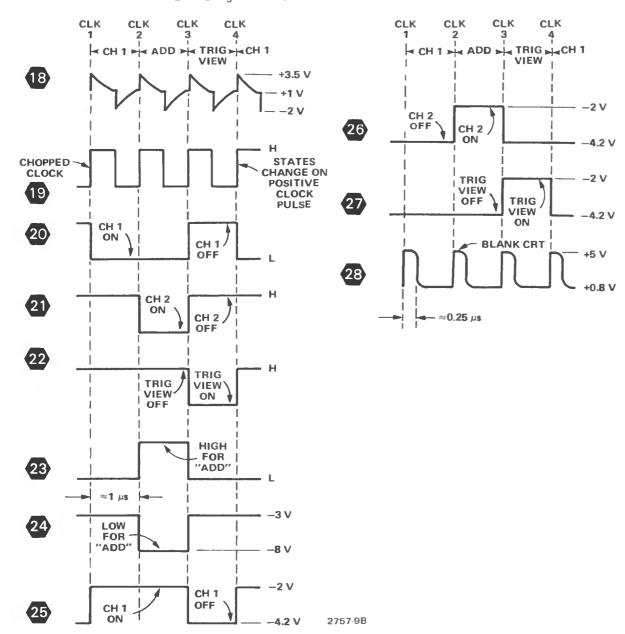
1 ms

A

GND

H = HI logic level > 2 vdcL = LO logic level < 0.8 vdc

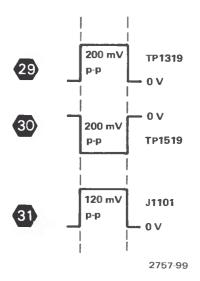
AC-GND-DC (both)



465B CONTROL SETTINGS

AC Waveforms

VERT MODE
VOLTS/DIV
5 mV
CH 1 AC-GND-DC
Vertical POSITION
Input
CH 1
5 mV
DC
Midrange
20 mV positive-going
square wave



VERTICAL SWITCHING LOGIC DIAGRAM ③

P/O A4 ASS	SY							
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARO LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P4061	6A	2H						
P/O A4 ASS 11, 12. and 1.		on diagram(s) 4	1, 5, 7, 8, 9, 10	0,				
P/O A5 ASS	SY							
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT	SCHEM LOCATION	BOARO LOCATION	CIRCUIT	SCHEM LOCATION	BOARD
C5018	2B	1B	P5001 P5005	2B 2A	1A 1B	S521 <i>0</i>	3B	3 A
P/O A5 ASS	Y also shown	on diagram 4						
P/O A7 ASS	SY							
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD
C710B	2A	2B	P7052	3A	1G	S7312B	1A	3C
P/O A7 ASS	Y also shown	on diagram(s) 6	5, 7, and 12					
CHASSIS MO	OUNTED PAR	RTS						
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD
DL11405	1M	CHASSIS						

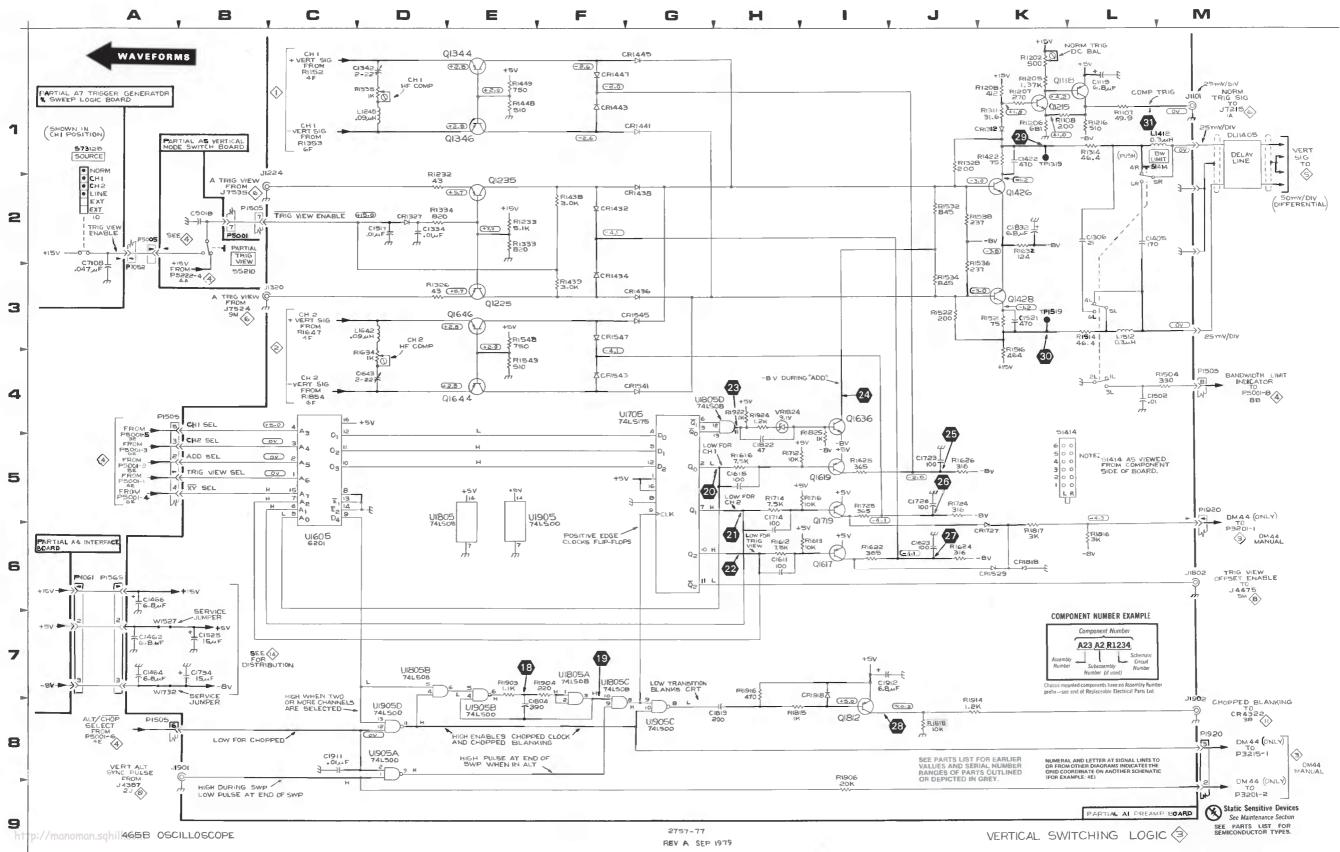
VERTICAL SWITCHING LOGIC

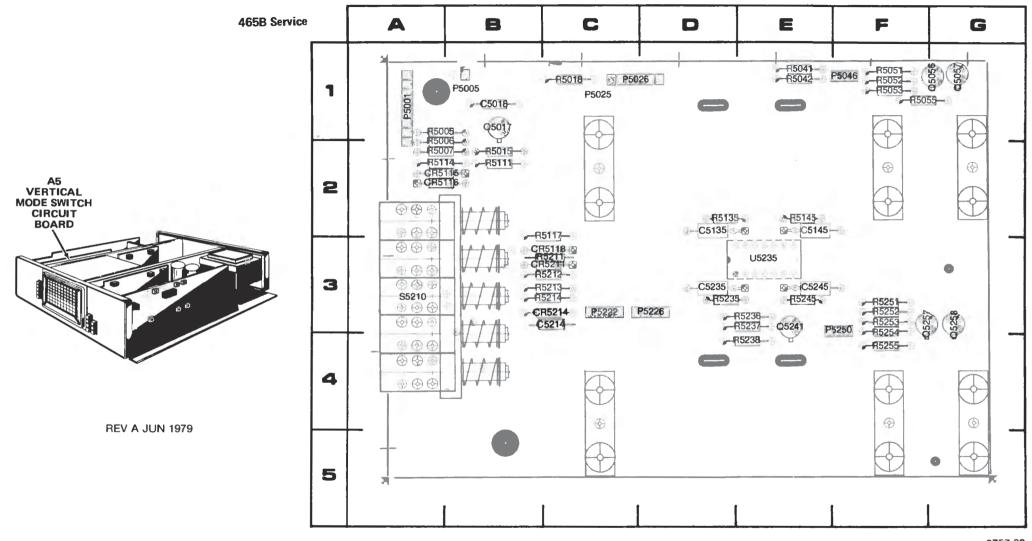


CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT	SCHEM LOCATION	BOARD
C1119	1L	2C	L1245	1D	2E	R1522	3 J	3C
C1306	2L	3B	L1412	1M	3B	R1532	2J	4D
					-			
C1342	1D	2E	L1512	3L	3B	R1534	3 J	4D
C1405	2L	3B	L1642	3D	4E	R1536	2K	4D
C1422	1K	3C				R153B	2K	4D
			P1505	2B	4B	R154B	3E	4E
C1462	7A	3F	P1505	4 A	4B	R1549	4E	4E
C1464	7A	3G	P1505	4M	4B	R1612	6H	4C
C1466	6A	3G	P1505	8 A	4B	R1613	61	4C
C1502	4L	3B	P1565	6A	3G	R1616	5H	4C
C1517	2D	4B	P1920	5M	6C	R1622	61	4C
C1521	3K	3C	P1920	BM	6C	R1624	6J	4C
			1 1320	DIVI	OC.		5I	4C
C1525	7B	4C	04445		0.0	R1625		
C1611	6H	4C	Q111B	1K	2B	R1626	5 J	4C
C1615	5H	4C	Q1215	1K	2B	R1632	2K	4D
C1623	6J	4C	Q1225	3E	2C	R1634	4D	4D
C1643	4D	4E	Q1235	2E	2D	R1712	5H	4C
C1714	5H	5C	Q1344	1E	2E	R1714	5H	5C
C1723	5 J	4C	Q1346	1E	3E	R1716	51	5C
C1726	5J	5C	Q1426	2K	3C	R1724	5J	4C
C1734	7B	5D	Q1428	3K	3C	R1725	51	5C
C1B04	BF	5A	Q1617	61	4C	R1815	BI	5C
C1B13	BH	5B	Q1619	51	4C	R1B16	6L	5C
C1B22	5H	5C	Q1636	41	4D	R1817	6K	5C
C1B32	2K	5D	Q1644	4E	4E	R1818*	8J	5C
C1911	BC	6B	Q1646	3E	4E	R1825	41	5C
C1912	71	6B	Q1719	51	5C	R1903	7E	6A
			Q1B12	В	5B	R1904	7F	6A
CR1312	1K	3B				R1906	81	6B 6C
CR1327	2D	2C	R1 107	1 L	2B	R1914 R1916	8J 7H	6C
CR1432	2F	3D	R110B	1K	2B	R1922	4H	6C
CR1434	3F	3D	R1202	1K	2A	R1924	4H	6C
CR1436	3G	3D	R1205	1K	2B	111324	711	00
CR143B	2G	3D	R1206	1K	2B	S1414	1M	3B
						51414	1171	36
CR1441	1G	3E	R1207	1K	2B		444	
CR1443	1F	3E	R1208	1K	2B	TP1319	1K	3C
CR1445	1G	3E	R1216	1L	2C	TP1519	3K	4C
CR1447	1F	3E	R1232	1D	2D			
CR1529	6K	4C	R1233	2E	2D	U1605	6C	4B
CR1541	4G	4D	R1311	1K	2B	U1705	4G	5B
CR1543	4F	4E	R1314	1L	3B	U1B05A	7F	5B
CR1545	3G	4E	R1326	3D	2C	U1B05B	7D	5B
CR1547	3G	4E	R132B	1J	3C	U1805C	7F	5B
CR1547	3F	4E	R1333	2E	2D	U1B05D	4H	5B
CR1727	6K	5C	R1334	2D	2D			6B
CR1727	6K	5C				U1905A	BD	
			R1335	1D	2D	U1905B	BE	6B
CR191B	81	6C	R1422	1K	3C	U1905C	BG	6B
						U1905D	BD	6B
J1101	1M	2B	R143B	2F	3D			
J1224	1B	2C	R1439	3F	3D	VR1B24	4H	5C
J1224	1B	2C	R1448	1E	3E			
J1320	3C	2C	R1449	1E	3E	W1527	7A	4C
J1B02	6M	5A	R1504	4M	3B	W1732	7A	4D
J1B02	6M	5A	R1514	3L	3B		7.7	45
J1901 J1902	BB BM	6A 6A	R1516 R1521	3K 3K	4B 3C			

P/O A1 ASSY also shown on diagram(s) 1, and 2

*See Parts List for serial number ranges.

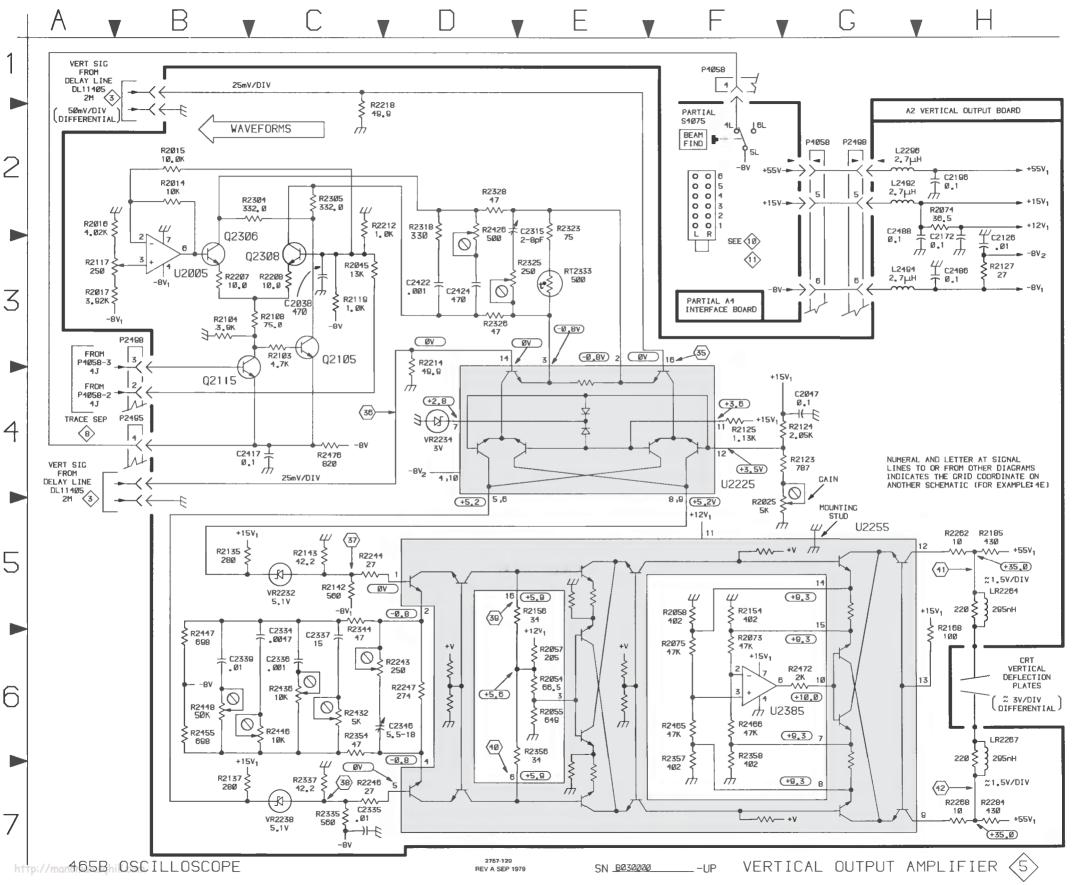




VERTICAL OUTPUT AMPLIFIER DIAGRAM 5

(SN B030000 & UP)

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATIO
C203B	3C	1D	R2054	6E	1E	R231B	2 D	3C
C2047	4G	1D	R2055	6E	1E	R2323	2E	2C
C2126	3H	1C	R2057	6E	1E	R2325	3E	2C
C2172	3H	1F	R205B	5F	1E	R2326	3D	3C
C2196	2H	2H	R2073	6F	1F	R2328	2D	3C
C2315	2E	2C	R2074	2H	1F	R2335	7C	3D
C2334	5C	3D	R2075	6F	1F	R2337	7C	3D
C2335	7C	3D	R2103	3C	1B	R2344	5C	3D
C2336	6C	3D	R2104	3B	1B	R2354	6C	2E
C2337	6C	2D	R210B	3C	1B	R2356	6E	2E
C2339	6B	3D	R2117	3A	1B	R2357	6F	2E
C2346	6D	2E	R2119	3C	2B	R2358	6F	3E
C2417	4B	3C	R2123	4G	1C	R2426	2D	3C
C2422	3D	3C	R2124	4G	1C	R2432	6C	3C
C2424	3D	3C	R2125	4F	1C	R2436	6C	3D
C2486	3H	3G	R2127	3H	1C	R2446	6C	3D
C2488	2G	3G	R2135	5B	1C	R2447	6B	3E
			R2137	7B	1D	R244B	6B	3E
L2296	2G	2H	R2142	5C	1D	R2455	6B	3E
L2492	2G	3H	R2143	5C	1D	R2465	6F	3F
L2494	3G	3H	R2154	5F	1E	R2466	6F	3F
			R2156	5E	2E	R2472	6G	3F
LR2264	5H	2F	R2168	5H	2F	R2476	4C	3F
LR2267	6H	2F	R2185	5H	2G			O.
P2495	4B		R2207	3B	2B	RT2333	3E	2C
P2498	3B	3H	R2208	3C	2B			
F243B	36	311	R2212	2C	2B	U2005	3B	1B
Q2105	3C	2B	R2214	3D	2B	U2225	4F	2C
Q2115	4B	1B	R221B	2C	2B	U2255	5G	2E
Q2306	2B	2B	R2243	6D	2D	U2385	6F	3G
Q2308	3C	2B	R2244	5C	2D	1/20000		
	•	25	R2246	7C	2D	VR2232	5C	2D
R2014	2B	1B	R2247	6D	2E	VR2234	4D	2D
R2015	2B	1B	R2262	5H	2F	VR223B	7 C	2D
R2016	2A	1B	R226B	7 H	2F			
R2017	3A	1B	R22B4	7H	2G			
R2025	5F	1C	R2304	2B	2B			
R2045	3C	1D	R2305	2C	2B			
/O A4 ASS	Υ							
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATIO
P4058	2G	2G	S4075	2J	2F			



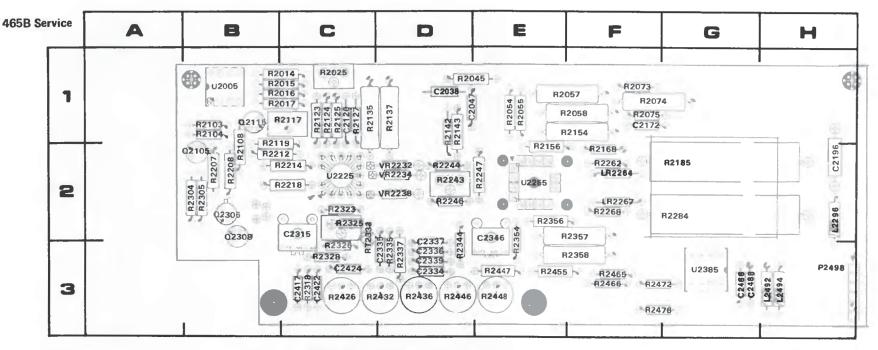
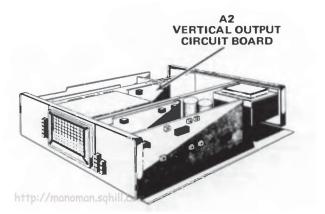


Figure 8-5A. A2 Vertical Output circuit board (\$N B030000 & up).



465B CONTROL SETTINGS

DC Voltages

VERT MODE CH 1
Vertical POSITION Midrange
AC-GND-DC (both) GND

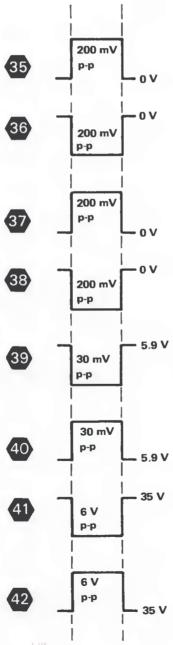
AC Waveforms

VERT MODE CH 1 VOLTS/DIV 5 mV CH 1 AC-GND-DC DC

Input 20 mV positive-going

square wave

REV A SEI

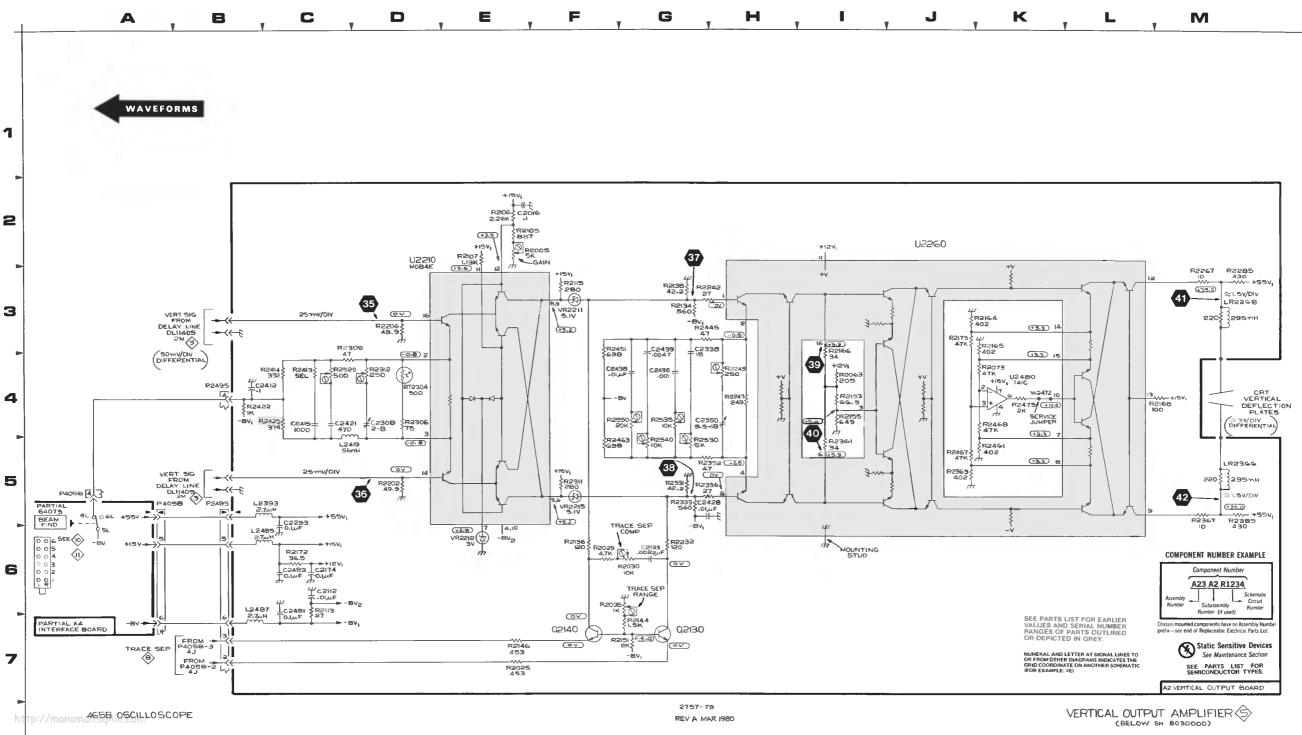


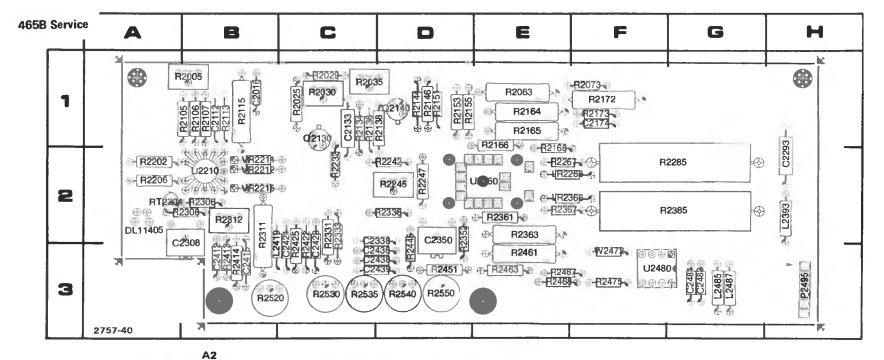
VERTICAL OUTPUT AMPLIFIER DIAGRAM (5)

(BELOW SN B030000)

A2 AS								
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C2016	2E	18	R2063	41	1E	R2336	5 G	2D
C2112	6C	1B	R2073	4K	1F	R2352	5G	2D
C2133	6C	1C	R2073	4K	1F	R2361	51	2E
C2174	6C	1F	R2105	2E	1B	R2363	5 J	26
C2293	5C	2 H	R2106	2E	18	R2367	5M	2E
C2308	4D	3B	R2107	2E	1B	R23B5	5M	2G
C233B	3G	3D	R2113	6C	1B	R2413	4C	3B
C2350	4H	2D	R2115	3F	1B	R2414	4C	3B
C2412	4C	3B	R2134	3G	1C	ł		
C2415	4C	3B	R2136	6F	1C	R2422	48	3C
C2421	4C	3C	R213B	3G	1D	R2425	4C	3C
C242B	5G	3C	R2144	7G	1D	R2445	3G	3D
C2426	5G	3C	R2146	7E	1D	R2451	3F	3D
C2436	4G	3D	R2151	7G	1D	R2461	5K	3E
C243B	4F	3D	R2153	41	1D	R2463	5G	3E
C2439	3G	3D	R2155	41	1D	R2467	5J	3E
C24B1	6C	3G	R2164	3K	1E	R2466	4K	3E
C24B3	6C	3G	R2165	3K	1E	R2475	4K	3F
			R2166	31	1E	R2520	4C	3B
L2393	5C	2H	R216B	4M	2E	R2530	5G	3C
L2419	5C	3C	R2172	6C	1F	R2535	4G	3C
L24B5	6C	3G	R2173	3 J	1F	R2540	5G	3D
L24B7	6C	3G	R2202	5D	2A	R2550	4G	3D
LR226B	3M	2E	R2206	3D	2A			
LR2366	5M	2E	R2231	5G	2C	RT2304	4D	2A
			R2232	6G	2C			
P2495	4B	3H	R2242	3G	2 D	U2210	2D	2B
			R2245	4H	2D	U2260	2 .J	2E
Q2130	7G	1C	R2247	4H	2D	U2480	4K	3F
Q2140	7F	1D	R2267	3M	2E			
			R2265	3M	2G	VR2211	3F	2B
R2005	2E	1B	R2306	4D	2B	VR2212	6E	2B
R2005	2F	1B	R2308	3D	2B	VR2215	5F	2B
R2025	7E	1C	R2311	5F	2B			
R2029	6F	1C	R2312	4D	2B	W2472	4K	3F
R2030	6G	1C	R2331	5G	2C			
R2035	6F	1C	R2333	5G	2C			
/O A4 ASS	SY					<u> </u>		
CIRCUIT	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT	SCHEM LOCATION	BOARD LOCATION
P405B	5A	2G	S4075	5A	2 J			

P/O A4 ASSY also shown on diagrams 3, 4, 7, 8, 9, 10, 11, 12, and 13





VERTICAL OUTPUT CIRCUIT BOARD

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Figure 8-5B, A2 Vertical Output circuit board (below SN B030000).

