TEKTRONIX®

J20/7J20 RAPID-SCANNING SPECTROMETER

SERVICE

INSTRUCTION MANUAL

Tektronix, Inc.
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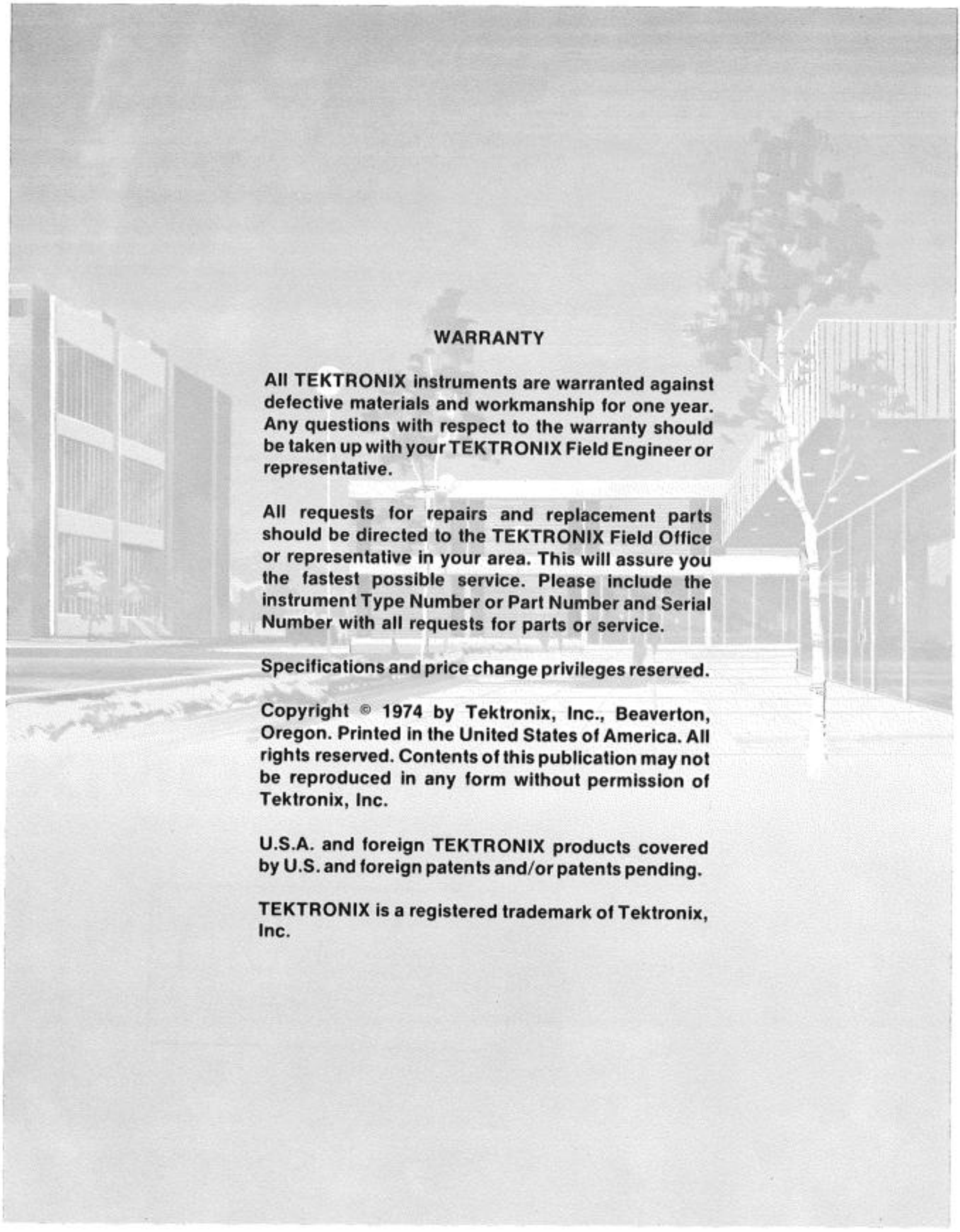

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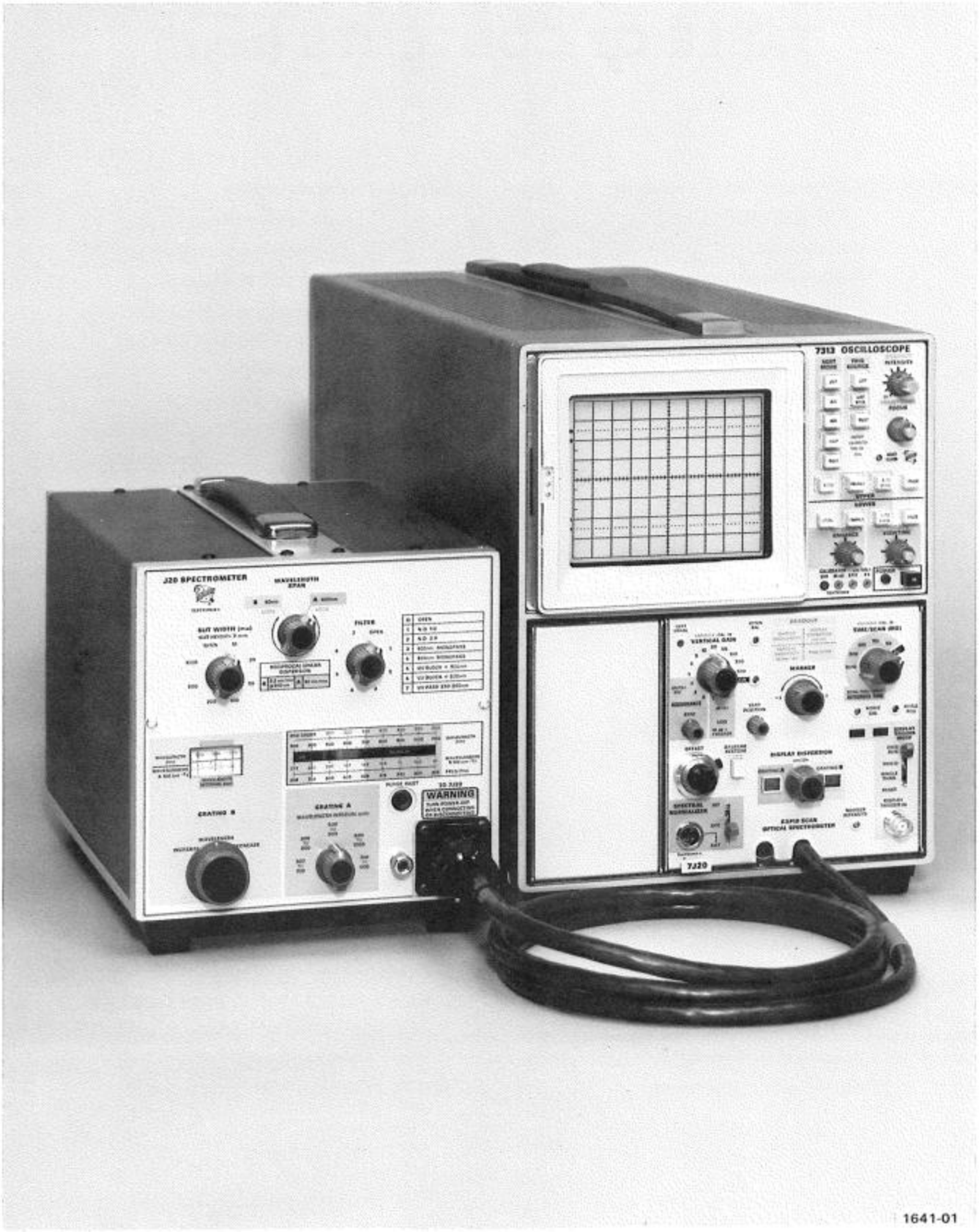
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WARNING
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SPECIFICATION

Description

The J20 Spectrometer and the 7J20 Spectrometer Plug-In form a Rapid-Scanning Spectrometer system capable of scanning the optical spectrum from 250 nm (ultraviolet) to 1100 nm (near infrared). The resulting spectral display is time-resolved spectral power (incident optical power versus wavelength) in calibrated absolute terms.

The J20 Spectrometer uses a Czerny-Turner grating monochromator without an exit slit. The spectral output of the monochromator is focused onto the target of a vidicon tube where the spectrum is stored as an electrical charge image. An electron beam periodically scans across the vidicon target converting the charge image into an electronic signal that is in turn processed by the 7J20 Spectrometer Plug-In. Design of the J20 Spectrometer features two switchable diffraction gratings, selection of entrance slit widths, and a choice of several optical filters any of which can be placed in front of the entrance slit. The two switchable gratings in the J20 Spectrometer allow scanning wide (400 nanometers) or narrow (approximately 40 nanometers) portions of the 250 to 1100 nanometer spectrum.

The 7J20 Spectrometer Plug-In is a two-hole-wide plug-in designed to operate in the Tektronix 7000-series family of oscilloscopes. It functions as an electronic signal-processor and controller between the J20 Spectrometer and the 7000-series oscilloscope. Design of the 7J20 Spectrometer Plug-In features some controls that allow signal manipulation to provide a variety of meaningful displays.

The VERTICAL GAIN switch provides three types of vertical deflection; linear, logarithmic, and inverse logarithmic (absorbance). The GAIN position of the switch displays a ramp signal on the crt to allow setting the output signal amplitude of the 7J20 to match the input sensitivity of the oscilloscope being used. The TIME/SCAN switch selects the mode and time of scanning the vidicon target to provide either repetitive scanning or integration modes of operation. The DISPLAY DISPERSION switch provides crt display horizontal expansion to increase crt display dispersion. Expansion is centered around the intensified wavelength marker. The MARKER control allows horizontal positioning of the intensified wavelength marker in the crt display to permit wavelength identification of specific portions of a spectral display. The SPECTRAL NORMALIZER switch selects between normalized and un-normalized operation. Normalized operation provides radiometric calibration of the spectrometer system.

The 7J20 Spectrometer Plug-In, though it will operate in any 7000-series oscilloscope (even those without crt readout), is primarily intended to be operated in a 7613. The 7613 offers adequate vertical amplifier bandpass to ensure optimum spectrometer performance, and crt readout to take advantage of spectrometer operational features such as the wavelength MARKER control. Additionally, the storage capabilities of the 7613 allow retention of multiple displays to permit direct waveform comparisons in real-time terms. Because the same signals used to scan the vidicon detector are used to provide horizontal deflection in the crt display, no additional plug-ins are necessary for spectrometer operation. The 7J20 Spectrometer Plug-In also features an Interface connector (located on the bottom of the plug-in) to facilitate signal interconnection between the spectrometer system and a recorder, a computer, or a digital signal processor such as the Tektronix 7000-series DPO system.

Specification

The following instrument specifications apply over the ambient temperature range of +15°C to +35°C unless specifically noted otherwise. Warm-up time required to achieve these specified accuracies is 20 minutes. Those characteristics having their limits listed in the Primary Limit column are instrument specifications. Data listed in the Secondary Limit column does not constitute instrument specifications and is provided for reference use only.

SYSTEM OPTICAL SPECIFICATION

CHARACTERISTIC	PRIMARY LIMIT			SECONDARY LIMIT
Spectral Sensitivity Range	250 nm to 1100 nm inclusive 300 nm to 1100 nm first order 250 nm to 330 nm second order with internal first order blocking filter			
Display Spectral Interval				
Grating A	400 nm, ±4 nm (±1%) full scan 200 nm, ±6 nm (±3%) expanded 100 nm, ±3 nm (±3%) expanded 40 nm, ±1.2 nm (±3%) expanded			
Grating B	**300 nm[1]**	**650 nm[1]**	**900 nm[1]**	**1000 nm[1]**
40 nm (Full Scan)	46 nm ±2%	40 nm ±2%	34 nm ±2%	30 nm ±2%
20 nm (Expanded)	23 nm ±4%	20 nm ±4%	17 nm ±4%	
10 nm (Expanded)	11.5 nm ±4%	10 nm ±4%	8.5 nm ±4%	
4 nm (Expanded)	4.6 nm ±4%	4 nm ±4%	3.4 nm ±4%	
Marker Wavelength Accuracy	Measured over the center two crt graticule divisions only			
Grating A				
At +25°C	±10 nm			
From +15°C to +35°C	±12 nm from 300 nm to 500 nm ±13 nm from 500 nm to 900 nm ±14 nm from 900 nm to 1100 nm			
Grating B				
At +25°C	±3 nm			Typically ±2 nm
From +15°C to +35°C	±5 nm from 300 nm to 500 nm ±6 nm from 500 nm to 900 nm ±7 nm from 900 nm to 1100 nm			
Wavelength Mechanical Repeatability[2]				
Grating A	±4 nm			
Grating B	±0.4 nm			

[1]**Display Center Wavelength.**

[2]**Fixed temperature, includes grating change and wavelength interval adjustment, not including digital readout.**

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SYSTEM OPTICAL SPECIFICATION (cont)

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
Wavelength Repeatability[1]		
Grating A	±1 nm	
Grating B	±0.5 nm	
Resolution (Bandwidth At Half Amplitude)		
Grating A	≤4 nm	
Grating B	≤0.4 nm	
Stray Light	≤1% at 600 nm to a notch filter with tungsten illumination	
Steradiancy	0.02 steradians, ±0.006 steradians (±3%)	
Field of View (Full Angle)		
Horizontal	8.2 degrees	
Vertical	9.5 degrees	
Equivalent *f*-number	*f*/6.3	
Ambient Light	10,000 LUX (1000 footcandles) or less of sunlight at all positions around the instrument excluding the optical field of view. No detectable effects.	

GENERAL (UN-NORMALIZED) SPECIFICATION

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
Display Vertical Drift (VERT GAIN 200)	≤1.5 major crt graticule divs/minute (≤0.75 nA/min) at +25°C	≤3 major crt graticule divs/minute at +35°C
Display Baseline Flatness (VERT GAIN 200)		≤6 major crt graticule divs p-p (≤3 nA p-p) at +25°C
Display Noise (VERT GAIN 200)	≤0.4 major crt graticule divs p-p (≤0.2 nA p-p) for 10 ms and 20 ms scan rates	Typically ≤0.2 major crt graticule divs p-p (≤0.1 nA p-p) at +25°C
Vertical Linearity Using Switched Attenuation (Linear Gains)	±4% of light level with oscilloscope crt linearity excluded	±2-1/2% crt linearity additive to Vertical Linearity specification

[1]**Fixed temperature, not including grating change, wavelength interval adjustment, or digital readout.**

GENERAL (UN-NORMALIZED) SPECIFICATION (cont)

CHARACTERISTIC	PRIMARY LIMIT		SECONDARY LIMIT
Logarithmic Gains Accuracy (300 nA Reference Level)			
True Log I	**Measured Log I**	**Error %**	
−1.0 dB	−1.04 dB to −0.918 dB	+3-1/2, −8.2	
−2.0 dB	−2.07 dB to −1.58 dB	+3-1/2, −21.1	
−3.0 dB	−3.11 dB to −1.78 dB	+3-1/2, −40.7	
Absorbance Gains Accuracy (300 nA Zero Absorbance Reference Level)			
True Absorbance	**Measured Absorbance**	**Error %**	
0 A	0	0	
0.3 A	0.311 to 0.284 A	+3-1/2, −5.3	
0.6 A	0.621 to 0.563 A	+3-1/2, −6.2	
1.0 A	1.04 to 0.918 A	+3-1/2, −8.2	
1.3 A	1.35 to 1.16 A	+3-1/2, −10.8	
1.6 A	1.66 to 1.37 A	+3-1/2, −14.4	
2.0 A	2.07 to 1.58 A	+3-1/2, −21.1	
3.0 A	3.11 to 1.78 A	+3-1/2, −40.7	
Vertical Deflection Electrical Sensitivity (Linear Gains)	$\left(\frac{100\text{ nA}}{\text{VERT GAIN}}\right)$ per div, ±5%		Typically ±3%

Typical Response Times (Lag) From Initial Signal Level I_0 to I_0 −0.9 Δ i For 10 ms & 20 ms Scan Rates

	Initial Signal Intensity Level, I_0					
Signal Change (Δ i)	**500 nA**	**200 nA**	**100 nA**	**50 nA**	**20 nA**	**10 nA**
500 nA	40 ms[4]					
200 nA		60 ms[4]				
100 nA		43 ms	82 ms[4]			
50 nA		35 ms	46 ms	97 ms[4]		
20 nA		34 ms	44 ms	64 ms	250 ms[4]	
10 nA		36 ms	47 ms	65 ms	135 ms	350 ms[4]

[4]To full off.

NORMALIZED OPERATION

CHARACTERISTIC	PRIMARY LIMIT		SECONDARY LIMIT
	All normalized operation limits are specified with a 20 ms scan rate. All radiometric measurements are made to a ribbon filament radiance lamp traceable to NBS. Specification limits arrived at by quadrature (square root of sum of squares).		
Radiometric			
Spectral Range	400 nm to 967 nm for Grating A 367 nm to 900 nm for Grating B		
Vertical Scale Factor Readout	W/(nm · div) of crt deflection as detected at J20 entrance slit.		
Radiant Power Accuracy	**Grating A**	**Grating B**	
400 nm—600 nm	±20%		
600 nm—967 nm	±12%		
367 nm—600 nm		±12%	
600 nm—900 nm		±11%	
Radiant Power Repeatability (To Individual Calibration Curve Available For Each Instrument)			
400 nm—600 nm	±13%		
600 nm—967 nm	±3.5%		
367 nm—600 nm		±5.5%	
600 nm—900 nm		±3%	
Spectral Flatness	±15% p-p	±15% p-p	
Noise Equivalent Power (20 μm Slit, VERT GAIN 200)	50 pW/nm (one div)	500 pW/nm (one div)	
Linearity	±6% not including oscilloscope linearity error over the range of noise level to 0.7 of saturation current.		
Dynamic Range	≥1500:1		Lower limit of dynamic range is Noise Equivalent Power Level for each grating.

NORMALIZED OPERATION (cont)

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
	All normalized photometric limits are specified using an external normalizer with the system normalized to 400 nA vidicon signal current over a wavelength interval using a quartz iodine lamp.	
Photometric Accuracy		
Linear Gains	±4% T un-normalized ±6% T normalized	Not including linearity error of oscilloscope
Absorbance Gains		
Un-normalized	Refer to limits specified in General Operation Specifications	
Normalized	Random error of 2% additive to un-normalized tolerance.	

J20 SPECTROMETER OPTICAL SPECIFICATION

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
Entrance Slits		
Height	7 mm, ±0.05 mm	
Widths	10 μm, ±5% 20 μm, ±2-1/2% 50 μm, ±3% 100 μm, ±2% 200 μm, ±1% 500 μm, ±1% 1000 μm, ±1%	
Spherical Mirrors		
Coating	Aluminum reflective coating with magnesium fluoride overcoating.	
Plane Flat Mirrors		
Coating	Aluminum reflective coating with magnexium fluoride overcoating.	
Diffraction Gratings		
Grooves/mm		
Grating A	Approximately 150 grooves/mm	
Grating B	1200 grooves/mm	

J20 SPECTROMETER OPTICAL SPECIFICATION (cont)

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
Neutral Density Filters		
Variation In Density	±5% of specified density from 400 nm to 1000 nm inclusive.	
Dimensions		
Height	15.8 mm, +0, −0.38 mm	
Width	7.9 mm, +0, −0.38 mm	
Thickness	2.8 mm to 3.3 mm inclusive	
Monopass Filters		
Peak Wavelength	Within 1 nm of specified value.	
Dimensions	Same as for Neutral Density Filters.	
Ultraviolet Cutoff Filters		
Dimensions	Same as for Neutral Density Filters.	
Ultraviolet Pass Filters		
Dimensions	Same as for Neutral Density Filters.	

J20 SPECTROMETER ELECTRICAL SPECIFICATION

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
Readout Circuits		
Center Wavelength Readout Signals		
Grating A		+2 V, +3 V, +4 V, +5 V, and +6 V (switched steps; all ±0.75%) 1 V/100 nm, ±0.2%[5]
Grating B		0 to +8 volts continuously variable. 1 V/100 nm, ±0.2%[5]
Preamplifier		
Gain		2 mV/nA, ±2-1/2% loaded
Bandwidth		150 kHz, ±25%
Transient Response		2.3 μs t_r, ±25%

[5]**Referenced to +8 V power supply.**

J20 SPECTROMETER ELECTRICAL SPECIFICATION (cont)

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
Noise		1 mV p-p, 1 kHz—300 kHz at −3 dB
Target Voltage		+8 V, ±5%
Horizontal Deflection Amplifier		
Input Signal		Ramp voltage waveform 0 to +8 volts.
Output		
Average Plate Potential		250 V, ±1 V (adjustable)
Voltage Differential		Approximately 95 V p-p each plate.
Gain Range		±10%
Position Range		±7 V differential each plate.
Slew Rate		≥6.3 volts/μs
Vertical Oscillator		
Frequency		1 MHz, ±25%
Amplitude		68 V, ±4V on one plate
Amplitude Range		25 to 70 volts p-p
Amplitude Stability		±4 volts p-p, 0 to +50° C

7J20 SPECTROMETER PLUG-IN ELECTRICAL SPECIFICATION

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
	Vertical specifications apply only when HORIZ CAL, ATTEN BAL, HORIZ POS, and GAIN adjustments are correctly adjusted.	
Vertical		
Linear Deflection		
Gain Accuracy	Within 1% between any two switch positions.	
Sensitivity		0.2 V/div, ±1% with VERTICAL GAIN set to 1 and SPECTRAL NORMALIZER set to OFF.