REV A JUN 1979

DC Voltages

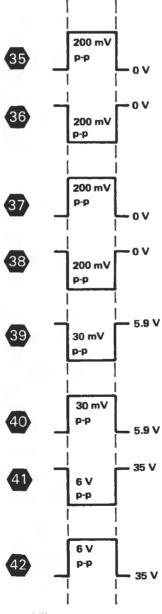
VERT MODE CH 1
Vertical POSITION Midrange
AC-GND-DC (both) GND

AC Waveforms

VERT MODE CH 1 VOLTS/DIV 5 mV CH 1 AC-GND-DC DC

Input 20 mV positive-going

square wave



SWEEP AND Z-AXIS LOGIC DIAGRAM

$\langle \hat{\gamma} \rangle$
\sim

CIRCUIT	SCHEM	BOARD	CIRCUIT	SCHEM	BOARD	CIRCUIT	SCHEM	BOARD
NUMBER	LOCATION	LOCATION	NUMBER	LOCATION	LOCATION	NUMBER	LOCATION	LOCATION
C439B	4B	7L	P439B	3A	7M	W4544	9N	9G
			P4561	5A	9H			
J4463	1A	9H	P4571	7N	101			
J4487	6B	9K						

P/O A4 ASSY also shown on diagrams 3, 4, 5, 8, 9, 10, 11, 12, and 13

P/O A6 ASSY

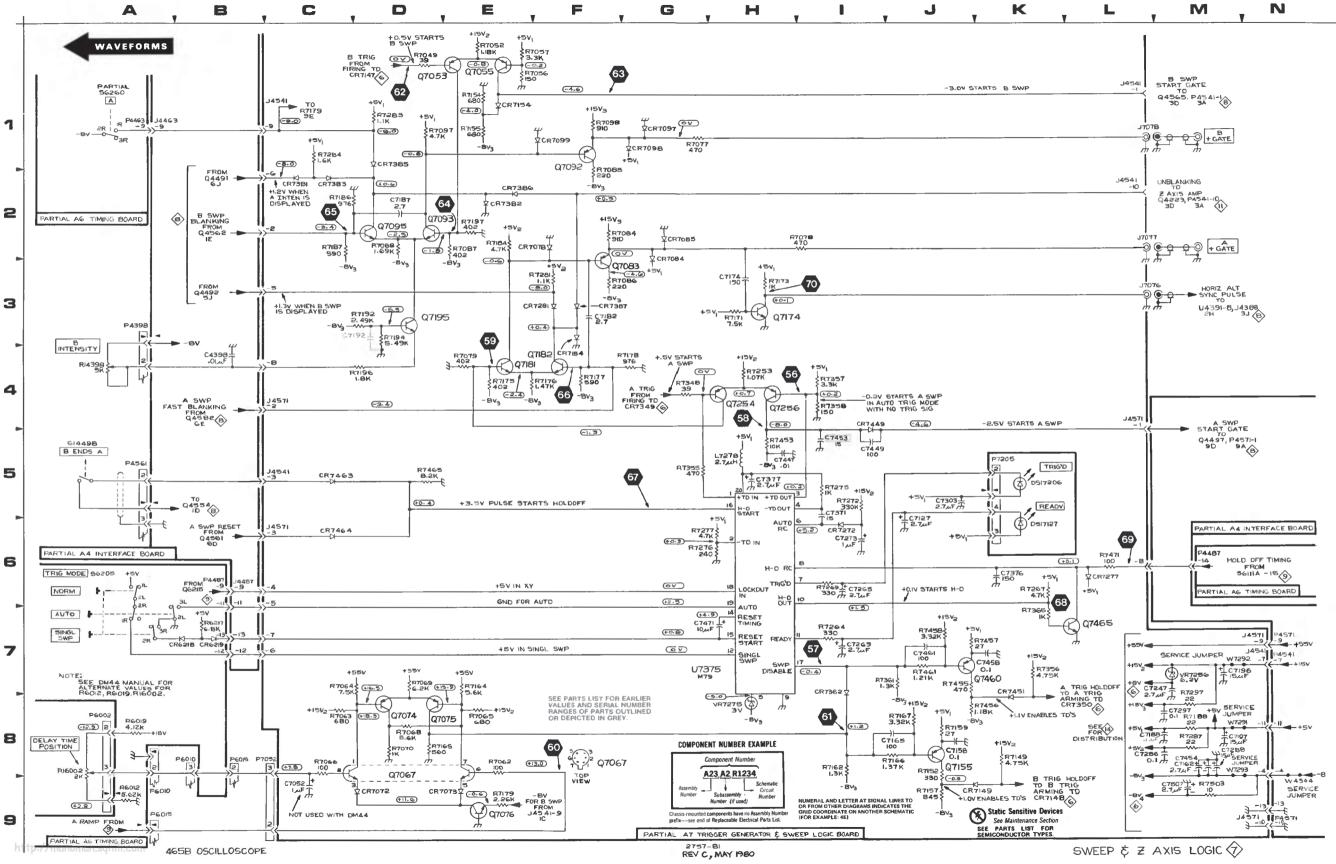
CIRCUIT	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
CR6218	7B	5D	P6010	ВВ	1D	R6019	8A	2 D
CR6219	7B	5D	P6010	9A	10	R6217	7B	5D
			P6015	BB	10			
P4487	6B	5D	P6015	9A	1D	S6205	6A	4B
P4487	6M	50				S6260	1A	4H
P6002	8A	1B	R6012	9A	1C			

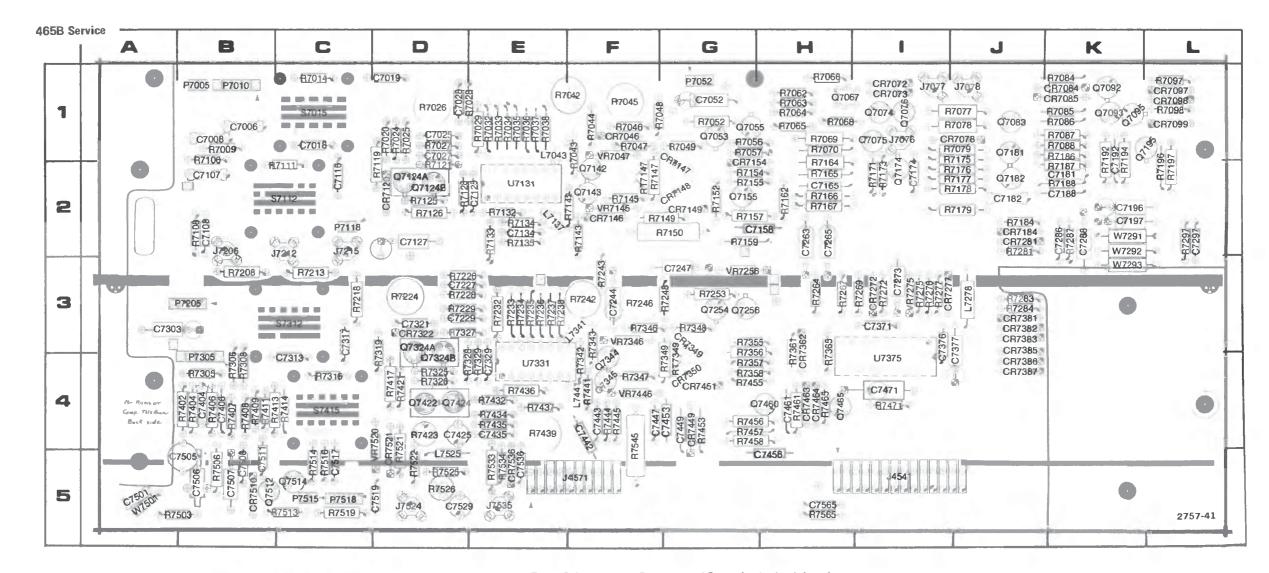
P/O A6 ASSY also shown on diagrams 8, 9, and 10

P/O A7 ASSY

CIRCUIT	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM	BOARD LOCATIO
C7052	9C	1G	CR7098	1G	1L	Ω7076	9E	11
C7127	5J	2D	CR7099	1F	1L	Q70B3	2F	1J
C7158	8J	2H	CR7149	9K	2G	Q7092	1F	1K
C7165	8J	2H	CR7154	1E	1G	Q7093	2D	1K
C7174	3H	21	CR7184	4F	2 J	Q7095	2D	1K
C7182	3F	2 J	CR7272	61	31	Q7155	8J	2G
C71B7	2D	2K	CR7277	6L	31	Q7174	3H	21
C718B	8M	2K	CR7281	3F	2 J	Q71B1	4E	1J
C7192*	3D	2K	CR7362	71	4H	Q7182	4F	2 J
C7196	7M	2K	CR7381	2C	3J	Q7195	3D	1L
C7197	8M	2K	CR7382	2E	3J	Q7254	4H	3G
C7247	7M	3G	CR7383	2C	3J	Q7256	4H	3G
C7263	71	2H	CR73B5	1D	3J	Q7460	7J	4H
C7265	61	2H	CR73B6	2E	4J	Q7465	7L	4H
C7273	61	31	CR7387	3F	4J		,,	•••
C72B6	8L	2K	CR7449	41	4G	R7049	1D	1G
C7288	8M	2K	CR7451	8K	4G	R7052	1E	1G
C7297	BM	2L	CR7463	5C	4H	R7056	1E	1G
C7303	5J	3A	CR7464	6C	4H	R7057	1E	1G
C7371	51	31		•		R7062	8E	1H
C7376	6K	31	J4541	1C	51	R7063	BC	1H
C7377	5H	3J	J4571	4C	5F	R7064	7C	1H
C7447	5H	4F	J 707 6	3L	11	R7065	8E	1H
C7447	51	4F	J7077	2L	11	R7066	8C	1H
C7449	51	4G	J7078	1L	1J	R706B	80	1H
C7453*	51	4G				R7069	7D	1H
C7458	7K	5H	L7278	5H	3J	R7070	8D	1H
C7461	7J	4H				R7077	1G	1J
C7471	7H	41	P7052	BC	1G	R707B	21	1J
C7507	9M	5B				R7079	4E	1J
CD7070	0.0	4.	Q7053	1E	1G	R7084	4E 2F	15 1K
CR7072 CR7073	9D 9E	11 11	Q 7 055	1E	1G	R70B5	2r 1F	1K
CR7073	9E 2F	11 1J	Q7067A	BE	1H	R7086	3F	1K
CR70B4	ŽG	1K	Q7067B	8C	1H	R7087	3F 2E	1K
CR70B5	2G	íŘ	Ω7074	8D	11			
CR7097	1Ğ	1L	Q7075	8D	11	R7088	2 D	1K







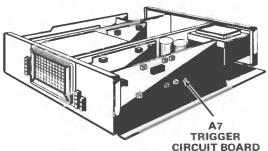


Figure 8-6. A7 Trigger Generator and Sweep Logic circuit board.

@ SEP 1979

DC Voltages

A TRIG MODE NORM (sweep not

running)

TRIGGER SOURCE (both) EXT
TRIGGER LEVEL (both) Midrange

TRIGGER SLOPE (both) +

TRIGGER COUPLING

(both) AC

VERT MODE A TRIG VIEW and CHOP

AC-GND-DC (both) GND

AC Waveforms

TIME/DIV 0.2 ms
TRIGGER SOURCE (both) EXT
TRIGGER LEVEL (both) Midrange
TRIGGER SLOPE (both) +

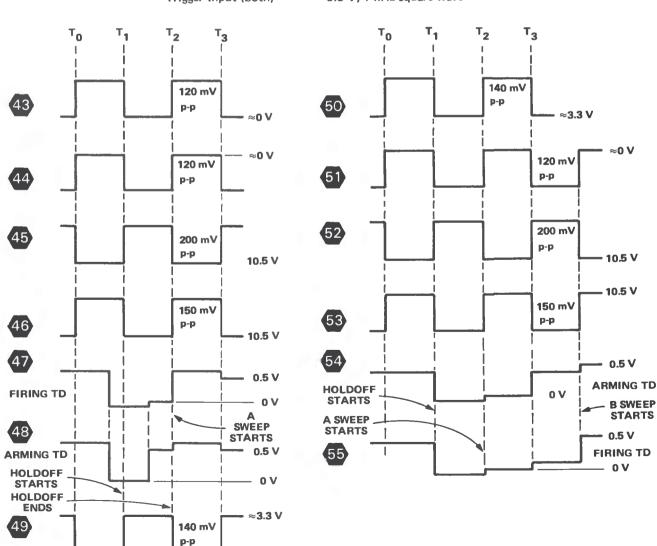
TRIGGER SLOPE (both)

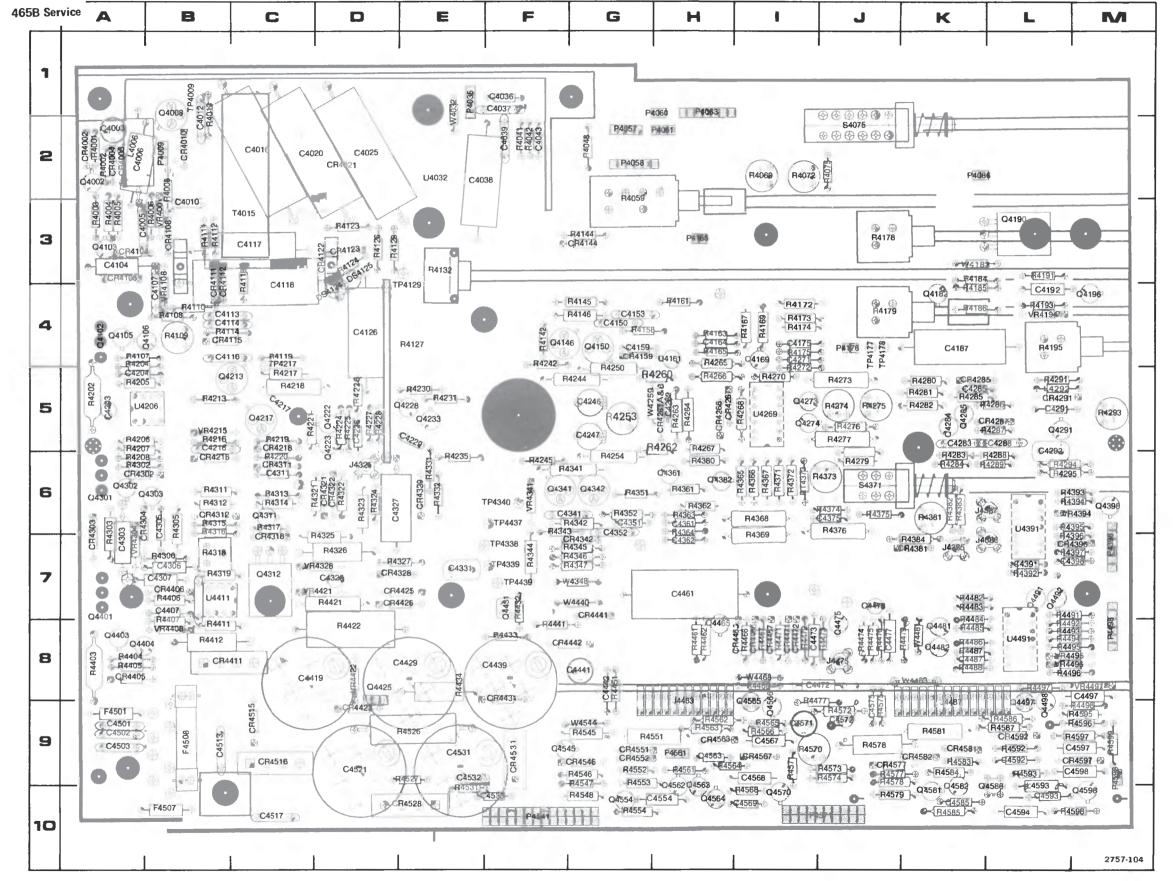
(both) AC

VERT MODE A TRIG VIEW and CHOP

HORIZ DISPLAY A INTEN

DELAY TIME POSITION Fully counterclockwise
Trigger Input (both) Fully counterclockwise
0.5 V, 1 kHz square wave





DC Voltages

A TRIG MODE

NORM (sweep not

running)

AC-GND-DC (both)

GND

AC Waveforms

A TRIG MODE B TRIGGER SOURCE AUTO (no trigger signal) STARTS AFTER DELAY

HORIZ DISPLAY

A INTEN 5.00

DELAY TIME POSITION A TIME/DIV

1 ms

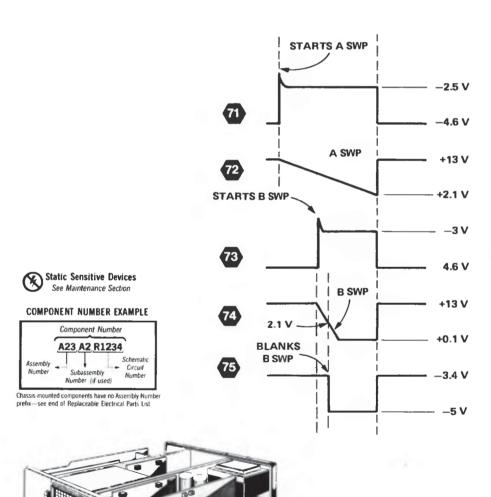
B TIME/DIV

0.1 ms

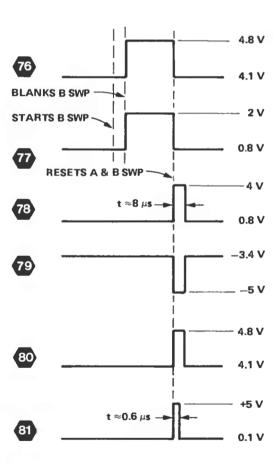
R LIME/DIA



GND



INTERFACE CIRCUIT BOARD



2757-42

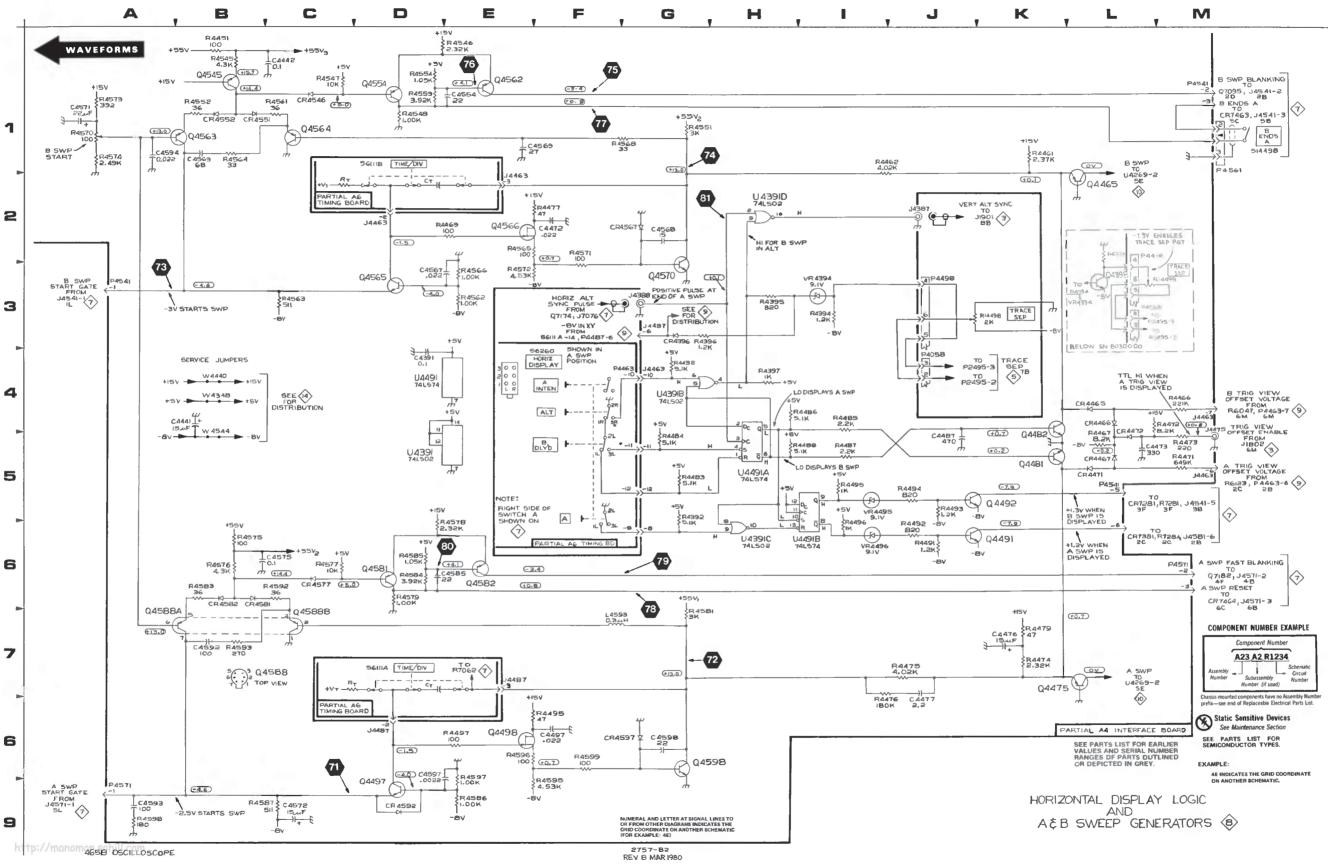
HORIZONTAL DISPLAY LOGIC AND A & B SWEEP GENERATORS **DIAGRAM**

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATIO
C4391	4D	7L	P4571	6M	101	R449B	8F	9M
C4441	4 B	BG	P4571	9A	10J	R4545	1B	9G
C4442	1C	BG				R4546	1E	9 G
C4442	1C	BG	Q4398*	31	6M	R4547	1C	10G
C4472	2F	71	Q4465	2L	BH	R454B	1D	10G
C4473	5L	81	Q4475	7K	8J	R4551	1G	9 G
C4476	7K	7 J	Q44B1	5K	BK	R4552	1B	9G
C4477	7J	8J	Q44B2	5K	BK	R4553	1D	10G
C44B7	5 J	BK	Q4491	6K	7L	R4554	1D	10G
C4497	BG	BM	Q4492	5K	7L	R4561	1C	9H
C4554	1E	10H	Q4497	9D	9L	R4562	3E	9H
C4563	1B	9H	Q4498	BF	9L	R4563	3C	9H
C4567	3D	91	Q4545	1B	9F	R4563	3C	9H
C456B	2G	91	Q4554	1D	10G	R4563	3C	9H
C4569	1E	101	Q4562	1E	10H	R4564	1B	9H
C4571	1A	91	Q4563	1B	10H	R4565	2E	91
C4572	9C	9 J	Q4564	1C	10H	R4566	3E	91
C4575	6C	9J	Q4565	3D	91	R456B	1G	101
C45B5	6E	10K	Q4566	2E	91	R4570	1A	91
C4592	7B	9L	Q4570	3G	101	R4571	2F	91
C4593	9A	10L	Q4581	6D	10K	R4571	2F	91
C4594	1A	10L	Q45B2	6E	10K	R4572	3E	9J
C4597	BD	9M	Q45B8	7B	1OL	R4573	1A	9J
C459B	8G	9M	Q45BBA	7A	10L	R4574	1A	9J
C403D	00	3141	Q458BB	7C	10L	R4575	6B	9J
CR4396	3G	7L	Q459B	BG	10M	R4576	6B	9J
CR4465	4L	BI	R4392	5G	7L	R4577	6C	9J
CR4466	4L	81	R4393*	31	6L	R4578	6E	9J
CR4467	5L	BI				R4579	6D	10K
CR4471	5L	BI	R4394	31	6L	R45B1	7G	9K
CR4472	5L	81	R4395	2H	6L	R4583	6B	9K
CR4546	1C	9G	R4396	3G	7L	R4584	6D	9K
CR4551	1B	9G	R4397	4H	7L	R4585	6D	10K
CR4551	1B	9G	R4451	1B	BG			9L
CR4563	3D	9H	R4461	1K	вн	R4586	9E	9L
CR4567	2G	9I	R4462	11	BH	R4587	9C	
CR4507 CR4577	6C	9J 9I	R4466	4M	BI	R4592	6C	9L
CR4577	6B	9K	R4467	5L	Bl	R4593	7B	9L 9M
			R4469	2E	81	R4595	9F	
CR45B2	6B	9K	R4471	5M	81	R4596	BF	9M
CR4592	9D	9L	R4472	4L	BI	R4597	9E	9M
CR4597	8G	9M	R4473	5M	8J	R459B	9A	10M
J4387	2J	6L	R4474	7K	8J	R4599	8 G	9M
J43BB	3G	7L	R 447 5	7 J	8J	U4391	5D	6L
J4463	2D	9H	R4476	7 J	8J	U4391B	4G	6L
J4463	2E	9H	R4477	2F	91			6L
J4463	2E	9H	R4479	7K	BK	U4391C U4391D	6I 2H	6L
J4463	4G	9H	R44B2	4G	7K			
J4463	4M	9H	R44B3	5G	7K	U4491	4D	BL
J4463	5M	9H	R4484	5G	BK	U4491A	5H	8L
J4475	5M	8J	R4485	41	8K	U4491B	61	BL
J44B7	3G	9K	R44B6	41	8K	V/D4304	21	61
J44B7	6E	9K	R44B7	51	8K	VR4394	31	6L
J4487	7E	9K	R44BB	5H	BK	VR4495	51	BL
J44B7	BD	9K	R4491	6 J	7L	VR4496	61	BL
J4541	1N	10F	R4492	6 J	BL	10/45 45	45	
J7J71	114	IOF	R4493	5J	BL	W434B	4B	7G
P4541	1M	10F	R4494	5J	BL	W4440	4B	7G
P4541	3A	1OF	R4495	51	BL	W4544	5B	9G
P4541	5L	10F	R4496	61	BL			
P4561	1M	9H	R4497	BF	BL	I		

P/O A4 ASSY also shown on diagrams 3, 4, 5, 7, 9, 10, 11, 12, and 13 "See Parts List for serial number ranges.

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P/O A6 ASS	SY							
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P4463	4G	5G	S6111A	7 D	3C	S6260	4F	4H
P/O A6 ASS	Y also shown	on diagrams 7.	, 9, and 10		!			
CHASSIS M	OUNTED PA	RTS	R14498	3K	CHASSIS			



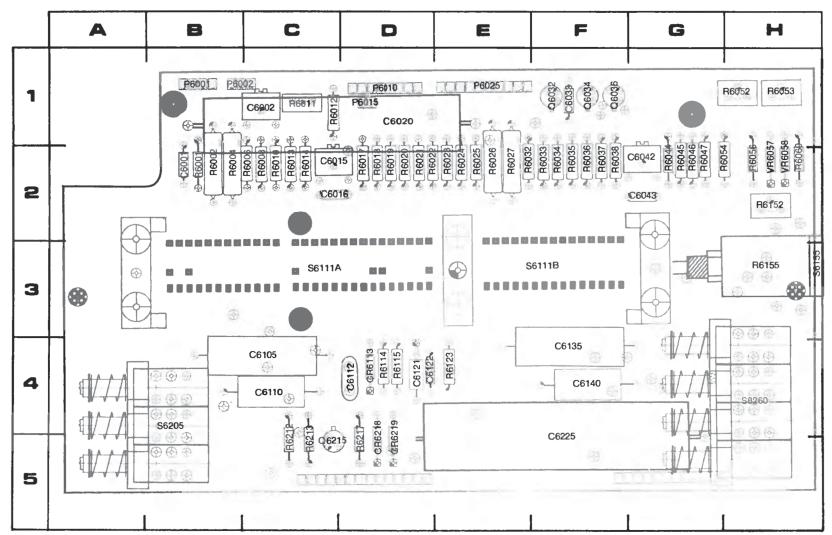
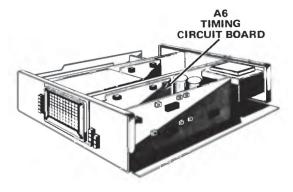


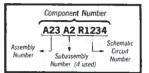
Figure 8-8. A6-Timing circuit board.

2757-44





COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

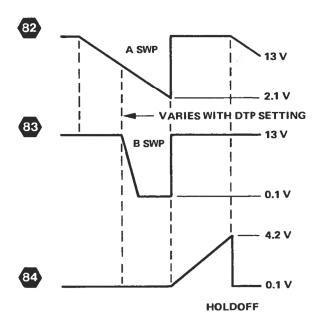
DC Voltages

A TIME/DIV X-Y AC-GND-DC (both) GND

AC Waveforms

A TRIG MODE AUTO (no trigger signal)
B TRIGGER SOURCE STARTS AFTER DELAY

HORIZ DISPLAY A INTEN
DELAY TIME POSITION 5.00
A TIME/DIV 1 ms
B TIME/DIV 0.1 ms
AC-GND-DC (both) GND



P/O A4 ASSY										
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION		
P4498	2G	вМ	W446B	1A	81	W4544	1A	9G		
VR4497	3G	8M	W44B1 W44B3	1A 1A	BK BK					

P/O A4 ASSY also shown on diagrams 3, 4, 5, 7, 8, 10, 11, 12, and 13

P/O A6 ASSY

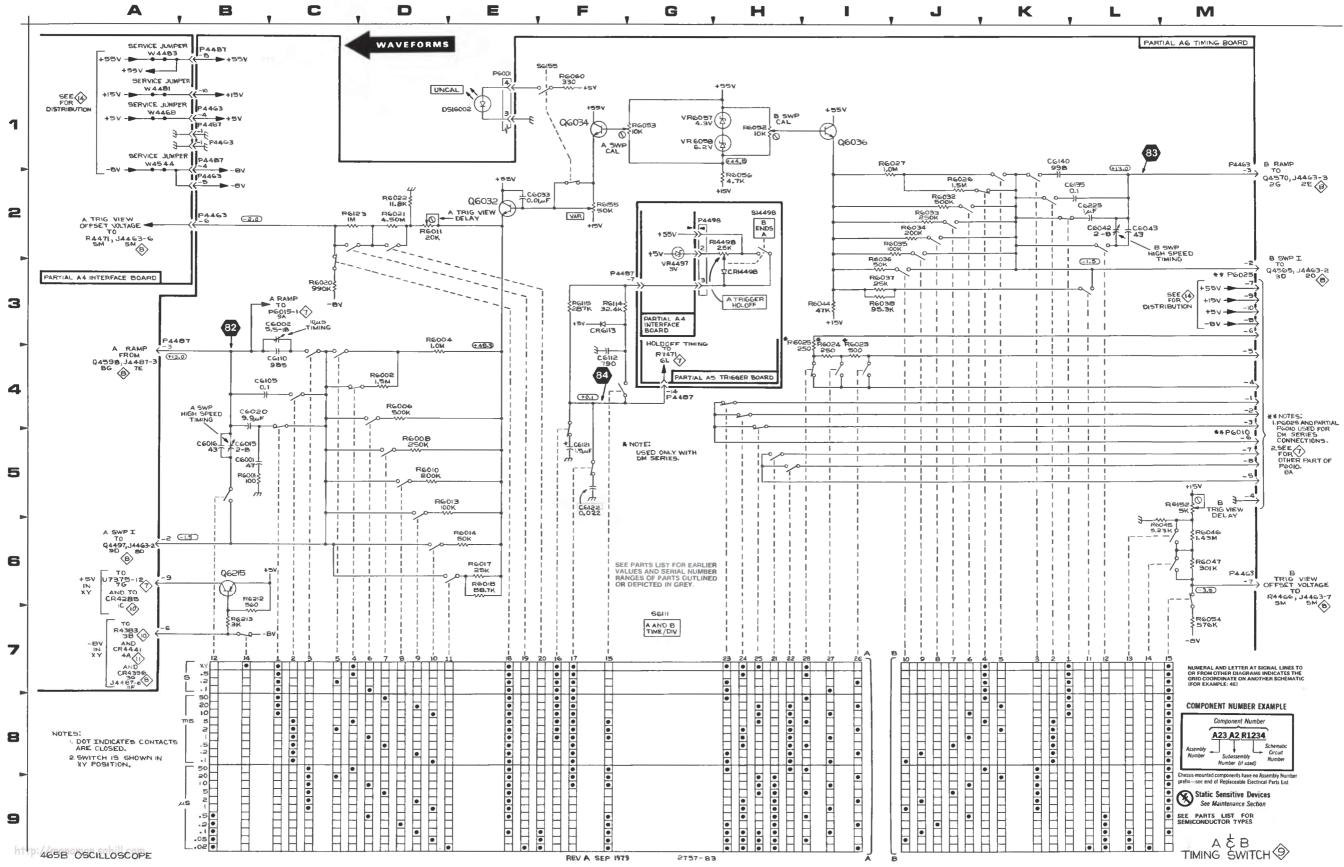
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C6001	5 B	28	Q6034	1F	1F	R6035	2 J	2F
C6002	3C	1C	Q6036	11	1F	R6036	21	2F
C6015	5B	2C	Q6215	6B	5C	R6037	31	2F
C6016	5 B	2C				R603B	31	2F
C6020	4B	2D	R6001	5B	2B	R6044	31	2G
C6033	2E	1F	R6002	4D	2B	R6045	6M	2G
C6042	2L	2G	R6004	4D	2B	R6046	6M	2G
C6043	2 L	2G	R6006	4D	2C	R6047	6M	2G
C6105	4B	4C	R6008	5D	2C	R6052	1H	1H
C6110	4C	4C	R6010	5D	2C	R6053	1G	1H
C6112	4F	4D	R6011	2D	1C	R6054	7M	2H
C6121	5F	4D	R6013	5E	2 C	R6056	2H	2H
C6122	5F	4D	R6014	6E	2C	R6060	1F	2H
C6135	2L	4F	R6017	6E	2D	R6114	3F	4D
C6140	1K	4F	R6018	6E	2D	R6115	3F	3H
C6225	2L	5 F	R6020	3C	2D	R6123	2C	4E
			R6021	2D	2D	R6152	5M	2H
CR6113	3F	4D	R6022	2D	2D	R6155	2F	3H
			R6023	41	2E	R6212	7B	5C
P4463	1B	5G	R6024	41	2E	R6213	7B	5C
P44B	1B	5D	R6025	31	2E			
P6001	1E	1B	R6026	2J	2E	S6111B	7G	3C
P6010	5M	1D	R6027	11	2E	\$6155	1F	3H
P6025	3M	1E	R6032	2J	2E			
			R6033	2J	2F	VR6057	1H	2H
Q6032	2E	1F	R6034	2 J	2F	VR6058	1H	2H

P/O A6 ASSY also shown on diagrams 7, 8, and 10

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
CR1449B	ЗН	CHASSIS	R1449B	2Н	CHASSIS			
DS16002	1E	CHASSIS	S1449B	3H	CHASSIS			

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DC Voltages

A TIME/DIV X-Y

CH 2 POSITION Beam centered

Horizontal POSITION Beam centered AC-GND-DC (both) GND

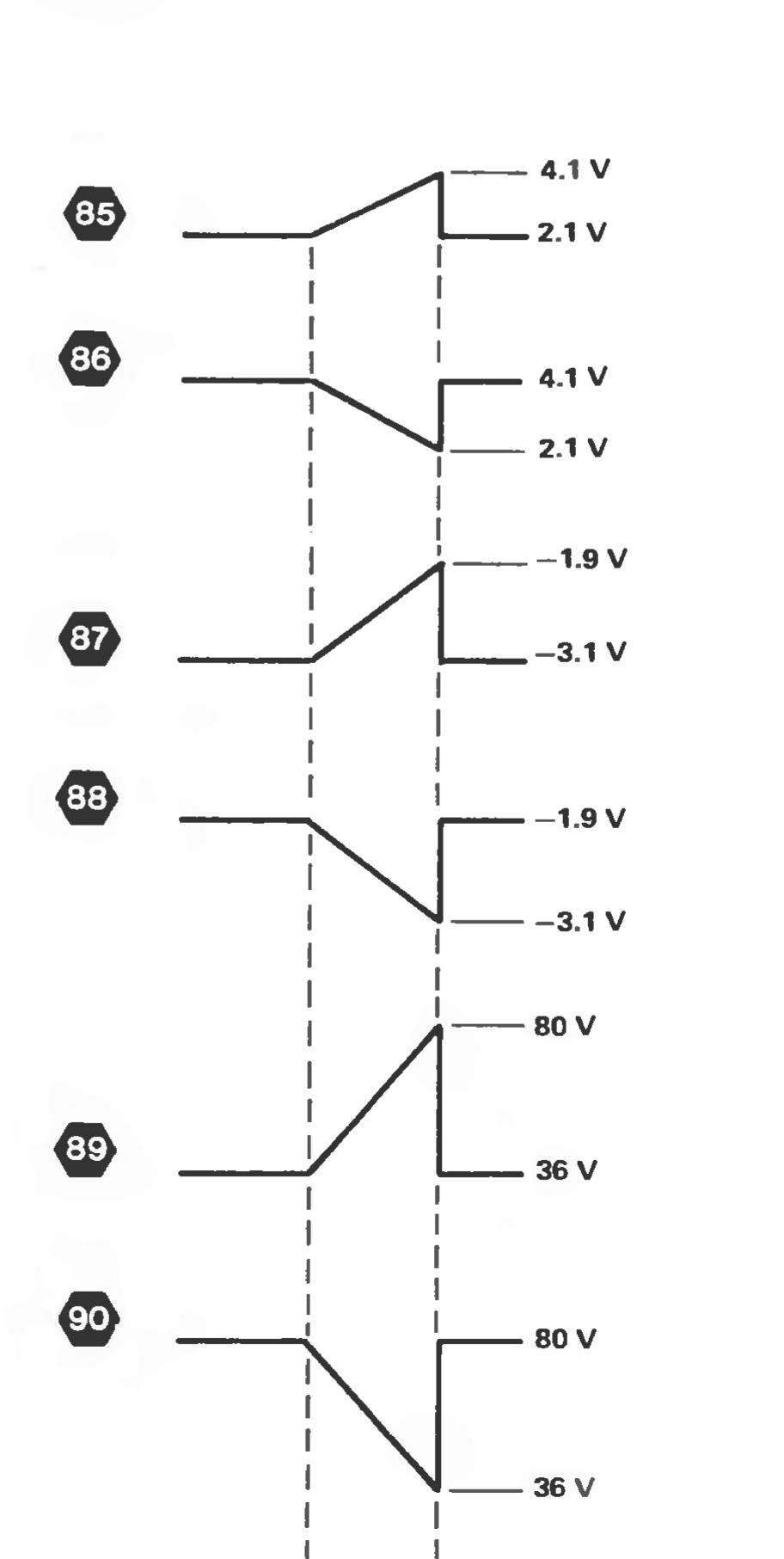
AC Waveforms

A TRIG MODE AUTO (no trigger signal)

HORIZ DISPLAY A

A TIME/DIV 1 ms
Horizontal POSITION Trace centered

AC-GND-DC (both) GND



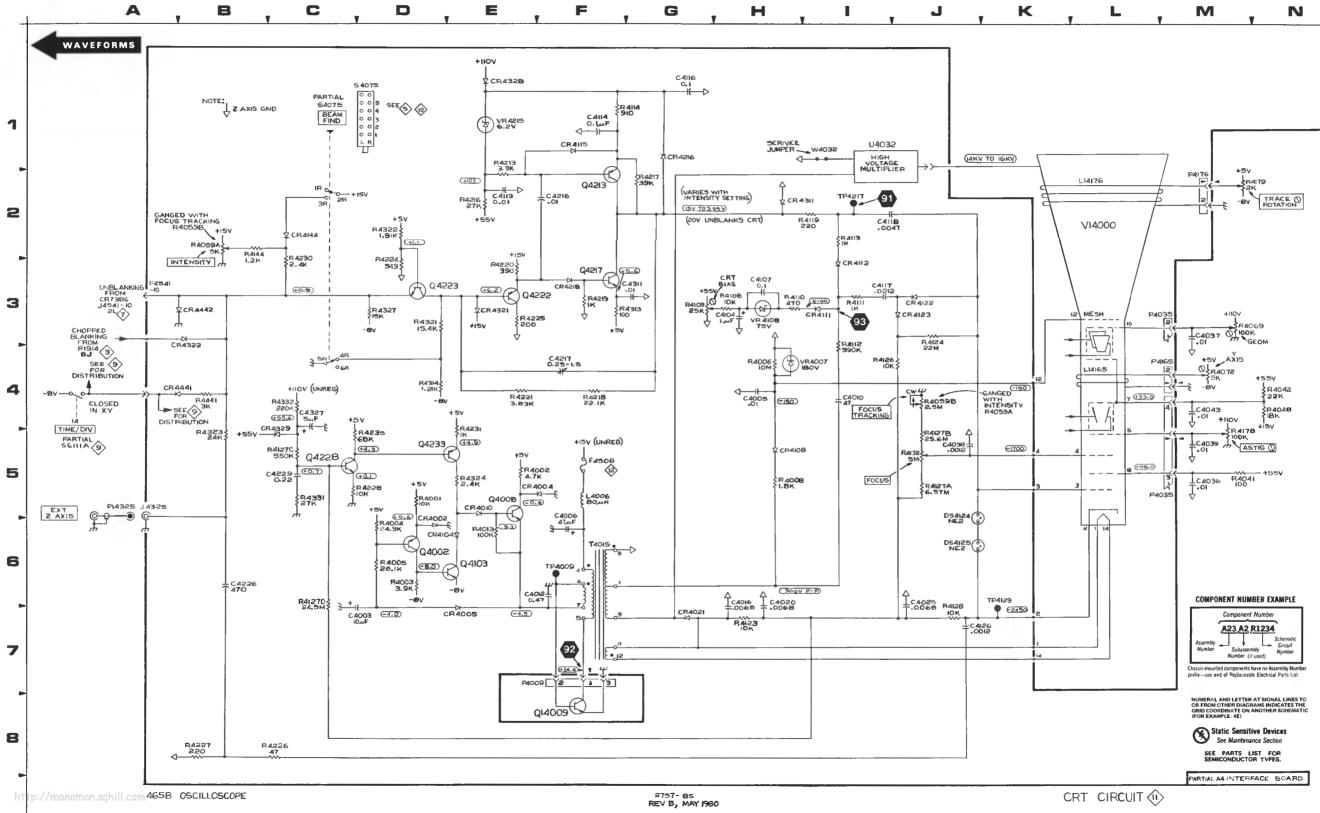
CRT CIRCUIT DIAGRAM (1)

CIRCUIT	SCHEM	BOARD	CIRCUIT	SCHEM	BOARD	CIRCUIT	SCHEM	BOARD
NUMBER	LOCATION	LOCATION	NUMBER	LOCATION	LOCATION	NUMBER	LOCATION	LOCATION
C4003	7D	2A	DS4124	5J	4D	R4127A	5J	4E
C4005	4H	3A	DS4125	6J	3D	R4127B	4J	4F
C4006	5F	2A				R4127C	5C	4E
C4010	41	2B	F4508	5F	9B	R4127D	6C	4F
C4012	6F	2B				R412B	6J	3D
C4016	6H	2C	J4325	5A	6D	R4132	5J	3E
C4020	6H	2C				R4144	2B	3G
C4025	6J	2D	L4006	5F	2A	R4178	5M	31
C4036	5M	1F				R4179	2M	4 J
C4037	3M	1F	P4009	7F	2B	R4213	1E	5B
C403B	5J	2E	P4035	5M	1E	R4216	2E	5 B
C4039	5M	2F	P4165	4M	3H	R4217	2G	5C
C4043	4M	2F	P4176	2M	4J	R4218	4F	3D
C4104	3H	3A	P4541	3A	10F	R4219	3F	5C
C4107	3H	4B				R4220	3E	6 C
C4113	2E	4B	Q4002	6D	2A	R4221	4E	5C
C4114	1F	4B	Q4008	5E	18	R4224	2D	5D
C4116	1G	48	Q4103	6E	3A	R4225	3E	5D
C4117	31	3C	Q4213	2F	5B	R4226	8C	5D
C4118	21	3C	Q4217	3F	5C	R4227	8B	5D
C4126	7 J	4D	Q4222	3E	5D	R422B	5C	5D
C4216	2F	5B	Q4223	3D	5D	R4230	3C	5E
C4217	4F	5C	Q4228	5C	5E	R4231	4E	5E
C4226	6B	5D	Q4233	5D	5E	R4235	5D	6E
C4229	5C	5E				R4313	3F	8C
C4311	3G	6C	R4001	5D	2A	R4314	4D	6C
C4327	4C	6D	R4002	5 E	2A	R4321	3D	6D
0.02.			R4003	6D	3A	R4322	2D	6D
CR4002	5D	2A	R4004	5D	3A	R4323	5B	6D
CR4004	5F	2A	R4005	6D	3A	R4324	5E	6D
CR4005	7E	2A	R4006	4H	2B	R4327	3D	7D
CR4010	5E	2B	R4008	5H	2B	R4331	4E	6E
CR4021	7G	2D	R4013	6E	2B 2B	R4331	5C	6E
CR4104	6E	3A	R4041	5M	2F	R4332	4C	6E
CR4108	5H	3B	R4042	4N	2F	R4441	4B	6F
CR4111	31	3B	R4048	4N	2G	S4075	1D	2J
CR4112	21	3B	R4059A	2B	2G 2G	T4015	6F	3C
CR4112	21 1F	4B	R4059A	25 4J	2G 2G	14019	UF.	30
CR4115	3J	3D	R4059B			TD4000	65	1B
CR4122 CR4123	3J	3D	R4069	3M	21	TP4009	6F	
		3G	1	4M	2I	TP4129	6K	3E
CR4144 CR4216	2C		R4108	3H	4B	TP4217	21	4C
	1G	6B	R4109	3G	4B	114000		05
CR421B	3F	5C	R4110	3H	4B	U4032	11	2 E
CR4311	2H	6C	R4111	31	3B			
CR4321	3E	6D	R4112	31	3B	VR4007	41	3B
CR4322	3B	6D	R4113	21	3C	VR4108	3H	2B
CR4328	1E	7D	R4114	1G	48	VR4215	1E	5 B
CR4329	4C	6E	R4119	21	4C			
CR4441	4B	7 G	R4123	7H	3D	W4032	11	1E
CR4442	3B	BG	R4124	3 J	3D			

P/O A4 ASSY also shown on diagrams 3, 4, 5, 7, 8, 9, 10, 12, and 13

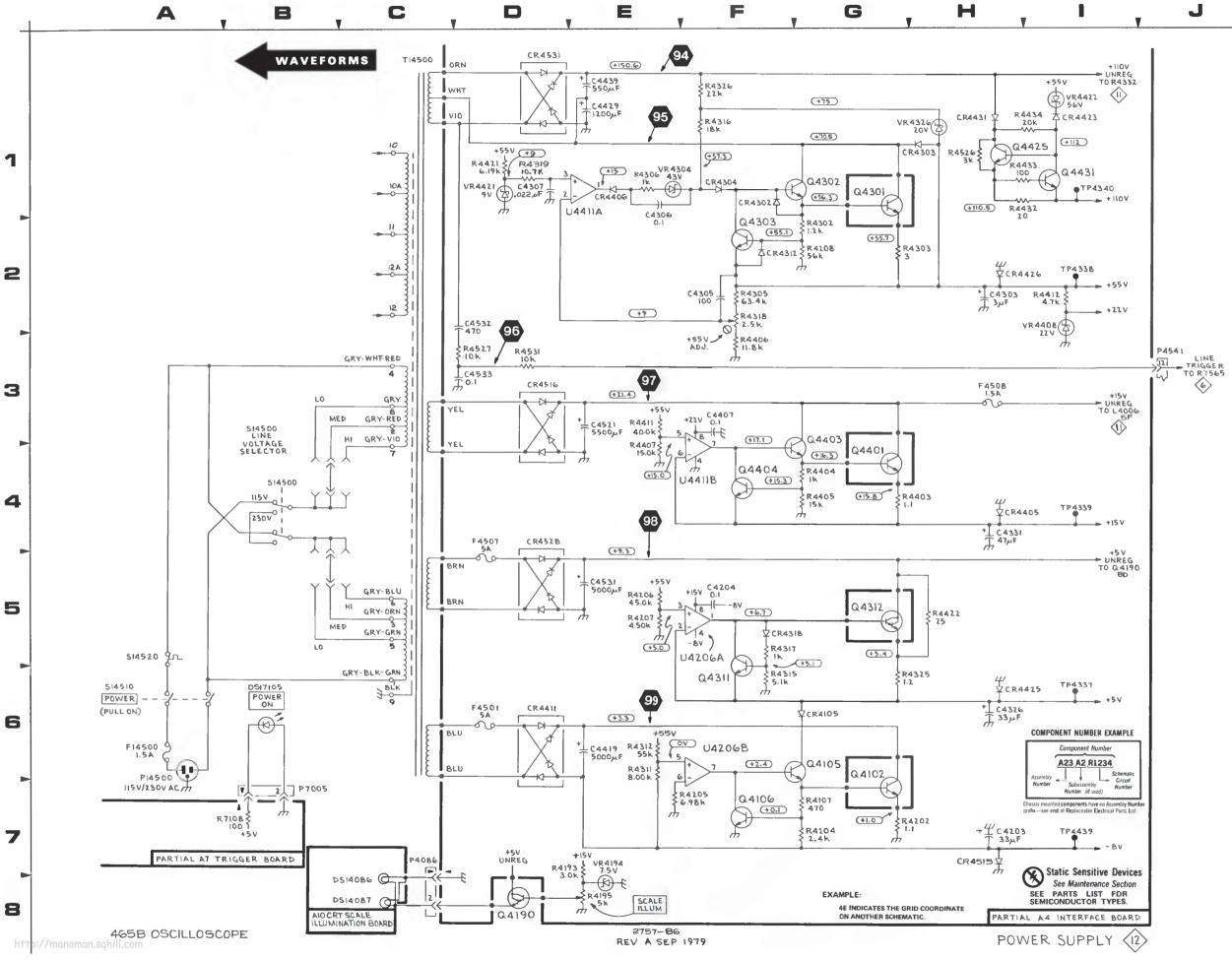
CHASSIS MOU	NITED DADTS	

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT	SCHEM LOCATION	BDARD LDCATION
L14165	4L	CHASSIS	R4059A	28	CHASSIS	S4075	1C	CHASSIS
L14176	2L	CHASSIS	R4059B	4J	CHASSIS	S6111A	4A	CHASSIS
			R4132	5J	CHASSIS			
P14325	5A	CHASSIS	R4178	4M	CHASSIS	V14000	2L	CHASSIS
			R4179	2M	CHASSIS			
Q14009	8F	CHASSIS						



POWER SUPPLY DIAGRAM (12)