7J20 SPECTROMETER PLUG-IN ELECTRICAL SPECIFICATION (cont)

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT	
Vertical Position Range	Can position display baseline to above the center horizontal graticule line and to below the bottom horizontal graticule line.		
Step Attenuator Balance	±0.4 division baseline shift		
Displayed Noise (Input Grounded VERT GAIN 200, TIME/SCAN 10 ms)			
Normalizer On		≤1 div p-p	
Normalizer Off		≤0.2 div p-p	
Deflection Linearity			
Normalizer On		±1% of full scale deflection	
Normalizer Off		±0.5% of full scale deflection	
Transient Response		**10 ms Scan**	**Other Scans**
Risetime			
Normalizer On		10.8 μs ±10%	18.2 μs ±10%
Normalizer Off		10.2 μs ±10%	14.8 μs ±10%
Aberrations		≤0.2 div	≤0.2 div
Offset			
Range	0—1000 nA of signal current		
Sensitivity (Normalizer Off)	100 nA, ±3%, ±1 nA signal current/turn	200 mV, ±2%, ±1 nA per turn at the input to the 7J20	
Drift	1.5 nA/minute at +35° C		
Baseline Restore Range		0—500 nA minimum	
Logarithmic Deflection (BASELINE RESTORE Recently Pushed)			
Input To Log Converter (Referred To 7J20 Input)	Signal current plus 2 to 6 nA		
Log Gain Accuracy Referred To Log Converter Input	±3-1/2% excluding oscilloscope linearity error	2-1/2% oscilloscope linearity error additive	
Offset	One turn = one decade		
Offset Accuracy	±2% of dial referenced to graticule		

7J20 SPECTROMETER PLUG-IN
ELECTRICAL SPECIFICATION (cont)

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
Inverse Logarithmic (Absorbance) Deflection Referred To Log Converter Input		
Gains Accuracy	±4-1/2% excluding oscilloscope linearity error	2-1/2% oscilloscope linearity error additive
Offset	One turn = one absorbance unit	
Offset Accuracy	±2% of dial referenced to graticule	
ABSORBANCE ZERO Range	Saturation to ≥10 nA equivalent	
Wavelength Marker Readout		
Center Wavelength Readout With Test Point 966 Grounded		
S964 In Ground		300 nm, ±1 nm
S964 In +8 V		1100 nm, ±3 nm
Change In Readout From Left Edge To Right Edge Of Graticule		400 nm, ±1 nm for Grating A. 40 nm, ±3 nm for Grating B.
Horizontal		
Scan Time Accuracy	±1% for 10 and 20 ms scan intervals ±3% for integrate mode scan intervals	
Variable Time/Scan Control Range	Increases scanning speed by a factor of at least 2.5:1.	
Holdoff and Reset Time		60 μs, ±3 μs
Ramp Levels		
At Holdoff		−0.2 V, ±0.1 V
At Peak		+8.25 V, ±0.25 V
Ramp Reset Time		≤0 V in less than 25 μs from trailing edge of SCAN pulse.
Restore Pulse		A 30 μs, ±3 μs wide pulse that goes positive 24 μs, ±2.5 μs after the end of scan.
Position Range (DISPLAY DISPERSION In Unexpanded Position)		At least a total of one div adjustment.

7J20 SPECTROMETER PLUG-IN ELECTRICAL SPECIFICATION (cont)

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
Horizontal Amplifier Gain		0.8 V/div, ±15% front panel calibration range.
DISPLAY DISPERSION Expansion Accuracy	±2%	
Wavelength Marker Stability		≤0.2 major crt graticule div variation with MARKER control fully cw, DISPLAY DISPERSION expanded.
Wavelength Marker Width		Less than 0.3 div of intensification with DISPLAY DISPERSION set for 10X expansion.
DISPLAY TRIGGER IN Connector		
Input Impedance	11 kΩ, ±10%	
Maximum Input Voltage	±50 V	
Signal Requirements For Display Triggering	Ground-closure logic or negative-going TTL (0 to +0.8 V = on; +2.4 V to +5 V = off) with a minimum pulse width of 1 μs.	
+8 Volt Reference		
Output Accuracy		±0.04 V
Stability		10 mV output variation over the +15° C to +35° C temperature range.
SCAN Control Input		
Signal Requirements	Positive-going signal with a minimum pulse width of 1 μs with the most positive excursion to a DC level between +2.4 V and +5 V.	

ENVIRONMENTAL SPECIFICATION

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
Temperature		Instrument will operate over 0° C to +40° C range but measurement accuracies are unspecified.
Operating	+15° C to +35° C	
Nonoperating	−30° C to +50° C	

ENVIRONMENTAL SPECIFICATION (cont)

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
Altitude		
Operating	To 15,000 feet	
Nonoperating	To 50,000 feet	
Humidity	≤95% relative humidity, noncondensing from +15°C to +35°C, operating or nonoperating for four hours.	
Vibration	15 minutes along each of the 3 major axes at a total displacement of 0.015 inch, p-p with frequency varied from 10 to 55 to 10 Hz in one-minute cycles. After sweep vibration in each axis, hold frequency steady at each major resonance for 3 minutes, or if no such resonances are found, hold at 55 Hz for 3 minutes.	
Transportation	Tested to National Safe Transit Committee procedure 1A with a 36 inch drop.	

PHYSICAL SPECIFICATION

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
J20 Spectrometer		
Height	8 inches	
Width	7 inches	
Depth	13 inches	
Net Weight (With Connection Cable)	16.5 pounds	
Domestic Shipping Weight	Approximately 21.6 pounds	
Export-Packed Weight	Approximately 29.6 pounds	
7J20 Spectrometer Plug-In		
Height	5 inches	
Width	5.5 inches	
Depth	14.5 inches	
Net Weight	4.3 pounds	
Domestic Shipping Weight	Approximately 9.3 pounds	
Export-Packed Weight	Approximately 16.5 pounds	

PHYSICAL SPECIFICATION (cont)

CHARACTERISTIC	PRIMARY LIMIT	SECONDARY LIMIT
J20/7J20 System (Packed Together)		
Domestic Shipping Weight	Approximately 34 pounds	
Export-Packed Weight	Approximately 49 pounds	

OPERATING INFORMATION

Introduction

This section of the manual is intended to familiarize the operator with the instrument's controls and connectors and provides instructions for obtaining one of the basic displays of which the instrument is capable. For more complete operating information, refer to the J20/7J20 Rapid-Scanning Spectrometer Operators Instruction Manual.

CONTROLS AND CONNECTORS

General

The controls and connectors essential to the operation of the Rapid-Scanning Spectrometer are located on the front panel of the 7J20 Spectrometer Plug-In and the rear panel of the J20 Spectrometer. A brief description of each control and connector follows. Refer to the appropriate instruction manual for the oscilloscope used for oscilloscope operating instructions.

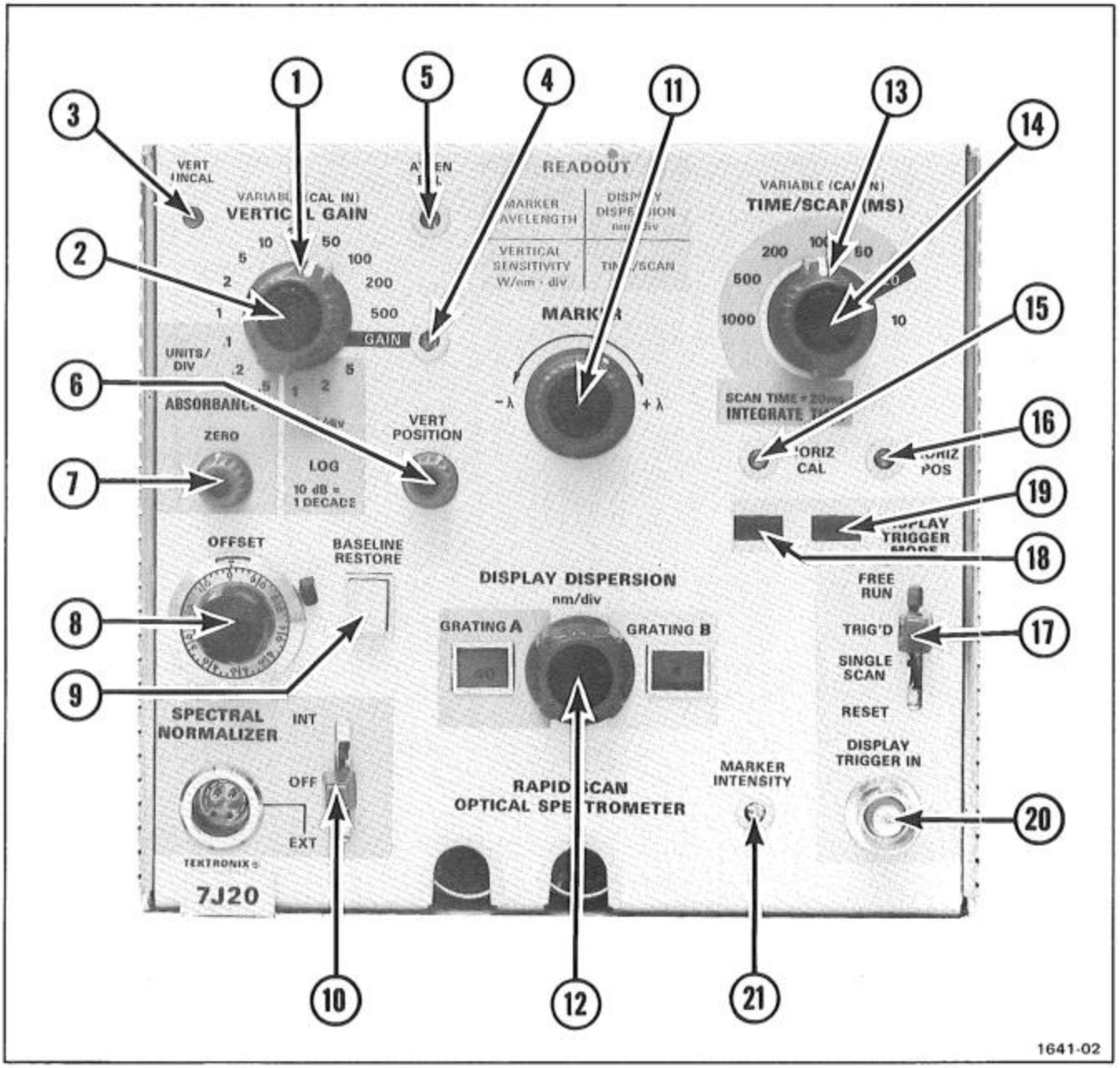


Fig. 2-1. 7J20 Spectrometer Plug-In controls and connectors.

7J20 Spectrometer Plug-In

1. VERTICAL GAIN Switch

This is a 16-position rotary switch that selects calibrated vertical deflection factors for the crt display. Three types of deflection are provided.

In the 1 through 500 positions of the switch, vertical deflection in the display is linear. The switch-position numbers indicate amplification factors (i.e., in the 10 position, the vertical signal is amplified ten times that in the 1 position). Vertical deflection in terms of nanoamperes of vidicon signal current is

$$\frac{100\ \text{nA}}{\text{VERTICAL GAIN.}}$$

In the LOG positions, vertical deflection is logarithmic and each vertical division in the display represents a specified number of decibels.

In the ABSORBANCE positions, vertical deflection is inverse logarithmic and each vertical division represents a specified number of absorbance units.

The lower-left portion of the crt readout indicates the vertical sensitivity.

2. VARIABLE Control

This is a combination pushbutton switch/rotary control. When the switch is set to the uncalibrated (button out) position, the vertical deflection is uncalibrated. The rotary control provides uncalibrated deflection factors continuously variable between the calibrated settings of the VERTICAL GAIN switch. In the calibrated (button in) position, the vertical deflection factor is calibrated and the rotary VARIABLE control has no effect.

3. VERT UNCAL Indicator

This is a lamp to indicate when the vertical deflection factor is uncalibrated. The lamp will be lit when the vertical VARIABLE control is in the uncalibrated (button out) position, when the FILTER switch on the J20 Spectrometer is not in the 0, 1, or 2 positions, when the TIME/SCAN switch on the 7J20 Plug-In is in the 10 ms position, when the SPECTRAL NORMALIZER switch on the 7J20 Plug-In is not in the INT position, or when the SLIT WIDTH switch on the J20 is in the OPEN position.

4. GAIN Adjust

A screwdriver adjustment used to set the vertical output signal amplitude of the 7J20 to match the input sensitivity of the vertical deflection system of the oscilloscope in which the plug-in is installed. Provides calibrated vertical deflection system operation.

5. ATTEN BAL Adjust

A screwdriver adjustment to minimize baseline shift in the crt display when switching between adjacent positions of the VERTICAL GAIN switch.

6. VERT POSITION Control

Controls the vertical position of the crt display.

7. ABSORBANCE ZERO Control

This control vertically positions the zero absorbance (100% T) reference line in the crt display. The control functions only in the three ABSORBANCE positions of the VERTICAL GAIN switch and is independent of the VERT POSITION control.

8. OFFSET Control

This is a multi-turn control used to offset high-amplitude, vertically-overscanned displays to bring the area of interest back within the limits of the crt graticule area.

9. BASELINE RESTORE Pushbutton

This pushbutton switch, when pushed, closes the entrance-slit shutter in the J20 Spectrometer. This provides a zero-light level reference baseline in the crt display and resets the dark-current restoring circuit.

10. SPECTRAL NORMALIZER Switch

This three-position lever switch allows selection of internal normalization, external normalization, or no normalization at all. When the switch is in the INT position, the system is radiometrically calibrated (provided the VERT UNCAL indicator is not lit).

11. MARKER Control

This is a horizontal positioning control for the intensified wavelength marker in the crt display. The upper-left portion of the crt readout indicates in nanometers the wavelength being highlighted by the intensified marker.

12. DISPLAY DISPERSION Switch

This is a four-position switch that selects the different calibrated dispersion factors for the horizontal axis of the crt display. When using Grating A, the dispersion factors are 40 nm/div, 20 nm/div, 10 nm/div, and 4 nm/div. For Grating B, the dispersion factors are 4 nm/div, 2 nm/div, 1 nm/div, and 0.4 nm/div. The upper-right portion of the crt readout indicates in nanometers the wavelength span displayed over one horizontal division of the crt graticule.

13. TIME/SCAN Switch

This seven-position rotary switch selects the mode and interval of scanning the vidicon target in the J20. In the 10 ms and 20 ms positions, the vidicon is scanned by successive sweeps, one immediately following another. In the 50 ms through 1000 ms positions, the vidicon is scanned by 20 ms sweeps, the start of each sweep separated from the start of the next by the amount of integration time selected. The lower-right portion of the crt readout indicates in milliseconds the time/scan selected by this switch.

14. VARIABLE Control

This is a combination pushbutton switch/rotary control. When the switch is set to the uncalibrated (button out) position, the time/scan is uncalibrated. The rotary control provides uncalibrated time/scan continuously variable between the calibrated settings of the TIME/SCAN switch. The VARIABLE control reduces the fastest scan interval to 4 ms or less. In the calibrated (button in) position, the time/scan is calibrated and the rotary VARIABLE control has no effect.

15. HORIZ CAL Adjust

This screwdriver adjustment sets the horizontal output signal amplitude of the 7J20 to match the input sensitivity of the horizontal deflection system of the oscilloscope being used. Provides calibrated horizontal deflection system operation.

16. HORIZ POS Adjust

A screwdriver adjustment that controls the horizontal position of the crt display.

17. DISPLAY TRIGGER MODE Switch

This four-position lever switch selects the mode of triggering a display. In the FREE RUN position, a display is continuously provided. In the TRIG'D position, a display is provided only when ground-closure logic is present at the DISPLAY TRIGGER IN connector. In the SINGLE SCAN position, one, and only one, scan is presented upon receipt of a ground-closure trigger signal. Two things are necessary for correct SINGLE SCAN operation. The DISPLAY TRIGGER MODE switch must be in the SINGLE SCAN position, and the circuit must be armed prior to receipt of the triggering signal. To arm the circuit, set the DISPLAY TRIGGER MODE switch to the RESET position briefly, then release it to return to the SINGLE SCAN position.

18. TRIG'D Light

This lamp indicates when a display trigger signal is present at the DISPLAY TRIGGER IN connector.

19. READY Light

This lamp indicates when the system is waiting for a trigger.

20. DISPLAY TRIGGER IN Connector

This is a BNC connector for application of external display-trigger signals. Negative-going trigger signals at least 1 μs wide with the most negative excursion to a dc level of between +0.8 V and 0 V will trigger a display. Ground-closure logic will provide adequate triggering.

21. MARKER INTENSITY Adjust

This screwdriver adjustment provides the ability to vary the relative intensity level of the wavelength marker in the crt display.

Interface Connector (Underside of instrument; not shown)

A 25-pin connector used to facilitate signal interconnection with a computer or data tape recorder.

Pin 1—Marker output; a TTL (transistor-transistor logic) signal that goes HI at the marker point. Capable of driving two TTL load units or less.

Pin 2—Grating number output; a TTL signal that goes HI for B grating and LO for A grating. Capable of driving two load units or less.

Pin 3—Wavelength center signal output; signal represents wavelength at the center of the vidicon scan area. Zero volts represents 300 nanometers. One volt change in output signal represents 100 nanometers change in center wavelength, ±2% (e.g., 2.5 V = 550 nm).

Pin 4—Ramp output; positive-going linear ramp signal with an amplitude of 0.8 V/horizontal division of deflection, ±10%. Maximum loading is 50 kΩ paralleled by 500 pF.

Pins 5, 6, and 7—Binary-coded TTL output signals; indicate TIME/SCAN switch position. Pin 7 output signal (output A) is the most significant digit; pin 5 output signal (output C) is the least significant digit. Each output is capable of driving two load units or less.

A*	B*	C*	TIME/SCAN
0	0	1	1000 ms
0	1	0	500 ms
0	1	1	200 ms
1	0	0	100 ms
1	0	1	50 ms
1	1	0	20 ms
1	1	1	10 ms

Pin 8—SCAN output; a TTL signal that goes HI when the vidicon target is being scanned. Output is capable of driving one load unit or less.

Pin 9—Z-Axis output; a TTL signal that goes HI when a display is being presented. Output is capable of driving two load units or less.

Pin 10—SCAN Control input; a TTL signal that causes normal scanning when it is HI. When LO, the ramp is held in reset. The ramp will start when "SCAN Control" goes HI. Minimum pulse width (HI) is 1 μs. Loading is equal to one load unit or less (51 Ω paralleled by 1000 pF).

Pin 11—Wavelength Marker Count Gate output; a TTL signal. While the Wavelength Marker Count Gate is HI, counting the negative transitions of the Wavelength Marker Clock will yield the Wavelength Marker readout in nanometers. Output is capable of driving two load units or less paralleled by 20 pF.

Pin 12—Wavelength Clock output; a TTL signal approximately 100 kHz in frequency. Counting the negative transitions of this clock signal while the Wavelength Marker Count Gate is HI will yield the Wavelength Marker readout in nanometers. Output is capable of driving two load units or less paralleled by 200 pF.

Pin 13—Ground.

Pin 14—Vertical Signal output; positive-going analog signal 2 mV/nA, ±5% in amplitude referenced to ground. Signal includes Normalizer and dark current correction but excludes switched attenuators. Output is capable of driving 5 kΩ paralleled by 500 pF.

Pin 15—Shield for center conductor of coaxial cable connected to pin 14.

Pin 16—Uncorrected Vertical Signal output; positive-going analog signal 1 mV/nA, ±5% in amplitude referenced to ground. Does not include Normalizer or dark current correction. Output is capable of driving 5 kΩ paralleled by 500 pF.

Pin 17—Shield for center conductor of coaxial cable connected to pin 16.

Pin 18—Display Vertical Signal output; positive-going analog signal 75 mV/div, ±10% in amplitude. Output is capable of driving 10 kΩ paralleled by 500 pF.

Pin 19—Shield for center conductor of coaxial cable connected to pin 18.

Pin 20—Not used.

Pin 21—Uncal Bus output; a TTL signal that, when HI, indicates that radiometric calibration is valid.

Pin 22—Baseline Restore. This is a combination input-output pin terminal.

Output: the output signal is HI (approximately +15 V) when the BASELINE RESTORE pushbutton is not pressed, and LO (zero volts) when the button is pressed. Peak output current is one ampere. Average output current is approximately 400 milliamperes.

Input: ground-closure logic at pin 22 causes the J20 Spectrometer shutter to close and also activates the dark-current restoring circuit in the 7J20 Spectrometer Plug-In.

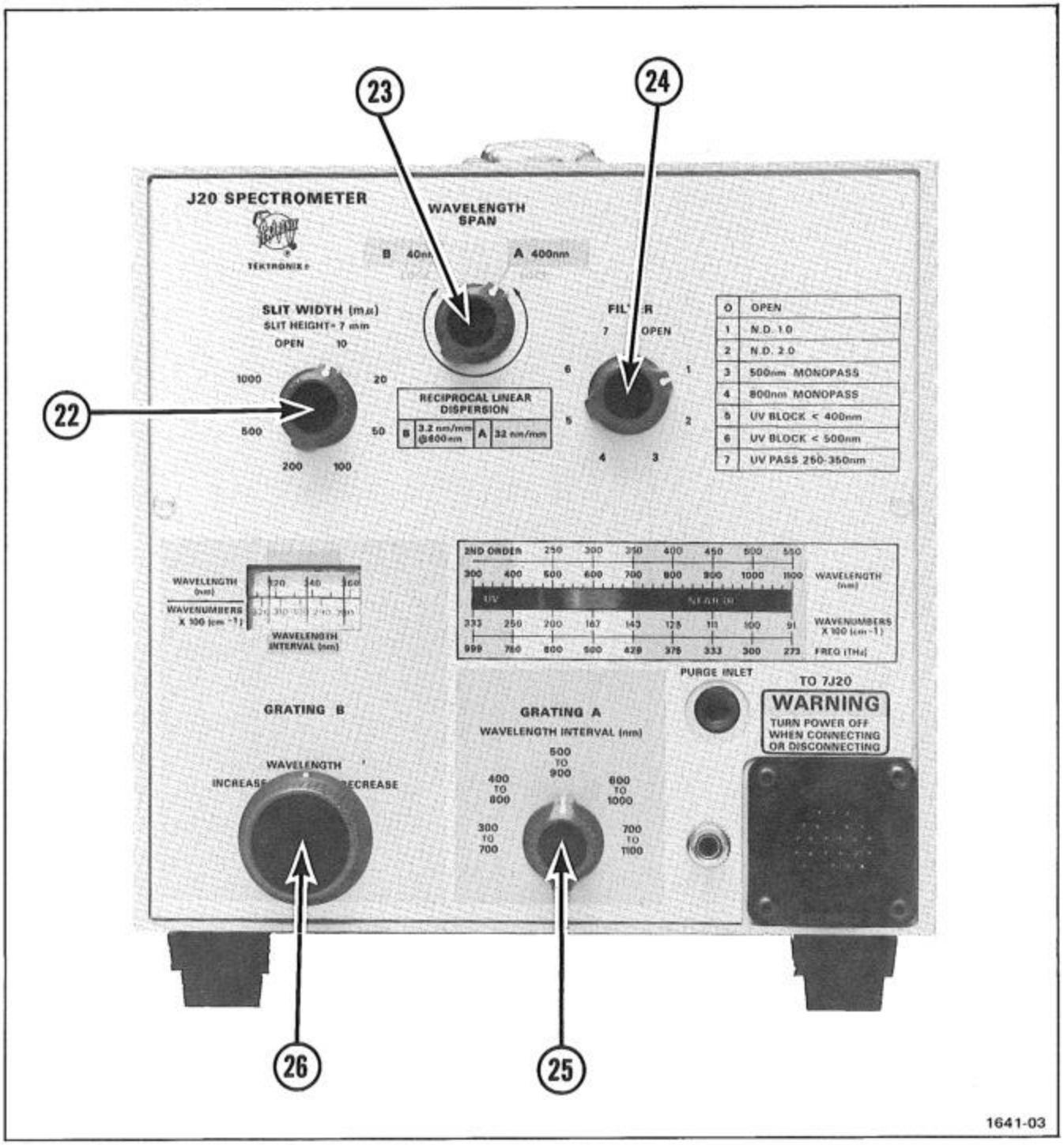
Pin 23—Slit Wheel Position output; an analog signal that, in conjunction with the "Drop Zero" signal (pin 24), indicates which entrance slit is being used in the J20. DC voltage levels output at this pin are accurate within 0.2 volt. Maximum loading for this output is one megohm.