CIRCUIT						1		
NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD
C4203	7H	5A	F4508	3H	98	R4317	5F	6C
C4203	7 H	5A				R4318	2F	7B
C4204	5F	5A	P4086	7C	2K	R4319	1D	78
C4303	2H	7A	P4541	3 J	10F	R4325	5H	7D
C4305	2F	6B	14041	33	101	R4326	1F	7D
C4306	1E	7B	Q4102	6G	4A	1		
C4307	1D	7B				R4403	4H	A8
C4307			Q4105	6G	4A	R4404	4G	BA
	6H	7 D	Q4106	7F	4A	R4405	4G	BA
C4331	4H	7 E	Q4190	8D	3L	R4406	3F	7 8
C4407	3F	7 B	Q4301	1G	6A	R4407	4E	88
C4419	6E	BD	Q4302	1G	6A	R4411	3E	8B
C4429	1E	8E	Q4303	2F	68	R4412	21	88
C4439	1E	8F	Q4311	6F	6 C	R4421	1D	7 D
C4521	3E	9D	Q4312	5G	7 C	R4422	5H	8D
C4531	5E	9E	Q4401	4G	7A	R4432	11	7F
C4532	2D	9E	Q4403	3G	8A	R4433	11	8F
C4533	3D	10F	Q4404	4F	8A	R4434	11	8E
		_	Q4425	11	BD	R4526	1H	9E
CR4105	6G	3A	Q4431	11	7F	R4527	3D	9E
CR4302	1F	6A	41131	**	//	R4527	3D	10E
CR4303	1H	7A	R4107	70	4.6	M4531	30	IOE
CR4303	1F	6A	R4107	7G 7E	4A	TD4007	6.	
CR4312	2F				4K	TP4337	61	6F
		68	R4195	8E	4K	TP4338	21	7F
CR431B	5F	7C	R4202	7 H	5A	TP4339	41	7F
CR4405	4H	8A	R4204	7G	4A	TP4340	11	6F
CR4406	1E	78	R4205	7F	5A	TP4439	71	7F
CR4411	6D	88	R4206	2G	5A			
CR4423	11	9D	R4206	5E	5A	U4206A	5F	5A
CR4425	61	7 D	R4207	5E	5A	U4206B	6F	5A
CR4426	21	7 D	R420B	2G	6A	U4411A	1E	7 B
CR4431	1H	BF	R4302	2G	6A	U4411D	4F	7 8
CR4515	7H	9C	R4303	2H	7A			
CR4516	3D	9C	R4305	2F	6B	VR4194	7E	4K
CR4528	4D	10E	R4306	1E	7B	VR4304	1E	7A
CR4531	1D	9F	R4311	6E	68	VR4326	1H	7D
			R4312	6E	6B	VR4408		
F4501	6D	9A	R4315	6F	68	1	21	88
F4507	4D	10B	R4316	1F	6B	VR4421 VR4422	1D 1I	7 D 8D
P/O A4 ASS	Y also shown	on diagrams 3	4, 5, 7, 8, 9,	10, 11, and 1	3	1		
	Y							- 11
P/O A7 ASS								
CIRCUIT	SCHEM	BOARD	CIRCUIT	SCHEM	BOARD	CIRCUIT	SCHEM	BOARD
	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD
CIRCUIT								
CIRCUIT NUMBER P7005	TB	LOCATION	NUMBER R710B	LOCATION	LOCATION			
CIRCUIT NUMBER P7005	TB	LOCATION 18	NUMBER R710B	LOCATION	LOCATION			
CIRCUIT NUMBER P7005 P/O A7 ASSY	TB Y also shown	LOCATION 18 on diagrams 3.	NUMBER R710B 6. and 7	LOCATION 78	LOCATION 2B	NUMBER	LOCATION	LOCATION
CIRCUIT NUMBER P7005	TB	LOCATION 18	NUMBER R710B	LOCATION	LOCATION			BOARD LOCATION BOARD LOCATION
CIRCUIT NUMBER P7005 P/O A7 ASSY A10 ASSY CIRCUIT	TB Y also shown SCHEM LOCATION	18 on diagrams 3. BOARD LOCATION	NUMBER R710B 6. and 7 CIRCUIT	78 SCHEM	2B BOARD	NUMBER	LOCATION	BOARD
P7005 P70 A7 ASSI A10 ASSY CIRCUIT NUMBER	TB Y also shown SCHEM	1B on diagrams 3.	NUMBER R710B 6. and 7 CIRCUIT	78 SCHEM	2B BOARD	NUMBER	LOCATION	BOARD
CIRCUIT NUMBER P7005 P/O A7 ASSY A10 ASSY CIRCUIT NUMBER DS14086 DS14087	COCATION 7B Y also shown SCHEM LOCATION 7C	BOARD LOCATION NONE NONE	NUMBER R710B 6. and 7 CIRCUIT	78 SCHEM	2B BOARD	NUMBER	LOCATION	BOARD
CIRCUIT NUMBER P7005 P/O A7 ASSY CIRCUIT NUMBER DS14086 DS14087 CHASSIS MC	SCHEM LOCATION 7C 8C DUNTED PAR	BOARD LOCATION NONE NONE	R710B 6. and 7 CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	NUMBER CIRCUIT NUMBER	SCHEM LOCATION	BOARD
CIRCUIT NUMBER P7005 P/O A7 ASSY A10 ASSY CIRCUIT NUMBER DS14086 DS14087	COCATION 7B Y also shown SCHEM LOCATION 7C 8C	BOARD LOCATION NONE NONE	NUMBER R710B 6. and 7 CIRCUIT	78 SCHEM	LOCATION 2B BOARD	NUMBER	LOCATION	BOARD LOCATION
CIRCUIT NUMBER P7005 P70 A7 ASSI A10 ASSY CIRCUIT NUMBER DS14086 DS14087 CHASSIS MC	SCHEM LOCATION 7C 8C DUNTED PAR	BOARD LOCATION NONE NONE BOARD	NUMBER R710B 6. and 7 CIRCUIT NUMBER CIRCUIT NUMBER Q1490	SCHEM LOCATION SCHEM LOCATION SCHEM LOCATION BD	BOARD LOCATION BOARD LOCATION CHASSIS	CIRCUIT NUMBER CIRCUIT NUMBER S14500	SCHEM LOCATION SCHEM LOCATION 48	BOARD LOCATION BOARD LOCATION CHASSIS
CIRCUIT NUMBER P7005 P/O A7 ASSY CIRCUIT NUMBER DS14086 DS14087 CHASSIS MC CIRCUIT NUMBER DS17105	COLORATION 7B Y also shown SCHEM LOCATION 7C 8C DUNTED PAR SCHEM LOCATION 6B	BOARD LOCATION NONE NONE BOARD LOCATION CHASSIS	NUMBER R710B 6. and 7 CIRCUIT NUMBER CIRCUIT NUMBER Q1490 Q4102	SCHEM LOCATION SCHEM LOCATION SCHEM LOCATION BD 6G	BOARD LOCATION BOARD LOCATION CHASSIS CHASSIS	CIRCUIT NUMBER CIRCUIT NUMBER S14500 S14510	SCHEM LOCATION SCHEM LOCATION 4B 6A	BOARD LOCATION BOARD LOCATION CHASSIS CHASSIS
CIRCUIT NUMBER P7005 P/O A7 ASSI A10 ASSY CIRCUIT NUMBER DS14086 DS14087 CHASSIS MC CIRCUIT NUMBER	SCHEM LOCATION 7C 8C DUNTED PAR SCHEM LOCATION	BOARD LOCATION NONE NONE BOARD LOCATION	NUMBER R710B 6. and 7 CIRCUIT NUMBER CIRCUIT NUMBER Q1490 Q4102 Q4301	SCHEM LOCATION SCHEM LOCATION BD 6G 1G	BOARD LOCATION BOARD LOCATION CHASSIS CHASSIS CHASSIS	CIRCUIT NUMBER CIRCUIT NUMBER S14500	SCHEM LOCATION SCHEM LOCATION 48	BOARD LOCATION BOARD LOCATION CHASSIS
CIRCUIT NUMBER P7005 P/O A7 ASSY CIRCUIT NUMBER DS14086 DS14087 CHASSIS MC CIRCUIT NUMBER DS17105 F14500	SCHEM LOCATION 7C 8C DUNTED PAR SCHEM LOCATION 6B 6A	BOARD LOCATION NONE NONE BOARD LOCATION CHASSIS CHASSIS	NUMBER R710B 6. and 7 CIRCUIT NUMBER CIRCUIT NUMBER 01490 04102 04301 04312	SCHEM LOCATION SCHEM LOCATION SCHEM LOCATION BD 6G	BOARD LOCATION BOARD LOCATION CHASSIS CHASSIS	CIRCUIT NUMBER CIRCUIT NUMBER S14500 S14510	SCHEM LOCATION SCHEM LOCATION 4B 6A	BOARD LOCATION BOARD LOCATION CHASSIS CHASSIS
CIRCUIT NUMBER P7005 P/O A7 ASSY CIRCUIT NUMBER DS14086 DS14087 CHASSIS MC CIRCUIT NUMBER DS17105 F14500 P4086	SCHEM LOCATION 7C 8C DUNTED PAR SCHEM LOCATION 6B 6A 7C	BOARD LOCATION BOARD LOCATION NONE NONE BOARD LOCATION CHASSIS CHASSIS CHASSIS	NUMBER R710B 6. and 7 CIRCUIT NUMBER CIRCUIT NUMBER Q1490 Q4102 Q4301	SCHEM LOCATION SCHEM LOCATION BD 6G 1G	BOARD LOCATION BOARD LOCATION CHASSIS CHASSIS CHASSIS	CIRCUIT NUMBER CIRCUIT NUMBER S14500 S14510	SCHEM LOCATION SCHEM LOCATION 4B 6A	BOARD LOCATION BOARD LOCATION CHASSIS CHASSIS
CIRCUIT NUMBER P7005 P/O A7 ASSY CIRCUIT NUMBER DS14086 DS14087 CHASSIS MC CIRCUIT NUMBER DS17105 F14500	SCHEM LOCATION 7C 8C DUNTED PAR SCHEM LOCATION 6B 6A	BOARD LOCATION NONE NONE BOARD LOCATION CHASSIS CHASSIS	NUMBER R710B 6. and 7 CIRCUIT NUMBER CIRCUIT NUMBER 01490 04102 04301 04312	SCHEM LOCATION SCHEM LOCATION BD 6G 1G 5G	BOARD LOCATION BOARD LOCATION CHASSIS CHASSIS CHASSIS CHASSIS	CIRCUIT NUMBER CIRCUIT NUMBER S14500 S14510 S14520	SCHEM LOCATION SCHEM LOCATION 4B 6A 5A	BOARD LOCATION BOARD LOCATION CHASSIS CHASSIS



465B Service

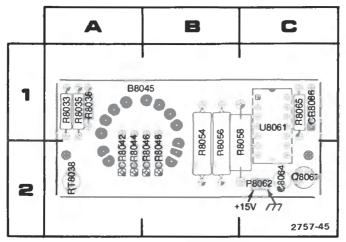
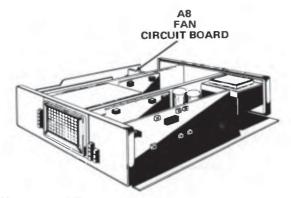


Figure 8-9. A8 Fan Circuit board.



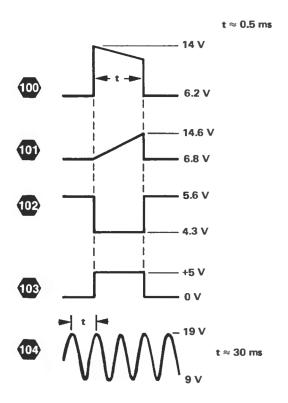
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DC Voltages

Remove Q1496 to make dc measurements in the Calibrator circuit.

AC Waveforms

Fan circuit waveform taken at 25°C ambient temperature.



CALIBRATOR AND FAN DIAGRAM 13

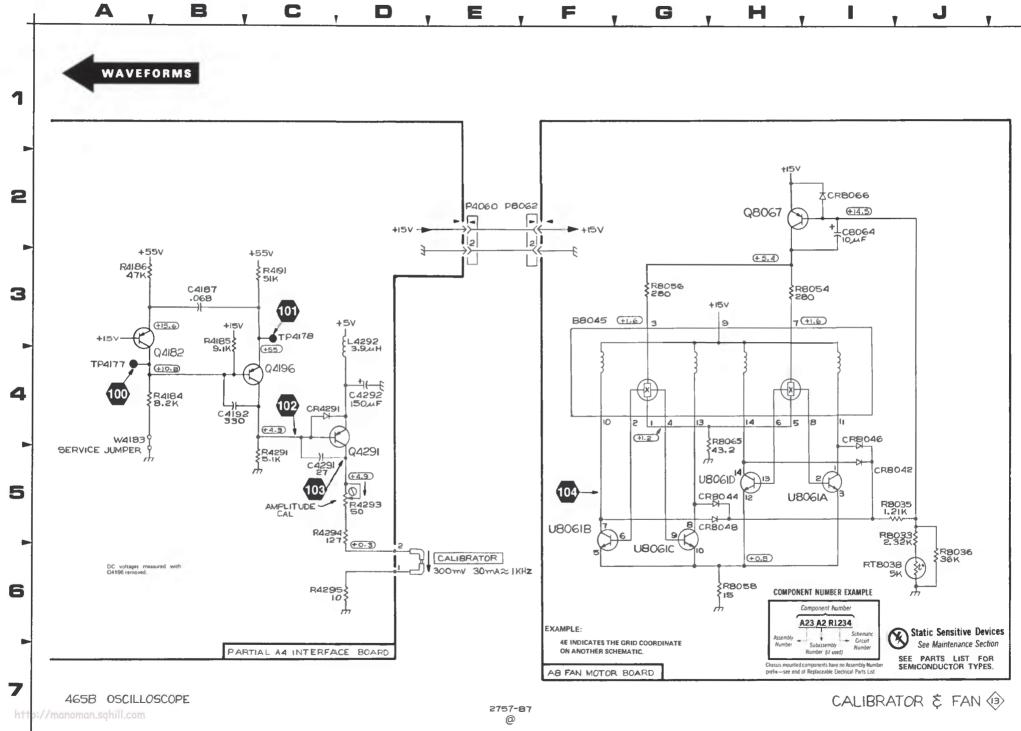
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C4187	3B	4K	R4184	4B	3K
C4192	4B	4L	R4185	3B	4K
C4291	5C	5L	R4186	3A	4K
C4292	4D	5L	R4191	3C	3L
			R4291	5C	5L
CR4291	4C	5L	R4293	5D	5M
			R4294	5D	6L
L4292	3D	5L	R4295	6D	6L
P4060	2E	1H	TP4177	4A	4 J
			TP4178	3C	4J
Q4182	3B	4K			
Q4196	4C	4M	W4183	4A	3K
Q4291	5D	5L			

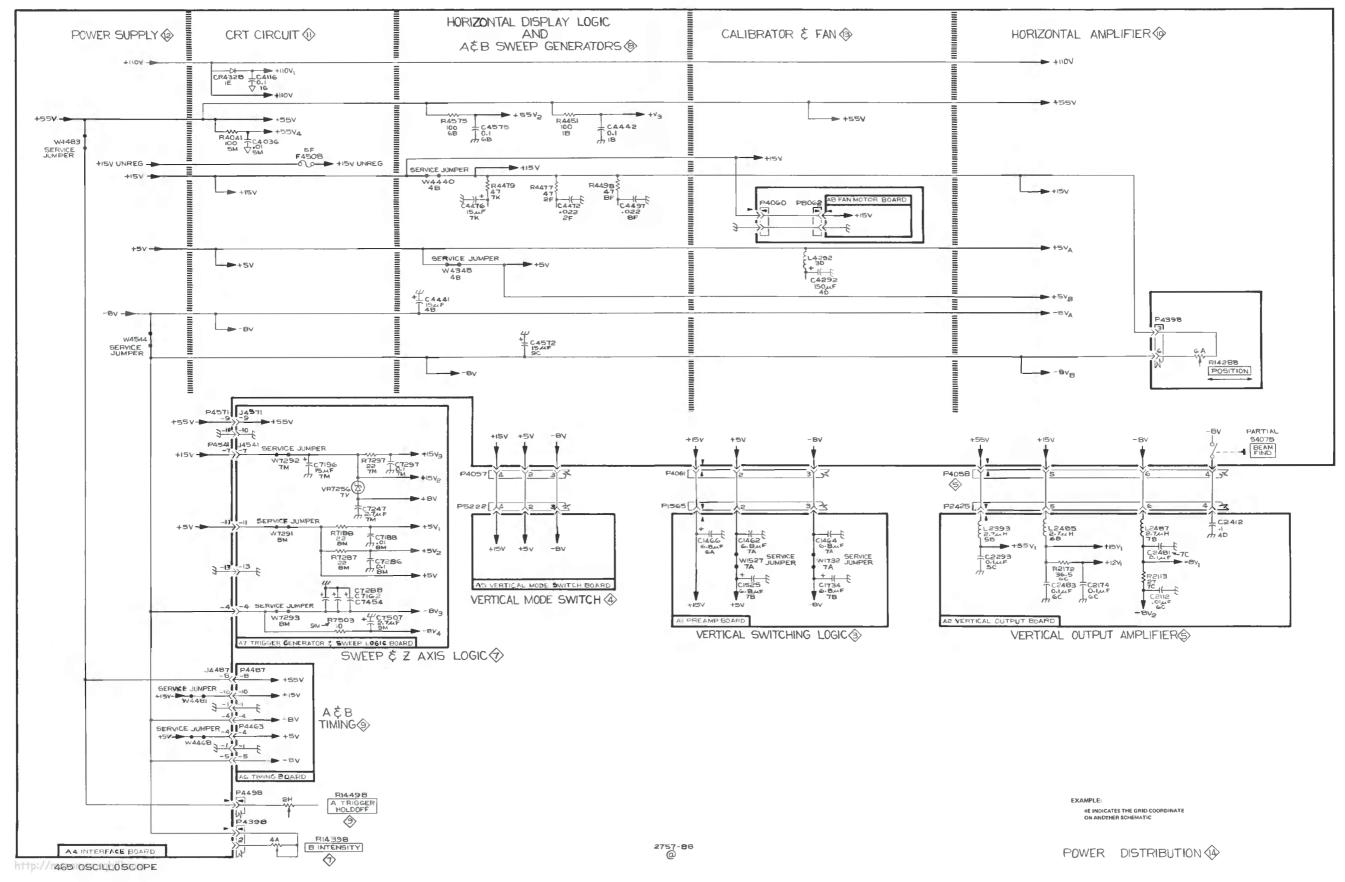
P/O A4 ASSY also shown on diagrams 3, 4, 5, 7, 8, 9, 10, 11, and 12

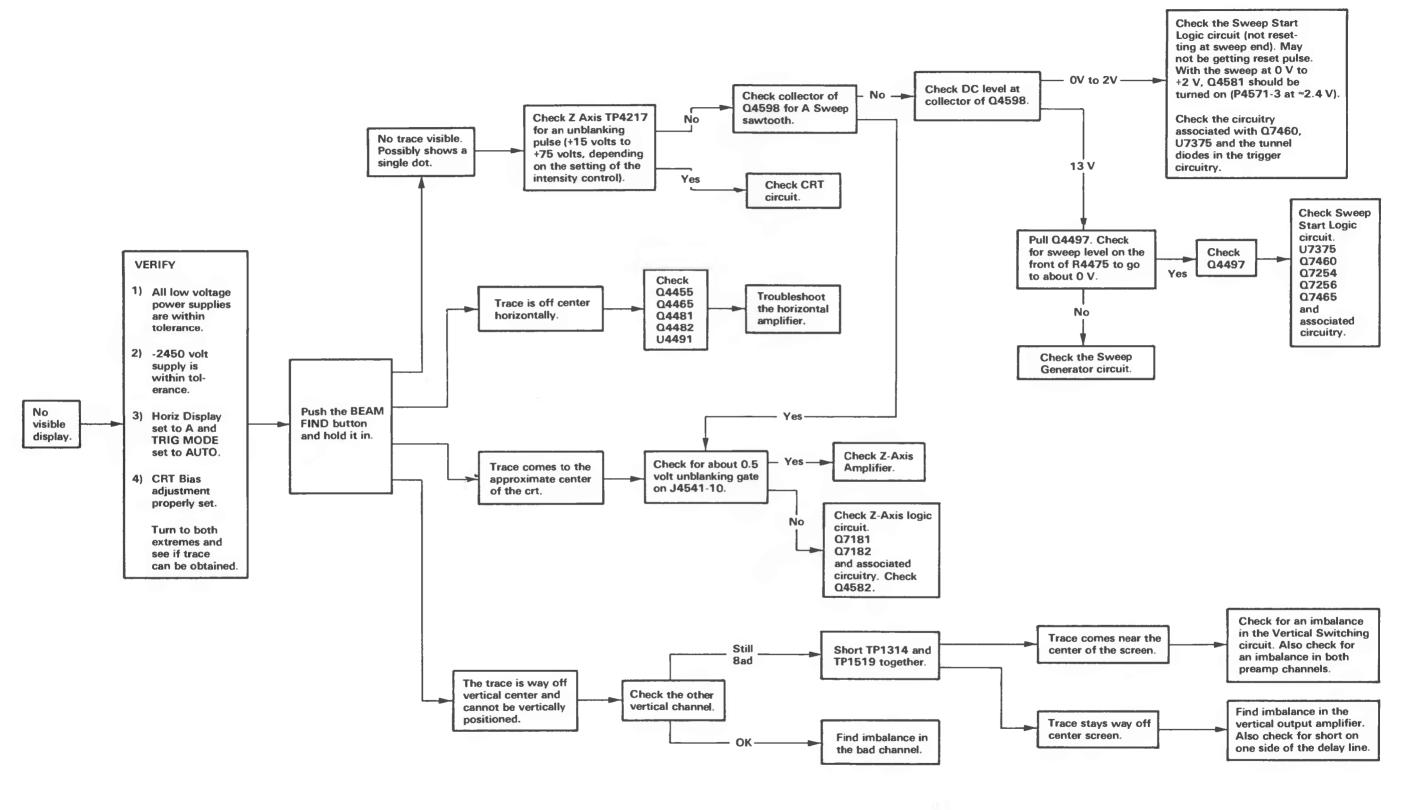
P/O A8 ASSY

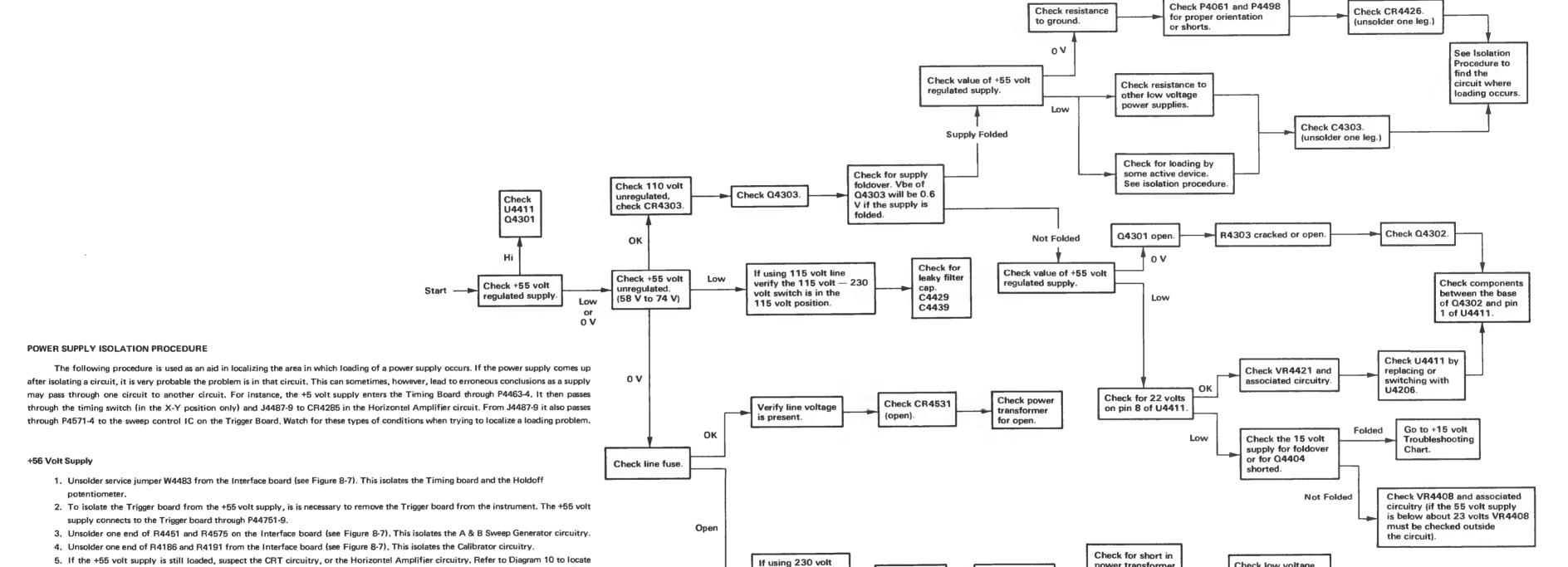
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
B8045	3F	1A	R8033 RB035	5J 5J	1A 1A
C8064	21	2 C	R8036 R8054	6J 3I	1A 2B
CR8042	51	2A	R8056	3G	2B
CR8044 CR8046	H 41	2A 2B	R8058 R8065	6H 4H	2C 1C
CR8048	5H	2B	D-T-0000	0.1	
CR8066	21	1C	RT8038	6J	2A
P8062	2F	2C	U8061A U8061B	5I 5F	1C 1C
Q8067	2H	2C	U8061C	5G	1C

CHASSIS MOUNTED PARTS						
CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	
C3042	1	2 J	Q4190	12	8D	
C3042	2	2J	Q4102	12	6G	
C13010	1	2A	Q4301	12	1G	
C13010	2	2A	Q4312	12	5G	
C13012	1	2A	Q4401	12	4G	
C13012	2	2A	Q14009	11	8F	
C15101	4	2A	W	• • •	0.	
C15101	4	7A	R3042	1	2 J	
C15101	4	2A	R3042	2	2J 2J	
C15103	4	7A	R3045	1	2J 2J	
CR14498	9	3H	R3045	1 2	2J 2K	
Chizado	5	311	R4059A	11		
DL11405	3	1M	R4059A R4059B		2B	
DELLACO	3	1101		11	4J	
DS9040	4	2F	R4132 R4178	11	5J	
DS9040 DS9040	4	2F 7F		11	4M	
DS9040 DS9060	4	7F 2 G	R4179	11	2M	
DS9060 DS9060	4	2G 7G	R4195	12	8E	
			R13010	1	2A	
DS14086	12	7C	R13010	2	2A	
DS14087	12	8C	R14288A	10	6A	
DS15034	4	1F	R14288B	10	6A	
DS15036	4	9C	R14398	7	4A	
DS15038	4	7F	R14498	8	3 J	
DS16001	10	8C	R14498	9	2H	
DS16002	9	1E	R15102	4	2A	
DS17105	12	6B	R15102	4	7A	
DS17127	7	5K	R16002	7	BA	
DS17206	7	5K	01005			
4500	12	GA.	S1285	4	1F	
F14500	12	6 A	S1782	4	8F	
14007	Ω	21	S4075	11	1C	
J4387	8	2J	S6111A	11	4A	
J13010	1	2A	S7112D	6	1M	
J13010	2	2A	S14498	7	5A	
114405	4.4	44	S14498	8	1N	
L14165	11	4L	S14498	9	2H	
L14176	11	2 L	S14500	12	4B	
	0	4.	S14510	12	6A	
P4058	8	4J	S14520	12	5A	
P4086	12	7C	S17010	6	3F	
P4498	8	3J		_		
P14325	11	5A	T14500	12	CA	
P14500	12	6A				









line, verify 115 V

230 V switch is in

the 230 V position.

Replace fuse.

Still blows fuse.

+55 volt connections to the Horizontal Amplifier circuitry and to Diagram 11 to locate +55 volt connectons to the CRT circuitry.

Check low voltage

unregulated supplies

for shorts to ground.

power transforme

primary circuit,

check CR4531

(shorted).

See Isolation Procedure to find the

circuit where

Check components

between the base

of Q4302 and pin

1 of U4411.

loading occurs.

Check CR4426.

(unsolder one leg.)

Check Q4302.

Check U4411 by

switching with

Chart.

the circuit).

Go to +15 volt

Troubleshooting

Check VR4408 and associated

circuitry (if the 55 volt supply

must be checked outside

is below about 23 volts VR4408

replacing or

U4206.

Check P4061 and P4498

for proper orientation

or shorts.

Low

Check for short in

power transformer

primary circuit,

check CR4531

(shorted).

Check the 15 volt

supply for foldover

Not Folded

or for Q4404

Check low voltage

unregulated supplies

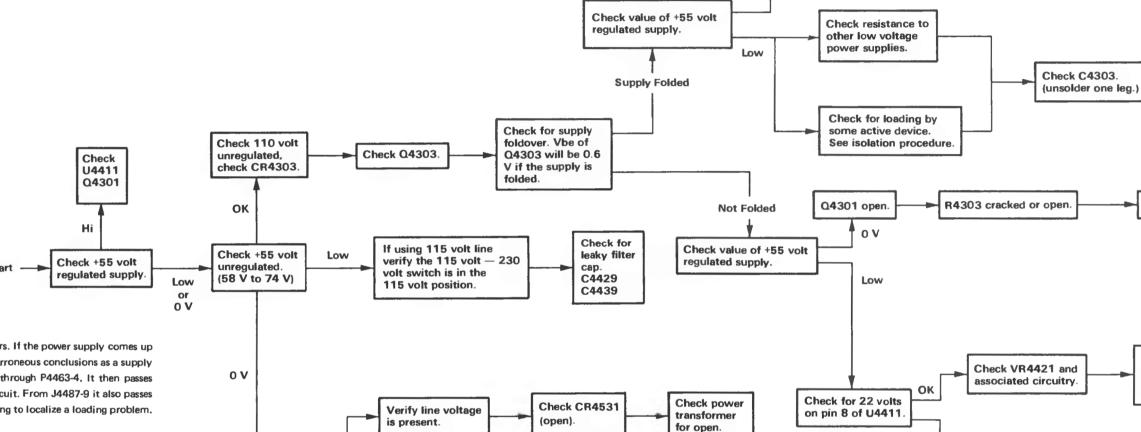
for shorts to ground.

shorted.

Check resistance

to ground.

0 V



Replace fuse.