***1 represents the HI state.**

DC Level	"Drop Zero"	Slit Position
14.0 V	1	OPEN
13.5 V	1	10 μm
13.0 V	1	20 μm
12.5 V	1	50 μm
12.0 V	1	100 μm
13.0 V	0	200 μm
12.5 V	0	500 μm
12.0 V	0	1000 μm

Pin 24—Drop Zero output; a TTL signal that is LO in 1000 μm, 500 μm, and 200 μm slit positions and HI for the remaining slit positions of the slit wheel in the J20. This output is capable of driving two load units or less.

Pin 25—Ground.



1641-03

Fig. 2-2. J20 Spectrometer controls and connectors.

J20 Spectrometer

22. SLIT WIDTH Switch

This is an 8-position switch used to select various dimensions for the entrance slit to the J20 Spectrometer. All slits have the same (7 mm) height. Slit widths that can be selected are 10 μm through 1000 μm in 1-2-5 steps, and fully open (5 mm).

23. WAVELENGTH SPAN Switch

This 2-position switch selects one of two diffraction gratings. Grating A has a 400 nm wavelength span in the display with 32 nm/mm reciprocal linear dispersion at the vidicon target. Grating B has a 40 nm wavelength span in the display with approximately 3.2 nm/mm reciprocal linear dispersion at 650 nm at the vidicon target.

24. FILTER Switch

This 8-position switch determines which optical filter is placed in front of the spectrometer entrance slit. The selection contains the following filters:

0	Open (no filter)
1	Neutral Density 1.0
2	Neutral Density 2.0
3	500 Nanometer Monopass
4	800 Nanometer Monopass
5	Ultraviolet Block <400 Nanometers
6	Ultraviolet Block <500 Nanometers
7	Ultraviolet Pass 250 nm—330 nm Second Order

The neutral density filters will not vary in specified density more than ±5% over the 400-1000 nanometer range (±12% from 250 nm to 400 nm and from 1000 nm to 1100 nm). The monopass filters exhibit very narrow bandpass characteristics with peak wavelength being within ±1 nm of the specified value. Transmission at peak wavelength is at least 25% with a half bandwidth of less than three nanometers. The artwork shown in Fig. 2-3 depicts the typical transmittance characteristics of the ultraviolet blocking and monopass filters.

25. GRATING A WAVELENGTH INTERVAL Switch

This rotary switch selects one of five fixed wavelength intervals to be scanned when using diffraction Grating A. The five intervals are 300-700 nm, 400-800 nm, 500-900 nm, 600-1000 nm, and 700-1100 nm.

26. GRATING B WAVELENGTH Control

When using Grating B, this multi-turn control determines where in the instrument's 300-1100 nanometer spectral range a 40-nanometer interval will be scanned. The 40-nanometer interval is continuously variable throughout the spectral range of the instrument.

OBTAINING A BASIC DISPLAY

Introduction

The following procedure is designed to assist an operator, unfamiliar with the J20/7J20 Rapid-Scanning Spectrometer system, to put the system into operation. Using this procedure allows the operator to obtain one of the basic displays of which the instrument is capable. This basic display can be used as a starting point for becoming familiar with the effect the various instrument controls have on the spectrometer display.

NOTE

To avoid unnecessary vidicon-detector aging and degradation, turn the instrument off when not actually being used.

Operation

To place the J20/7J20 Rapid-Scanning Spectrometer into operation, proceed as follows:

1. Connect the J20 Spectrometer to the 7J20 Spectrometer Plug-In using the interconnect cable provided with the instrument. Lock the cable onto the Spectrometer connector (on the bottom of the 7J20) using a small tool (such as a small-bladed screwdriver) to push the connector lock into place. Slide the cable retainer into place on the bottom of the 7J20.

2. Install the 7J20 Spectrometer Plug-In into the oscilloscope. Make sure the plug-in occupies one horizontal and one vertical plug-in compartment of the oscilloscope.

3. Set the following oscilloscope controls to the positions indicated.

VERTICAL MODE	RIGHT
HORIZONTAL MODE (if applicable)	A
STORE (if applicable)	Button out (non-store)

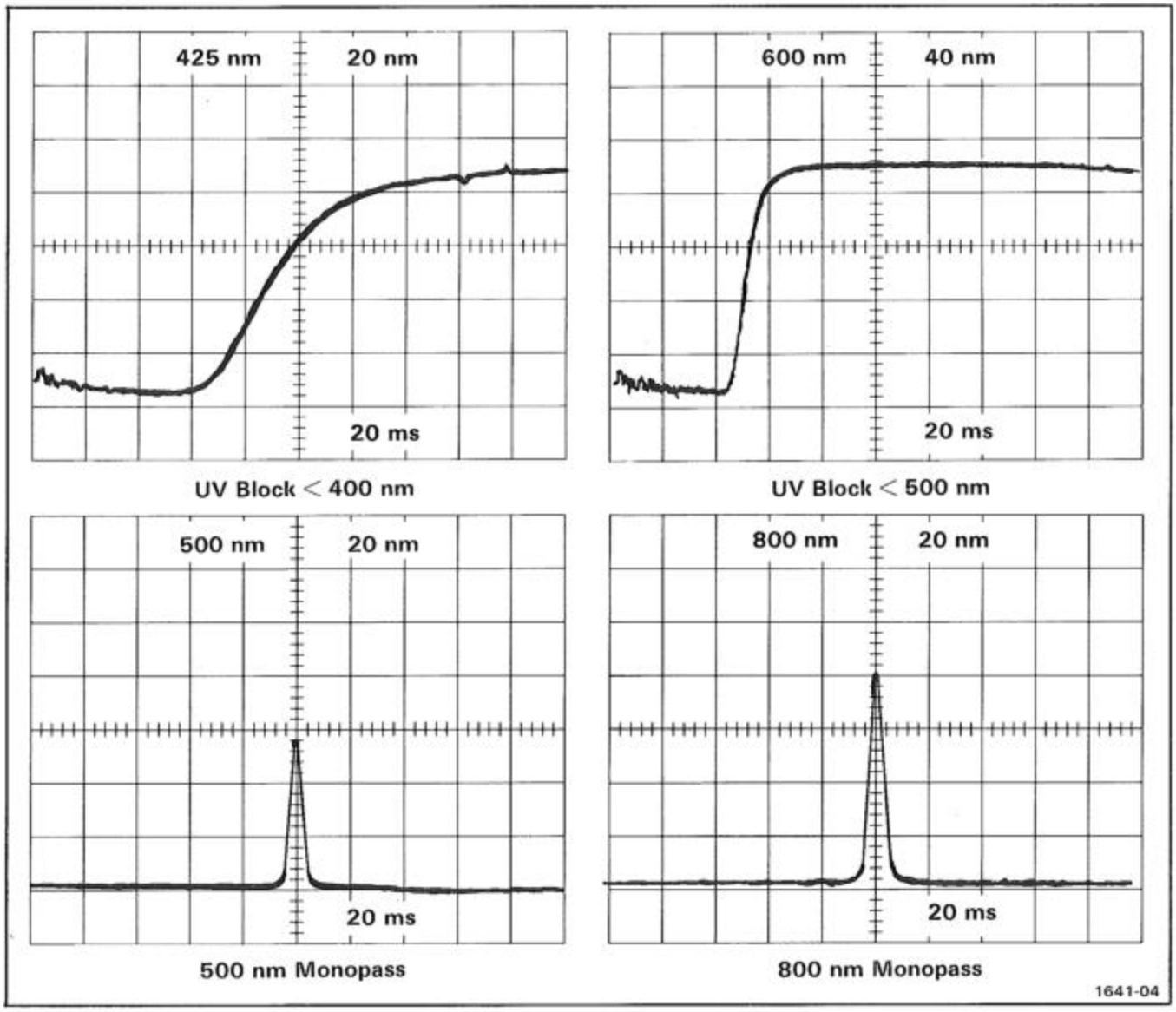


Fig. 2-3. Typical transmission characteristics for the ultraviolet-blocking filters used in the J20 Spectrometer.

4. Set the following J20 Spectrometer controls as indicated.

SLIT WIDTH	20 μm
WAVELENGTH SPAN	A400 nm
FILTER	Position #3 (500 nm monopass)
GRATING A WAVELENGTH INTERVAL	300-700 nm

5. Set the following 7J20 Spectrometer Plug-In controls as indicated.

VERTICAL GAIN	1
VARIABLE	CAL IN
TIME/SCAN	20 ms
VARIABLE	CAL IN
DISPLAY DISPERSION	30 nm/div
OFFSET	0.00 and locked
SPECTRAL NORMALIZER	OFF
DISPLAY TRIGGER MODE	FREE RUN

6. Turn the oscilloscope power on, adjust the 7J20 MARKER control for a reading of 500 nm, and allow 20 minutes warmup.

7. Using the VERT POSITION control, position the display baseline on screen and adjust the oscilloscope INTENSITY and READOUT INTENSITY controls for a comfortable viewing level. Adjust the oscilloscope FOCUS control for a well-focused display.

8. Push the BASELINE RESTORE pushbutton briefly and release.

9. Vertically position the display baseline to the bottom crt graticule line.

10. Position a tungsten light source (such as a 60-watt incandescent lamp) in front of the spectrometer entrance slit. Observe the spectrometer display and position the lamp to obtain maximum signal amplitude.

11. Adjust the VERTICAL GAIN switch to a linear gain position that will provide approximately four divisions or more of vertical deflection.

The spectrum present in the spectrometer display is the transmission spectrum of a narrow bandpass filter. Use this display as a starting point while reading the explanation of instrument controls given in this manual, and observe the effect the various instrument controls have on the display.

CIRCUIT DESCRIPTION

This section of the manual contains a detailed description of the electrical circuitry used in the J20/7J20 Rapid Scanning Spectrometer. This description starts with a discussion of the instrument using the block diagram. Then each circuit is described in detail using simplified diagrams where deemed necessary.

Complete schematics of each circuit as well as an overall instrument block diagram are given in the Diagrams section at the rear of the manual.

The detailed circuit descriptions are organized in a by-diagram order beginning with Diagram 1. Refer to the diagrams at the rear of the manual throughout the following circuit descriptions for electrical values and relationships.

BLOCK DIAGRAM

General

The following description is provided to aid in understanding the overall concept of the J20/7J20 Rapid-Scanning Spectrometer (RSS) before the individual circuits are discussed in detail. A basic block diagram of the RSS is shown in the Diagrams section at the rear of this manual. Only the basic interconnections between the individual blocks are shown. Each block represents a major circuit within the instrument. The number on each block refers to the complete circuit diagram, which is also in the Diagrams section.

Vidicon Tube

The spectrometer focuses the dispersed spectrum onto the target of a vidicon detector. The silicon-diode array target in the vidicon converts the spectral information into a stored charge. Scanning an electron beam across the vidicon target converts the stored charge into an electrical signal current.

Vertical Oscillator

The Vertical Oscillator circuit is an approximately 1 MHz sinewave oscillator whose push-pull output signals provide vertical axis deflection of the scanning beam in the vidicon. The frequency of the vertical scanning signal is considerably faster than the horizontal scanning signal, which results in a scanning beam similar in shape to the spectrometer entrance slit (narrow and tall).

Horizontal Deflection Amplifier

The Horizontal Deflection Amplifier converts the single-ended input ramp signal (generated in the 7J20) into push-pull output ramp signals of the proper amplitude and dc levels required by the vidicon for horizontal deflection of the scanning beam.

Vidicon Regulator

The Vidicon Regulator circuitry provides vertical and horizontal alignment currents and a focusing current to provide proper alignment and focus of the scanning electron beam. The Vidicon Regulator also contains the vidicon cathode-current regulator.

Vertical Preamplifier

The Vertical Preamplifier in the J20 is basically a feedback amplifier that converts the input signal current from the vidicon into an output signal voltage. Output signal amplitude from the Vertical Preamplifier is approximately 2 mV per nanoampere of input signal current.

Normalizer Circuitry

The Normalizer circuitry produces gain-correcting signals to be used by the Multiplier circuit in the 7J20 Vertical Amplifier. The Multiplier circuit uses these gain-correcting signals to achieve radiometrically-calibrated vertical deflection in the spectrometer display. The Normalizer circuitry consists basically of two sections, each section containing a driver circuit and a programmable function generator. One section functions in conjunction with Grating A and the other in conjunction with Grating B.

Vertical Input Amplifier

The electronic signal representing the spectrum to be displayed connects to the input of the Vertical Input Amplifier Circuit in the 7J20. The Vertical Input Amplifier circuit contains the Baseline Correction Amplifier and the Multiplier circuit.

Baseline Correction Amplifier

The Baseline Correction Amplifier sets the reference baseline in the spectrometer display to a level equal to the average level of vidicon dark current during the middle approximately 30% of the scan. Baseline correction occurs when the BASELINE RESTORE pushbutton is pressed. In the INT position of the SPECTRAL NORMALIZER switch, the Multiplier circuit alters the gain of the Vertical Input Amplifier using a gain-correction signal from the Normalizer circuitry in the J20. This gain-correction signal compensates for the varying spectral response of the system at different wavelengths and results in a displayed spectrum that represents spectral power in calibrated absolute terms. In the EXT position of the SPECTRAL NORMALIZER switch, the gain-correction signal comes from an external device (such as the Tektronix 016-1000-00 External Normalizer) connected to the SPECTRAL NORMALIZER input connector. Gain correction in this mode is arbitrary and does not result in radiometrically-calibrated vertical deflection.

Vertical Output Amplifier, Log Converter, and Absorbance Amplifier

The Vertical Output Amplifier provides the final amplification of the vertical-deflection signal before it is connected to the oscilloscope. The amplifier provides three types of vertical deflection: linear, logarithmic, and inverse logarithmic (Absorbance). For linear deflection, the vertical signal from the Vertical Input Amplifier connects directly to the Vertical Output Amplifier. For logarithmic deflection, the linear signal passes through a logarithmic converter prior to application to the Vertical Output Amplifier. For Absorbance measurements, the vertical deflection required is the inverse of logarithmic deflection. In the ABSORBANCE positions of the VERTICAL GAIN switch, the vertical signal passes through the log converter and an inverting feedback amplifier (Absorbance Amplifier) with a gain of one prior to application to the Vertical Output Amplifier. The Vertical Output Amplfier contains the VERTICAL GAIN switching, the OFFSET control, the ABSORBANCE ZERO control, the ATTEN BAL control, the VARIABLE VERTICAL GAIN control, the GAIN adjustment, and the VERT POSITION control. The Vertical Output Amplifier has six signal outputs: + and − deflection signals, + and − trigger signals, a sample of the vertical signal taken prior to the log converter (sent to the Interface connector), and a sample of the + deflection signal (sent to the Interface connector).

Horizontal Ramp Generator

The Horizontal Ramp Generator is a free-running integrator circuit that produces a linear sawtooth output signal. This ramp signal provides horizontal deflection in the spectrometer display as well as the horizontal scanning deflection in the vidicon detector. The slope of the ramp and the mode of scanning are controlled by the TIME/SCAN switch. In the 10 ms and 20 ms positions, the start of one ramp is separated from the start of the next by the scan time selected. In the INTEGRATE positions of the TIME/SCAN switch, the scanning ramp is a 20 ms ramp with the start of one ramp separated from the start of the next by the amount of integrate time selected by the TIME/SCAN switch. The Scan Control input allows synchronizing ramp generation with events external to the 7J20. A sample of the ramp signal is sent to the oscilloscope where the signal is made available at the A Sweep connector. The Auxiliary Z Axis portion of the Marker Amplifier produces a pulse that connects to the Z Axis circuit in the oscilloscope. This pulse brightens up the trace in a small spot and provides the intensified wavelength marker in the spectrometer display.

Horizontal Amplifier

The Horizontal Amplifier in the 7J20 is a switchable-gain feedback amplifier that provides the ability to achieve increased dispersion in the spectrometer display. The circuit does this by expanding (controlled by the DISPLAY DISPERSION switch) the display horizontal-deflection signals but does not affect the actual vidicon-target dispersion. Expansion occurs centered around the intensified wavelength marker in the display. The circuit converts the single-ended input signal into the push-pull output signals required by the oscilloscope.

Z Axis Circuit

The Z Axis circuit in the 7J20 controls unblanking and presentation of the spectrometer display. The DISPLAY TRIGGER MODE switch selects one of three operating modes for the circuit. In the FREE RUN mode, displays are continuously presented, one immediately following another. In the TRIG'D mode, the Z Axis circuit allows display presentation only as long as an adequate trigger signal is present at the DISPLAY TRIGGER IN connector. In the SINGLE SCAN mode, one, and only one, display will be presented following receipt of an adequate trigger. The RESET position of the DISPLAY TRIGGER MODE switch "arms" the circuit in preparation for single-scan mode operation.

Vertical Readout Circuit

The Vertical Readout circuit controls presentation of the Vertical Sensitivity portion of the spectrometer-display readout. In the linear deflection (1 through 500) positions of the VERTICAL GAIN switch, vertical sensitivity is given in terms of W/(nm · div). In the LOG positions vertical sensitivity is given in terms of a specified number of decibels per division of vertical deflection. In the ABSORBANCE positions, vertical sensitvity is given in terms of a specified number of Absorbance units per division of vertical deflection.

Horizontal Readout

The Horizontal Readout circuit contains two separate circuit functions, both associated with spectrometer-display readout. One portion of the circuit controls presentation of the Display Dispersion readout with dispersion given in terms of nanometers per horizontal division. The remaining portion of the Horizontal Readout circuit controls presentation of the Scan Time portion of the readout with scan times given in terms of milliseconds per scan.

Marker Readout

The Wavelength Marker Readout circuit controls presentation of the Wavelength Marker portion of the spectrometer-display readout. That portion of the readout indicates in nanometers the wavelength being highlighted by the intensified wavelength marker in the spectrometer display.

VERTICAL AMPLIFIER

Introduction

The voltage signal from the Preamplifier circuit (shown on Diagram 9 at the rear of this manual) in the J20 Spectrometer connects to the input of the Vertical Amplifier. This signal represents the spectrum to be displayed and is used to provide vertical deflection in the spectrometer display. Diagram 1 at the back of this manual shows a detailed schematic of the Vertical Amplifier circuit.

Input Paraphase Amplifier

Q2, Q8, and Q12 form a paraphase amplifier. This stage changes the single-ended input signal from the J20 into a double-ended, push-pull output signal. Q8 is a constant-current source for Q2 and Q12.

The video signal representing the spectrum to be displayed on the oscilloscope crt is connected to J10 (located on the 7J20 Vertical circuit board) via the spectrometer connector J100 (located on the under side of the 7J20). The center (signal carrying) conductor of the coaxial cable (internal to the 7J20) connects to the base of Q2 while the coaxial shield (grounded in the J20 Spectrometer) connects to the base of Q12.

A second signal source is available to the input of this stage. Moving jumper P2 from pins 1 and 2 to pins 2 and 3 disconnects the video signal and applies in its place the sawtooth ramp signal generated in the 7J20. This a troubleshooting convenience and can be readily used to verify correct Vertical Amplifier circuit operation.

The output signals from the Input Paraphase Amplifier are connected to the bases of Q16 and Q18 in the Active Filter Amplifier.

Active Filter Amplifier

Q16 and Q18 along with their associated components form the Active Filter Circuit. Basically they are emitter followers that with C10, R13, C14, R14, C16, R16, C17, and R17, form 3-pole active filters. These filters limit the −3 dB bandwidth of the stage to approximately 62 kHz. The output signals from this stage are connected to the gates of Q22A and Q22B in the DC Restorer Amplifier circuit.

DC Restorer Amplifier

Transistors Q20, Q22A, Q22B, Q24, Q26, and Q28, along with their associated components, form the DC Restorer Amplifier. Q22A and Q22B are source followers and Q24 and Q26 are constant-current sources for the source followers. Balance adjustment R25 adjusts the output dc balance of this stage to achieve a zero-volt level at "Output I" test point TP 33 under no-signal conditions.

The signal path from the emitter of Q16 to the base of Q22A is dc-coupled while the complimentary signal path from the emitter of Q18 to the base of Q22B is ac-coupled through C18. This configuration eliminates the effects that any dc drift, occurring in any of the stages preceeding this one, might have on the dc level of the display. However, with this configuration it is necessary to "artifically" maintain the proper dc level at the base of Q22B to keep the stage in dc balance. FET Q20, along with switching transistor Q28, does this in the following manner.

During the time the scanning ramp is running up, Q28 is on. The collector current of Q28 through R21 sets the gate of Q20 negative enough to turn Q20 off. The voltage level at the base of Q22B will be whatever the charge level is on C18. Then, when the scanning ramp resets to zero, a positive-going rectangular pulse approximately 30 μs in duration is applied to the emitter of Q28 through C28. This turns off Q28, which lets the gate of Q20 go positive to approximately the same dc level as that present on the source of Q20. Q20 now turns on and effectively becomes a short circuit connecting the bases of Q22A and Q22B together. During this time, C18 charges to the average dc level present on the gate of Q22A. After the Restore pulse terminates, Q28 again conducts, which causes Q20 to turn off. The charge level on C18 acquired during the restore time maintains the dc level on the gate of Q22B at a level that provides dc balance for this stage.

The output signals from this stage connect to the positive inputs of U32A and U32B in the Voltage Followers stage.

Voltage Follower Amplifiers

U32A and U32B are feedback amplifiers connected as voltage followers. The input signals are connected to the positive inputs of the amplifier cells with the outputs fed directly back to the negative inputs. This configuration provides a voltage gain of one and features high input impedance and low output impedance. The stage provides the necessary isolation between the source followers in the preceeding stage and the stages following this one.

The output signals from this stage are connected to First Differential-To-Single-Ended amplifier U48 and to the bases of Q72A and Q72B in the Gain Setting Amplifier.

First Differential-To-Single-Ended Amplifier

U48 and its associated components form the First Differential-To-Single-Ended Amplifier stage. This stage converts the push-pull input signals into a single-ended output signal. The input signals applied to the stage through R32 and R37 are equal in amplitude but opposite in phase. The signal applied to R32 is connected to the negative input of U48 and the signal applied to R37 is connected to the positive input of U48. The gain of the stage is equal to:

$$\left[\frac{R33}{R32}\right] + \left[\left(\frac{R37}{R37 + R34}\right)\left(\frac{R32 + R33}{R32}\right)\right] =$$

$$\left[\frac{2.5}{10}\right] + \left[\left(\frac{2.5}{2.5 + 10}\right)\left(\frac{2.5 + 10}{10}\right)\right] =$$

$$\left[\frac{2.5}{10}\right] + \left[\left(\frac{2.5}{12.5}\right)\left(\frac{12.5}{10}\right)\right] =$$

$$0.25 + (0.2)(1.25) = 0.25 + 0.25 = 0.5$$

Since the signal connected to R32 is inverted through U48 while the signal connected to R37 is not, the output signal from U48 will be in phase with the signal applied to R37 and approximately equal to one-half its amplitude.

The output signal from U48 is connected to pin 16 of the Interface connector J200 (located on the under side of the 7J20) and has an amplitude of 1 mV/nA of vidicon signal current.

Gain Setting Amplifier

Q72A, Q72B, and Q74 with their associated components form the Gain Setting Amplifier stage. Q72A and Q72B are configured as an emitter-coupled, push-pull amplifier with the gain of the stage adjusted by variable resistor R75. Q74 functions as a switch and is either on or off depending on the position of the TIME/SCAN switch.

In the 10 ms position of the TIME/SCAN switch, a negative level is applied to the gate of Q74 through CR72 which turns off Q74. Thus, C74 alone is connected between the push-pull signal paths. In all positions of the TIME/SCAN switch other than 10 ms, the gate of Q74 is allowed to go in a positive direction to a voltage level approximately equal to the voltage level at its source. This allows Q74 to turn on very hard, which in turn connects C73 in parallel with C74.

R50 and R51 along with the value of capacitance (C73 andC74) connected between the push-pull signal paths form a one-pole filter to limit the bandpass of the amplifier stage. In the 10 ms position of the TIME/SCAN switch, bandpass of the stage is limited to approximately 72 kHz. In all other positions of the TIME/SCAN switch, bandwidth of the stage is limited to approximately 30 kHz.

The output current signals from the Gain Setting Amplifier are connected to the Second Differential-To-Single-Ended Amplifier, U120B.

Baseline Correction Amplifier

Q82A, Q82B, and Q86 and their associated components form the Baseline Correction Amplifier stage. Q82A and Q82B are common-source amplifiers that conduct offset currents into the push-pull signal paths. Q86 is a constant-current source for Q82A and Q82B.

Q82A has its gate set to a fixed voltage level determined by the divider R81-R82. The gate of Q82B sits at a voltage level determined by the charge present on C83. The baseline correction signal (available only when the BASELINE RESTORE pushbutton is pressed) from the Baseline Restore Circuit determines what the charge level will be on C83. Thus the amount of offset current conducted by Q82A and Q82B is determined by the baseline correction signal. For a complete explanation of baseline correction, refer to the circuit description for the Baseline Restore Circuit.

Baseline Restore Circuit

Q54, VR57, Q58, Q92, and U98 along with their associated components comprise the Baseline Restore circuit. This circuit generates the baseline correction signal used to charge C83 in the Baseline correction Amplifier.

Q54, VR57, and Q58 form a switching circuit. This circuit generates a positive-going, rectangular-pulse output at the collector of Q58 that is time-related to the scanning ramp and is used to turn Q92 on and off. The positive-going scanning ramp is applied to the top of R52 and to the cathode of VR57. As the ramp starts to run up, Q54 is on very hard and VR57 is off. The collector of Q54 is near ground, which (through the divider R57-R58) turns on Q58. The collector of Q58 goes to a level negative enough to turn off Q92 which prevents Q92 from delivering its correction signal to switch S92.

When the scanning ramp waveform rises to a level more positive than approximately +2.5 volts, Q54 turns off. The collector of Q54 goes negative which turns off Q58. This allows Q92 to turn on and deliver the baseline correction signal to switch S92. As the scanning ramp waveform continues to go positive, the voltage across VR57 begins to develop. When the ramp reaches a level of approximately +5 volts, Q58 again turns on which turns off Q92. Q58 remains off until the reamp resets and again rises to approximately +2.5 volts. Q54 turns on again when the ramp resets. As a result of this switching-circuit action, Q92 is allowed to conduct only during approximately the middle 30% of the scanning ramp time.

The baseline correction signal from Q92 is applied to C83 only when the BASELINE RESTORE pushbutton is pushed. Also, when the BASELINE RESTORE pushbutton is pushed, the entrance slit shutter in the J20 Spectrometer closes. Under these conditions, the signal applied to the plus input (pin 3) of U98 represents the vidicon baseline and any signal variations are caused by leakages in the vidicon-target silicon-diode array.

U98 is configured as a non-inverting feedback amplifier for the vidicon-baseline signal. It has a gain of

$$\frac{R94 + R97}{R97} = \frac{10000 + 10}{10} = \frac{10010}{10} = 1001$$

X Zero adjustment R100 is an offset adjustment used to set the voltage level at the "X" test point (TP 101) to zero volts under no-signal conditions when the BASELINE RESTORE pushbutton is pushed. The output from U98 is connected to Q92. Q92 is a high-impedance current source and is turned on and off by the switching signal from Q58. The current signal from Q92 charges C83 which sets the dc balance in the Baseline Correction Amplifier to make the zero reference level in the display equal to the average signal level of the vidicon baseline during approximately the middle 30% of the scan.

Second Differential-To-Single-Ended Amplifier

U120B and its associated components form the Second Differential-To-Single-Ended Amplifier stage. The stage is a differential-input feedback amplifier that converts its push-pull input signal currents into a single-ended output voltage signal. The output signal from this stage will be 1 volt in amplitude for each 1 milliampere of differential-input signal current.

The output signal from the Second Differential-To-Single-Ended Amplifier is connected to Multiplier Circuit U102, the Baseline Restore Circuit previously described, and to switch S120 for application to the Vertical Output circuitry.

Multiplier Circuit

U102 with its associated components form the Multiplier Circuit. U102 is a monolithic 4-quadrant multiplier integrated-circuit device. A dynamic variable-voltage signal from the Normalizer Circuit in the J20 Spectrometer varies the gain of this stage. This allows the output signal from U102 (which represents the spectrum to be displayed) to be used to provide spectrometer-display vertical deflection that represents spectral power in calibrated absolute terms.

The signal input nodes to U102 are differential pairs (pins 6 and 9 for the Y inputs and pins 10 and 13 for the X inputs). A single-ended voltage input signal (from U120B) is connected to the X-axis input at pin 10. A single-ended dynamic "gain-correcting" voltage signal from the Normalizer Circuit in the J20 Spectrometer is connected to pin 9 of U102 when the SPECTRAL NORMALIZER switch is set to the INT position. R108, R109, TP107, TP108, and TP109 are calibration aids to facilitate adjustment of the X and Y offsets. The X and Y offset adjustments adjust for no voltage difference between pins 10 and 13, and pins 6 and 9 respectively for quiescent, no-signal conditions.

The resistor (R101) connected to pin 1 of U102 sets the value of a reference current internal to U102. The resistor connected between pins 7 and 8 (R111) determines the gain of the Y inputs in U102, and the resistor connected between pins 11 and 12 (R112) determines the gain of the X inputs. Pins 2 and 4 are regulated-voltage outputs from U102. R106 sets a current level between these regulated voltages to improve temperature stability of the device. Pin 3 is a ground return, pin 5 is the minus V_{cc} connection, and pin 15 is the plus V_{cc} connection. Pin 16 is not used.

The single-ended output signal current from pin 14 is connected to the Multiplier Current Converter circuit.

Multiplier Current Converter

U120A and its associated components comprise the Multiplier Current Converter circuit. It is configured as a feedback amplifier and converts the output signal current from U102 into a signal voltage.

The voltage gain of the circuit from the input of U102 (pin 10) to the output of U120A (pin 1) is adjusted by Mult Gain R120, and is set to be 1 when the amplitude of the gain correcting signal applied to pin 9 of U102 is zero. Then, when the amplitude of the gain correcting signal is at its maximum (approximately 5.5 volts), the X-input signal will appear at the output of U120A (pin 1) attenuated by a factor of at least 6:1 (typically greater than 7:1). Output voltage at pin 1 of U120A is calculated by the formula:

$$V_o = V_{in} \frac{6.25 - V_{cor}}{6.25}$$

where V_{in} = the differential voltage between pins 10 and 13 (which approximately equals the signal voltage from U120B).

V_{cor} = the amplitude of the gain correcting signal from the Normalizer circuit in the J20 (0 to +5.5 volts).

6.25 = the maximum amplitude of differential signal that can appear between pins 9 and 13 of U102 (when $V_{cor} = 0$).

Mult Offset R115 adjusts offset in the Multiplier Current Converter so the dc level at the output of U120A (pin 1) matches the dc level at the input of U102 (pin 10). C115, C114, and R114 are an RC filter network to limit the bandpass through the Multiplier Current Converter. Q114 functions as a switch and is either on or off depending on the position of the TIME/SCAN switch.

In the 10 ms position of the TIME/SCAN switch, a negative level applied to the gate of Q114 by Q120 turns off Q114 which removes C114 from the circuit. C115 and R114 then limit the bandpass of the circuit to approximately 145 kHz. In all positions of the TIME/SCAN switch other than 10 ms, the gate of Q114 is allowed to go positive toward the same level present on its source, which turns Q114 on very hard and connects C114 in parallel with C115. Now, the parallel value of C114 and C115 in conjunction with R114 limits the bandpass of the stage to approximately 38 kHz.

The output signal from the Multiplier Current Converter is connected to switch S120 whose switching action is controlled by the SPECTRAL NORMALIZER switch S130. Switch S120 selects an output signal from U120A or U120B to be connected to the Vertical Output circuit.

Bandpass Switching Circuit

Q120, Q124, and Q128 along with their associated components comprise the Bandpass Switching Circuit. Limiting the bandpass of the Vertical Amplifier integrates out any intensity variations that might be detected along the vertical axis of the vidicon target. Bandwidth limiting is switchable because the frequency of the scanning signals in the 10 ms position of the TIME/SCAN switch is above the bandwidth limit established for the other scan rates. Additional bandwidth limiting is provided in the Multiplier Current Converter circuit to reduce the effects of noise generated in the Multiplier circuit.

In the 10 ms position of the TIME/SCAN switch, a positive voltage is applied to the junction of R124 and R126. This turns on Q124, which turns on Q120 and causes the output switching signal from the collector of Q120 to go negative. At the same time, Q128 is turned on and its collector goes to a LO logic level. The collector of Q128 connects to an internal uncal bus line. Whenever this uncal bus line goes LO, the front-panel UNCAL lamp comes on to indicate the system is radiometrically uncalibrated.

In all positions of the TIME/SCAN switch other than 10 ms, the junction of R124 and R126 is grounded, which turns Q120, Q124, and Q128 off. The output switching signal from Q120 goes positive, and Q128 allows the uncal bus line to go HI provided it is not held LO by another source.

VERTICAL OUTPUT AMPLIFIER

Introduction

The Vertical Output Amplifier on Diagram 2 contains the stages that provide final amplification of the vertical deflection signals. Included in these stages are the vertical positioning control, OFFSET control, ATTEN BAL adjustment, and a front-panel GAIN adjustment to match output signal amplitude of the 7J20 to the input sensitivity of the oscilloscope. The VERTICAL GAIN switch alters the gain of these stages to achieve the calibrated deflection sensitivities indicated on the 7J20 front panel. Also included in the Vertical Output Amplifier is the circuitry that converts the linear, vertical-deflection signals into logarithmic and inverted-logarithmic (Absorbance) signals. Diagram 2 at the back of this manual shows a detailed schematic of the Vertical Output Amplifier circuit.

Interface Vertical Signal Amplifier

U164B and its associated components comprise the Interface Vertical Signal Amplifier. It is configured as an inverting feedback amplifier with unity gain. Output signal amplitude is 2 mV/nA of vidicon signal current.

The output signal from U164B is connected to pin 14 of the Interface connector J200 (located on under side of 7J20).

−8-Volt Power Supply

U150B and its associated components comprise the −8-Volt Power Supply. Basically, it is a unity-gain, inverting, feedback amplifier with the regulated +8-volt power supply connected to its input.

The −8-volt output also has limited use in the Vertical Amplifier circuitry on Diagram 1.

Offset Amplifier

U150A and its associated components comprise the Offset Amplifier. The stage is configured as a non-inverting, voltage follower with unity gain. The input signal to the stage is a variable offset voltage, the amplitude of which is determined by the setting of the front-panel OFFSET control. This offset voltage is used to bring over-amplified areas of interest back to within the limits of the spectrometer display. When the BASELINE RESTORE pushbutton is pressed, the input to the amplifier goes to ground, which sets its output to zero. This provides a zero-reference baseline in the display that contains no offset.

The output from the Offset Amplifier is connected to the Signal-Source Selection Amplifier through R151.

Logarithmic Converter

U164A, U178, Q182A, Q182B, U190, and U192, along with their associated components, comprise the Logarithmic Converter circuit. The Logarithmic Converter circuit changes the linear input signal into a logarithmic output signal that has a scale factor of 1 volt per decade.

U164A is a feedback amplifier that inverts the input signal and half-wave rectifies the output. Positive signals applied to R161 are inverted at pin 1 of U164A, which causes CR166 to turn off and CR164 to turn on and clip the positive signals. Negative signals applied to R161 appear at pin 1 of U164A as positive signals that turn CR164 off and CR166 on. For negative input signals, the stage has a gain of

$$\frac{R164}{R161} = \frac{9.09\ k\Omega}{9.09\ k\Omega} = 1.$$

Positive input signals are rectified and are not available to the following stage. R165 and the resistor network connected to pin 3 of U164A (R160, R162, and R163) adjust offset of the stage to prevent the output of the converter from ever going negative.

The remainder of the circuitry forms the actual log converter. Q182A is a non-linear feedback element for the differential comparator U192. U190 buffers the base current of Q182A from the input signal current through resistor R166. Q182B is the feedback element for operational amplifier U178. Negative feedback is applied to the emitter of Q182A through the voltage divider between pin 6 of U192 and ground, and the emitter-base junction of Q182B. This forces the collector current of Q182A to equal the current through input resistor R166, and the collector current of Q182B to remain constant and be equal to the current through R176. Since the collector current of Q182B remains constant, the emitter-base voltage also remains constant. Therefore, only the emitter-base voltage of Q182A varies with a change in input signal. Circuit output voltage is a function of the difference in emitter-base voltages of Q182A and Q182B. Since the emitter-base voltage in a transistor varies logarithmically with linear changes in current, the circuit output voltage will vary logarithmically. Thermistor RT187 changes value with changes in ambient temperature to compensate for changes in emitter-base voltage that occur in Q182A and Q182B with changes in ambient temperature.

Inverse-Logarithmic Amplifier

U196A and its associated components comprise the Inverse-Logarithmic Amplifier. The stage is configured as a unity-gain, inverting, feedback amplifier. ABSORBANCE ZERO R200 is an offset control for the stage, and is used to vertically position an absorbance display independent of the VERT POSITION control.

The output signal from this stage is connected to the Signal-Source Selection Amplifier through R197, and is used to provide vertical deflection for absorbance displays.

Signal-Source Selection Amplifier

U196B and its associated components comprise the Signal-Source Selection Amplifier. It is configured as an inverting, feedback amplifier with the gain of the stage dependent upon the signal source selected for amplification. The output from the Offset Amplifier is always connected to this stage. Additionally, the VERTICAL GAIN switch selects one of four other signals to be applied to this stage with the offset signal. The four selectable signals are:

(1) The video signal from Diagram 1 through R154.

(2) The ramp signal from Diagram 1 through R156.

(3) The log signal from the Logarithmic Converter through R193.

(4) The inverse logarithmic signal from U196A through R197.

As different signal sources for U196B are selected, gain through the stage changes because differing values of input resistance are selected. For the offset signal, the stage has a gain approximately equal to the ratio of R211 and R151

$$\left(\frac{5\ k\Omega}{20\ k\Omega}\right) = 0.25$$

For the four selectable signals, the stage has the following gains:

(1) Video signal: $\frac{R211}{R154} = \frac{5\ k\Omega}{5\ k\Omega} = 1$

(2) Ramp signal: $\frac{R211}{R156} = \frac{5\ k\Omega}{33.33\ k\Omega} = .15$

(3) Log signal: $\frac{R211}{R193} = \frac{5\ k\Omega}{25.05\ k\Omega} = .20$

(4) Inverse-log signal: $\frac{R211}{R197} = \frac{5\ k\Omega}{25.05\ k\Omega} = .20$

C211 limits the bandpass of the stage to approximately 105 kHz.

The output signal from the Signal-Source Selection Amplifier is connected to the base of U212A in the Gain-Switching Amplifier.

Gain-Switching Amplifier

U212A, U212B, U212C, U212D, and U212E with their associated components comprise the Gain-Switching Amplifier. The gain of this stage is switchable to provide the various vertical sensitivities indicated by the VERTICAL GAIN switch.

U212A and U212B are configured as a paraphase amplifier and convert the single-ended input signal into push-pull output signals. U212C is a constant-current source for U212A and U212B. U212D and U212E are emitter followers to provide isolation between the gain-switching circuit and the following stages.

VERTICAL GAIN switch S190 controls the gain of this circuit by selecting various values of resistance between the emitters of U212A and U212B in conjunction with switchable values of load resistance between the collectors of U212A and U212B. For example, in the 1 position of the VERTICAL GAIN switch, the differential voltage gain of the circuit is approximately 0.04. In the 2 position of the switch, the resistance between the emitters of U212A and U212B is reduced by a factor of 2, which doubles the differential voltage gain of the circuit to approximately 0.08.

R230 adjusts dc balance of the stage, and R235 allows precise adjustment of stage gain for the 100, 200, and 500 positions of the VERTICAL GAIN switch. ATTEN BAL, R220 adjusts for no baseline shift when switching between positions of the VERTICAL GAIN switch.

The push-pull output signals from the Gain-Switching Amplifier are connected to the bases of Q244A and Q244B in the Vertical Position Amplifier.

Vertical Position Amplifier

Q244A, Q244B, and Q254 with their associated components comprise the Vertical Position Amplifier. Q244A and Q244B are configured as an emitter-coupled, push-pull amplifier. VARIABLE VERTICAL GAIN control R245 is connected in series with R244 between the emitters of Q244A and Q244B. In the CAL IN switch position, R245 is shorted out by S245A and has no effect on stage gain. In the uncalibrated (button out) position, S245A is open. With S245A open and R245 adjusted to its maximum value, the gain of the stage is reduced by a factor of at least 2.5:1.

Q254 is a constant-current source for Q244A and Q244B. VERT POSITION control R255 adjusts the dc balance of the stage to achieve vertical positioning in the spectrometer display.

The push-pull output signals from the Vertical Position Amplifier are connected to the bases of Q262 and Q282 in the Vertical Output Amplifier.

Vertical Output Amplifier

Q262, Q268, Q282, and Q284 with their associated components comprise the Vertical Output Amplfier. Q262 and Q282 basically are emitter followers that (in conjunction with C260, R260, C261, R280, and C281) form 2-pole active filters to limit the bandpass characteristics of the stage. Q268 and Q284 are an emitter-coupled, push-pull amplifier with the gain of the stage adjusted by GAIN adjustment R275. This provides the ability to match the output signal amplitude of the 7J20 with the input vertical deflection sensitivity of the oscilloscope in which the 7J20 is being operated. Differential voltage gain of the stage is adjustable from slightly above to slightly below unity.

The push-pull trigger and vertical-deflection output signals are taken from the collector circuits of Q268 and Q284 and connect to the plug-in compartment connector of the 7000-series oscilloscope in which the 7J20 is installed.

HORIZONTAL RAMP GENERATOR AND AMPLIFIER

Introduction

The Ramp Generator on Diagram 3 produces a sawtooth voltage that is used to provide horizontal scanning deflection in the vidicon and horizontal deflection in the spectrometer display. Normally, this sawtooth signal is generated in a repetitive, free-running manner, but the circuitry of the Ramp Generator provides the ability to synchronize ramp generation with events external to the spectrometer. The Ramp Generator also produces several output pulses that synchronize other circuit functions in the spectrometer with ramp generation (e.g., display unblanking). The Horizontal Amplifier contains a switchable-gain stage to achieve the calibrated, display-dispersion factors indicated on the instrument front panel, and a variable-gain stage that matches the output-signal amplitude of the 7J20 to the input sensitivity of the oscilloscope horizontal-deflection system. Diagram 3 at the back of this manual contains a detailed schematic of these circuits.

Ramp Generator

U346A, U360, Q362, and Q364 with their associated components comprise the Ramp Generator circuit. The output of the circuit is a linear, positive-going, voltage ramp approximately 8.5 volts in amplitude. This ramp is used to provide horizontal scanning in the vidicon detector, and horizontal deflection in the spectrometer display.