Still blows fuse

OK

Open

If using 230 volt

line, verify 115 V

230 V switch is in

the 230 V position.

Check line fuse.

POWER SUPPLY ISOLATION PROCEDURE

The following procedure is used as an aid in localizing the area in which loading of a power supply occurs. If the power supply comes up after isolating a circuit, it is very probable the problem is in that circuit. This can sometimes, however, lead to erroneous conclusions as a supply may pass through one circuit to another circuit. For instance, the +5 volt supply enters the Timing Board through P4463-4. It then passes through the timing switch (in the X-Y position only) and J4487-9 to CR4285 in the Horizontel Amplifier circuit. From J4487-9 it also passes through P4571-4 to the sweep control IC on the Trigger Board. Watch for these types of conditions when trying to localize a loading problem.

+56 Volt Supply

- Unsolder service jumper W4483 from the Interface board (see Figure 8-7). This isolates the Timing board and the Holdoff potentiometer.
- 2. To isolate the Trigger board from the +55 volt supply, is is necessary to remove the Trigger board from the instrument. The +55 volt supply connects to the Trigger board through P44751-9.
- 3. Unsolder one end of R4451 and R4575 on the Interface board (see Figure 8-7). This isolates the A & B Sweep Generator circuitry.
- 4. Unsolder one end of R4186 and R4191 from the Interface board (see Figure 8-7). This isolates the Calibrator circuitry.
- 5. If the +55 volt supply is still loaded, suspect the CRT circuitry, or the Horizontel Amplifier circuitry. Refer to Diagram 10 to locate +55 volt connections to the Horizontal Amplifier circuitry and to Diagram 11 to locate +55 volt connections to the CRT circuitry.

POWER SUPPLY ISOLATION PROCEDURE

The following procedure is used as an aid in locelizing the area in which loading of a power supply occurs. If the power supply comes up after isolating a circuit, it is very probable the problem is in that circuit. This can sometimes, however, lead to erroneous conclusions as a supply may pass through one circuit to another circuit. For instance, the +5 volt supply enters the Timing Board through P4463-4. It then passes through the timing switch (in the X-Y position only) and J44B7-9 to CR4285 in the Horizontal Amplifier circuit. From J4487-9 it also passes through P4571-4 to the sweep control IC on the Trigger Board. Watch for these types of conditions when trying to localize a loading problem.

+15 Volt Supply

- 1. Pull P4061 from the Interface board. This isolates the Vertical Preamplifier board.
- 2. Pull P4060 from the Interface board. This isolates the Fan Motor circuit.
- 3. Pull P4057 from the Interface board. This isolates the Vertical Mode board.
- 4. Pull P4058 from the Interface board. This isolates the Vertical Output board.
- 5. Pull P4398 from the Interface board. This isolates the Horizontal POSITION potentiometers.
- 6. Unsolder service jumper W7292 on the Trigger board (see Figure 8-6). This isolates the Trigger board.
- 7. Unsolder service jumper W44B1 from the Timing board (see Figure 8-8). This isolates the Timing board.
- 8. Unsolder service jumper W4440 on the Interface board (see Figure 8-8), This isolates the A & B Sweep Generator circuitry and the Horizontal Amplifier circuitry.
- If the +15 volt supply is still losaded, suspect the CRT circuitry (Z-Axis Amplifier). Refer to Diagram 11 to locate +15 volt connection to the CRT circuitry.

+5 Volt Supply

- 1. Pull P4061 from the Interface board. This isolates the Vertical Preamplifier board.
- 2. Pull P4057 from the Interface board. This isolates the Vertical Mode board.
- 3. Pull P4058 from the Interface board. This isolates the Vertical Output board.
- 4. Pull P4498 from the Interface board. This isolates the HOLDOFF potentiometer.
- 5. Unsolder service jumper W4468 from the Interface board (see Figure 8-7). This isolates the Timing board.
- 6. Unsolder service jumper W7291 from the Trigger board (see Figure 8-6). This isolates the Trigger board.
- 7. Unsolder service jumper W4348 from the Interface board (see Figure 8-7). This isolates the A & 8 Sweep Generator circuitry and part of the Horizontal Amplifier circuitry.
- 8. Unsolder one end of R4158 and R4263 from the Interface board (see Figure 8-7). This isolates the rest of the Horizontal Amplifier circuitry.
- 9. Unsolder L4292 from the Interface board (see Figure 8-7). This isolates the Calibrator circuitry.
- 10. If the +5 volt supply is still loaded, the CRT circuitry should be suspected. Refer to Diagram 11 to locate +5 volt connections to the CRT circuitry.

-8 Volt Supply

- 1. Pull P4061 from the Interface board. This isolates the Vertical Preamplifier board.
- 2. Pull P4057 from the Interface board. This isolates the Vertical Mode board.
- 3. Pull P4058 from the Interface board. This isolates the Vertical Output Amplifier board.
- 4. Pull P4398 from the Interface board. This isolates the Horizontal POSITION and B INTENSITY potentiometers.
- 5. Unsolder service jumper W7293 from the Trigger board to isolate part of the Trigger board. Unsolder one end of R7503 from the Trigger board to isolate the rest of the Trigger board (see Figure 8-6).
- 6. Unsolder service jumper W4544 from the Interface board (see Figure 8-7). This isolates the Timing board, A & B Sweep Generator circuitry, and part of the Horizontal Amplifier circuitry. It will also completely remove the —8 volts from the Trigger board if step 5 is not done.
- 7. Check C4441 for a short or leakage.
- 8. If the -8 volts supply is still loaded, suspect the CRT circuitry (Z-Axis Amplifier), or the Horizontal Amplifier circuitry. Refer to Diagram 10 for the -8 volt connections to the Horizontal Amplifier circuitry and to Diagram 11 for the -8 volt contections to the CRT circuitry.

Short to ground circuit isolation or other low voltage power procedure supply. 0 V Check the value of the regulated supply. Low **Folded** Check the following resistor for a crack or changed value: Check for supply foldover. +15 V — R4403 Vbe of the shutdown +5 V - R4325 transistor will be ≥0.6 V. The -8 V — R4202 transistor will be turned on. Yes OK Not Folded Replace the resistor. Check the following transistors. Check the supply reference voltages. Check the 15 - Q4403 +15 V - Pin 5 of U4411 - +15 volts value of Q4401 +5 - Pin 3 of U4206 - +5 volts the regulated **- Q4312** -8 - Pin 5 & 6 of U4206 - 0 V supply. - Q4105 Q4102 Bad Check the unregulated Check the bridge rectifier supply on its associated in the affected supply for Replace the filter cap. full wave rectification. If OK -Check the unregulated transistor +15 — C4521 good, there should be filter capacitor on the +5 - C4531 120 Hz ac ripple on the Start affected supply -8 - C4419 unregulated supply. 60 Hz +15 V — C4521 VERIFY ripple indicates only +5 V - C4531 Low halfwave rectification. Loaded by the failure of some active Yes -8 V - C4419 1) +55 V rnust be +15 - CR4516 component supplied by the affected Low present for the +5 - CR4528 power supply. Check: Pass transisto proper operation -8 - CR4471 Check the IC power supply +15 - Q4401 Could also be caused by the failure of Bad of the +15 volt. 0 V +5 - 04312a tantalurn decoupling capacitor. A Measure +5 volt, and -8 U4411: pin 8 (20 to 22 volts) -8 - Q4102: supply affected by a bad tantalum can supply. volt supplies. U4206: pin 8 (15 volts) be recognized as follows. When the Reference on + input **Replace Rectifier** of the regulating IC's; 0 V pin 4 (-8 volts) instrument is at room temperature and +15 V rnust be Regulating I.C.'s. just turned on, the affected supply present for the +22 V to pin 8 of U4411 is cornes up to or near normal voltage. proper operation supplied from a dropping Bad As the instrument is left on and warrns of the +5 volt network off the +55 volt Repair the bad Check the bridge rectifier up, the supply voltage begins to and the -8 volt supply supplies in the in the affected supply for slowly go down as the tantalurn tries to supplies. following order: an open. draw more current from the supply. +55 +15 V - CR4516 +15 Check for an open +5 V - CR4528 power transformer -8 V — CR4471 secondary.

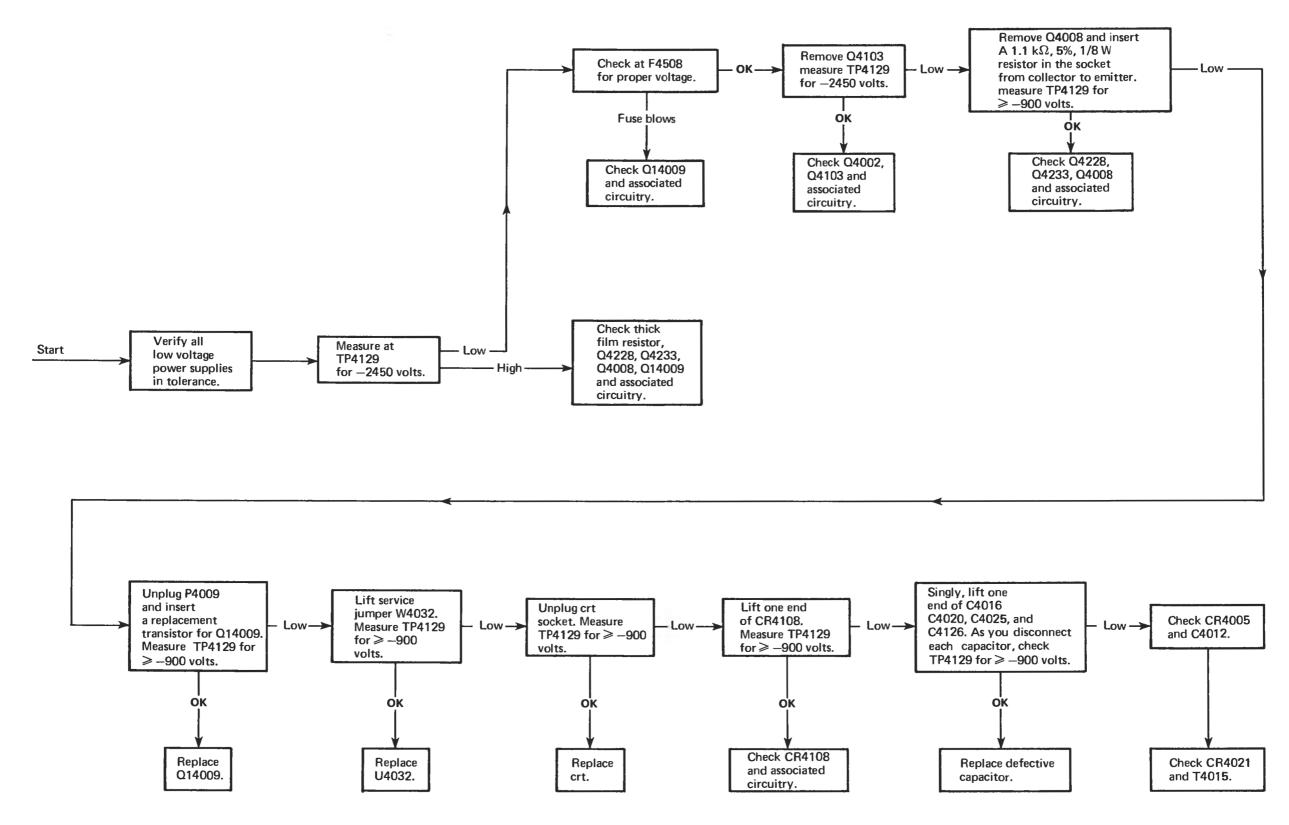
2757-52

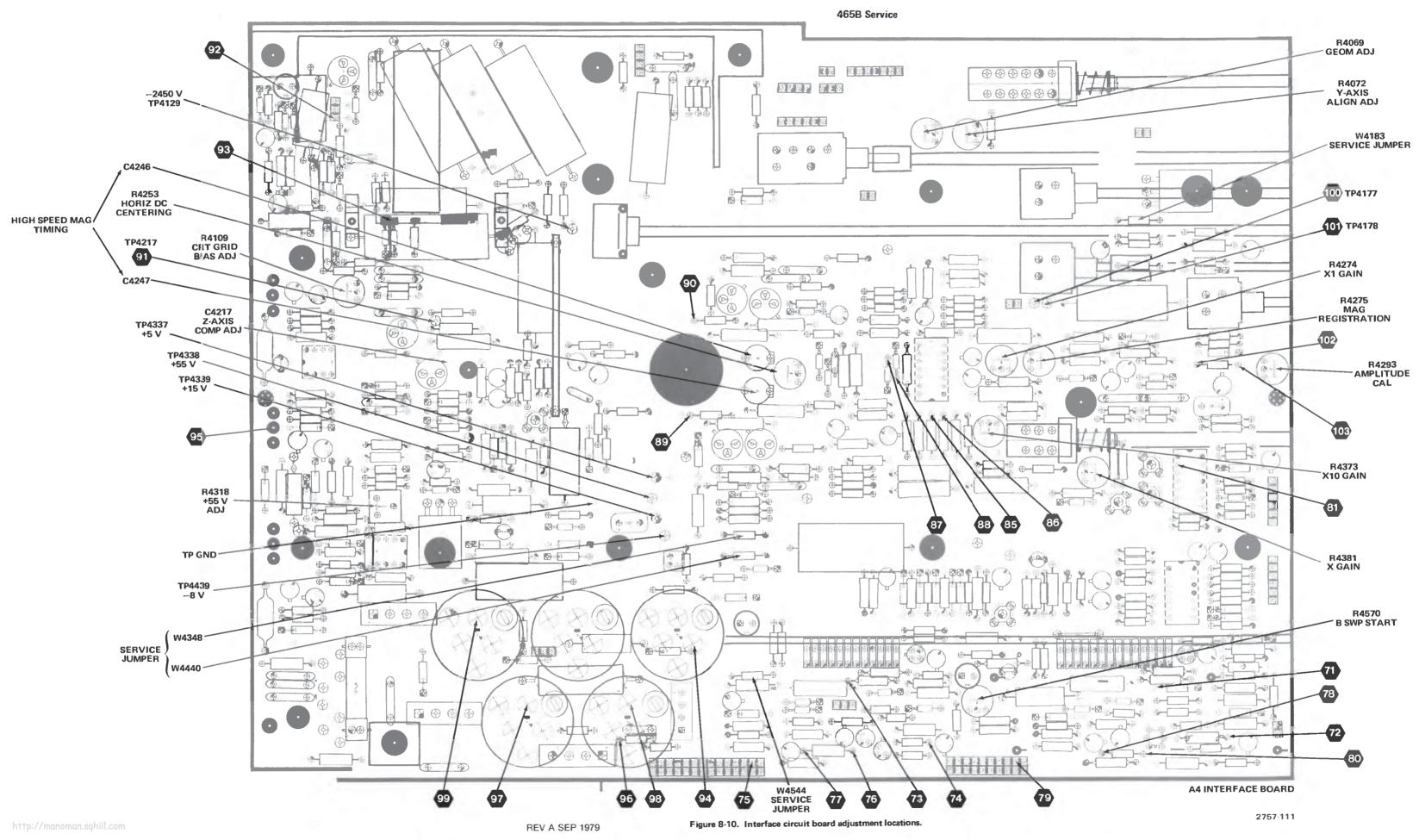
465B Service

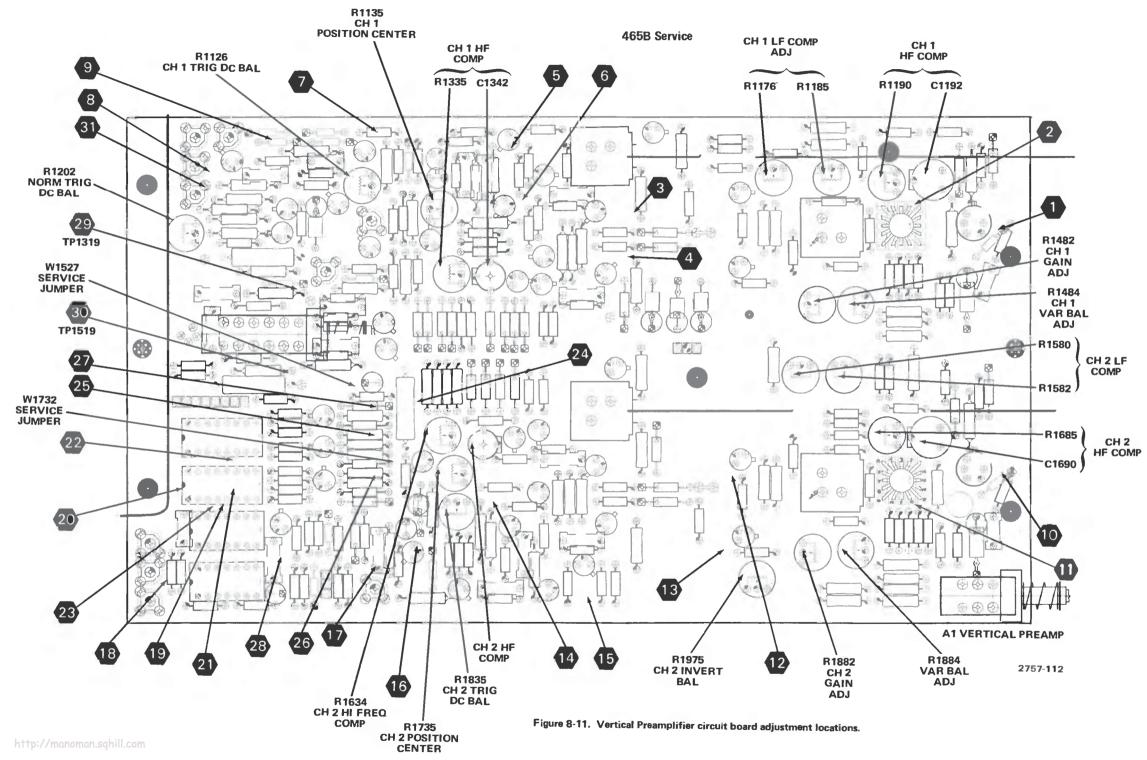
See the

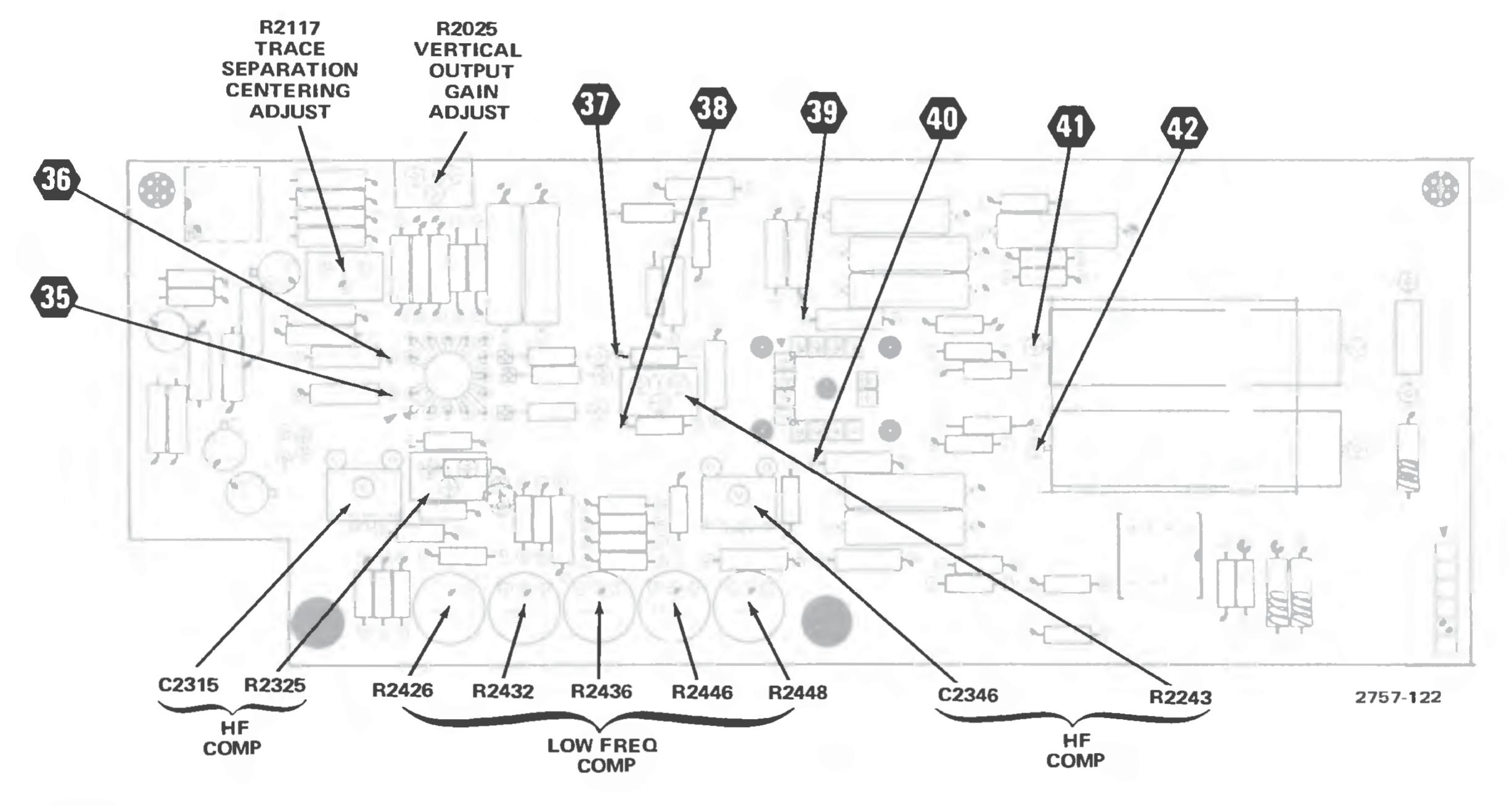
short

@ +15 V, +5 V, AND -8 V SUPPLIES TROUBLESHOOTING









465B Service

Figure 8-12A. A2 Vertical Output Amplifier circuit board adjustment locations (SN B030000 & up).

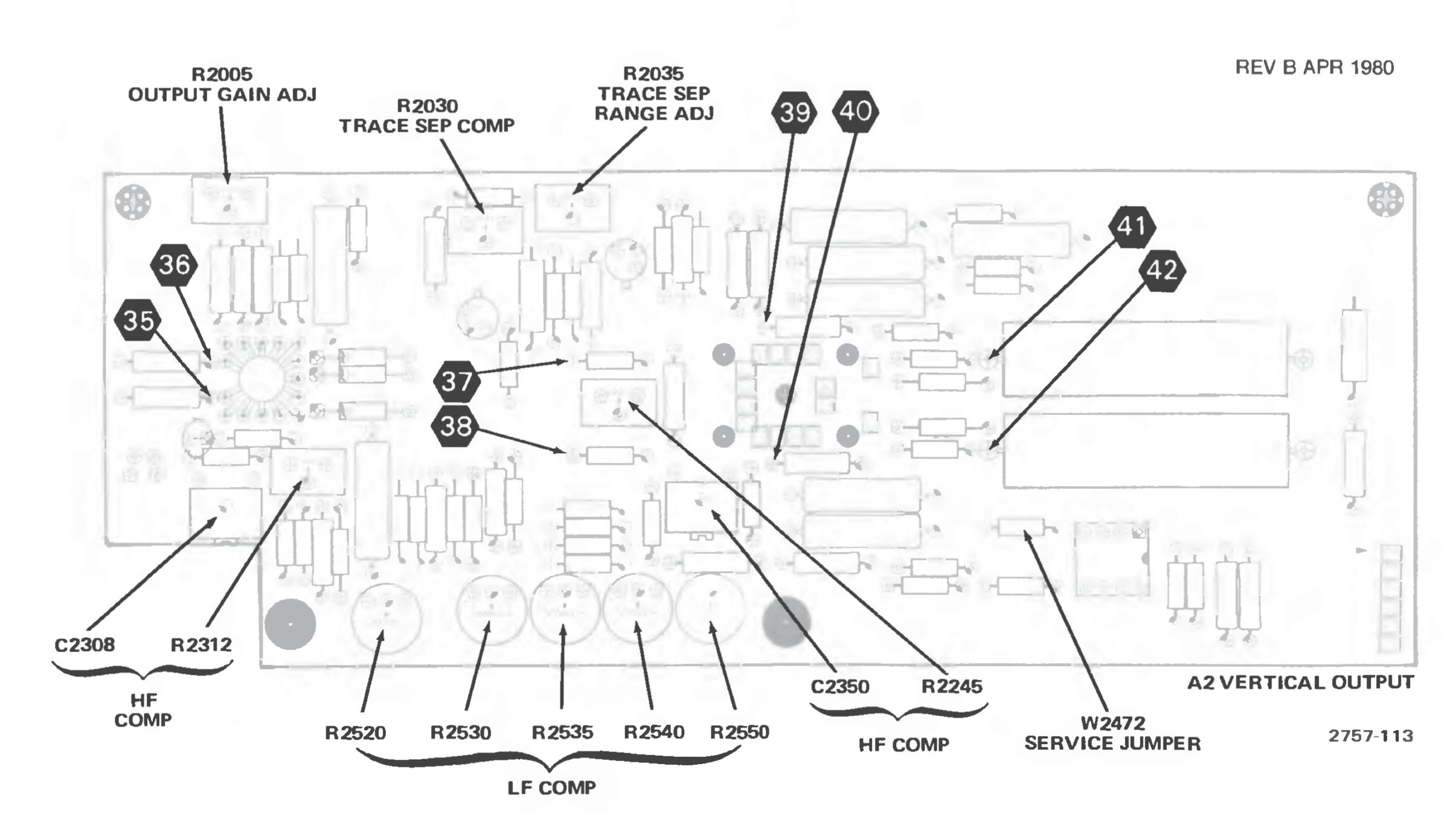


Figure 8-12B. Vertical Output Amplifier circuit board adjustment locations below SN B030000.