Timing Voltage Amplifier. Basically U346A is a noninverting, feedback amplifier with a voltage level connected to its plus input through an input resistance and the feedback connected to its minus input. The stage has a gain of approximately 5 in the 10 ms position of the TIME/SCAN switch, and approximately 2.5 in all other switch positions. Because of the switchable gain, the stage generates two switchable fixed voltages (with the VARIABLE TIME/DIV control set to the calibrated [button-in] position) that are applied to the timing resistance in the integrator circuit. Ramp Timing adjustment R345 provides the ability to adjust the output voltage level of the stage to achieve precise ramp-timing accuracy. C351 limits the bandpass of the stage to approximately 10 Hz to ensure the output voltage will be relatively insensitive to noise in the stage's input circuitry.

Integrator. U360 is a feedback amplifier with a capacitor used for the feedback element. This configuration forms an integrator whose output signal is a positive-going, linear voltage ramp when a fixed negative voltage is applied to the timing resistance (R357 plus R358). The voltage level of the ramp at holdoff is approximately −0.2 volt (set by R360/R361) and the voltage level at the ramp peak is approximately +8.25 volts (set by the End-Of-Ramp Switching Circuit). During the time the ramp waveform is running up, Q364 is on and Q362 is off. When the ramp reaches its most positive level, Q364 is turned off and Q362 turns on, which discharges C362 and resets the ramp.

End-Of-Ramp Switching Circuit

U346B and Q370 with their associated components comprise the End-Of-Ramp Switching Circuit. The circuit generates a switching pulse used to initiate resetting the Ramp Generator.

U346B is a differential comparator. As the ramp starts to run up, the output of U346B tries to go positive. CR370, however, turns on and limits the positive movement to approximately +0.6 volt. This sets the base of Q370 and pins 5 and 6 of U346B a few millivolts above ground because of the ratio of the divider made up of R375 and R377. With the base of Q370 near ground and its emitter at approximately +0.6 volt, Q370 is biased off. As the ramp goes positive, it will reach a dc level (determined by R372 and R373) where the output of U346B goes negative. Q370 turns on and conducts briefly, generating a short-duration, negative-going pulse in its collector circuit. This pulse triggers the Holdoff Timer Multivibrator, which causes the ramp to reset. When the ramp resets, U346B becomes biased on and Q370 turns off.

Holdoff Timer Multivibrator

U368 and its associated components comprise the Holdoff Timer Multivibrator. It generates a positive-going reset pulse approximately 60 μs in duration that terminates ramp generation and resets the Ramp Generator to its holdoff level.

U368 functions as a monostable multivibrator. Pin 2 is the trigger-input terminal and pin 3 is the pulse-out terminal. Since Q370 is turned off during the ramp time, pin 2 of U368 is pulled HI through R370. The output of U368 at pin 3 is LO at this time. Upon receipt of the negative pulse from Q370 at the end-of-ramp time, the output of U368 goes HI and remains there for a period of time approximately equal to 1.1RC where R = 60.4 kΩ (R367) and C = 890 pF (C368). Approximately 60 μs after the output of U368 goes HI it goes LO again and awaits receipt of the next trigger.

The output of the Holdoff Timer Multivibrator is connected to the Restore Pulse Multivibrator and to the Ramp-Reset Logic Circuit.

Ramp-Reset Logic Circuit

U450A, U450C, and U540D form the Ramp-Reset Logic Circuit. The circuit provides the logic that controls the sequence of events surrounding the initiation and termination of ramp generation. There are three basic modes of operation for the circuit.

(1) Repetitive-scan mode (10 ms and 20 ms scan rates)

(2) Integrate-scan mode (50 ms through 1000 ms integrate scan rates)

(3) Scanning externally synchronized (all rates)

The output logic level at pin 12 of U450A (SCAN) determines whether the Ramp Generator will be allowed to run or will be reset. When pin 12 is HI, the Ramp Generator will run, and when pin 12 is LO, the Ramp Generator will be reset. The SCAN signal connects to three other circuits in the spectrometer. The three are:

(1) Pin 8 of the Interface connector

(2) U560 in the Z Axis Circuit (display unblanking)

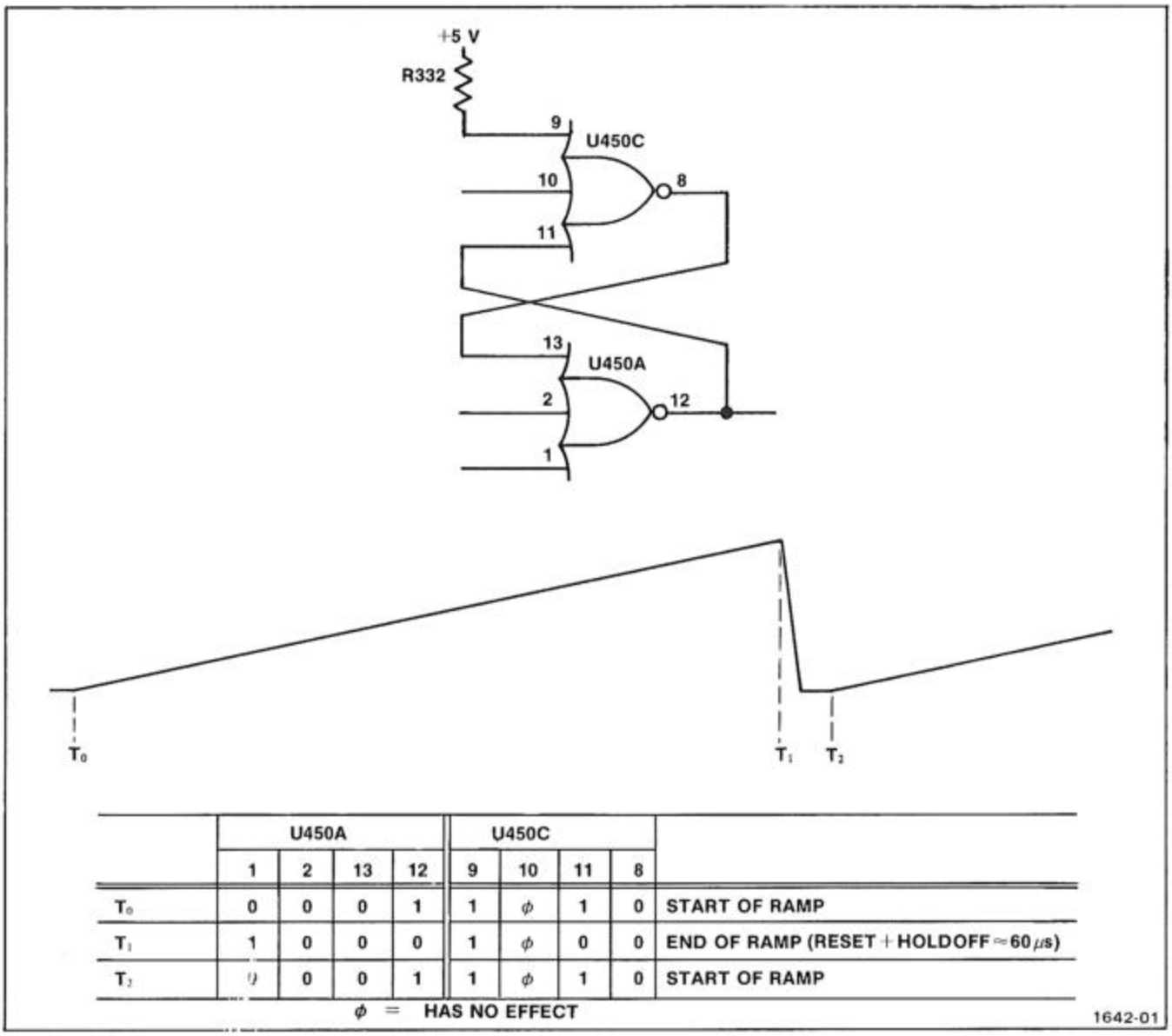
(3) Q1482 in the Vidicon Regulator Circuit (vidicon unblanking)

Repetitive-Scan Mode. The first mode of operation to be discussed is the repetitive-scan mode. In this mode, one scanning ramp is immediately followed by another with only negligible holdoff between ramps. Fig. 3-1 illustrates the sequence of logic for this mode of scanning.

In the 10 ms and 20 ms positions of the TIME/SCAN switch, pin 9 of U450C is pulled HI through R332; therefore, pin 8 of U450C and pin 13 of U450A will be LO and will remain LO until integrated scanning is selected. The Scan Control input (pin 11 of U540D) is pulled HI through R446, so pin 13 of U540D and pin 2 of U450A will be held LO. If pins 2 and 13 of U450A are held LO, the controlling input to U450A is pin 1.

For purposes of explanation, assume the Holdoff Timer output has just stepped LO to initiate ramp generation. All three inputs to U450A are LO; therefore, pin 12 of U450A is HI. Q364 is turned on, which turns off Q362 and the Ramp Generator starts to run up.

When the ramp waveform reaches its maximum amplitude, the output from the Holdoff Timer goes HI and pin 12 of U450A goes LO. Q364 turns off and Q362 turns on, which shorts out C362 and resets the Ramp Generator. Since the output of the Holdoff Timer remains HI for approximately 60 μs, the Ramp Generator will be reset for the same period and allow sufficient time for the Ramp Generator to settle to quiescence prior to generating the next ramp. After 60 μs, the output of the Holdoff Timer steps LO again, which causes pin 12 of U450A to go HI. Q364 turns on and Q362 turns off, which allows ramp generation to start again.



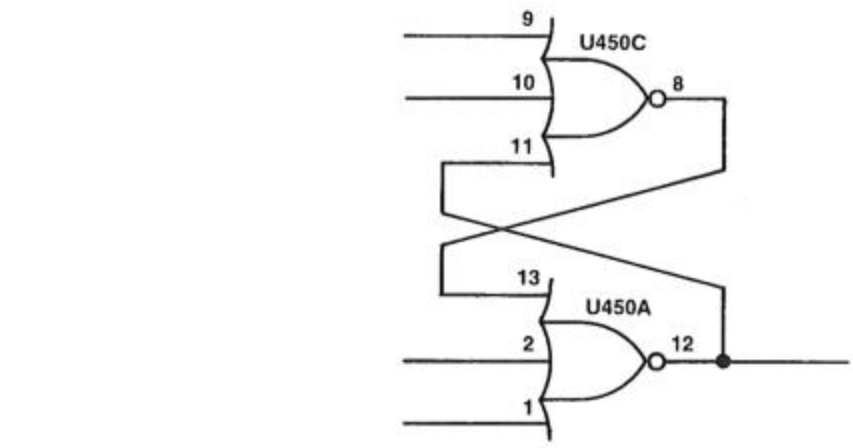
	U450A				U450C				
	1	2	13	12	9	10	11	8	
T_0	0	0	0	1	1	ϕ	1	0	START OF RAMP
T_1	1	0	0	0	1	ϕ	0	0	END OF RAMP (RESET + HOLDOFF ≈ 60 μs)
T_2	0	0	0	1	1	ϕ	1	0	START OF RAMP

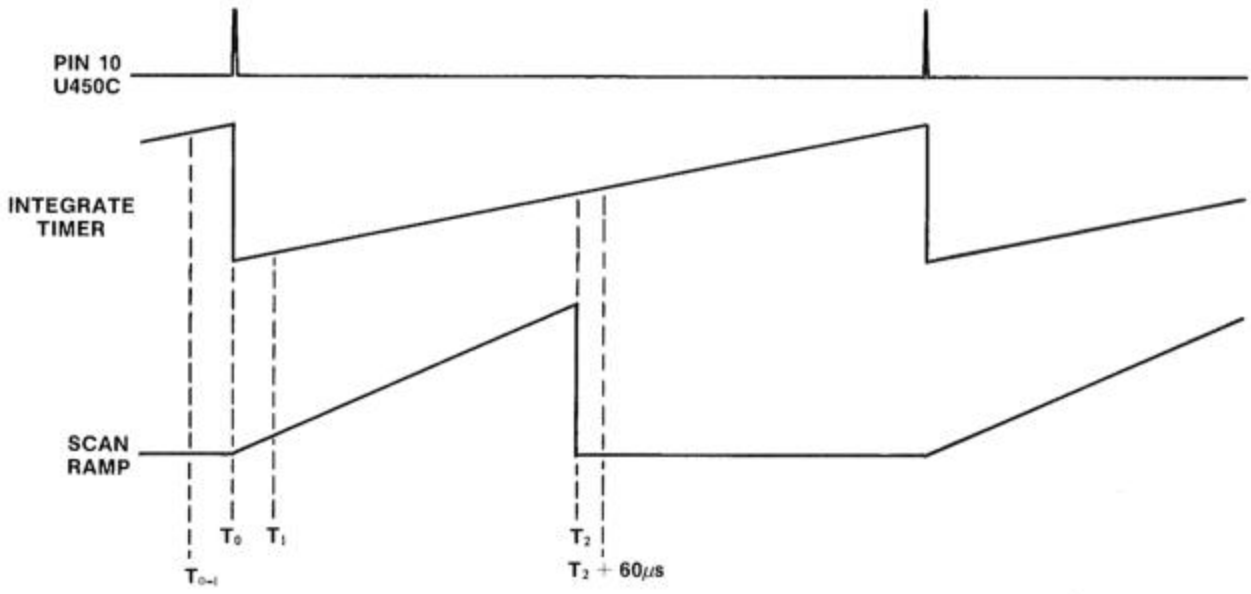
ϕ = HAS NO EFFECT

1642-01

Fig. 3-1. Repetitive-scan logic sequence in Ramp-Reset Logic Circuit.

Integrate-Scan Mode. In the integrate positions of the TIME/SCAN switch, pin 9 of U450C is grounded and no longer has independent control of U450C as it did in the normal-scan mode. Fig. 3-2 illustrates the sequence of logic for this mode of operation. For purposes of explanation of integrate-mode switching logic, assume the Ramp Generator has been reset and the holdoff time has elapsed but the integrate time has not. All three inputs to U450C will be LO, which sets the output (pin 8) of U450C HI and causes the output of U450A to be LO. The circuit will remain in this condition until the integrate time selected by the TIME/SCAN switch has elapsed. At the end of the





	U450A				U450C				
	1	2	13	12	11	10	9	8	
T_{0-1}	0	0	1	0	0	0	0	1	HOLDOFF JUST PRIOR TO SCAN START
T_0	0	0	0	1	1	1	0	0	Q322 TRIGGERED; SCAN STARTS
T_1	0	0	0	1	1	0	0	0	Q322 TURNS OFF
T_2	1	0	1	0	0	0	0	1	END OF SCAN; U368 TRIGGERED
$T_2 + 60\mu s$	0	0	1	0	0	0	0	1	U368 RESETS

1642-02

Fig. 3-2. Integrate-scan logic sequence in Ramp-Test Logic Circuit.

integrate time, a short-duration, positive-going pulse is applied to pin 10 of U450C. The output of U450C goes LO and the output of U450A goes HI, which initiates ramp generation. The HI from pin 12 of U450A is coupled back to pin 11 of U450C, which ensures the circuit will stay in this condition until ramp generation is completed. The output from the Holdoff Timer circuit steps HI at the end-of-ramp time to reset the Ramp Generator in the same manner as for normal scanning. The output of U450A steps LO, which switches the output from U450C HI and the circuit again waits for expiration of the integrate time.

Externally-Triggered Scan. The Scan Control input from pin 10 of the Interface connector provides the ability to synchronize ramp generation with an external signal. Upon completion of a ramp-generation cycle, the Ramp Generator will be held in reset if the Scan Control input is LO. This is true for both the normal-scan and the integrate-scan modes.

In the normal-scan mode, the Ramp Generator will be held in reset after the holdoff cycle is completed as long as the Scan Control level is LO. Then, when the Scan Control level goes HI, ramp generation begins immediately. In the integrate-scan mode, the same is true except ramp generation will not start until the next positive pulse from the Integrate Timer circuit is received by pin 10 of U450C after the Scan Control level goes HI.

Restore Pulse Multivibrator

Q436 and U440 with their associated components form the Restore Pulse Multivibrator circuit. The output logic signal from U440 triggers the between-scan, dc restoration that occurs in the DC Restorer Amplifier on Diagram 1.

For purposes of explanation, assume a ramp is being generated but has not yet reached its maximum amplitude. The output logic level from the Holdoff Timer Multivibrator will be LO, which turns off Q436. The collector of Q436 will be positive and C440 is charged to +5 volts through R438 and R440. The output logic level from U440 will be LO. Now, when the logic level from the Holdoff Timer Multivibrator goes HI at the end of the ramp, Q436 turns on, causing its collector to be very near zero volts. Application of this LO to pin 2 of U440 is delayed by the combination of R440 and C440. Pin 2 of U440 will not go LO enough to trigger U440 until C440 discharges through R440 to a level approximately equal to $1/3V_{cc}$. This discharge time is approximately equal to 1.1 RC where R equals R440 and C equals C440 (1.1 x 24 kΩ x 890 pf ≈24 μs). Approximately 24 μs after the start of holdoff, U440 is triggered and its output (pin 3) steps HI. The length of time the output stays HI is approximately equal to 1.1 RC where R equals R441 and C equals C441 (1.1 x 30 kΩ x 890 pF ≈30 μs).

When the output of U440 goes HI, CR442 turns on and charges C440 to slightly below the HI level present on pin 3 of U440. Since the emitter of Q436 is connected to the output of U440, Q436 turns off when the output of U440 goes HI and C440 starts to charge positive again toward +5 volts. After the output of U440 returns LO, Q436 comes back into conduction but there is not sufficient time for C440 to discharge low enough to trigger U440 again. Thus the output of U440 goes HI approximately 24 μs after the start of holdoff. The output of U440 remains HI for approximately 30 μs and returns LO approximately 6 μs before the end of holdoff.

Variable Time/Scan Amplifier

Q328 and Q344 with their associated components comprise the Variable Time/Scan Amplifier. The circuit provides the ability to obtain uncalibrated scan times that are continuously variable between the calibrated positions of the TIME/SCAN switch.

When the VARIABLE TIME/SCAN control is in the calibrated (button-in) position, the base of Q328 is returned to the same voltage level present on the emitter. Thus, the base-emitter junction of Q328 has zero bias and does not conduct. This, in turn, means the base-emitter junction of Q344 has zero bias because there is no current through R343, and Q344 will not conduct. As a result, the circuit has no effect on the reference voltage supplied to pin 3 of U346A by the voltage divider made up of R343, R345, and R346.

When the VARIABLE TIME/SCAN control is in the uncalibrated (button-out) position and rotated slightly, the base-emitter junction of Q328 becomes forward biased and Q328 begins to conduct. As Q328 conducts, Q344 is biased into conduction. The reference voltage supplied to pin 3 of U346A by R343, R345, and R346 becomes more negative, which causes the timing voltage supplied to the Ramp Generator by U346A to become more negative, resulting in a shorter-duration, steeper-sloped, ramp waveform.

For an explanation of Q330 and the Integrate Timing adjustment R320, refer to the Integrate Timing Circuit description.

Integrate Timing Circuit

Q330 and Q332 with their associated components comprise the Integrate Timing Circuit. This circuit controls the initiation of ramp generation when operating in the INTEGRATE positions of the TIME/SCAN switch.

Q332 is a programmable unijunction transistor and operates as a relaxation oscillator. The programmable unijunction used for Q332 becomes biased into conduction whenever the voltage on the anode reaches a level approximatley 0.6 volt more positive than the level at the gate. When Q332 conducts, the current through Q332 discharges the capacitance connected to the anode of Q332 until the value of current through Q332 falls below the level necessary to maintain conduction. Q332 then turns off and the anode capacitance starts to charge toward +15 volts again. The amount of calibrated integration time is precisely adjusted by Int Timing adjustment R320, which controls the reference level at the gate of Q332. The VARIABLE TIME/SCAN control has approximately the same range of adjustment for the gate reference voltage as it does for the timing reference voltage to maintain the same ratio of scan time to integrate time for any setting of the VARIABLE TIME/SCAN control. The output trigger signal from the Integrate Timing Circuit is developed across R338 in the cathode circuit of Q332.

Q330 controls whether Q332 will be allowed to free run or not. In the 10 ms and 20 ms positions of the TIME/SCAN switch, the junction of R332-R331 is ungrounded and Q330 turns on very hard. The collector of Q330 comes down very near to ground, which sets the reference level at the gate of Q332 low enough to prevent it from free running. In all positions of the TIME/SCAN switch other than 10 ms and 20 ms, the junction of R331 and R332 is grounded, which turns off Q330. Now the gate of Q332 is allowed to rise to its reference level and the circuit free runs.

A Sweep Amplifier

U416B and its associated components comprise the A Sweep Amplifier. The stage is configured as an inverting feedback amplifier with a gain of less than one. The output signal of this stage provides the signal available at the + Sawtooth output connector on the front panel of the oscilloscope in which the 7J20 is being operated.

Display Wavelength Marker Generator

U388A, U392, Q398, and Q400 with their associated components comprise the Display Wavelength Marker Generator. The circuit generates the signals used to present the wavelength marker and the wavelength readout in the spectrometer display.

U392 is a differential comparator. The positive-going ramp waveform is connected to the plus input and a voltage level, variable between ground and +8 volts (from the MARKER control), is connected to the minus input. The dc level of the ramp waveform will always start out at some level negative with respect to the reference level connected to pin 3 of U392. As long as the ramp level is negative with respect to the reference level, the output of U392 will be LO. After the ramp waveform rises to a dc level positive with respect to the reference level, the output of U392 steps HI and remains HI until the Ramp Generator is reset at the beginning of holdoff.

The output of U392 is connected to pin 1 of the Interface connector and to the base of Q398. C396 in conjunction with R395 and R397 differentiates the positive step that occurs at the marker point into a short-duration, positive-going pulse. This positive-going pulse turns Q398 off briefly, which allows the Auxiliary Z Axis output to go LO. This provides additional unblanking to brighten up the wavelength marker spot in the spectrometer display. In the 10 ms position of the TIME/SCAN switch, a smaller value of resistance is selected for the differentiator. This ensures that the width of the intensified marker spot in the display will remain approximately the same regardless of the scan rate selected. Q400 is turned on during the ramp holdoff time to ensure there will be no display unblanking during the inter-scan interval.

U338A is an inverting, feedback amplifier with unity gain. The input signal to the stage is the variable voltage level from the MARKER control. The inverted output is used in the Display Dispersion Amplifier on Diagram 3, and in the Wavelength Readout circuit on Diagram 7.

Display Dispersion Amplifier

U416A, Q420, Q424, and Q426 with their associated components comprise the Display Dispersion Amplifier. The stage is an inverting, feedback amplifier with switchable gain to achieve the expanded display-dispersion factors indicated by the DISPLAY DISPERSION switch.

Q420, Q424, and Q426 are field-effect transistors used as switches with their switching action controlled by the DISPLAY DISPERSION switch S420. The FET switches alter the value of feedback resistance for U416A to change the gain of the stage. The gain of the stage in the 4 (.4) nm/div switch position is unity, and is reduced to 0.1 in the 40 (4) nm/div position. In the 40 (4) nm/div position of the DISPLAY DISPERSION switch, HORIZ POS adjustment R385 provides the ability to adjust the horizontal position of the spectrometer display by varying the value of an offset current applied to U416A. In the other positions of the DISPLAY DISPERSION switch, the output of U388A is used to provide the offset to U416A. This scheme provides display expansion centered around the wavelength marker spot with the marker spot fixed centrally in the display.

Display Horizontal-Deflection Output Amplifier

U388B and U410 with their associated components comprise the Display Horizontal-Deflection Output Amplifier. U388B is an inverting, feedback amplifier with adjustable gain (via HORIZ CAL R435) to match the output signal amplitude to the input sensitivity of the horizontal deflection system of the oscilloscope in which the 7J20 is installed. Diodes CR413 and CR414 limit the maximum output signal amplitude when the display is expanded to prevent overdriving the horizontal deflection system of the oscilloscope. U410 is an inverting, feedback amplifier with unity gain. The output signal from U410 is equal in amplitude but opposite in phase to the output from U388B. The two output signals comprise the push-pull input signal required by the oscilloscope's horizontal deflection system.

Grating Change Logic Circuit

Q310, Q312, Q314, Q316, and Q318 with their associated components comprise the Grating Change Logic Circuit. The circuit controls the presentation of the uncalibrated indicator (an X) in the Display Dispersion portion of the display readout. The circuit also controls illumination of the Grating A and Grating B lamps that backlight the DISPLAY DISPERSION switch.

When the WAVELENGTH SPAN control on the J20 is in the B40 nm position, the logic level applied to the base of Q310 is HI. In this switch position, the following conditions exist:

(1) Q310 and Q312 are on.

(2) Q314, Q316, and Q318 are off.

(3) DS312 will be lit to indicate Grating B display dispersion factors, and DS314 is off.

(4) The oscilloscope's readout system generates an uncalibrated indicator (an X) in front of the Display Dispersion portion of the display readout.

When the WAVELENGTH SPAN control on the J20 is in the A400 nm position, conditions are reversed. The Grating A display dispersion factors are indicated, and the readout system does not generate the uncalibrated indicator (provided dispersion is calibrated).

TIME/SCAN Switch Binary Logic

Cam sections 9, 10 and 11 of the TIME/SCAN switch generate a binary-coded, 3-digit, logic signal that is connected to the Interface connector and indicates TIME/SCAN switch positions. Cam 9 generates the most-significant digit (digit A) and cam 11 the least-significant digit (digit C).

A*	B*	C*	Switch Position
1	1	1	10 ms
1	1	0	20 ms
1	0	1	50 ms
1	0	0	100 ms
0	1	1	200 ms
0	1	0	500 ms
0	0	1	1000 ms

***1 represents a HI.**

Cam 12 of the TIME/SCAN switch generates a logic signal used to switch bandpass in the Vertical Amplifier circuitry of Diagram 1. In the 10 ms position, the logic level is HI and the bandpass of the Vertical Amplifier is increased. In all other switch positions, the logic level is LO and the bandpass of the Vertical Amplifier is reduced.

Z AXIS CIRCUIT

Introduction

The Z Axis Circuit on Diagram 4 generates the logic signals associated with unblanking the oscilloscope crt. There are three modes of operation for the circuit.

(1) Free run (continuous displays)

(2) Triggered (displays presented only when triggered)

(3) Single scan (only one display presented following receipt of a trigger)

Diagram 4 at the back of this manual contains a detailed schematic of the Z Axis Circuit.

Z Axis Output Logic Circuit

U448B, Q570, Q572, and Q576 with their associated components comprise the Z Axis Output Logic Circuit. Q572 is an inverting amplifier that provides the Sweep Gate logic signal to unblank the oscilloscope crt via pin A1. A HI at pin A1 unblanks the display; a LO blanks the display. In order to get a HI at pin A1, the output logic from U448B (pin 6) must be LO.

Q570 is an emitter follower that provides the Holdoff logic signal sent to the oscilloscope via pin B4. The output logic at pin B4 is in phase with the output of U448B, and is used to derive the alternate switching signal in the oscilloscope.

Q576 is used as a switching amplifier. When the 7J20 is installed in a 7000-series oscilloscope correctly, pin A6 is common (ground), and pin A16 connects to +5 volts. The signal connected to B7 controls channel blanking associated with chopped and alternate oscilloscope modes. When the logic level at B7 is HI, the 7J20 Z Axis output is disabled; when LO, the Z Axis output is enabled. The logic level at B7 is a fixed LO when the oscilloscope is not operating in the alternate or chopped modes. For this condition, the output logic signal from pin 9 of U560 exercises independent control of U448B.

Synchronizing Multivibrator

U560 with its associated components comprises the Synchronizing Multivibrator circuit. The circuit synchronizes display unblanking with the generation of the scanning ramp.

U560 is a D-type, edge-triggered flip-flop with a data input, a direct preset input, and complementary outputs. A LO input to the clear input (pin 13) sets the pin 9 output LO and the pin 8 output HI independent of the clock pulse (pin 11). The logic level present at the data input (pin 12) is transferred to the pin 9 output on the positive edge of the clock pulse. After the clock input threshold voltage has been passed, the data input (pin 12) is locked out.

The Scan pulse that originates in the Ramp Generator circuitry is used to clock U560. The Scan pulse steps LO at the end of a ramp and steps HI at the beginning of the next ramp. The LO coincident with the end of the ramp is capacitively coupled to the clear input (pin 13) through C562. This sets the pin 9 output LO, which blanks the display. Then, when the clock pulse steps positive, the logic level on pin 12 is transferred to pin 9. If the logic level is HI, the display will be unblanked; if LO, the display remains blanked. After the clock pulse steps HI, the data input (pin 12) is locked out so any variations at the data input will have no effect on the display until the next time the clock pulse steps HI.

When the pin 9 output of U560 steps LO to terminate a display, the LO is coupled to that portion of the Display Wavelength Marker Generator circuit (Q400) on Diagram 3 that controls the Auxiliary Z-Axis input to the oscilloscope. This ensures there will be complete blanking of the spectrometer display during the ramp holdoff time.

Trigger Latch Circuit

U450B, U540C, and Q554 with their associated components comprise the Trigger Latch Circuit. The circuit recognizes and stores the first adequate trigger signal that occurs following the beginning of a scan. This will enable display presentation commencing with the start of the next scan. The output logic level at pin 6 of U448B must be LO if the oscilloscope crt is to be unblanked to present a display. There are three modes of operation to consider when examining Trigger Latch Circuit operation: free-run, triggered, and single-scan.

Free Run. In the free-run mode, pin 8 of U540C is always HI, which represents a constantly-triggered condition to the Trigger Latch Circuit. Therefore, pin 10 of U540C will always be LO. The output logic level from the Single-Scan Logic Circuit (connected to pin 4 of U450B) also will always be LO during free-run operation. The logic level applied to pin 3 of U450B by the collector of Q554 is always LO except for a brief period (approximately 6 μs) just after the beginning of a scan. As a result, the output of U448B (pin 6) is always LO at the beginning of each scan resulting in displays being continually presented.

Triggered. Prior to reception of a trigger signal, pin 8 of U540C is LO. Just after the beginning of the previous display, Q554 set pin 3 of U450B HI, which causes pin 9 of U540C to step LO. With both inputs to U540C LO, the output at pin 10 steps HI. This HI at pin 5 of U450B holds the output of U450B (pin 6) LO until the next trigger signal is received. When the trigger signal is received, pin 8 of U540C steps HI, pin 10 of U540C steps LO. Now, all three inputs to U450B are LO and the output of U450B (pin 6) steps HI to enable a display. Just after the beginning of the display, Q554 applies a HI to pin 3 of U450B and the output of U450B (pin 6) steps LO. This LO is coupled back to pin 9 of U540C. If the trigger signal is no longer present, both inputs to U540C will be LO and the Trigger Latch Circuit will reset in preparation for accepting the next trigger signal. The output LO at pin 6 of U450B prevents display presentation until receipt of another trigger signal.

Single Scan. The circuit action of the Trigger Latch Circuit in the single-scan mode is the same as for the triggered mode with the additional condition that pin 4 of U450B steps HI just after the beginning of a display. This allows display of only one scan at a time and prevents display of subsequent scans until the Single-Scan Logic Circuit is reset.

Trigger Input Circuit

Q502, Q504, Q510, and Q534 with their associated components comprise the Trigger Input Circuit. This circuit provides the ability to synchronize display presentation with external trigger signals when the DISPLAY TRIGGER MODE switch S520 is in the TRIG'D or SINGLE SCAN positions.

In the FREE RUN position of S520, the base of Q534 is grounded, which will set the collector of Q534 HI and cause the circuit output to continuously register a triggered condition. In the TRIG'D and SINGLE SCAN posiitons, the base of Q534 is ungrounded and the level at the collector of Q534 is controlled by the signal connected to the DISPLAY TRIGGER IN connector J500. When a TTL (transistor-transistor logic) LO level (or ground-closure logic) is applied to J500, the emitter of Q510 goes LO. This turns off Q534 whose collector goes HI to register a trigger in the Trigger Latch Circuit. The LO level at the emitter of Q510 also turns off Q504, which causes Q502 to turn on and conduct through DS500. The TRIG'D lamp DS500 becomes illuminated to indicate the presence of an adequate, external, trigger signal. When the level at J500 is HI, the emitter of Q510 is HI, which turns on Q534 and sets the collector of Q534 LO. A LO at the collector of Q534 prevents registering a trigger in the Trigger Latch Circuit. At the same time, Q504 turns on and Q502 turns off preventing DS500 from illuminating.

Display Enable Circuit

Q550, Q582, and Q586 with their associated components comprise the Display Enable Circuit. A logic signal from the oscilloscope connects to the emitter of Q586 and determines whether the 7J20 Z Axis circuit function will be enabled or not. When the logic level at pin B8 is LO, pin 2 of U540A is also LO and normal Z Axis circuit action is enabled. When the level at B8 is HI, pin 2 of U540A will be HI and the Z Axis circuit action is inhibited (display blanked).

Single-Scan Logic Circuit

U448A, U448C, U448D, Q514, Q518, Q524, U540A, and U540B with their associated components comprise the Single-Scan Logic Circuit. The primary circuit function is to ensure that, upon receipt of an adequate trigger signal in the single-scan mode, there will be one, and only one, scan displayed.

Q514 and Q518 originate a logic signal that informs the oscilloscope logic circuitry when the spectrometer is operating in the single-scan mode. When the DISPLAY TRIGGER MODE switch S520 is in SINGLE SCAN or RESET, pin 5 of U540B is held LO. This turns off Q518, which turns on Q514. This generates a HI at pin A15. A HI at A15 indicates single-scan operation; a LO indicates non-single-scan operation.

Prior to presentation of a single scan, the Single-Scan Logic Circuit must be reset. A LO from the oscilloscope logic circuitry applied to the base of Q524 via pin B15, or setting the DISPLAY TRIGGER MODE switch briefly to the RESET position, will reset the circuit. In the SINGLE SCAN mode prior to reset, pin 8 of U448C is LO and pin 11 of U448D is HI. Upon receipt of a reset LO, the outputs of U448C and U448D switch states (pin 8 of U448C goes HI; pin 11 of U448D goes LO). During the presence of a reset LO, pin 2 of U448A is held LO, which forces pin 3 of U448A HI to prevent display presentation. Pin 8 of U540C is also held LO during reset to prevent undesired premature display triggering.

After reset is completed, pin 8 of U540C returns to the level at the collector of Q534, and the output of U448A goes LO. Under these conditions, the next scan following receipt of an adequate trigger will be displayed. When the display is unblanked at the beginning of a scan, a LO is coupled through C546 to pin 13 of U448D, which causes pin 11 of U448D to go HI and pin 8 of U448C to go LO. The output LO from U448C causes the output of U540B to go HI. The output of U540A goes LO, which causes the output of U448A to go HI and prevent the display of subsequent scans.

Ready Circuit

Q538, Q590, and Q592 with their associated components comprise the Ready Circuit. In the triggered and single-scan modes of operation, the Ready Circuit lights READY lamp DS594 and provides a logic level to the oscilloscope to indicate the circuit is prepared to accept a display trigger.

For triggered mode operation or when the Single-Scan Logic Circuit has been reset in the single-scan mode, the logic level at pin 1 of U540A is HI. After a single-scan display is initiated, the logic level at pin 1 of U540A goes LO. A HI at pin 1 of U540A turns Q592 on, which causes READY lamp DS594 to be lit. Also, when Q592 is on, Q590 conducts and creates a HI logic level at pin A10. When a trigger is received, the HI that occurs at pin 8 of U540C turns on Q538, which puts a LO on the base of Q592. This turns off Q592, Q590, and DS594 to indicate a triggered (not ready) condition. The LO that occurs at pin 1 of U540A after a single-scan display is initiated maintains the Ready Circuit in the not-ready condition until the Single-Scan Logic Circuit is reset.

VERTICAL READOUT CIRCUIT

Introduction

The Vertical Readout circuit on Diagram 5 encodes the signal currents required by the 7000-series oscilloscope readout system to display the Vertical Sensitivity readout and a portion of the Marker Wavelength readout. The signal currents associated with the Vertical Channel 1 Row and Column information lines control the Marker Wavelength portion of the readout. The signal currents associated with the Vertical Channel 2 Row and Column information lines control the Vertical Sensitivity portion.

It is necessary to have an understanding of the 7000-series oscilloscope readout system in order to fully understand the readout circuitry in the 7J20. Readout encoding in the 7J20 is not done in the standard format. The display of decimal points and zeros is accomplished in a slightly different manner. Diagram 5 at the back of this manual contains a detailed schematic of the Vertical Readout Circuit.

Marker Wavelength

The Marker Wavelength portion of the readout occupies the Right Vertical Channel 1 position in the display. There are five components on Diagram 5 associated with the Marker Wavelength readout. For purposes of explanation, the circuit function of these five components will be discussed in time-slot sequence.

TS 1: R638 encodes a SKIP signal in time slot 1, and provides compatibility with the 7000-series DPO system.

TS 8: R640 and R642 encode the letter n.

TS 9: R641 and R644 encode the letter m.

The remainder of the Marker Wavelength readout encoding circuitry is shown on Diagram 7.

Vertical Sensitivity

The Vertical Sensitivity portion of the readout occupies the Right Vertical Channel 2 position in the display. Sensitivity is indicated in terms of watts (units are actually watts per nanometer). All of the Vertical Readout circuit components located on the Readout Board (except for CR739 and CR757) encode the readout displayed for the linear-deflection positions of the VERTICAL GAIN switch. The Vertical Readout circuit components on the Vertical Board encode the readout displayed for the remaining VERTICAL GAIN switch positions.

Uncal Circuit. Q670, Q674, and Q676 comprise the circuit that controls display of the uncalibrated indicators. Whenever the vertical sensitivity is uncalibrated, the Uncal Bus (signal line that connects to the junction of R680 and R682) will be LO. This turns off Q676, which allows Q674 to turn on. When Q674 conducts, it causes UNCAL indicator lamp DS674 to be lit, and also turns off Q670. CR669 and CR670 form a current gate. When Q670 is on, the column current that flows through R669 is conducted by Q670 and does not reach the oscilloscope readout system. For this condition, R636 by itself encodes a SKIP signal in time slot 3. When Q670 is off, the column current through R669 is conducted through CR669 to the oscilloscope readout system. For this condition, R636 and R669 encode the uncalibrated indicator X in the readout display.

Absorbance Readout. In all positions of the VERTICAL GAIN switch other than the ABSORBANCE positions, Q656 is biased on and conducts the column currents that flow through R648, R650, and R652. In the ABSORBANCE positions, the VERTICAL GAIN switch grounds the junction of R654 and R656, which turns off Q656. Now, the column currents through R648, R650, and R652 flow through CR648 to the oscilloscope readout system. Character encoding occurs as follows:

TS 1: R632 encodes a SKIP signal, and provides DPO compatibility.

TS 2: R634 and R648 encode a decimal point.

TS 4: R650 encodes the number 1. To encode a 2, R647 is connected in parallel with R650. For a 5, R646 and R647 are connected in parallel with R650.

TS 9: R637 and R652 encode the letter A.

SKIP signals are encoded in all the other time slots.

Logarithmic Readout. In all positions of the VERTICAL GAIN switch other than LOG, Q666 and Q668 are biased on and conduct the column currents that flow through R658, R660, and R662, and the row current through R668. In the LOG positions, the VERTICAL GAIN switch grounds the junction of R664, R667, and R666, which turns off Q666 and Q668. Now, the column currents through R658, R660, and R662 flow through CR657 and the row current through R668 flows through CR668 to the oscilloscope readout system. Character encoding occurs as follows:

TS 1: R632 encodes a SKIP signal and provides DPO compatibility.

TS 2: R634 encodes a SKIP signal.

TS 4: R662 encodes the number 1. To encode a 2, R647 is connected in parallel with R662. For a 5, R646 and R647 are connected in parallel with R662.

TS 8: R658 and R668 encode the letter d.

TS 9: R637 and R660 encode the letter B.

SKIP signals are encoded in all other time slots.

GAIN Position. In the GAIN position of the VERTICAL GAIN switch, cam 16 opens the Channel 2 Column signal line, which prevents display of sensitivity readout.

Linear Deflection Readout. When the VERTICAL GAIN switch is in one of the linear positions (1 through 500) and the TIME/SCAN switch is not set to one of the INTEGRATE positions, all of the inputs to U734B will be HI. The output of U734B then will be LO, which biases Q736 on. When Q736 is on, Q726 and Q750 are biased on and the row and column signal currents are allowed to flow to the oscilloscope readout system. If the VERTICAL GAIN switch is in one of the ABSORBANCE or LOG positions, or the TIME/SCAN switch is in one of the INTEGRATE positions, at least one of the inputs to U734B will be LO. This sets the output of U734B HI, which turns off Q736. Q726 and Q750 become biased off and the row and column currents from U736 and U710 are not allowed to flow to the oscilloscope readout system.

U712 is an analog-to-digital converter. The device has ten output lines, only one of which will be LO at any one time. The remaining lines will be HI. The amplitude of the voltage connected to pin 10 determines which of the ten output lines will be LO. The voltage divider switched by the SLIT WIDTH switch in conjunction with voltage divider R714-R730 (switched by cam five of the VERTICAL GAIN switch) determines the amplitude of the voltage applied to pin 10 of U712. Table 3-1 defines the output logic versus the input voltage for U712.

TABLE 3-1

U712 Output Logic Defined

Slit Width	Cam 5 Switch Open		Cam 5 Switch Closed	
	Pin 10 Volts	Output Line LO	Pin 10 Volts	Output Line LO
OPEN	14.0 V	Pin 11 (W1)	11.5 V	Pin 4 (W6)
10 μM	13.5 V	Pin 6 (W2)	11.0 V	Pin 14 (W7)
20 μM	13.0 V	Pin 12 (W3)	10.5 V	Pin 3 (W8)
50 μM	12.5 V	Pin 5 (W4)	10.0 V	Pin 15 (W9)
100 μM	12.0 V	Pin 13 (W5)	9.5 V	Pin 2 (W10)
200 μM	13.0 V	Pin 12 (W3)	10.5 V	Pin 3 (W8)
500 μM	12.5 V	Pin 5 (W4)	10.0 V	Pin 15 (W9)
1000 μM	12.0 V	Pin 13 (W5)	9.5 V	Pin 2 (W10)

Whenever Pin 4 or pin 11 of U712 is LO, the Uncal Bus is pulled LO through CR739 or CR757 to indicate the vertical sensitivity is uncalibrated. The voltage from the divider switched by the SLIT WIDTH switch is connected to pin 23 of the Interface connector J200. The logic at the base of Q798 (also controlled by the SLIT WIDTH switch) is connected to pin 24 of the Interface connector. The combination of the two provides SLIT WIDTH position information to the device connected to the Interface connector.

U736 is a digital-to-analog converter whose output signal current at pin 19 provides row encoding. The output current from pin 19 will either be 0 μA or 900 μA, depending on which of the word inputs is LO, and what 4-bit decoding logic is present at pins 14, 15, 16, and 17. 900 μA of row current encodes a blank in the readout display. The occasional insertion of blanks keeps the characters displayed in correct decimal relation. 0 μA of row current puts the readout system in that portion of the character matrix that generates numbers. Table 3-2 shows all the combinations of decoding logic possible for U736 during each time slot.

TABLE 3-2

U736 Decoding Logic*

Time Slot	VERTICAL GAIN Cam 6 Switch Closed D C B A	VERTICAL GAIN Cam 6 Switch Open D C B A
1	1 1 1 1	1 1 1 0
2	1 1 1 1	1 1 1 0
3	1 1 1 1	1 1 1 0
4	1 1 0 1	1 1 0 0
5	1 0 1 1	1 0 1 0
6	1 1 1 1	1 1 1 0
7	1 1 1 1	1 1 1 0
8	0 1 1 1	0 1 1 0
9	1 1 1 1	1 1 1 0
10	1 1 1 1	1 1 1 0

***1 represents a HI.**

Table 3-3 shows the output current of U736 for each decoding logic/word input combination. U736 will provide the output currents shown only when the associated word input is LO.

TABLE 3-3

U736 Output Current As A Function Of Word Input And Decoding Logic

		Decoding Logic*									
		1111	1110	1101	1100	1011	1010	1001	1000	0111	0110
Word Inputs	W1			900 μA	900 μA		900 μA				
	W2				900 μA						
	W3				900 μA						
	W4			900 μA	900 μA		900 μA				
	W5			900 μA	900 μA						
	W6			900 μA							
	W7										
	W8			900 μA							
	W9			900 μA							
	W10			900 μA							

***1 represents a HI.**

U710 also is a digital-to-analog converter whose output signal current at pin 19 provides column encoding. The output current from pin 19 will be discrete current levels that will vary between 0 and 900 μA in 100 μA increments. The actual value of output current will depend on which of the word inputs is LO, and what 4-bit decoding logic is present at pins 14, 15, 16, and 17. U710 encodes the numbers displayed in the sensitivity readout for linear deflection, and, for certain sensitivities, encodes a decimal point during time slow 2. Table 3-4 shows all the combinations of decoding logic possible for U710 during each time slot.