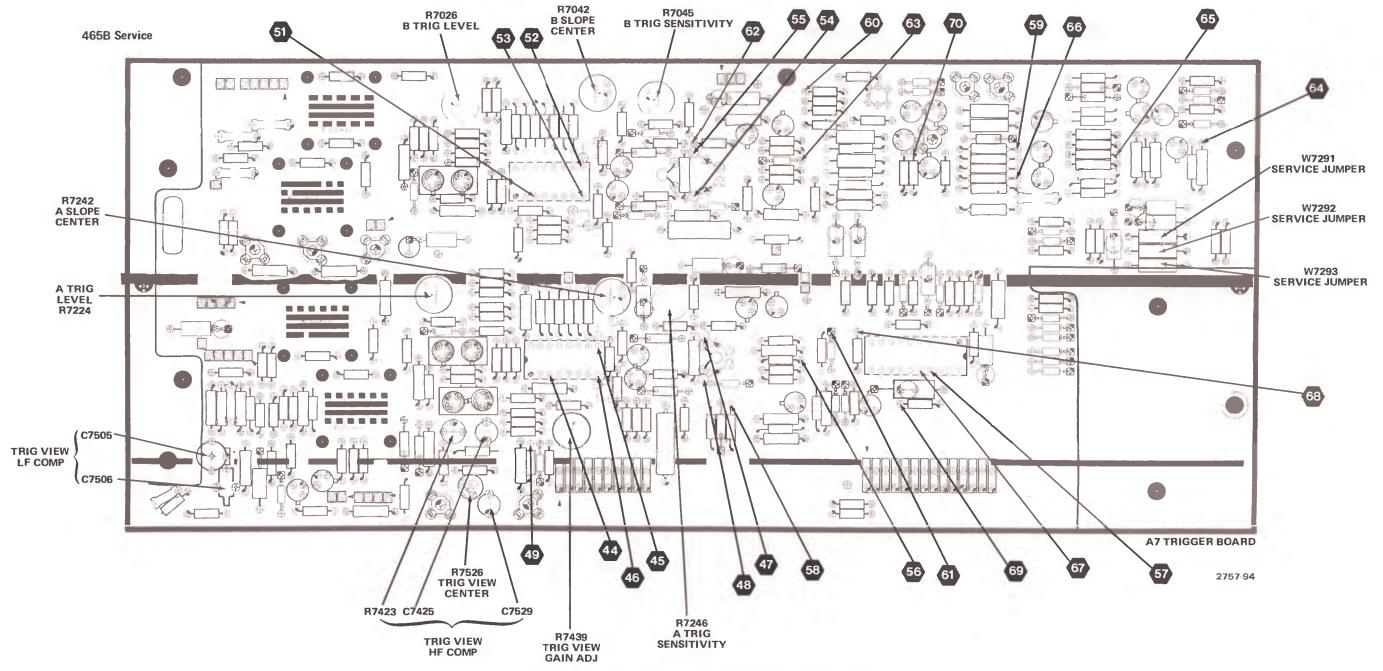


Figure 8-13. Trigger Generator and Sweep Logic circuit board adjustment locations.

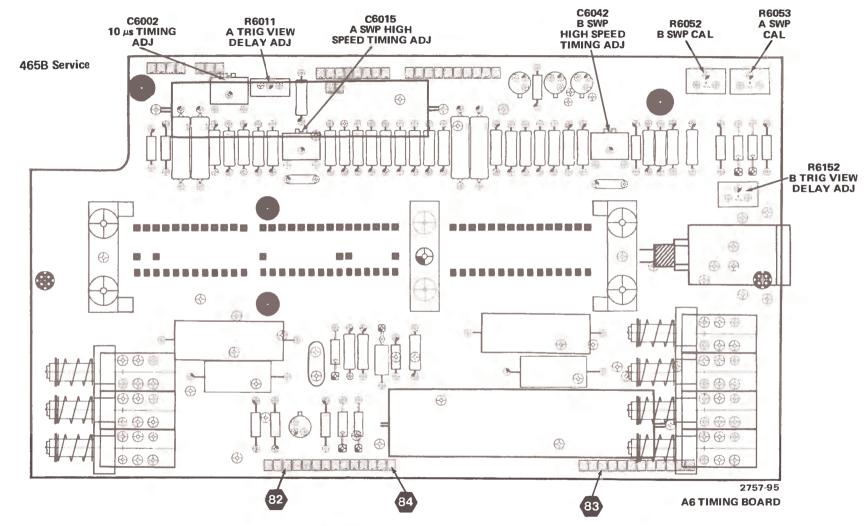


Figure 8-14. Timing circuit board adjustment locations.

REPLACEABLE **MECHANICAL PARTS**

PARTS ORDERING INFORMATION

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

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

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

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

SPECIAL NOTES AND SYMBOLS

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

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5

Name & Description

Assembly and/or Component Attaching parts for Assembly and/or Component

Detail Part of Assembly and/or Component Attaching parts for Detail Part

Parts of Detail Part Attaching parts for Parts of Detail Part

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

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

ABBREVIATIONS

# ACTR ADPTR ALIGN AL ASSEM ASSY ATTEN AWG BD BRKT BRS BRZ BSHG CAB CAP CER CHAS COMP CONN COV CPLG	INCH NUMBER SIZE ACTUATOR AOAPTER ALIGNMENT ALUMINUM ASSEMBLED ASSEMBLY ATTENUATOR AMERICAN WIRE GAGE BOARD BRACKET BRASS BRONZE BUSHING CABINET CAPACITOR CERAMIC CHASSIS CIRCUIT COMPOSITION CONNECTOR COVER COUPLING	ELCTRN ELEC ELCTLT ELEM EPL EOPT EXT FIL FLEX FLH FSTNR FT FXD GSKT HDL HEX HD HEX HD HEX SOC HLCPS HLEXT HV IC	ELECTRON ELECTRICAL ELECTROLYTIC ELEMENT ELECTRICAL PARTS LIST EQUIPMENT EXTERNAL FILLISTER HEAD FLEXIBLE FLAT HEAD FILTER FRAME OF FRONT FASTENER FOOT FIXED GASKET HANDLE HEXAGONAL HEAD HEXAGONAL HEAD HEXAGONAL SOCKET HELICAL EXTENSION HIGH VOLTAGE INTEGRATED CIRCUIT	IN INCAND INSUL INTL LPHLDR MACH MECH MTG NIP NON WIRE OBD OD OVH PH BRZ PL PLSTC PN PNH PWR RCPT RES RGD RLF RTNR	INCH INCANDESCENT INSULATOR INTERNAL LAMPHOLDER MACHINE MECHANICAL MOUNTING NIPPLE NOT WIRE WOUND ORDER BY DESCRIPTION OUTSIDE DIAMETER OVAL HEAD PHOSPHOR BRONZE PLAIN OF PLATE PLASTIC PART NUMBER PAN HEAD POWER RECEPTACLE RESISTOR RIGID RELIEF RETAINER	SE SECT SEMICONE SHLD SHLDR SKT SL SLFLKG SLFLKG SLFLKG SPR SQ SST STL TERM THD THK TNSN TPG TRH V VAR W/	SINGLE END SECTION SEMICONDUCTOR SHIELD SHOULDERED SOCKET SLIDE SELF-LOCKING SLEEVING SPRING SQUARE STAINLESS STEEL STEEL SWITCH TUBE TERMINAL THREAD THICK TENSION TAPPING TRUSS HEAD VOLTAGE VARIABLE
COV CPLG CRT DEG	COVER COUPLING CATHODE RAY TUBE DEGREE	HV IC ID IDENT	HIGH VOLTAGE INTEGRATED CIRCUIT INSIDE DIAMETER IOENTIFICATION	RLF RTNR SCH SCOPE	RELIEF RETAINER SOCKET HEAD OSCILLOSCOPE	VAR W/ WSHR XFMR	VARIABLE WITH WASHER TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

0 9-1

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
000ВК	STAUFFER SUPPLY	105 SE TAYLOR	PORTLAND, OR 97214
000CY	NORTHWEST FASTENER SALES, INC.	7923 SW CIRRUS DRIVE	BEAVERTON, OREGON 97005
OOOEX	O'HARA METAL PRODUCT COMPANY	542 BRANNAN STREET	SAN FRANCISCO, CA 94107
000GE	SCREWMATIC INC.	925 WEST FIRST ST.	AZUZA, CA 91702
000GF	DUDEK & BOCK SPRING MFG CO.	5100 W ROOSEVELT RD.	CHICAGO, IL 60650
00779	AMP, INC.	P 0 BOX 3608	HARRISBURG, PA 17105
01963	CHERRY ELECTRICAL PRODUCTS CORPORATION	3600 SUNSET AVENUE	WAUKEGAN, IL 60085
05006	TWENTIETH CENTURY PLASTICS, INC.	415 E WASHINGTON BLVD.	LOS ANGELES, CA 90015
05129	KILO ENGINEERING COMPANY	2015 D	LA VERNE, CA 91750
06540	AMATOM ELECTRONIC HARDWARE, DIV. OF MITE CORP.		
06666	GENERAL DEVICES CO., INC.	446 BLAKE ST. 525 S. WEBSTER AVE.	NEW HAVEN, CT 06515
07700	TECHNICAL WIRE AND PRODUCTS, INC.	129 DERMODY ST.	INDIANAPOLIS, IN 46219 CRANFORD, NJ 07016
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
08530	RELIANCE MICA CORP.	342-39TH ST.	BROOKLYN, NY 11232
12014	CHICAGO RIVET AND MACHINE CO.	950 S. 25TH AVENUE	BELLWOOD, IL 60104
12327	FREEWAY CORPORATION	9301 ALLEN DRIVE	CLEVELAND, OH 44125
12360	ALBANY PRODUCTS CO., DIV. OF PNEUMO	9301 ALLEN DRIVE	CEEVELAND, OH 44123
12300		1/5 HOODHARD AVENUE	COUTH NORMALK OF 06586
12511	DYNAMICS CORPORATION	145 WOODWARD AVENUE	SOUTH NORWALK, CT 06586
13511	AMPHENOL CARDRE DIV., BUNKER RAMO CORP.	D 0 BOY 1221	LOS GATOS, CA 95030
16428	BELDEN CORP.	P. O. BOX 1331	RICHMOND, IN 47374
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
23050	PRODUCT COMPONENTS CORP	30 LORRAINE AVE.	MT VERNON, NY 10553
24011	ELECTRONIZED CHEMICALS CORPORATION	S BEDFORD STREET	BURLINGTON, MA 01803
24931	SPECIALITY CONNECTOR CO., INC.	2620 ENDRESS PLACE	GREENWOOD, IN 46142
26233	USM CORP NYLOC FASTENER DIV.	1501 W SEPULVEDA BLVD.	monn.von
07110	.=	P.O. BOX 3158	TORRANCE, CA 90510
27143	ATLAS SPRING AND MFG. CO.	1805 N. SPAULDING AVE.	CHICAGO, IL 60647
28520	HEYMAN MFG. CO.	147 N. MICHIGAN AVE.	KENILWORTH, NJ 07033
28817	CAL-METEX CORP., SUBSIDIARY OF METEX		
	CORP.	509 HINDRY AVE.	INGLEWOOD, CA 90301
42838	NATIONAL RIVET AND MFG. CO.	1-21 EAST JEFFERSON ST.	WAUPUN, WI 53963
46384	PENN ENGINEERING AND MFG. CORP.	P O BOX 311	DOYLESTOWN, PA 18901
51316	ANGELUS WASHER AND STAMPING CO.	1411 ESPERANZA ST.	LOS ANGELES, CA 90023
55210	GETTIG ENG. AND MFG. COMPANY	PO BOX 85, OFF ROUTE 45	SPRING MILLS, PA 16875
56878	STANDARD PRESSED STEEL COMPANY	BENSON EAST	JENKINTOWN, PA 19046
57771	STIMPSON, EDWIN B., CO., INC.	900 SYLVAN AVENUE	BAYPORT, NY 11705
63743	WARD LEONARD ELECTRIC CO., INC.	31 SOUTH ST.	MOUNT VERNON, NY 10550
70278	ALLIED STEEL AND CONVEYORS, DIV. OF		
	SPARTON CORP.	17333 HEALY	DETROIT, MI 48212
70485	ATLANTIC INDIA RUBBER WORKS, INC.	571 W. POLK ST.	CHICAGO, IL 60607
71159	BRISTOL SOCKET SCREW, DIV. OF		
	AMERICAN CHAIN AND CABLE CO., INC.	P O BOX 2244, 40 BRISTOL ST.	WATERBURY, CT 06720
71279	CAMBRIDGE THERMIONIC CORP.	445 CONCORD AVE.	CAMBRIDGE, MA 02138
71400	BUSSMAN MFG., DIVISION OF MCGRAW-		
	EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71590	CENTRALAB ELECTRONICS, DIV. OF		
	GLOBE-UNION, INC.	P 0 BOX 858	FORT DODGE, IA 50501
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL		
	MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
75497	LAMSON AND SESSIONS CO.	5000 TIEDEMAN ROAD	CLEVELAND, OH 44144
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
77250	PHEOLL MANUFACTURING CO., DIVISION		
	OF ALLIED PRODUCTS CORP.	5700 W. ROOSEVELT RD.	CHICAGO, IL 60650
78189	ILLINOIS TOOL WORKS, INC.		
	SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
79136	WALDES, KOHINOOR, INC.	47-16 AUSTEL PLACE	LONG ISLAND CITY, NY 11101
79807	WROUGHT WASHER MFG. CO.	2100 S. O BAY ST.	MILWAUKEE, WI 53207
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80033	PRESTOLE EVERLOCK, INC.	P. O. BOX 278,1345 MIAMI ST.	TOLEDO, OH 43605
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
83486	ELCO INDUSTRIES, INC.	1103 SAMUELSON ROAD	ROCKFORD, IL 61101
86445	PENN FIBRE AND SPECIALTY CO., INC.	2032 E. WESTMORELAND ST.	PHILADELPHIA, PA 19134
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
	10. at 20 50000 6 177.7	_	

9-2 REV F, JUN 1980

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
89663	REESE, J. RAMSEY, INC.	71 MURRAY STREET	NEW YORK, NY 10007
91260	CONNOR SPRING AND MFG. CO.	1729 JUNCTION AVE.	SAN JOSE, CA 95112
93907	CAMCAR SCREW AND MFG. CO.	600 18TH AVE.	ROCKFORD, IL 61101
95987	WECKESSER CO., INC.	4444 WEST IRVING PARK RD.	CHICAGO, IL 60641
97464	INDUSTRIAL RETAINING RING CO.	57 CORDIER ST.	IRVINGTON, NJ 07111

REV C, MAY 1980 9-3

Replaceable Mechanical Parts-465B Service

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
, ,	200 1/11 00			P		00000	
1-1	200-1411-00		1		5.422 X 4.743X 0.441,GRAY	80009	200-1411-00
-2 -3	213-0313-00				O X 0.45 INCH, KNURLED	80009	213-0313-00
-4	337-1674-00 366-0494-00		1	SHLD, ELCTRN TUB: KNOB: GRAY WITH S		80009 80009	337-1674-00 366-0494-00
4	213-0153-00		1		X 0.125,STL BK OXD,HEX	000CY	0BD
-5	366-1031-02		2		27ID X 0.392 OD	80009	366-1031-02
	213-0153-00		1	. , ,	X 0.125, STL BK OXD, HEX	000CY	OBD
-6	366-1426-00		2	KNOB: GRAY	01123,012 2 010,112	80009	366-1426-00
	213-0153-00		1		X 0.125, STL BK OXD, HEX	000CY	OBD
-7	366-0215-02		2	KNOB: LEVER SWITC		80009	366-0215-02
-8	366-1559-00			PUSH BUTTON: SIL	GY,0.18 SQ X 0.43	80009	366-1559-00
-9	366-0494-00		3	KNOB: GRAY WITH S		80009	366-0494-00
	213-0153-00)	1	. SETSCREW: 5-40	X 0.125, STL BK OXD, HEX	000CY	OBD
-10	366-0494-00		1	KNOB: GRAY WITH S	SETSCREW	80009	366-0494-00
	213-0153-00		1	. SETSCREW:5-40	X 0.125,STL BK OXD,HEX	000CA	OBD
-11	331-0328-00		1		TURN FOR 0.25 DIA SHAFT	05129	461-S-70
	213-0048-00		I		X 0.125 INCH, HEX SOC STL	74445	OBD
-12	366-1346-02		1	KNOB: RED		80009	366-1346-00
1.2	213-0243-00		1		X 0.25 INCH, HEX SOC STL	70276	OBD
-13	366-1219-01		1	KNOB: GRAYDLYD		80009	366-1219-01
-14	213-0153-00		2		X 0.125,STL BK OXD,HEX	000CY 80009	OBD
-14	354-0442-01 213-0005-00		1 1	RING, KNOB SKIRT:	X 1.25 INCH, HEX SOC STL	74445	354-0442-01 OBD
-15	401-0080-01		1		0.789 ID X 8.66"OD PLASTIC	80009	401-0080-01
	366-0494-00		3	KNOB: GRAY WITH S		80009	366-0494-00
	213-0153-00		1		X 0.125,STL BK OXD,HEX	000CY	OBD
-17	366-1278-00		2	KNOB: GRAY	,	80009	366-1278-00
	213-0153-00		1		X 0.125,STL BK OXD,HEX	000CY	OBD
-18	366-1280-00		1	KNOB: GRAY		80009	366-1278-00
	213-0153-00		1	. SETSCREW: 5-40	X 0.125,STL BK OXD,HEX	000CY	OBD
	366-0494-00		1	KNOB: GRAY WITH S	SETSCREW	80009	366-0494-00
	213-0246-00		1	. SETSCREW: 5-40	X 0.093 ITL BK OXD, HEX SKT	71159	OBD
	426-1072-00			FRAME, PUSH BTN:		80009	426-1072-00
	358-0216-00		1		0.257 ID X 0.412 INCH OD	80009	358-0216-00
-21			5		0.125 ID X 0.234 THK, PLSTC	28520	B-187-125
-22	358-0540-00		2		25-32 X 0.128 ID X 0.24" L	80009	358-0540-00
-23	210-0583-00	1	2		ATTACHING PARTS) 0.25-32 X 0.312 INCH, BRS	73743	2X20317-402
-24	210-0940-00		2		5 ID X 0.375 INCH OD, STL	79807	OBD
	210 0740 00		2	WHOMER, PERIOTE	*	7,007	ODD
-25	378-0635-00		4	LENS, LIGHT: WHITE		80009	378-0635-00
-26			1		(SEE R16002 EPL)		
-27			1		(SEE R14288, R14289 EPL)		
					ATTACHING PARTS)		
	210-0583-00				0.25-32 X 0.312 INCH, BRS	73743	2X20317-402
-29	210-0940-00		1	WASHER, FLAT: 0.25	ID X 0.375 INCH OD, STL	79807	OBD
20					*		
-30			1	RES., VAR, NONWIR:	(SEE RI4398 EPL) ATTACHING PARTS)		
-31	210-0583-00		1	-	0.25-32 X 0.312 INCH, BRS	73743	2X20317-402
	210-0940-00		1		5 ID X 0.375 INCH OD, STL	79807	OBD 402
32	210 0740 00		1	WASHER, PEAT.O.2	*	,,,,,,	020
-33	210-0046-00		1	WASHER, LOCK: 0.26	1 ID, INTL, 0.018 THK, BRS	78189	1214-05-00-0541C
-34		,	1		(SEE R15102 EPL)		
					ATTACHING PARTS)		
	210-0583-00		1		0.25-32 X 0.312 INCH, BRS	73743	2X20317-402
-36	210-0940-00		1	WASHER, FLAT: 0.25	ID X 0.375 INCH OD, STL	79807	OBD
0.7	010 0017		_		*		
	210-0046-00		I		ol ID, INTL, 0.018 THK, BRS	78189	1214-05-00-0541C
-38			1		(SEE R14498 EPL)		
-39	210-0583-00	1	1		ATTACHING PARTS)	72712	2820317-402
-40	210-0940-00		l		0.25-32 X 0.312 INCH, BRS 5 ID X 0.375 INCH OD, STL	73743 79807	
			•		1 0.575 1000 00,010	, ,007	~

9-4 REV G, OCT 1980

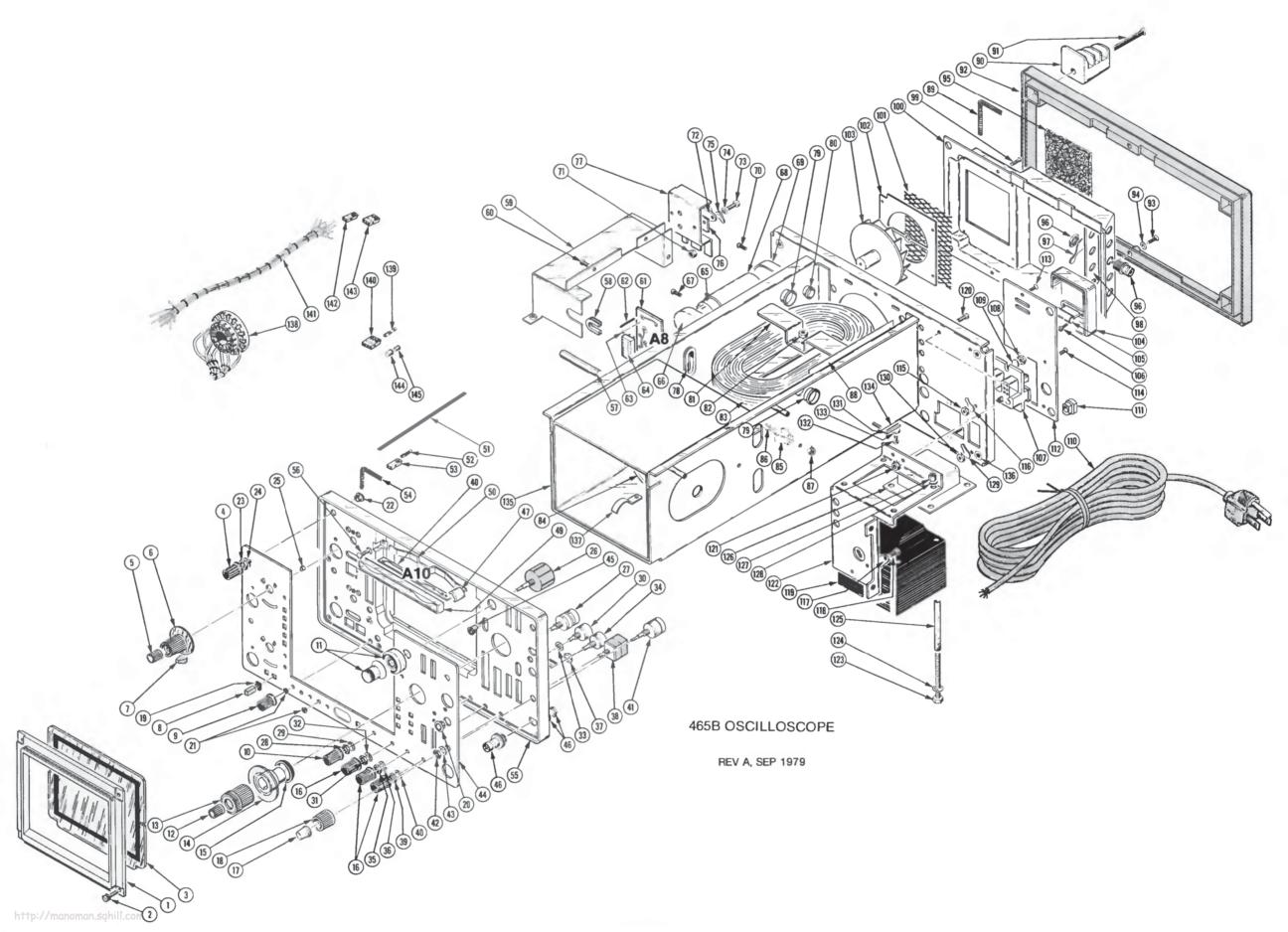
Fig. & Index No.	Tektronix Part No.	Serial/Mo Eff	odel No. Dscont	Otv	1 2	3 4 5		Name & De	scrintion		Mfr Code	Mfr Part Number
1-41				2			ONWIR:(SEE R17105,R	17305 EPL)			
-42	210-0583-00			2	NIIT	DIAIN		TACHING PART			73743	2X20317-402
-43	210-0940-00			2			T:0.25	ID X 0.375 II			79807	OBD
-44	333-2524-00			1	PANE	L, FRON					80009	333-2524-00
-45	352-0477-00			8		EŔ,LED					80009	352-0477-00
-46	131-0955-00			2	CONN	ECTOR,	RCPT,:C	KT BD,28/56	CONTACT		13511	31-279
-47	386-2340-00					-	T:FRONT				80009	386-2340-00
-48	279 0729 00			1				r scale illu		L)	20000	279 0729 00
-49 -50	378-0728-00 352-0329-00			1 1				:SCALE ILLUM E ILLUMINATI			80009 80009	378-0728-00 352-0329-00
- 50	198-2862-00			1		RE SET		E ILLUMINATI	ON		80009	198-2862-00
-51	175-0825-00						-	AL:2 WIRE RI	BBON		80009	175-0825-00
-52	131-0707-00							M.:22-26 AWG		GOLD	22526	47439
-53	352-0169-02			1				EL:2 WIRE RE			80009	352-0169-00
-54	348-0276-00			FT				026 OD NPRNW			28817	01-0404-3719
~55	426-1607-00			1	FRAM	E, CABI	NET: FRO	NT TACHING PART	s)		80009	426-1607-00
-56	213-0183-00			4	SCR,	TPG, TH		-20 X 0.5 TY	PE B, PNH, STL	•	83385	OBD
-57	129-0385-00			1	SPAC	ER, POS	T:1.77	L,W/6-32& 4-	40 THD ENDS		80009	129-0385-00
-58	348-0115-00			1	GROM	MET, PL	ASTIC:U	-SHP,0.548 X	0.462 INCH		80009	348-0115-00
-59	337-1688-03			1	SHLD	, ELECT		IGH VOLTAGE FACHING PART	s)		80009	337-1688-03
-60	211-0065-00	B010100	B042994	3				0 X 0.188 IN			77250	OBD
	211-0661-00	B042995		3	SCRE	-	INE:4-4	0 X 0.25 INC	H, PNH, STL		83385	OBD
-61				1	CKT	BOARD	ASSY:FA	N MOTOR(SEE	A8 EPL)			
-62	131-0608-00			2	. TE	RMINAL	,PIN:0.	365 L X 0.02	5 PH BRZ GOL	ď.	22526	47357
-63	136-0252-07			3				:W/O DIMPLE			22526	75060-012
-64	136-0269-02			1				MICROCIRCUIT	,14 DIP,LOW	CLE	73803	CS9002-14
-65 -66	426-0781-00			1				8045 EPL)			80009	426-0781-00
-00	420-0701-00			1	. mo	UNT, MO		TACHING PART	s)		00009	420-0701-00
-67	213-0088-00			2	SCR,	TPG, TH	D CTG:4	-24 X 0.25 I			83385	OBD
-68	337-1762-00			1	SHLD	.ELECT		AN MOTOR			80009	337-1762-00
-69	426-0781-00			1		T,MOTO					80009	426-0781-00
-70	213-0088-00			2			(AT	TACHING PART			83385	OBD
					,	•		*				
	644-0150-00			1	XSTR	BRKT		TACHING PART	s)		80009	644-0150-00
-71	210-0586-00			2	NUT,	PL,ASS		-40 X 0.25,S			83385	211-041800-00
				-	. TR	ANS BR	KT ASSY	INCLUDES:				
-72				-	. TR	ANSIST		Q14009 EPL) TACHING PART	s)			
-73	211-0012-00			2	. SC	REW, MA	CHINE: 4	-40 X 0.375,	PNH STL CD P	L	83385	OBD
-74	358-0214-00			2	. IN	SULATO	R, BSHG:	0.25 DIA X 0	.188 INCH L		24011	OBD
-75	210-0205-00			1	. TE	RMINAL	, LUG: SE	#8 *			86928	5442-7
-76	214-1610-00			1				TRANSISTOR			80009	214-1610-00
-77	407-1153-00			1			XSTR: AL		2 040 005		80009	407-1153-00
-78 -70	348-0253-00			1				LACK, OBLONG,			80009 80009	348-0253-00
-79 -80	348-0064-00			2				.625 INCH DI			80009	348-0064-00 348-0056-00
-00	348-0056-00 348-0442-00			1 1				.375 INCH DI LACK,ROUND,O			28520	SB-500-6
	348-0517-00			2				LACK, ROUND, O			28520	SB-375-4
	348-0518-00	B010100	B010549	2				LACK, ROUND, O			28520	SB-625-8
	348-0518-00	B010550		1				LACK, ROUND, O			28520	SB-625-8
	348-0064-00	B010550		1		-		.625 INCH DI			80009	348-0064-00
	358-0540-00			2				5-32 X 0.128		L	80009	358-0540-00