TABLE 3-4

U710 Decoding Logic*

Time Slot	VERTICAL GAIN Cam 6 Switch Closed D C B A	VERTICAL GAIN Cam 6 Switch Open D C B A
1	1 1 1 1	1 1 1 0
2	1 1 0 1	1 1 0 0
3	1 1 1 1	1 1 1 0
4	1 0 1 1	1 0 1 0
5	1 0 0 1	1 0 0 0
6	0 1 1 1	0 1 1 0
7	1 1 1 1	1 1 1 0
8	1 1 1 1	1 1 1 0
9	1 1 1 1	1 1 1 0
10	1 1 1 1	1 1 1 0

*1 represents a HI.

Table 3-5 shows the output current of U710 for each decoding logic/word input combination. U710 will provide the output currents shown only when the associated word input is LO.

Q794, U774, U734A, and U734C comprise a decade circuit that controls the display of prefixes, the decimal point, and one additional zero. The biasing on the base of Q794 establishes an approximate +5 V level at the emitter of Q794. Current through Q794 is altered by connecting additional resistors in parallel with R794. The SLIT WIDTH, FILTER, WAVELENGTH SPAN, and VERTICAL GAIN switches control the addition of these parallel resistors. These discrete variations in current through Q794 establish voltage levels at pin 10 of U774 that occur in 0.5-volt increments.

U774 is an analog-to-digital converter of the same type as U712. The device has ten output lines, seven of which are used in this application. The amplitude of the voltage present at pin 10 of U774 determines which of its output

TABLE 3-5

U710 Output Current As A Function Of Word Input And Decoding Logic

		1111	1110	1101	1100	1011	1010	1001	1000	0111	0110
Word Inputs	W1							300 μA		100 μA	500 μA
	W2					300 μA		100 μA	500 μA	100 μA	100 μA
	W3					200 μA		100 μA	300 μA	100 μA	100 μA
	W4							500 μA		100 μA	900 μA
	W5							300 μA		100 μA	500 μA
	W6							200 μA		100 μA	
	W7					200 μA		100 μA		100 μA	
	W8							600 μA		100 μA	
	W9							300 μA		100 μA	
	W10							200 μA		100 μA	
	W11			500 μA	500 μA						

*1 represents a HI.

lines will be LO. Table 3-6 shows the parallel resistances possible, the current that will flow through Q794, the voltage that will be present at pin 10 of U774, and which output pin of U774 will be LO.

TABLE 3-6

Current/Voltage Conditions For Q794 and U774

Parallel Resistance	Q794 Current	U774 Pin 10 "E"	U774 Pin LO
4.99 k	1.0 mA	13.0 V	12
4 k	1.25 mA	12.5 V	5
3.333 k	1.5 mA	12.0 V	13
2.857 k	1.75 mA	11.5 V	4
2.5 k	2.0 mA	11.0 V	14
2.222 k	2.25 mA	10.5 V	3
2 k	2.5 mA	10.0 V	15

When pin 12, 4, or 15 of U774 is LO, U710 in conjunction with R634 will encode a decimal point during time slot 2. R762 and R776 encode the symbol μ (micro) during time slot 8. Q786 and CR783 form a current gate. When Q786 is on, it conducts the column curent that flows through R782. When Q786 is off, the column current through R782 is conducted by CR783 to the oscilloscope readout system. This added column current in conjunction with the column current through R776 encodes the letter n (nano). The circuit action of Q784 and CR781 is the same as that for Q786 and CR783. When Q784 turns off, R780 causes sufficient column current to flow to encode the letter p (pico). Whenever pin 12, 5, or 13 of U774 is LO, the prefix p will be displayed. When pin 4, 14, or 3 is LO, the prefix n will be displayed. When pin 15 is LO, the prefix μ will be displayed. When pin 13 or 15 is LO, Q768 will turn off and R766 will encode a zero in time slot 7.

HORIZONTAL READOUT

Introduction

The Horizontal Readout Circuit encodes the signal currents required by the 7000-series oscilloscope readout system to display the DISPLAY DISPERSION and TIME/SCAN switch-position information. The signal currents associated with the Horizontal Channel 1 Row and Column information lines control the Display Dispersion portion of the readout, and the signal currents associated with the Horizontal Channel 2 Row and Column information lines control the Time/Scan portion.

It is necessary to have an understanding of the 7000-series oscilloscope readout system in order to fully understand the readout circuitry in the 7J20. Readout encoding in the 7J20 is not done in the standard format. The display of decimal points and zeroes is accomplished in a slightly different manner. Diagram 6 at the back of this manual contains a detailed schematic of the Horizontal Readout Circuit.

Display Dispersion

The Display Dispersion portion of the readout occupies the A Horizontal Channel 1 position in the display. Display Dispersion is indicated in terms of nanometers per division of horizontal deflection. For purposes of explanation, the circuit description for Display Dispersion readout is given in the time-slot sequence commencing with time slot 1.

TS 1: R813 encodes a SKIP signal in time slot 1, and provides compatibility with the 7000-series DPO system.

TS 2: Decimal point encoding is accomplished in time slot 2. With the DISPLAY DISPERSION switch in the .4 nm/div position and the WAVELENGTH SPAN switch in the B40 nm position, a decimal point is encoded. In all other positions of these two switches, a SKIP signal is generated. Q836, CR837, and CR838 form a current gate. When Q836 is on, the column current that flows through R837 is conducted by Q836. When Q836 is off, the column current through R837 is conducted through CR838 to the oscilloscope readout system. Q836 is off only when generating a decimal point.

TS 3: Time slot 3 generates the uncalibrated indicator (an X) as explained in the circuit description for the Grating Change Logic Circuit portion of Diagram 3.

TS 4: Time slot 4 generates the characters 1, 2, or 4. R832 generates the 4, R830 the 2, and R831 the 1.

TS 5: When the WAVELENGTH SPAN switch is in the A400 nm position and the DISPLAY DISPERSION switch is not in the 4 nm/div position, time slot 5 encodes the zero in 10, 20, or 40. Q842, CR843, and CR844 form a current gate. When Q842 is on, the column current that flows through R843 is conducted by Q842. When Q842 is off, the column current through R843 is conducted through CR844 to the oscilloscope readout system. Q842 is off only when generating a zero. When Q842 is on, time slot 5 generates a SKIP signal.

TS 6 and TS 7: SKIP signals are generated in these time slots for the Display Dispersion portion of the readout.

TS 8: R817 and R821 encode the letter n in time slot 8.

TS 9: R816 and R822 encode the letter m in time slot 9.

TS 10: No connections to this time slot cause a SKIP signal to be encoded.

Time/Scan

The Time/Scan portion of the readout occupies the A Horizontal Channel 2 position in the display. Scan time is indicated in terms of milliseconds per scan. Again, for purposes of explanation, the circuit description for Time/Scan readout is given in time-slot sequence commencing with time slot 1.

TS 1: R801 encodes a SKIP signal in time slot 1, and provides compatibility with the 7000-series DPO system.

TS 2: No connections to this time slot cause a SKIP signal to be generated.

TS 3: When the VARIABLE TIME/SCAN switch S325B is in the uncalibrated (button out) position, R804 and R807 encode the uncalibrated symbol <. When the switch is in the calibrated (button in) position, R807 is disconnected from the circuit leaving R804 to generate a SKIP signal.

TS 4: Time slot 4 encodes the characters 1, 2, or 5. R809 by itself encodes a 1. R809 in parallel with R827 encodes a 2. R809 in parallel with R826 encodes a 5.

TS 5: R820 encodes the zero in 10, 20, or 50.

TS 6: R823 encodes the last zero in 100, 200, or 500.

TS 7: R825 encodes the last zero in 1000.

TS 8: R805 and R810 encode the letter m.

TS 9: R806 and R812 encode the letter s.

TS 10: No connections to this time slot cause a SKIP signal to be encoded.

WAVELENGTH MARKER READOUT

Introduction

The Wavelength Marker Readout circuit encodes the signal currents required by the 7000-series oscilloscope readout system to display the numerals in the Wavelength Marker portion of the readout. The units-of-measure portion (nm) of the Wavelength Readout is encoded by several components shown on Diagram 5 with their circuit function explained in the Marker Wavelength portion of the VERTICAL READOUT circuit description. The signal currents associated with the Vertical Channel 1 Column information line control the Wavelength Marker Readout. Diagram 7 at the back of this manual contains a detailed schematic of the Wavelength Marker Readout Circuit.

Variable Voltage Amplifier

U962 and its associated components comprise the Variable Voltage Amplifier stage. The stage generates a variable output voltage that represents the wavelength of the marker in the display.

U962 is configured as a feedback amplifier with the gain-determining resistors in the minus input and a voltage divider in the plus input. The λ_c voltage connected to R964 represents the wavelength at the center of the vidicon scan area. Stage gain for this voltage is

$$\left(-\frac{R963}{R964}\right) = -1.$$

The λ_m voltage connected to R966 represents the location of the marker spot in the display in relation to center screen. The voltage is controlled by the MARKER control and will vary between 0 and −8 volts. The voltage divider made up of R965, R966, and R967 limits the movement at pin 3 of U962 to between +1 volt and −1 volt when operating on Grating A. When operating on Grating B, R968 is connected in parallel with R967 to change the ratio of the divider and limit the movement at pin 3 to between +0.1 volt and −0.1 volt. The voltage gain of the stage for the voltage at pin 3 is

$$\left(\frac{R963 + R964}{R964}\right) = 2.$$

R962 adjusts offset for U962.

The +8/NORM/GND switch S964 is a calibration aid to facilitate adjustment of circuit wavelength range. The λ_c voltage is also connected to pin 3 of the Interface connector. Zero volts represents 300 nm; each 1 V variation in λ_c represents a 100 nm change in wavelength.

Grating Switching Circuit

Q970, Q974, and Q976 and their associated components comprise the Grating Switching Circuit. When operating on Grating A, the logic level at pin 1 of plug P970 is LO. This turns off Q970, Q974, and Q976. When operating on Grating B, the logic level at pin 1 of plug P970 is HI. The HI level turns on Q970, Q974, and Q976. Q970 acts as a switch to connect R968 in parallel with R967, which reduces the voltage-swing capabilities at pin 3 of U962 to between +0.1 volt and −0.1 volt. Q976 also acts as a switch to connect R977 into the Decade Circuit (on Diagram 5), which modifies the Vertical Sensitivity Readout. The logic level at pin 1 of plug P970 connects to pin 2 of plug P380 on Diagram 3 and to pin 2 of the Interface connector.

Integrator Circuit

U950A and U950B and their associated components comprise the Integrator Circuit. U950A is configured as an integrator and U950B is a constant-current reference source (≈1 mA) for U950A. CR947 and CR954 form a current gate for the reference current. When the output logic at pin 11 of U942D is LO, CR947 turns on and conducts the reference current, which turns off CR954 preventing application of the reference current to the Integrator. For this condition, the output of the Integrator will be a positive-going ramp whose slope will be a function of the current through R956 and R960. When the logic output of U942D is HI, CR947 turns off and CR954 conducts applying the reference current to the integrator. Now, the output of the integrator will be a negative-going ramp whose slope will be a function of the reference current minus the current through R956 and R960.

Integrator Gating Circuit

U942A, U942B, U942C, and U942D and their associated components comprise the Integrator Gating Circuit. U942A, U942B, and R949 form a trigger circuit that generates a short-duration LO pulse to terminate the negative slope of the Integrator. When the negative-going slope of the Integrator output crosses the threshold voltage of U942A (≈+1.4 volt), the output of U942B steps LO, which causes the output of U942C to step HI. Now, both inputs to U942D are HI and its output steps LO. This turns on CR947 and removes the reference current from the input to the Integrator. The output of the Integrator now goes in the positive direction and sets pin 9 of U942C HI again but pin 8 of U942C remains HI because of the LO on pin 10. When the Four-Decade Counter U920 reaches full count, C944 capacitively couples a short-duration LO to pin 13 of U942D. The output of U942D goes HI, the output of U942C goes LO, and the Integrator output goes in the negative direction. Q940 is a common-emitter amplifier that operates in the off-to-saturated mode. The output signal of Q940 is inverted with respect to the logic signal present at pin 8 of U942C, and connects to pin 11 of the Interface connector.

Four-Decade Counter

Q934 and Q932 form an astable multivibrator with a frequency of approximately 100 kHz. The output of this circuit is used as the clock for the 4-decade counter. Q938 is a common-emitter amplifier that operates in the off-to-saturated mode. The inverted clock signal at the collector of Q938 connects to pin 12 of the Interface connector. Q918 and VR913 with their associated components comprise a −5-volt power supply that is derived from the −15-volt decoupled supply.

U920 is a 4-decade counter with integral latching, multiplexing, and digital-to-analog conversion. The clock signal connects to pin 1 of U920 through C923. The reset input (pin 2) is held LO by R921 connected to −5 volts and performs the reset function only at instrument turn on.

While the 4-decade counter is counting toward 9999, the logic level at pin 5 of U920 is LO. One-half of a clock cycle after the counter reaches 9999, pin 5 steps HI. Then, when the counter goes to 0000 on the next negative transition of the clock, pin 5 steps back LO. This LO movement is capacitively coupled from emitter follower Q946 to pin 13 of U942D by C944. Pin 11 of U942D steps HI and turns off CR947, which causes CR954 to turn on and reapply the reference current to the Integrator. The output of the Integrator had been positive going prior to this but now switches and becomes negative going. The Integrator output goes in the negative direction until it reaches the threshold level of U942A. At this point, pin 9 of U942C steps LO and pin 8 of U942C steps HI. A short-duration HI is capacitively coupled to pin 10 of U920 from pin 8 of U942C by C920. This brief HI transfers the count accumulated in the counter portion of U920 to its digital-to-analog converter section, which stores it. The digital-to-analog converter section converts the stored number into discrete current levels where a 100 μA output current equals 0, 200 μA output equals a 1, 300 μA output equals a 2, etc. Time slots 4, 5, 6, and 7 interrogate each decade in the following manner. When time slot 4 steps LO, it interrogates the fourth decade circuit, which represents thousands. The number in this decade can only be a 0 or a 1. If the number is a 0, pin 15 of U920 will remain LO. With both time slot 4 and pin 15 LO, Q908 will be biased off, which sets pin 9 of U920 HI. A HI at pin 9 inhibits current output from pin 6 of U920. If the number in the fourth decade is something other than a 0, pin 15 of U920 will step HI and Q908 will be biased on. This will set pin 9 of U920 LO and the fourth decade digital-to-analog converter will

output 200 μA of column current from pin 6. Each decade digital-to-analog converter is interrogated sequentially. The zero-suppression circuit (Q908) only inhibits display of zeroes in the fourth decade. For example, if the number to be displayed were 905 nm, the output currents from pin 6 of U920 would be as follows:

Time Slot	0	9	0	5
4	0			
5		1000 μA		
6			100 μA	
7				600 μA

The Reference Current adjustment R925 adjusts the absolute level of the analog output currents from pin 6 of U920. The CAL/NORM switch S901 and test points TP 901 and TP 903 are calibration aids to facilitate adjustment of R925.

HIGH VOLTAGE SUPPLY

Introduction

The circuitry on the High Voltage Supply circuit board generates two voltage supplies required by circuitry in the J20 Spectrometer. The two supply voltages are +350 volts and +6.3 volts. The +6.3-volt supply provides filament power to the vidicon in the J20, and the +350 volt supply is used by several circuits in the J20. Diagram 8 contains a detailed schematic of the High Voltage Supply.

Primary Circuit

The Primary Circuit of the High Voltage Supply consists of a two-transistor oscillator and an overload protection circuit. Q1012 and Q1014 comprise a free-running oscillator with a frequency of approximately 50 kHz. CR1012 and CR1013 provide reverse-breakdown protection for Q1012 and Q1014 respectively. The base-drive signal for Q1012 and Q1014 is referenced to the output level of U1022 through VR1016 and R1017.

Q1002 and U1008 provide protection for the primary circuit when the secondary circuit is overloaded. Under secondary-overload conditions, Q1012 and Q1014 will conduct abnormally high amounts of current which will develop sufficient voltage across R1002 to bias Q1002 on. When Q1002 conducts, its collector moves negative, which functions as a trigger for U1008. R1004 and C1004 delay application of this LO trigger to pin 2 of U1008 for a period of time approximately equal to 1.1 RC where R = 22 kΩ (R1004) and C = 2.2 μF (C1004). U1008 functions as a monostable multivibrator. Pin 2 is the trigger-input terminal and pin 3 is the pulse-output terminal. When Q1002 is off, pin 2 of U1008 is pulled HI through R1004 and R1006. The output of U1008 at pin 3 is LO at this time. Upon receipt of a LO trigger from Q1002, the output of U1008 goes HI and remains there for a period of time approximately equal to 1.1 RC where R = 220 kΩ (R1008) and C = 2.2 μF (C1008). Approximately one-half second after the output of U1008 goes HI, it goes LO again. While the output of U1008 is HI, Q1008 is biased into saturation which removes the base drive from Q1012 and Q1014 and shuts down the oscillator. When the output of U1008 goes LO, Q1008 turns off, which returns base drive to Q1012 and Q1014. If the secondary overload has disappeared, operation resumes as normal. If, however, the overload has not disappeared, Q1002 triggers U1008 and the protection cycle begins again.

Secondary Circuit

The Secondary Circuit of the High Voltage Supply consists of the +350-volt supply, the +6.3-volt supply, and a feedback regulator. CR1026, CR1027, CR1028, and CR1029 with their associated components comprise a full-wave, voltage quadrupler. The quadrupler is a +320-volt supply referenced to +50 volts so the absolute voltage level at the junction of CR1029 and R1036 is approximately +370 volts. Q1042 and Q1044 are a shunt regulator that sets the supply output at test point TP 1041 to +350 volts.

U1022 is the feedback regulator. It is configured as a comparator with +8 volts connected to the plus input (through R1023), and a sample of the variations in the quadrupler output connected to the minus input. When the output of the quadrupler varies, U1022 generates an error signal at pin 6 that changes the base drive of Q1012 and Q1014. The change in base drive alters the amplitude of oscillation to maintain the proper voltages in the secondary circuit. C1022 and R1022 limit the bandwidth of U1022 to prevent unwanted circuit oscillations.

The +6.3-volts supply is actually a +1.3-volt, full-wave rectified supply referenced to +5 volts. The regulation action of U1022 also achieves a measure of regulation for the +6.3-volt supply.

+8-Volt Power Supply

U1102 and Q1106 with their associated components form the +8-Volt Power Supply. U1102 is a comparator with the zener voltage developed by VR1100 (approximately +6.2 volts) connected to the plus input and a sample of the supply output voltage connected to the minus input. R1101 and C1101 limit the −3 dB bandwidth at the plus input to U1102 to approximately 40 Hz to suppress noise and oscillation. R1110 adjusts the ratio of the divider made up of R1108, R1110, and R1112 to precisely adjust the output level of the supply. Q1106 is an emitter follower whose base is controlled by the output of comparator U1102.

VIDICON DEFLECTION CIRCUITS

Horizontal Amplifier

The Horizontal Amplifier in the J20 converts the single-ended, input ramp signal from the 7J20 into push-pull, output ramp signals of the proper amplitude required by the vidicon. Fig. 3-3 shows a simplified diagram of the J20 Horizontal Amplifier. Refer to the simplified diagram and Diagram 9 in the Diagrams section while reading this circuit description.

Basically the Horizontal Amplifier in the J20 consists of two feedback amplifiers, one inverting and the other non-inverting. In the simplified diagram, Feedback Amplifier A consists of U1328, Q1344, Q1350, and Q1352. Feedback Amplifier B consists of U1328, Q1342, Q1358, and Q1360. Amplifier A is non-inverting and has a gain of

$$\frac{R_f}{R_i} + 1$$

where R_f = R1346 and R_i = R1315 + R1317. Amplifier B is inverting and has a gain of

$$\frac{R_f}{R_i}$$

where R_f = R1340 and R_i = R1319 in parallel with the sum of R1315 and R1317. Feedback Amplifiers A and B have output signals equal in amplitude but opposite in polarity. H Gain adjustment R1315 adjusts the gain of both amplifiers to maintain equality.

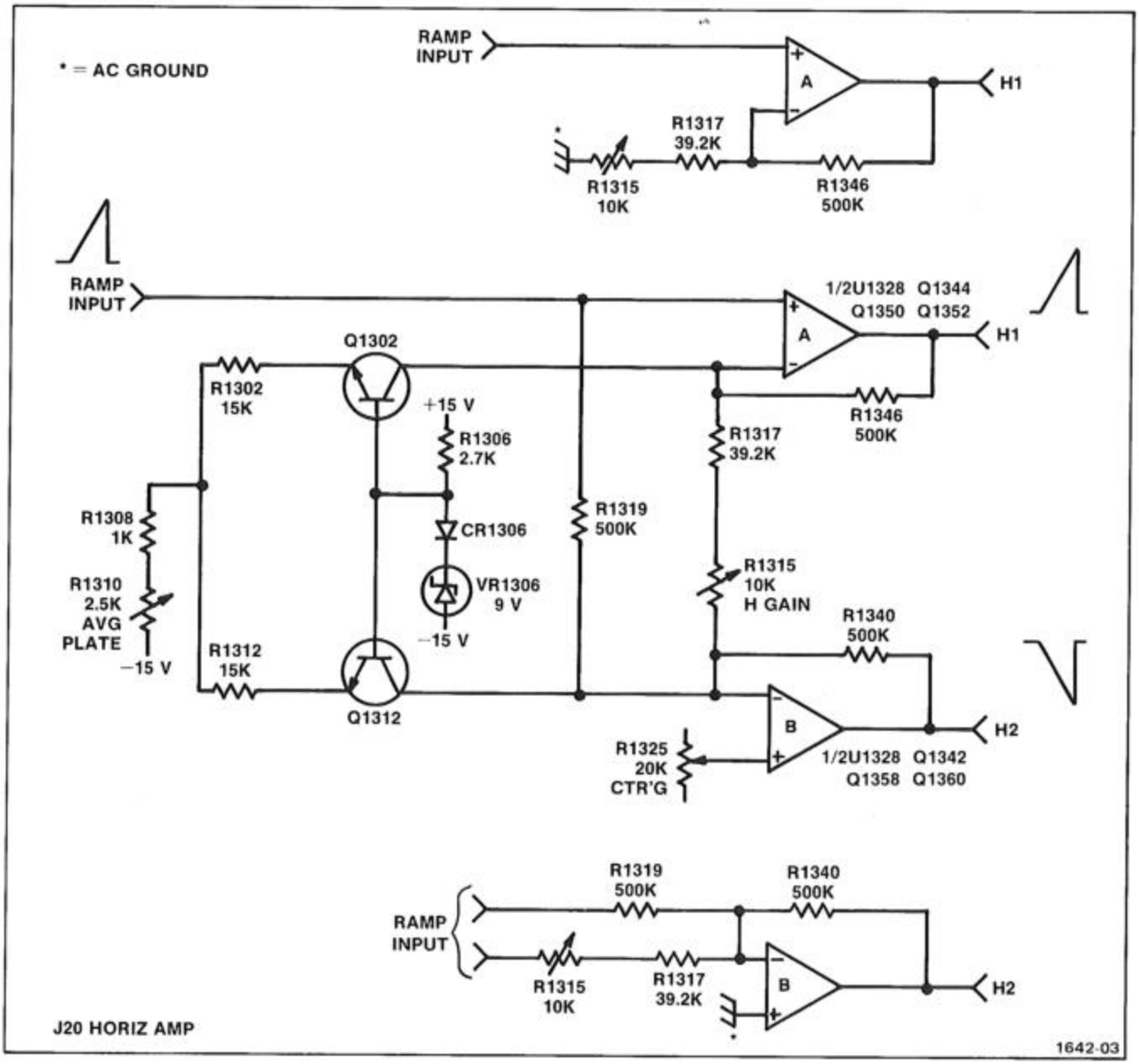


Fig. 3-3. Simplified diagram of the J20 Horizontal Amplifier.