Replaceable Mechanical Parts—465B Service

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	0tv	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
	407-1138-00			BRKT, DELAY LINE: A		80009	407-1138-00
-82	210-0457-00		1	NUT, PL, ASSEM WA: 6	TACHING PARTS) -32 X 0.312 INCH,STL	83385	OBD
_02	343-0144-00		1	CLAMP, LOOP:0.125		95987	1-8-2
-63	131-1002-02		1 1	DELAY LINE: (SEE D		80009	131-1002-02
0.4	131-1313-00		1	. RETAINER, WIRE, E	:DELAY LINE TERMINAL	80009	131-1313-00
	344-0250-00		1	COIL, TUBE DEFLE: (: CLIP, ELECTRICAL: C		80033	E50005-007
-86	211-0008-00		1		0 X 0.25 INCH, PNH STL	83385	OBD
-87	210-0586-00		1		-40 X 0.25,STL CD PL	83385	211-041800-00
-88	337-1763-01		1	SHIELD, ELEC: TRANS		80009	337-1763-01
-89	348-0349-00			SHLD GSKT, ELEC: 0.	187 INCH DIA,2.75 FT L		2143951
-90	348-0339-00		4	FOOT, CABINET: W/CO	RD WRAP TACHING PARTS)	80009	348-0339-00
-91	212-0020-00		4	SCREW, MACHINE: 8-3	2 X 1.0 INCH, PNH STL	93907	OBD
-92	426-0970-00		1	FR SECT., CAB.: REA		80009	426-0970-00
-93	211-0516-00		2		2 X 0.875 INCH, PNH STL	83385	OBD
-94	210-1002-00		2	WASHER, FLAT: 0.125	ID X 0.25 INCH OD, BRS	12327	OBD
-95	378-0044-01		1	FILTER ELEM, AIR: 2		80009	378-0044-01
-96	131-0955-00		4	CONNECTOR, RCPT, : C	KT BD,28/56 CONTACT	13511	31-279
-97	210-0255-00		4	TERMINAL, LUG:0.39	l" ID INT TOOTH	80009	210-0255-00
-98	386-2408-00			PLATE, CONN MTG: AL		80009	386-2408-00
	200-1445-05		1	COV, LINE V SEL: W/	HARDWARE TACHING PARTS)	80009	200-1445-05
-99	211-0101-00		2	SCREW, MACHINE: 4-4	0 X 0.25" 100 DEG, FLH STL	83385	OBD
			-	. COVER INCLUDES:			
			1	. COVER, SCORE: REA	R(AVAILABLE AS ASSY ONLY)		
	378-0807-01			. SCREEN, FAN: 2.5	-	80009	
	200-1399-02			. COVER, FAN IMPLR		80009	200-1399-02
-103	369-0031-00				.60 INCH OD, PLASTIC	80009	369-0031-00
104	213-0022-00				0.188 INCH, HEX SOC STL	74445	
	200-1445-05		1	COV, LINE V SEL:W/	HARDWARE 2"ID TUBE FOR CRTG FUSE	80009	
	352-0102-00		1	(AT	TACHING PARTS)	80009	352-0102-00
-106	213-0717-00		2		20 X 0.312 PNH, STL, CD PL	93907	OBD
-107		B010100 B010799	1	BODY ASSY, LINE:			204-0549-01
	204-0549-03	B010800	1	BODY ASSY, LINE:	TACHTNC DARTC	80009	204-0549-03
-108	210-0407-00		2		TACHING PARTS) 32 X 0.25 INCH,BRS	73743	3038-0228-402
	210-0006-00			WASHER, LOCK: #6 IN	TL,0.018THK,STL CD PL		1206-00-00-0541C
			-	. BODY ASSY, LINE			
	131-1318-01		2	. BUS CONDUCTOR:	2.10202201	80009	131-1318-01
	210-0666-00				.188 L X 0.125 OD, BRS	12014	3329-3-16LONG
	214-0778-00	B010100 B010799	1	,	LINE V SEL, LOW/MED/HI	80009	214-0778-00
	214-0778-01	B010800	1		:LINE V SEL, LOW/MED/HI	80009	214-0778-01
	344-0135-00		2	. CLIP, ELECTRICAL	:FUSE,CU BE ALBALOY PL	80009	
-110	161-0033-07		1		WIRE,92 INCH LONG TACHING PARTS)	16428	КН8389
-111	358-0161-00		1		OR 0.50 INCH HOLE, PLASTIC	28520	SR5P4
-112	386-2332-10		1	PANEL, REAR:	TACHING PARTS)	80009	386-2332-10
-113	211-0105-00		1		0 X 0.188"100 DEG,FLH STL	83385	OBD
	211-0138-00		1	•	O X 2.562 INCH, PNH STL	83486	
-115	210-0586-00		1		-40 X 0.25,STL CD PL	83385	
-116	210-0202-00		1		6 ID, LOCKING, BRZ TINNED	78189	2104-06-00-2520N

9-6 REV F, JUN 1980

Fig. &	T.11	0					
Index	Tektronix	Serial/Model No.	04	10015	Name & Description	Mfr	M(-D-AN-AN-A
No.	Part No.	Eff Dscont	uty	1 2 3 4 5	Name & Description	Code	Mfr Part Number
1-117			1	,			
-118	213-0138-00		2		TTACHING PARTS) K 0.188 INCH,PNH STL	83385	OPD
110	213 0130 00		2		*	03303	OBD
-119			1	TRANSFORMER: (SEE			
-120	211-0538-00		2		TTACHING PARTS) 32 X 0.312"100 DEG,FLH STL	02205	ORD
	210-0457-00				5-32 X 0.312 INCH, STL	83385 83385	OBD OBD
	211-0114-00				40 X 0.438 INCH, FLH STL	83385	OBD
	210-0551-00		1		-40 X 0.25 INCH, STL	83385	OBD
	210 0331 00		1		-40 X 0.25 INCH, SIL	03303	OBD
			-	. TRANSFORMER IN			
-122	407-1066-00		1	. BRACKET, XFMR: A		80009	407-1066-00
	212-0523-00				10-32 X 2.750, HEX HD STL	83385	OBD
-124	210-0812-00			. WASHER, NONMETA		86445	OBD
	166-0457-00		4	,	0:0.19 ID X 1.875"LONG MYLAR	80009	166-0457-00
	200-1544-00				R:2.0 X 2.5 X 0.65, STEEL	80009	200-1544-00
-127	220-0561-00				:10-32 X 0.25 INCH, BRS	80009	220-0561-00
	210-0056-00		4		LIT, 0.195 ID X 0.32" OD, P BRZ	83385	OBD
	210-0202-00		1		46 ID, LOCKING, BRZ TINNED	78189	2104-06-00-2520N
			-		TTACHING PARTS)	,010,	2104 00 00 252011
-130	210-0586-00		1		4-40 X 0.25,STL CD PL	83385	211-041800-00
					*		
-131			2	TRANSISTOR: (SEE	04102,04401 EPL)		
			1	TRANSISTOR: (SEE			
					TTACHING PARTS)		
-132	211-0012-00		3		40 X 0.375, PNH STL CD PL	83385	OBD
-133	210-0071-00		3		0.146 ID X 0.323" OD, STL	78189	4706-05-01-0531
					*		
-134	342-0163-00		3	INSULATOR, PLATE:	KSTR,0.675 X 0.625 X 0.001"	80009	342-0163-00
-135	441-1084-05		1	CHASSIS, SCOPE: W/I	-	80009	441-1084-05
-136	129-0394-00		4	. SPACER, POST: 0.	50L,W/8-32 THD	000GF	50-832-16
-137	214-0291-00				1.188 X 0.375 X 0.25 INCH	80009	214-0291-00
	136-0515-01		1	SKT, PL-IN ELEK: EI	CTRN TUBE, 14 CONT W/LEAD	80009	136-0515-01
-138	136-0202-01		1	. SOCKET, PLUG-IN		80009	136-0202-01
-139	131-0707-00		4		:22-26 AWG, BRS& CU BE GOLD	22526	47439
-140	352-0162-00		1	. HLDR, TERM CONN	-	80009	352-0162-00
-141	179-2670-00		1	WIRING HARNESS:MA		80009	179-2670-00
-142	352-0169-00		1	. HLDR, TERM CONN		80009	352-0169-00
	352-0161-00		1	. HLDR, TERM CONN		80009	352-0161-00
-144	210-0774-00		23		0:0.152 OD X 0.245 INCH L,BRS	80009	210-0774-00
-145	210-0775-00				0:0.126 OD X 0.23 INCH L, BRS	80009	210-0775-00
				•			



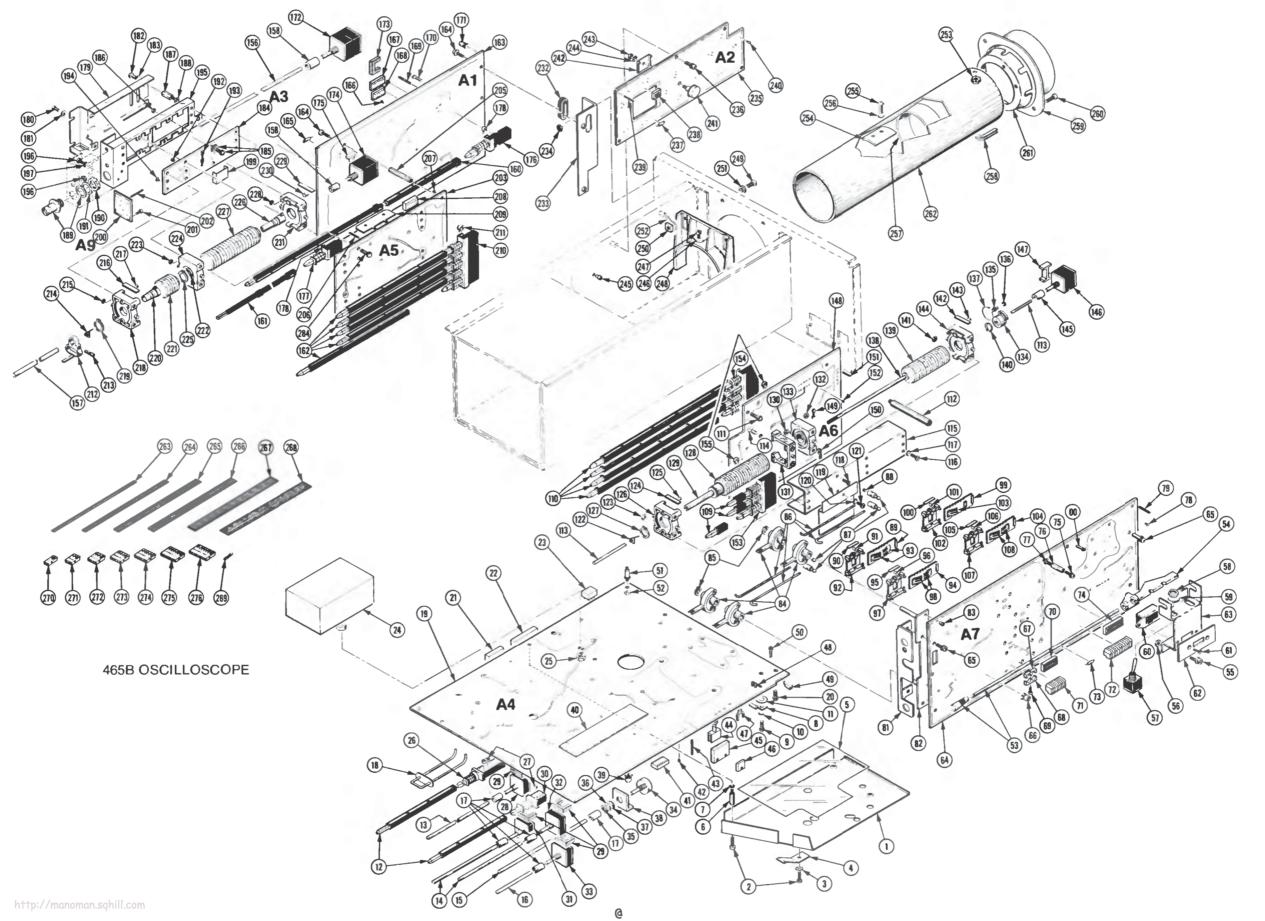


Fig. &							
Index No.		Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-1	337-1711-03		1	SHIELD, ELEC: HIGH	VOLTAGE TTACHING PARTS)	80009	337-1711-03
-2	211-0244-00		3		-40 X 0.312 INCH, PNH STL	78189	OBD
-3	210-0004-00		4	WASHER, LOCK: #4 I	NTL,0.015THK,STL CD PL	78189	1204-00-00-0541C
	131-1428-00		1	CONTACT, ELEC: GRO		80009	131-1428-00
	211-0012-00		1	,	40 X 0.375, PNH STL CD PL	83385	OBD
	210-0851-00		1	,	9 ID X 0.375 INCH OD, STL	12327	OBD
-4 -5	131-1428-00		1	CONTACT, ELEC: GRO		80009	131-1428-00
-6	342-0175-00 129-0413-01		1 4	INSULATOR, FILM: 3	8 L,W/4-40 TAP 1 END	80009 80009	342-0175-00 129-0413-01
-7	210-0994-00		4		5 ID X 0.25" OD, STL	86928	5714-147-20N
-8			2	TRANSISTOR: (SEE		00720	3714 147 2011
-9	211-0182-00		2		-56 X 0.312 INCH, PNH, STL	12360	OBD
-10	210-1156-00		2		9 ID X 0.085 D,NYL,0.2 OD	80009	210-1156-00
-11	342-0166-00		2	INSULATOR, PLATE:		80009	342-0166-00
-12	384-1408-00		2		3.8 L, MOLDED PLASTIC	80009	384-1408-00
-13	384-0457-00		1		6.7 L X 0.1230D EPOXY-GL	80009	384-0457-00
-14 -15	384-1187-00 384-1179-00		2 1	EXTENSION SHAFT:		80009 80009	384-1187-00 384-1179-00
-16	384-1174-00		1	EXTENSION SHAFT:		80009	384-1174-00
-17	376-0029-00		5		.128 ID X 0.312 OD X 0.5"L	80009	376-0029-00
			_	EACH COUPLING SH			
	213-0075-00				X 0.094, STL BK OXD, HEX SKT	000BK	
	195-0276-01				0.062 DIA, BRS, W/MLD COLLAR	80009	195-0276-01
-19			1	(A'	NTERFACE(SEE A4 EPL) TTACHING PARTS)		
-20	211-0244-00		7		-40 X 0.312 INCH, PNH STL	78189	OBD
			_	. CKT BOARD ASSY			
	136-0499-12			. CONNECTOR, RCPT	To the state of th		4-380949-2
-22	136-0499-14 136-0514-00			. CONNECTOR, RCPT			4-380949-4
-24	136-0314-00		1 1		:MICROCIRCUIT,8 DIP I:V MULTI(SEE U4032 EPL)	/3803	CS9002-8
			1		TTACHING PARTS)		
-25	220-0736-00		1	. NUT, PL, EXT WSH	R:8-32 X 0.344 HEX, NYLON	23050	OBD
-26			1	. PUSHBUTTON SW:	BEAMFIND(SEE S4075 EPL)		
-27		B010100 B010849	4		ROWN, 0.275 INCH LONG	80009	361-0382-00
0.0	361-0608-00	B010850	4	. SPACER, PUSH SW		80009	361-0608-00
-28	361-0607-00				R:INTENSITY(SEE R4059 EPL)	00000	261 0607 00
	361-0607-00		1	. SPACER, SWITCH:	X10 MAG(SEE S4371 EPL)	80009	361-0607-00
			1		R:ASTIG(SEE R4178 EPL)		
-32			1		R:TRACE ROTATION(SEE R4179 EPL)		
-33			1		R:SCALE ILLUM(SEE R4195 EPL)		
-34			1		R:FOCUS(SEE R4132 EPL) TTACHING PARTS)		
-35	210-0583-00		1		:0.25-32 X 0.312 INCH, BRS	73743	2X20317-402
-36 -37	210-0046-00		1		261 ID, INTL, 0.018 THK, BRS	78189	1214-05-00-0541C
-37	210-0940-00		1		25 ID X 0.375 INCH OD, STL	79807	OBD
-38	386-2433-00		1		S:CIRCUIT CARD MOUNTING	80009	386-2433-00
-39	131-1003-00		5	, ,	:CKT BD MT,3 PRONG	80009	131-1003-00
-40	337-1759-00		1	. SHLD, ELECTRICA		80009	337-1759-00
-41	136-0269-02	2010100 20001	3		:MICROCIRCUIT, 14 DIP, LOW CLE	73803	CS9002-14
-42	136-0252-04	B010100 B033189	168		M:U/W 0.016-0.018 DIA PINS	22526	75060-007
-43	136-0252-07 131-0608-00	B033190 B010100 B033189	165 43	. SOCKET, PIN CON	.365 L X 0.025 PH BRZ GOLD	22526 22526	75060-012 47357
7.3	131-0608-00	B033190	41		.365 L X 0.025 PH BRZ GOLD	22526	47357
-44	358-0214-00		3		:0.25 DIA X 0.188 INCH L	24011	OBD
-45	124-0092-00		2	,	:3 NOTCH, CERAMIC, CLIP MTD	80009	124-0092-00

Replaceable Mechanical Parts—465B Service

Fig. & Index No.		Serial/Model No. Eff Dscont	Otv	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
		2000111					
	124-0118-00				NOTCH, CERAMIC, CLIP MTD	80009	124-0118-00
	344-0154-00			. CLIP, ELECTRICAL		80009	344-0154-00
	131-1261-00			. CONTACT, ELEC: F-S		00779	1-380953-0
	131-0566-00				MMY RES,2.375,22 AWG	55210	L-2007-1
-50		B010100 B010849		. TERM, TEST POINT		80009	214-0579-00
		B010850 B039949		. TERM, TEST POINT		80009	214-0579-00
	214-0579-02	B039950		. TERM, TEST POINT		80009	214-0579-02
-51	131-0382-00		1	. TERMINAL, STUD: 0		71279	572-4822-01-05-1
					CACHING PARTS)		
-52	210-0586-00		1		:4-40 X 0.25,STL CD PL	83385	211-041800-00
					*		
	198-2850-00			. WIRE SET, ELEC:		80009	198-2850-00
	384-1159-00				0.384 INCH LONG, W/KNOB	80009	384-1159-00
-54	214-1756-00		1	ACTUATOR, SWITCH: PO	DWER	80009	214-1756-00
	644-0151-00		1	SWITCH ASSY:		80009	644-0151-00
	011 0044 00				TACHING PARTS)	70100	Ann
	211-0244-00		I		O X 0.312 INCH, PNH STL	78189	
-56	210-0551-00			NUT, PLAIN, HEX.: 4-		83385	OBD
	210-0406-00				0 X 0.188 INCH, BRS		2X12161-402
	210-0994-00		1		ID X 0.25" OD, STL	86928	5714-147-20N
			_		*		
-57				. SWITCH ASSY INC	OWER ON(SEE S14510 EPL)		
-57			1	,	TACHING PARTS)		
-58	210-0562-00		1		0.25-40 X 0.312 INCH, BBS	727/2	2X20224-402
-	210-0302-00				51 ID, INTL, 0.018 THK, BRS		1214-05-00-0541C
-39	210-0046-00		1		*	70109	1214-03-00-03410
-60			1	. SWITCH, SLIDE: LI	NE SELECT(SEE S14500 EPL)		
-61	211-0101-00		2	. SCREW, MACHINE: 4	-40 X 0.25" 100 DEG, FLH STL	83385	OBD
-62	200-1526-00		1		*	00000	200 1526 00
	407-1133-00			. CON, INV SW HOLE . BRACKET, ELEC SW		80009 80009	200-1526-00 407-1133-00
03	386-2660-00		1	SUPPORT, CKT BD: ACI		80009	386-2660-00
-64					IG GEN & SWP LOG(SEE A7 EPL)	80009	380-2000-00
04			1		TACHING PARTS)		
-65	211-0244-00		4		40 X 0.312 INCH, PNH STL	78189	ORD
	211 0244 00		4		*	70107	000
			_	. CKT BOARD ASSY	INCLUDES:		
-66	131-1003-00			. CONN, RCPT, ELEC:		80009	131-1003-00
-67				,	DUAL TO-18, ALUMINUM	80009	200-0945-00
-68			3		DUAL TO-18,W/2-56 THD	80009	200-0945-01
	-00 07.5		_		CACHING PARTS)		
-69	211-0062-00		1		-56 X 0.312 INCH, RDH STL	83385	OBD
				-	*		
-70	136-0260-02		2	. SKT, PL-IN ELEK:	AICROCIRCUIT, 16 DIP, LOW CLE	71785	133-51-92-008
	136-0499-10		1	. CONNECTOR, RCPT,			4-380949-0
	136-0499-14		1	. CONNECTOR, RCPT,	:14 CONTACT	00779	4-380949-4
-73	131-0566-00		3	. BUS CONDUCTOR: D	JMMY RES,2.375,22 AWG	55210	L-2007-1
-74	136-0634-00		1	. SOCKET, PLUG-IN:	20 LEAD DIP, CKT BD MTG	73803	CS9002-20
-75	211-0244-00		1	. SCR, ASSEM WSHR:	4-40 X 0.312 INCH, PNH STL	78189	OBD
-76	129-0413-01		1	. SPACER, POST: 0.5	38 L,W/4-40 TAP I END	80009	129-0413-01
-77	210-0994-00		1	. WASHER, FLAT: 0.1	25 ID X 0.25" OD, STL	86928	5714-147-20N
-78	136-0252-07		108	. SOCKET, PIN CONN	:W/O DIMPLE	22526	75060-012
-79	131-0608-00				365 L X 0.025 PH BRZ GOLD	22526	47357
-80	214-0579-00	B010100 B039949	3	. TERM, TEST POINT	BRS CD PL	80009	214-0579-00
	214-0579-02	B039950		. TERM, TEST POINT		80009	214-0579-02
-81	407-1157-00		1	. BRACKET, ELEC SW	ALUMINUM	80009	407-1157-00
-82	386-2376-00		1	. PLATE, LEVER MTG	SLIDE SWITCH	80009	386-2376-00
					CACHING PARTS)		
-83	210-0657-00		2		:0.089 OD X 0.218 L,BR	57771	GS3-7
	01/ 1770 00		,		*	00000	01/ 1770 00
-84	214-1770-00		4	. LEVER, SLIDE SW:	CACHING DADWG	80009	214-1770-00
-85	3 54-0165-00		4	. RING, RETAINING:	TACHING PARTS) 0.114 FREE IDX 0.025 INCH	97464	1000-15
				-	*		

9-10 REV G, JUN 1980

Fig. & Index		Serial/Model No.	0.		0.0.4.5	No 0 D		Mfr	Mfc David Neverbase
No.	Part No.	Eff Dscont	uty	1	2 3 4 5	Name & D	escription	Code	Mfr Part Number
2-86	384-1160-00					AFT:3.05 INCH I		91260	OBD
-87						PLG: SLIDE TO SH		80009	376-0142-00
-88	213-0048-00					-40 X 0.125 INC	,	74445	OBD
	351-0355-01		1			B COUPLING(SEE E SW:W/SPRINGS		80009	351-0355-01
-89	351-0355-00				GUIDE, SL		AND ROLLERS	80009	351-0355-00
-90	214-1126-01					LAT: GREEN COLOR	RED	80009	214-1126-01
	214-1127-00		2				X 0.125 INCH L	80009	214-1127-00
	105-0804-00					L SW:4 OF 5 POS		80009	105-0804-00
-93	131-2235-07 210-0779-00		1 1			EC:COPPER BERYL		80009	131-2235-07
	210-0779-00					B SOURCE(SEE S7	0.115 INCH LONG	42838	RA-29952715
	351-0355-01		1			E SW:W/SPRINGS		80009	351-0355-01
-94	351-0355-00		1		GUIDE, SL			80009	351-0355-00
	214-1126-01		2			LAT: GREEN COLOR	RED	80009	214-1126-01
	214-1127-00						X 0.125 INCH L	80009	214-1127-00
	105-0807-00 131-2235-07		1			L SW:5 OF 6 POS		80009	105-0807-00
-90	210-0779-00		1 1			EC:COPPER BERYI	0.115 INCH LONG	80009 42838	131-2235-07 RA-29952715
			1			A COUPLING(SEE		42030	RA-29932/13
	351-0355-01		î			E SW:W/SPRINGS		80009	351-0355-01
-99	351-0355-00		1		GUIDE, SL			80009	351-0355-00
	214-1126-01		2		SPRING, F	LAT: GREEN COLOR	RED	80009	214-1126-01
	214-1127-00						X 0.125 INCH L	80009	214-1127-00
	105-0805-00 131-2235-07		1			L SW:4 OF 6 POS		80009 80009	105-0805-00 131-2235-07
103	210-0779-00					EC:COPPER BERYL	0.115 INCH LONG	42838	RA-29952715
			î			A SOURCE(SEE S7		12050	141 07730113
	351-0355-01		1			E SW:W/SPRINGS		80009	351-0355-01
	351-0355-00		1		GUIDE, SL			80009	351-0355-00
	214-1126-01		2	٠	SPRING,F	LAT: GREEN COLOR	RED	80009	214-1126-01
	214-1127-00 105-0805-00		2	•	RULLER, D	ETENT:0.125 DIA L SW:4 OF 6 POS	X 0.125 INCH L	80009	214-1127-00
	131-2235-07		1			EC:COPPER BERYL		80009 80009	105-0805-00 131-2235-07
100	210-0779-00				-		0.115 INCH LONG	42838	RA-29952715
-109	384-1136-00		-			T:0.95 INCH LON		80009	384-1136-00
-110	384-1059-00					r:6.58 INCH LON	lG	80009	384-1059-00
	672-0781-00		1	CK	T BOARD ASSY		20)	80009	672-0781-00
111	211-0244-00		1	SC		(ATTACHING PART :4-40 X 0.312 I		78189	OBD
	129-0386-00					:HEX,1.593 INCH			129-0386-00
					,	*		00007	
			-		TIMING ASSY				
-113	384-1105-00					AFT:8.241 L X 0	0.081 INCH OD	80009	384-1105-00
	131-0963-00 334-3448-00				CONTACT, ELEC	:GROUNDING :MARKED NOTICE		000EX	334-3448-00
			1			AS:TIME/CM(SEE		00009	334-3446-00
			•	•		(ATTACHING PART			
-114	211-0244-00		8		SCR, ASSEM WS	HR:4-40 X 0.312	INCH, PNH STL	78189	OBD
						*	•		
115	200 221/ 00		-			SSY INCLUDES:	4. 104.5.1104	00000	200 2214 00
-115	200-2314-00		1	•		SW:43 ELEMENTS,		80009	200-2314-00
-116	211-0673-00		6			(ATTACHING PART INE:6-32 X 3.0			
	210-0004-00					K:#4 INTL,0.015		78189	1204-00-00-0541C
	211-0101-00					INE:4-40 X 0.25	" 100 DEG, FLH STL		OBD
						*	•		
-119	337-2621-00		1	•	. SHIELD, ELE		26)	80009	337-2621-00
-120	211-0673-00		1			(ATTACHING PART	L,HEX,STL,CD PL	80009	211-0673-00
	210-0004-00					K:#4 INTL,0.015		78189	1204-00-00-0541C
	_ 10 0001 00		-	•		*		/0.0/	
	131-0963-00		1		. CONTACT, EL	EC: GROUNDING		000EX	OBD
	210-0406-00					HEX.:4-40 X 0.1	•	73743	2X12161-402
-124	214-1139-02 214-1139-03					T:GREEN COLORED F:RED COLORED)		214-1139-02
	~17 1137-03		L	•	. SINING, FLA	. KED COLOKED		00009	214-1139-03

Fig. & Index	Tektronix	Serial/Model No.	0+		1 /	2 2 4 5	No	ma & Description	Mfr	Mfr Part Number
No.	Part No.	Eff Dscont	uty		۱ ،	2 3 4 5	IVal	me & Description	Code	Mfr Part Number
	214-1752-00 401-0180-00		2 1			ROLLER, DETER	SW:FRO	NT NG PARTS)	80009 80009	214-1752-00 401-0180-00
-127	354-0390-00		1				ING:0.3	38 ID X 0.025" THK, STL	79136	5100-37MD
-128	105-0801-01		1			ACTUATOR, CA	M SW:TI	ME/CM,DRUM	80009	105-0801-01
	210-1160-00		1					109 ID X 0.25 INCH OD	86445	OBD
-120	214-1416-00		1					OD X 0.835 INCH LONG	27143	OBD
	384-0878-02 210-0406-00		1 4			SHAFT, CAM S		0 X 0.188 INCH, BRS	80009 73743	384-0878-02 2X12161-402
	407-1199-00		1			BRACKET, COV		0 x 0.100 1Non, 5R5	80009	
	210-0406-00		4					0 X 0.188 INCH, BRS	73743	2X12161-402
-133	401-0178-02		1					28 ID, PLASTIC	80009	401-0178-02
-134	352-0464-00		1			HOLDER, STOP			80009	352-0464-00
105	213-0075-00		1					094,STL BK OXD,HEX SKT	000BK	OBD
	105-0733-00		1		•	,		,BRASS	80009	105-0733-00
	354-0392-00 214-2478-00		1 1			RING, RETAIN		5 DIA MUSIC WIRE	79136 80009	5555-12MD 214-2478-00
	384-0882-06		1					L, INTMDCNCTRC, W/DRIVER	80009	384-0882-06
	105-0802-01		1			ACTUATOR, CA	M SW:TI		80009	105-0802-01
-140	354-0390-00		1				ING:0.3	38 ID X 0.025" THK, STL	79136	5100-37MD
-141	210-0406-00		4			NUT, PLAIN, H	EX.:4-4	0 X 0.188 INCH, BRS	73743	2X12161-402
-142	214-1139-02		1			SPRING, FLAT			80009	214-1139-02
1/2	214-1139-03		1			SPRING, FLAT		LORED	80009	214-1139-03
	214-1752-00 401-0180-00		2			ROLLER, DETE		NIT	80009 80009	214-1752-00 401-0180-00
	376-0039-00		1			BEARING, CAM		8 AND 0.082"DIA SHAFT	80009	376-0039-00
	213-0022-00		2				40 X 0.	188 INCH, HEX SOC STL	74445	OBD
-147	361-0515-00		1		S	PACER, SWITCH	: PLASTI		80009	361-0515-00
-149	131-0604-00		42					D SW,SPR,CU BE	80009	131-0604-00
-150	131-1261-00		26			CONTACT, ELE			00779	1-380953-0
	131-0608-00		17					L X 0.025 PH BRZ GOLD	22526	47357
	136-0252-07		12			SOCKET, PIN			22526	75060-012
			1 1			-		DE(SEE S6205 EPL) DE(SEE S6260 EPL)		
	361-0542-00		8			SPACER, SWIT			71590	J-64281
	384-1007-01		2			-		L X 0.124 OD PLSTC	80009	384-1007-01
-157	384-1149-00		2			ENSION SHAFT			80009	384-1149-00
-158	376-0029-00		2	C	PL	G,SHAFT,RGD:	0.128 I	D X 0.312 OD X 0.5"L	80009	376-0029-00
	376-0051-01	B010850	2					ID X 0.375 OD	80009	376-0051-01
	213-0022-00 384-1542-00		4					8 INCH, HEX SOC STL	74445	OBD
-159	384-1060-00		1			XTENSION SHAFT		L X 0.187 SQ,PLSTC	80009	384-1542-00 384-1060-00
	384-1101-00		1			XTENSION SHA			80009	384-1101-00
-161	384-1560-00		1					L GL FILLED NYLON	80009	384-1560-00
	384-1129-00		5 1			ENSION SHAFT BOARD ASSY:		INCH LONG EAMP(SEE Al EPL)	80009	384-1129-00
-164	211-0244-00		2	S	CR		4-40 X	NG PARTS) 0.312 INCH,PNH STL	78189	OBD
			_		C	KT BOARD ASS		*		
-165	131-0566-00		2					RES,2.375,22 AWG	55210	L-2007-1
	136-0252-07		171			OCKET, PIN CO		-	22526	75060-012
	136-0260-02		2		S	KT, PL-IN ELE	K:MICRO	CIRCUIT, 16 DIP, LOW CLE	71785	133-51-92-008
	136-0269-02		2					CIRCUIT, 14 DIP, LOW CLE	73803	CS9002-14
	131-0608-00	P010100 -000	_					X 0.025 PH BRZ GOLD	22526	47357
-170	214-0579-00		5			ERM, TEST POI			80009	214-0579-00
-171	214-0579-02 131-1003-00	B039950	5 10			ERM,TEST POIS			80009 80009	214-0579-02 131-1003-00
			2					TION(SEE R1055,R1558 EP		131-1003-00
	361-0607-00		2			PACER, SWITCH			80009	361-0607-00
			2			ES., VAR, NONW				

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Fig. & Index		Serial/Model No.						Mfr	M/ Do AN - I
No.	Part No.	Eff Dscont	Qty	У	1 2 3 4 5	Name & Description		Code	Mfr Part Number
-176	361-0515-00		2 1 1			:PLASTIC :BW LIMIT(SEE S1414 EPL) :INVERT(SEE S1995 EPL)		80009	361-0515-00
-178	361-0411-00		4		. SPACER, PUSH S	W:0.13 W X 0.375 INCH L,P	LSTC	71590	J64285-00
	334-3448-00		2		MARKER, IDENT: MA			80009	334-3448-00
170	672-0791-00				CKT BOARD ASSY:			80009	
-1/9	200-1439-00		2		. COVER, CHASSIS			80009	200-1439-00
-180	213-0055-00		2			ATTACHING PARTS) OR:2-32 X 0.188 INCH, PNH	CTI	93907	OBD
	210-0938-00		2			.109 ID X 0.25 INCH OD, ST		75497	
	211-0097-00	B010100 B042994	8			:4-40 X 0.312 INCH, PNH ST		83385	OBD
	211-0661-00		8			:4-40 X 0.25 INCH, PNH, STL		83385	
-183	210-0994-00	B010100 B022379	8			.125 ID X 0.25" OD, STL		86928	5714-147-20N
	210-1307-00	B022380	8			.115 ID, SPLIT, 0.025 THK		86928	A384-25N
-184			2			* Y:ATTENUATOR(SEE A3 EPL) ATTACHING PARTS)			
-185	211-0244-00		8			R:4-40 X 0.312 INCH, PNH S	TL	78189	OBD
	210-0580-00		8			.:0.312-32 X 0.474 INCH, B		73743	OBD
	129-0299-00		8		. POST, ELEC-MEC	H:HEX,0.333 INCH LONG		80009	129-0299-00
-188	210-1307-00		8		. WASHER, LOCK: 0	.115 ID,SPLIT,0.025 THK		86928	A384-25N
			_		FACH CKT BO	* ARD ASSY INCLUDES:			
-189	131-0679-02		2			CPT,:BNC,MALE,3 CONTACT		24931	28JR270-1
			_		· .	ATTACHING PARTS)			
-190	220-0695-00		2			ODEC:0.500-28 X 0.90 INCH	, BRS	73743	OBD
-191	210-1039-00		2		WASHER, LOCK	:INT,0.521 ID X 0.625 INC	H OD	24931	OBD
100	12/ 0252 07					*		00506	75060 010
-192	136-0252-07		24		SOCKET, PIN			22526	75060-012
-193	136-0333-00 131-1030-00		2 10			TERM: 0.138 INCH LONG		00779 80009	1-331677-4 131-1030-00
-193	131-1030-00		10			LEC:CAM SWITCH, BOTTOM Y,EL:CAM SWITCH, TOP			131-1031-00
-194	210-3082-00		10			LLIC:0.047 OD X 0.133 L,B	RASS	80009	210-3082-00
	441-1058-02		1		CHASSIS,SCO		14100		441-1058-02
						ATTACHING PARTS)			
	211-0001-00		2			NE:2-56 X 0.25 INCH, PNH S		83385	
	210-0053-00					:INTL,0.092 ID X 0.175"OD		83385	OBD
~198	210-0405-00		2		, ,	EX.:2-56 X 0.188 INCH, BRS		73743	2X12157-402
	210-0845-00 210-1008-00		1 2			:0.500 ID X 0.625 INCH OD :0.09 ID X 0.188" OD,BRS	, STL	89663 12360	
	210-1000-00		2		WASHER, FLAI	*		12300	OBD
-199	337-1406-00		1		SHLD, ELECTR	ICAL: CAM CONTACTS		80009	337-1406-00
~200			2		CKT BOARD ASSY:	PROBE CODING(SEE A9 EPL)			
						ATTACHING PARTS)			
-201	211-0065-00		2		SCREW, MACHINE: 4	-40 X 0.188 INCH, PNH STL		77250	OBD
			-		. CKT BOARD ASS				
-202	131-0608-00					0.365 L X 0.025 PH BRZ GO	LD	22526	47357
-203					. CKT BOARD ASS	Y:VERT MODE SW(SEE A5 EPL			
201	011 00// 00					ATTACHING PARTS)	on r	70100	0.00
	211-0244-00		1		•	R:4-40 X 0.312 INCH, PNH S	TL	78189	
~205	129-0457-00		1		. SPACER, POST: 1	.07L,W/4-40 TAP 1 END		80009	129-0457-00
			_		CKT BOARD A				
-206	131-0589-00		8			46 L X 0.025 SQ.PH BRZ GL		22526	47350
	131-0608-00					N:0.365 L X 0.025 PH BRZ		22526	47357
	136-0252-07				SOCKET, PIN				75060-012
	136-0269-02		1			LEK:MICROCIRCUIT,14 DIP,L	OW CLE		CS9002-14
	337-0896-00		2			SHLD: CKT BOARD MOUNT, BRS		80009	337-0896-00
	361-0411-00				SWITCH, PB: (DICTO	71500	16/285-00
	105-0243-00		4 2		SPACER, PUSH	SW:0.13 W X 0.375 INCH L	, FLSIC	71590 80009	J64285-00 105-0243-00
			_			ATTACHING PARTS)			
-213	213-0214-00		2			CH:2-56 X 0.375"HEX HD ST	L	70278	OBD
						*			

Replaceable Mechanical Parts-465B Service

Fig. &											
Index	Tektronix	Serial/Model No.							Mf		
No.	Part No.	.Eff Dscont	Qty	1 2	3 4	1 5		Name & Description	Со	de	Mfr Part Number
2-	263-1065-00		2		. SI	W CAM	ACTR	AS:VOLTS/DIV	800	09	263-1065-00
			-		. E	ACH CA	AM SW	ACTR INCLUDES:			
	131-0963-00						-	: GROUNDING		EX	
	210-0406-00							X.:4-40 X 0.188 INCH, BRS	737		2X12161-402
	214-1139-02							GREEN COLORED	800		214-1139-02
	214-1752-00						, DETEN		800		214-1752-00
-218	401-0180-00		1		. Bl	EARING		SW: FRONT	800	09	401-0180-00
210	254 0200 00							ACHING PARTS)	701	~ .	5100 27WD
-219	354-0390-00		1		. R	ING, RI		NG:0.338 ID X 0.025" THK,	STL /91	36	5100-37MD
-220	384-0878-02		1		S	HAFT (CAM SW		800	00	384-0878-02
	105-0282-01					,		SW: DC, GND, AC	800		105-0282-01
-222	210-1189-00						-	0.195 ID X 0.367 INCH OD,			OBD
	214-2043-00							:CONICAL, 0.20 INCH LONG	800		214-2043-00
-223	210-0406-00		4		. N	UT, PL	AIN, HE	X.:4-40 X 0.188 INCH, BRS	737	43	2X12161-402
-224	401-0178-00							SW:CENTER/REAR	800	09	401-0178-00
							(ATT	ACHING PARTS)			
-225	354-0443-00		1		. R	ING, RI	RETAINI	NG:0.328 FREE IDX 0.448 0	D 974	64	200-37
	201 2222		_					*		0.5	201 2002 22
	384-0880-00					-	CAM SW		800		384-0880-00
	105-0521-00							SW: ATTEN	800		105-0521-00
	210-0406-00							X.:4-40 X 0.188 INCH, BRS	737		2X12161-402
-229	214-1139-02							GREEN COLORED	800		214-1139-02
220	214-1139-03							RED COLORED	800		214-1139-03
	214-1752-00						R, DETEN		800	-	214-1752-00
	401-0180-00							SW: FRONT	800 800		401-0180-00
	348-0253-00 407-1127-00		1 1					ACK,OBLONG,3.0X0.925 R,BRASS CU-SN-ZN PL	800		348-0253-00 407-1127-00
233	407-1127-00	1	1	DRAC	KEI	, FREAR		ACHING PARTS)	500	0 9	407-1127-00
-234	210-0586-00)	2	NUT.	PL.	ASSEM		40 X 0.25,STL CD PL	833	85	211-041800-00
			_	,	,			*			
-235			1	CKT	BOA	RD AS	SSY:VER	T OUTPUT(SEE A2 EPL)			
							(ATT	ACHING PARTS)			
-236	211-0244-00)	2	SCR,	ASS	em wsi		O X 0.312 INCH, PNH STL	781	89	OBD
								*			
007	101 0544 00		-					NCLUDES:			
	131-0566-00							MMY RES, 2.375, 22 AWG			L-2007-1
	136-0514-00							ICROCIRCUIT, 8 DIP			CS9002-8
	131-0608-00							65 L X 0.025 PH BRZ GOLD		26	
	136-0252-07					,		W/O DIMPLE	225	26	75060-012
	407-1149-00							E U2260 EPL) OCIRCUIT,BRASS	800	09	407-1149-00
242	407-1149-00	'	1	. DR	MON	EI,GNI		ACHING PARTS)	800	09	407-1149-00
-243	220-0456-00)	1	NIIT	P[.4	IN. HEY		2 X 0.25 INCH, STL	737	43	9038
	210-0055-00							0.145 ID X 0.253 OD, STL			OBD
- / *			-		-		-	*	230	-	
-245	361-0008-00)	3	SPAC	ER.	SLEEVE	Æ:0.11	ID X 0.25 OD X 0.28"H	800	09	361-0008-00
-246	210-0202-00)	1					ID, LOCKING, BRZ TINNED	781	89	2104-06-00-2520N
						-	(ATT	ACHING PARTS)			
-247	211-0507-00		1	SCRE	W,M	ACHIN	NE:6-32	X 0.312 INCH, PNH STL	833	85	OBD
								*			
	386-4225-00		1			-	IP: ALUM		800		386-4225-00
-248	407-1128-00)	1	BRKT	,CR	T SHI		AR, NYLON	800	09	407-1128-00
-240	211.0507.00			0000				ACHING PARTS)	022	0 =	OBD
	211-0507-00 220-0419-00		2					X 0.312 INCH, PNH STL		85 85	OBD OBD
	210-0803-00		1					X 0.312 INCH, STL D X 0.032 THK, STL CD PL	833 123		OBD
	210-0303-00		l		,			ID, LOCKING, BRZ TINNED	781		2104-06-00-2520N
	210-0457-00		1					32 X 0.312 INCH, STL	833		OBD
-,,	2.37 00		-	,	,			*	00,	-	
-254	343-0217-00)	1	CLAM	P,C	01L:Y-	Z-AXIS		800	09	343-0217-00
						-		ACHING PARTS)			
-255	211-0147-00)	2	SCRE	W,M	ACH I NI		X 0.25 INCH, PNH STL	833	85	OBD
-256	210-0994-00)	2	WASH	ER,	FLAT:(ID X 0.25" OD, STL	869	28	5714-147-20N
							-	*			

9-14 REV A, JUN 1980

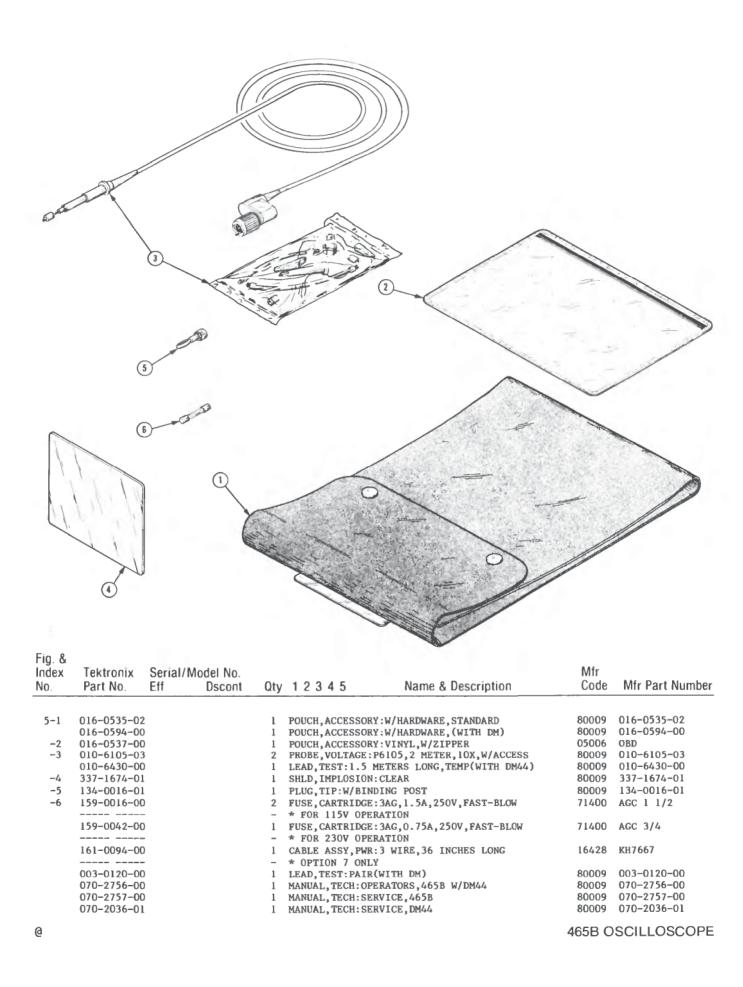


Fig. &								
Index	Tektronix	Serial/Model No.					Mfr	
No.	Part No.	Eff Dscont	Qty	12	3 4 5	Name & Description	Code	Mfr Part Number
2-257			1	COIL	DEFLEC	TION: Y-AXIS(SEE L14165 EPL)		
-258	348-0145-00		1	GROM	IET, PLA	STIC:U-SHP,1.0 X 0.42 INCH	80009	348-0145-00
-259	200-1459-00		1	COVE	R, CRT: RI	EAR	80009	200-1459-00
						(ATTACHING PARTS)		
-260	211-0244-00		2	SCR,	ASSEM W	SHR:4-40 X 0.312 INCH,PNH STL	78189	OBD
						*		
	386-2246-00		1		ORT, CRT		80009	386-2246-00
-262	337-1644-00		1			ICAL: CRT NECK	80009	337-1644-00
	198-4146-00		1		SET, EL		80009	198-4146-00
	175-0825-00		\mathbf{FT}		,	TRICAL: 2 WIRE RIBBON	80009	175-0825-00
	175-0826-00		FT		•	TRICAL: 3 WIRE RIBBON	80009	175-0826-00
	175-0827-00		FT			ELEC:4,26 AWG,STRD,PVC JKT,RBN	08261	SS04267(1061)0C
	175-0828-00		FT			TRICAL:5 WIRE RIBBON	08261	SS-0526-710610C
	175-0829-00		FT	_		TRICAL:6 WIRE RIBBON	08261	SS-0626-710610C
-268	175-0830-00		FT			TRICAL: 7 WIRE RIBBON	08261	SS-0726-710610C
-269	131-0707-00		111			TERM.: 22-26 AWG, BRS& CU BE GOLD	22526	47439
	131-0472-00		4			,PIN:FEMALE	000GE	OBD
-270	352-0169-00		14		•	CONN: 2 WIRE BLACK	80009	352-0169-00
-271	352-0161-00		8			CONN:3 WIRE BLACK	80009	352-0161-00
-272	352-0162-00	B010100 B010799	1			CONN:4 WIRE BLACK	80009	352-0162-00
	352-01 62- 01	B010800	1	. CO	NN BODY	,PL,EL:4 WIRE BROWN	80009	352-0162-01
-273	352-0163-00		3	. CO	NN BODY	,PL,EL:5 WIRE BLACK	80009	352-0163-00
-274	352-0164-00		3	. co	NN BODY	,PL,EL:6 WIRE BLACK	80009	352-0164-00
-275	352-0165-00		3	. CO	NN BODY	,PL,EL:7 WIRE BLACK	80009	352-0165-00
-276	352-0166-00		1	. CO	NN BODY	,PL,EL:8 WIRE BLACK	80009	352-0166-00
	195-0528-00	XB010850	1	LEAD	ELECTR	ICAL:22 AWG,2.0 L,0-N	80009	195-0528-00

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

	Comparison of Main Character	ISTICS
DM 501 replaces 7D13		
PG 501 replaces 107 108 111 114 115	PG 501 - Risetime less than 3.5 ns into 50 Ω. PG 501 - 5 V output pulse; 3.5 ns Risetime. PG 501 - Risetime less than 3.5 ns; 8 ns Pretrigger pulse delay. PG 501 - ±5 V output. PG 501 - Does not have Paired, Burst, Gated, or Delayed pulse mode; ±5 V dc Offset. Has ±5 V output.	 107 - Risetime less than 3.0 ns into 50 Ω. 108 - 10 V output pulse; 1 ns Risetime. 111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger Pulse delay. 114 - ±10 V output. Short proof output. 115 - Paired, Burst, Gated, and Delayed pulse mode; ±10 V output. Short-proof output.
DO 500 reals as 407		
PG 502 replaces 107 108 111	PG 502 - 5 V output PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay.	108 - 10 V output. 111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay.
114 115	PG 502 - ±5 V output PG 502 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; Has ±5 V output.	114 - ±10 V output. Short proof output. 115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; ±10 V output. Short-proof output.
2101	PG 502 - Does not have Paired or Delayed pulse. Has ±5 V output.	2101 - Paired and Delayed pulse; 10 V output.
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V.	106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190,		
190A, 190B 191 067-0532-01	SG 503 - Amplitude range 5 mV to 5.5 V p-p. SG 503 - Frequency range 250 kHz to 250 MHz. SG 503 - Frequency range 250 kHz to 250 MHz.	190B - Amplitude range 40 mV to 10 V p-p. 191 - Frequency range 350 kHz to 100 MHz. 0532-01 - Frequency range 65 MHz to 500 MHz.
TG 501 replaces 180,		
180A	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Marker outputs, 5 sec to 1 µs. Sinewave available at 20, 10, and 2 ns. Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181	TG 501 - Marker outputs, 5 sec to 1 ns. Sine- wave available at 5, 2, and 1 ns.	181 - Marker outputs, 1, 10, 100, 1000, and 10,000 μs, plus 10 ns sinewave.
184	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Marker outputs, 5 sec to 2 ns. Sinewave available at 50, 20, 10, 5, and 2 ns. Separate trigger pulses of 1 and .1 sec; 10, 1, and .1 ms; 10 and 1 μs. Marker amplifier provides positive or negative time marks of 25 V min. Marker intervals of 1 and .1 sec; 10, 1, and .1 ms; 10 and 1 μs.
2901	TG 501 - Marker outputs, 5 sec to 1 ns. Sine- wave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - Marker outputs, 5 sec to 0.1 μs. Sinewave available to 50, 10, and 5 ns. Separate trigger pulses, from 5 sec to 0.1 μs. Multiple time-marks can be generated simultaneously.

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in Instruments require TM 500-Series Power Module.

REV. A, OCT 1975



Date: ____8-13-80

____ Change Reference: _

Product: _

465B SERVICE

SN B046449

_ Manual Part No.: 070-2757-00

DESCRIPTION

REPLACEABLE ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

A1

670-5997-03

CKT BOARD ASSY: VERTICAL PREAMP

A1R1035

315-0271-00

RES., FXD, CMPSN: 270 OHM, 5%, 0.25W

A1R1035 is located on the A1 VERTICAL PREAMP board and is shown on CH 1 VERTICAL PREAMP diagram 1.



Date: 8-27-80

___ Change Reference: _

M39087

Product: _

465B SERVICE EFF SN BO45775-UP

_ Manual Part No.: __

070-2757-00

DESCRIPTION

REPLACEABLE ELECTRICAL PARTS AND SCHEMATIC CHANGES

CHANGE TO:

A1

670-5997-01

CKT BOARD ASSY: VERTICAL PREAMP

A1Q1028

151-0438-00

TRANSISTOR: SILICON, PNP, MPSH81

ADD:

A1C1906

281-0799-00

CAP., FXD, CER DI:62PF, 2%, 100V

Above components apply to the A1 VERTICAL PREAMP board. Q1028 is located on CH 1 VERTICAL PREAMP diagram 1 and C1906 is added in parallel with R1906 on VERTICAL SWITCHING LOGIC diagram 3.

NOTE

The new Q1028 emitter and base leads are transposed with respect to previous version (leads must be crossed to fit existing socket).

2-20-80 Change Reference:

M38666

Product: .

MMITTED TO EXCELLENCE Date: ______ 465B SERVICE SN B039950-UP

Manual Part No.: _

070-2757-00

DESCRIPTION

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

REMOVE:

A7C7192

281-0773-00

CAP., FXD, CER DI:0.01UF, 10%, 100V

C7192 is removed from the A7 TRIGGER GEN & SWEEP LOGIC board and

SWEEP & Z-AXIS LOGIC diagram 7.

6-17-80 Date: ___

____ Change Reference: M40219

Product: _

465B SERVICE SN B045400-up

Manual Part No.: ___

070-2757-00

DESCRIPTION

465B OPTION 05 ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

C13009 (CH 1 & CH 2)

SELECTED AND ADDED WHEN REQUIRED

(VALUE BETWEEN 0.0 PF AND 0.8 PF TO PROVIDE

TOTAL INPUT CAPACITANCE OF ≈ 24 PF FOR OPTION

05 INSTRUMENTS)