Q1302 and Q1312 are constant-current sources that provide offset currents to the Feedback Amplifiers. R1310 varies the value of the offset currents, which varies the average voltage level of the output signals. Centering adjustment R1325 controls the bias level at the input of Feedback Amplifier B to match its average output voltage level with that of Feedback Amplifier A. R1352 reduces the impedance of the emitter circuit of Q1352 to improve the ability of that output to move rapidly in the negative direction during scan retrace.

Q1382, Q1386, and the primary of T1380 form a tuned oscillator with a frequency of approximately one megahertz. Q1388 is a constant-current source for Q1382 and Q1386. C1384, CR1384, and CR1390 form an ac-coupled, half-wave rectifier that samples the amplitude of oscillation and stores the sample as a negative charge in C1390. This stored sample is fed back to the plus input of U1394 via R1393. The output of U1394 controls the level on the base of Q1388. Varying the base level of Q1388 will vary the amount of current provided to Q1382 and Q1386. This; in turn, controls the amplitude of oscillation in the primary of T1380, which regulates the output amplitude in the secondary of T1380.

Vertical Oscillator

There are two circuits on the Vertical Oscillator Board. One is a +265-volt power supply and the other is a sine-wave oscillator with a frequency of approximately one megahertz.

Q1374 and Q1378 are emitter followers that regulate the +265-volt power supply. The horizontal deflection signals from the Horizontal Amplifier are connected to R1370 and R1371. The average dc voltage level at pins J and K is adjusted to be +250 volts. The voltage divider made up of R1370, R1371, and R1373 set the base of Q1374 at approximately +265 volts. Since Q1374 and Q1378 are both silicon devices, the voltage level at the emitter of Q1378 will be the same as the level at the base of Q1374. Voltage divider R1378-R1379 sets the center tap of the secondary of T1380 to approximately +250 volts.

Preamplifier

The Preamplifier Circuit in the J20 converts the input signal current from the vidicon into an output signal voltage. Output signal amplitude at P1450 is 2 millivolts per nanoampere of input signal current. Fig. 3-4 shows a simplified diagram of the Preamplifier Circuit. Refer to the simplified diagram and Diagram 9 in the Diagram section while reading this circuit description.

U1496 and Q1498 with their associated components comprise the Focus Current circuit. The circuit is a constant-current supply whose output is variable between 20 mA and 40 mA approximately. Focus Current adjustment R1495 sets the voltage level at the plus input of U1496. U1496 and Q1498 set the voltage level at test point TP 1497 equal to the voltage level at the plus input to U1496. The amount of focus current flowing through Q1498 is determined by measuring the voltage developed across precision resistor R1497.

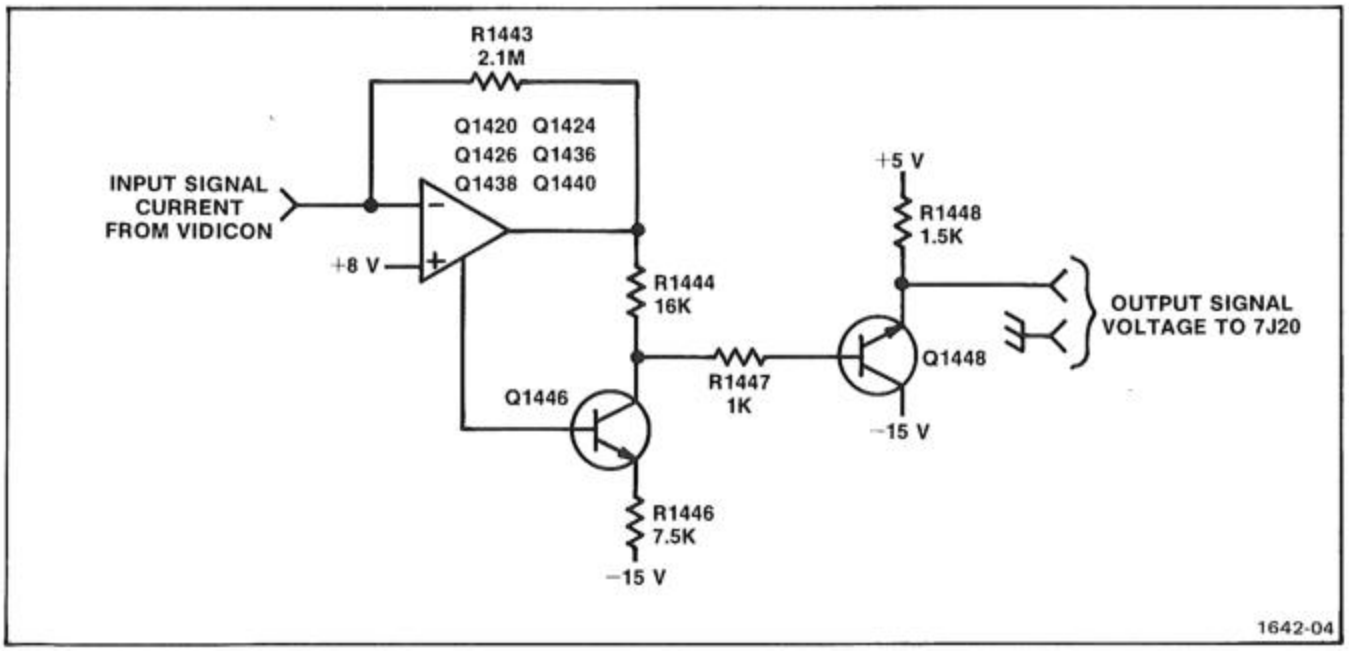


Fig. 3-4. Simplified diagram of the J20 Preamplifier.

The Preamplifier Circuit is basically a feedback amplifier whose output drives an emitter follower. R1443 is the feedback element between the output and the minus input. The feedback amplifier converts the input signal current into an output signal voltage. Q1446 is a constant-current source that provides dc-level shifting through R1444. Q1448 is an emitter follower to provide isolation and a relatively low output impedance. Output signal amplitude from emitter follower Q1448 is approximately 2 mV per nanoampere of vidicon signal current.

VIDICON REGULATOR AND NORMALIZER CIRCUITS

Vidicon Regulator Board

The Vidicon Regulator Board contains two alignment-current supplies, a focus-current supply, and the vidicon cathode-current and grid-voltage supplies. Q1472 and Q1476 (Diagram 10) with their associated components comprise the Vertical Alignment Current circuit. The circuit is a constant-current supply whose output is variable between approximately +10 mA and −10 mA with respect to ground. CR1471 and CR1476 compensate for changes in output current that would occur with variations in ambient temperature. Q1462 and Q1466 with their associated components comprise the Horizontal Alignment Current circuit, which is identical to the Vertical Alignment Current circuit.

Q1482, Q1484, Q1488, U1488, and Q1490 with their associated components comprise the Vidicon Cathode Current and Grid Voltage supplies. Q1484 and Q1488 function as switches whose switching action is controlled by Q1482. The SCAN pulse connects to the emitter of Q1482. When the SCAN pulse is HI (during ramp generation), Q1482 turns on, which biases Q1484 and Q1488 into saturation and connects R1485 into the circuit. When the SCAN pulse is LO (during holdoff), Q1482 turns off, which biases Q1484 and Q1488 off and disconnects R1485. This circuit action blanks the vidicon during ramp retrace, which occurs during holdoff.

Cathode I adjustment R1481 varies the voltage level at the plus input of U1488 between zero and +0.2 volts approximately. The minus input of U1488 will seek the same level as the plus input, which will also be the level present at test point TP 1485. The voltage across R1485 determines the amount of vidicon cathode current allowed to flow. The output of U1488 (pin 6) controls the current through Q1490 whose collector voltage sets the voltage on the vidicon control grid. If, for example, the vidicon tries to increase conduction, the voltage level at test point TP 1485 will try to go positive. This will set the minus input of U1488 more positive than the plus input, and the output of U1488 (pin 6) will go negative. This more negative level will reduce the currrent through Q1490, which in turn will reduce the grid drive to the vidicon. Lower grid drive results in less conduction in the vidicon.

Normalizer Driver Board

U1542 and Q1544 and their associated components form an adjustable constant-current supply. The supply provides a reference current of approximately 2 mA to the 40 nm Normalizer Programming Board. The plus input of U1542A is connected to ground, which sets the minus input to zero volts. The amount of current that flows through Q1544 is determined by the adjustment of R1540. U1542B and Q1538 form another identical constant-current supply that provides a reference current to the 400-nm Normalizer Programming Board.

U1522 is a voltage follower with unity gain. The output voltage at pin 6 of U1522 represents the wavelength at the center of the vidicon target. Zero volts equals 300 nm. Each 1-volt change in voltage represents a 100-nm change in wavelength.

U1524A is a non-inverting feedback amplifier with a gain of

$$\frac{R1542 + R1526}{R1524} = \frac{12\text{ k} + 10\text{ k}}{12\text{ k}} \approx 1.8.$$

The input signal to the stage is the ramp waveform from the Ramp Generator on Diagram 3, and is offset by the +8-volt supply through R1524. The output voltage swing from this stage represents the difference in wavelength from the left edge to the right edge of the vidicon scan area.

U1534A and Q1534 with their associated components form a voltage-to-current converter. The circuit converts the voltages from U1522 and U1524A into a ramp current that represents the wavelength region being scanned. The output current from Q1534 connects to pin 5 of U1590 on the 400-nm Normalizer Programming Board. U1524B and Q1532 form a similar voltage-to-current converter whose output current change is 0.1 that of the U1534A-Q1534 output change. The output current from Q1532 connects to pin 5 of U1550 on the 40-nm Normalizer Programming Board and has a smaller change because of the 10:1 ratio in wavelength scanned between Grating A and Grating B.

Normalizer Programming Boards

The 40-nm and 400-nm Normalizer Programming Boards contain identical circuitry. For purposes of explanation, only the circuitry on the 400-nm Normalizer Programming Board will be discussed.

U1590 is a programmable, function-generator, integrated circuit. It has 19 discrete output-current nodes, each capable of supplying a current approximately equal

to half the value of the reference current connected to pin 7. The amplitude of the current connected to pin 5 determines which one of the output nodes will be conducting. Each node comes into conduction in a gradual, linear fashion. Between each of the 19 discrete conduction points, the value of output current will be shared between two adjacent output-current nodes. R1628 adjusts the ratio of some currents internal to U1590.

U1534B is a current-to-voltage converter. The output voltage signal from U1534B varies the gain of the Multiplier Circuit (U102) on Diagram 1 to provide radiometrically-calibrated, vertical deflection in the spectrometer display. The amplitude of the output signal from U1534B is adjusted at 19 discrete points in the spectrometer's 300-1100 nm operating range by variable resistors R1590 through R1626.

MAINTENANCE

Cover Removal

WARNING

Dangerous potentials exist at several points throughout this instrument. Tektronix, Inc. recommends that the instrument not be operated with the covers removed. Disconnect power before cleaning the instrument or replacing parts.

The interior of both the J20 Spectrometer and the 7J20 Spectrometer Plug-In are readily accessible by removing the instrument covers. However, if it is necessary to gain access to the interior of the J20 Spectrometer, Tektronix, Inc. recommends the J20 covers be removed only in a room having a relatively clean atmosphere (no smoke, dust, etc.). The J20 contains delicate optical components whose performance could be adversely affected by any humidity or other accumulation of foreign matter on their surfaces. To remove the covers from the J20, use a 5/64-inch Allen wrench and remove the four Allen-head screws that secure the covers to the end castings. Pull the covers away from the handle and remove the bottom edge of each cover from the slot in the bottom side rails. To remove the covers from the 7J20, grasp the rear of one of the side covers and pull it from the slots in the corner rails.

PREVENTIVE MAINTENANCE

General

There are no preventive maintenance routines recommended for the J20 Spectrometer. The delicate nature of the optical components contained in the J20 make it imperative that no spray cleaners or lubricants be used in the interior of the J20. If the covers of the J20 are kept in place and the instrument is operated and stored in properly clean atmospheres, the instrument should operate reliably for extended periods of time. The 7J20, however, can benefit from certain preventive maintenance routines.

Preventive maintenance consists primarily of cleaning and visual inspection. The severity of the environment to which the RSS is subjected will determine the frequency of maintenance. A convenient time to perform preventive maintenance is just prior to recalibration of the instrument.

Cleaning

Generally, Tektronix, Inc. recommends no cleaning of any portion of the interior of the J20 Spectrometer. The external panels of the J20, however, can be cleaned as often as operating conditions require. Loose dust accumulated on the outside of the J20 can be removed with a soft cloth or small paint brush. The paint brush is particularly useful for dislodging dirt on and around external controls. Dirt that remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should not be used.

Dust in the interior of the 7J20 Spectrometer Plug-In should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-pressure air. Remove any dirt that remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning circuit boards.

The switches used in the 7J20 are installed with proper lubrication applied where necessary and will only rarely require any additional lubrication.

A large portion of the switching in the 7J20 is accomplished with cam-actuated contacts mounted on circuit-boards. Care must be exercised to maintain the switching action of these contacts. An acceptable contact cleaner-restorer is No Noise (Electronic Company). If lubrication is required, use Silicone Versilube (General Electric Co.), Rykon R (Standard Oil), or WD-40 (Rocket Chemical Co.) as switch lubricants.

Transistor Checks

Periodic checks of the transistors and other semiconductors in the J20/7J20 Rapid Scanning Spectrometer are not recommended. The best check of semiconductor performance is actual operation in the instrument.

Recalibration

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

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

CORRECTIVE MAINTENANCE

General

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

Obtaining Replacement Parts

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

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance in the instrument. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Special Parts. In addition to the standard electronic components, some special components are used in the RSS. These components are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. These special components are indicated in the Electrical Parts List by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix, Inc. Field Office or representative.

Ordering Parts. To order replacement parts, see the ordering instructions given at the beginning of the appropriate parts list (mechanical or electrical) section.

Soldering Techniques

WARNING

Always disconnect instrument power before attempting to solder in the instrument. When soldering in the J20, use a fan to pull any smoke out of the instrument to prevent contaminating the optical elements.

Ordinary 60/40 solder and a 35- to 40-watt pencil-type soldering iron can be used to accomplish the majority of the soldering to be done in the RSS. 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. Use care when soldering in the J20, or when soldering in the general area of any cam-switch contacts. Clean the contacts after completion of the soldering.

Circuit Board and Component Replacement

WARNING

Always disconnect the instrument power prior to attempting to replace components.

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 ncessary steps to facilitate instrument disassembly. Most of the connections to the circuit boards in the instrument are made with pin connectors. However, some connections may be soldered to the board. Observe the soldering precautions given under Soldering Techniques in this section.

7J20 Vertical Circuit Board Removal.

1. Remove the instrument side covers.

2. Remove the knobs from the VERTICAL GAIN switch and the VARIABLE VERTICAL GAIN control.

3. Remove the eight screws securing the plug-in rear plate to the corner rails and remove the rear plate.

4. Disconnect all cable connections from the Vertical Circuit Board.

5. Remove the five screws securing the Vertical Circuit Board in the instrument.

6. Spread the corner rails slightly and lift the Vertical Circuit Board out of the instrument. Exercise caution so as not to bend the interconnect pins to the Readout Circuit Board.

To reinstall the Vertical Circuit Board assembly, reverse the order of the removal steps.

7J20 Readout Circuit Board Removal.

1. Remove the Vertical Circuit Board as outlined previously.

2. Disconnect all cable connections to the Readout Circuit Board.

3. Using a 1/4-inch nutdriver, remove the two hex-head screws that secure the Horizontal Circuit Board to the aluminum blocks attached to the Readout Circuit Board.

4. Remove the two screws that secure the two aluminum blocks to the corner rail and lift the Readout Circuit Board out of the instrument.

To reinstall the Readout Circuit Board, reverse the order of the removal steps.

7J20 Horizontal Circuit Board Removal.

1. Remove the instrument side covers.

2. Remove the knobs from the TIME/SCAN switch and the VARIABLE TIME/SCAN control.

3. Disconnect all cable connections to the Horizontal Circuit Board.

4. Remove the eight screws securing the plug-in rear plate to the corner rails and remove the rear plate.

5. Using a 1/4-inch nutdriver, remove the four hex-head screws securing the Horizontal Circuit Board in the instrument and lift the board out of the instrument.

To reinstall the Horizontal Circuit Board, reverse the order of the removal steps.

7J20 High Voltage Circuit Board Removal.

1. Remove the metal cover over the High Voltage Circuit Board.

2. Disconnect all cable connections from the High Voltage Circuit Board.

3. Using a 3/16-inch nutdriver, remove the four posts securing the High Voltage Circuit Board and lift the board out of the instrument.

To reinstall the High Voltage Circuit Board, reverse the order of the removal steps.

J20 Circuit Board Removal. There are nine circuit boards in the J20. Eight of the nine are installed in a module just above and behind the entrance slit. Remove the side cover on the same side as the entrance slit to gain access to this module. The Vidicon Regulator Board, Horizontal Amplifier Board, Vertical Oscillator Board, Normalizer Driver Board, and the two Normalizer Programming Boards disconnect from the Interface Board readily by pulling evenly on both upper corners of each board. Exercise caution when removing the boards so as not to bend the interconnect pins on the Interface Board. To remove the Preamplifier Board, remove the handle as well as the side cover over the circuit-board module. Remove the metal cover over the Preamplifier Board and disconnect the input- and output-signal coaxial cables from the board. Slide the board out of the instrument in the same manner as the previous six boards. To remove the Interface Board, remove all seven boards mounted on it and disconnect all cable connections to the Interface Board. Remove the securing hardware and lift the Interface Board out of the instrument.

The ninth circuit board in the J20 is the Vidicon Socket Board. This board plugs onto the rear of the vidicon and is difficult to remove due to inadequate mechanical clearance. The board contains only a minimum of circuitry and replacement should seldom, if ever, be necessary.

Semiconductor Replacement. Most of the semiconductors used in the RSS are of the plug-in variety. Occasionally, it may be necessary to remove some of these devices for checking and/or replacement. Fig. 4-1 shows the electrode configuration for the various devices used in the RSS. Refer to Fig. 4-1 to ensure proper lead identification and device reinstallation.

J20 Optical Component Replacement. Tektronix, Inc. recommends that replacement of the optical components in the J20 (other than the optical filters) be accomplished only by Tektronix, Inc. Field Service Centers or the Tektronix, Inc. Factory Service Center. Contact your local Tektronix, Inc. Field Office or representative for further information.

Filter Replacement. The optical filters associated with the FILTER switch in the J20 may occasionally require replacement, or the spectrometer operator may desire to replace one of the standard filters with one of his own choosing. Refer to the following procedure for filter replacement instructions.

1. Set the FILTER switch half way between the 0 and 1 positions.

2. With a 3/32-inch Allen wrench, remove the Allen-head cap screw visible through the entrance aperture in the front of the J20.

3. Set the FILTER switch completely to the 0 position.

4. With a small-bladed screwdriver, reach through the entrance aperture and hold the shiny plate in place while turning the FILTER switch. Turn the FILTER switch until the desired filter is placed in front of the entrance slit.

5. With a pair of tweezers or small needle-nose pliers, reach through the entrance aperture and remove the filter. Touch only the sides of the filter with the tweezers.

6. Install the new filter in the filter-holder wheel. When replacing one of the monopass filters, install the new filter with the shiny side out. For neutral density filters, the shiny side of the filter goes on the inside. The remainder of the filters can be installed in either direction.

7. Continue to hold the shiny plate in place while setting the FILTER switch half way between the 0 and 1 positions.

8. Align the screw hole in the shiny plate with the screw hole in the filter wheel.

9. Replace the Allen-head cap screw in the filter wheel.

Recalibration After Repair

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

INSTRUMENT STORAGE

Occasionally, periods of inactivity may allow temporary storage of the RSS. The delicate nature of the optical components used in the RSS makes certain precautions necessary prior to instrument storage. The actual precautions taken depend on the length of time the instrument will be stored.

If the instrument is to be stored only briefly (one or two days for example), all that is necessary is to make sure that the instrument is kept in a clean, dry atmosphere. Ambient temperature during storage should be kept below +30° C. If, however, the instrument is to be stored for an extended period of time, or the instrument is being repackaged for shipment, observe the following precautions.

1. Purge the interior of the J20 with dry nitrogen gas.

2. Replace the cap over the J20 entrance-slit aperture.

3. Set the SLIT WIDTH switch and the FILTER switch to their OPEN positions. Make sure the WAVELENGTH SPAN control is positively set to either the A400 nm or the B40 nm position.

4. Place the J20 and a good dessicant in a plastic bag.

5. Purge the plastic bag with dry nitrogen gas and tie off the plastic bag.

6. Store the instrument in a room having an ambient temperature between +10° C and +20° C.

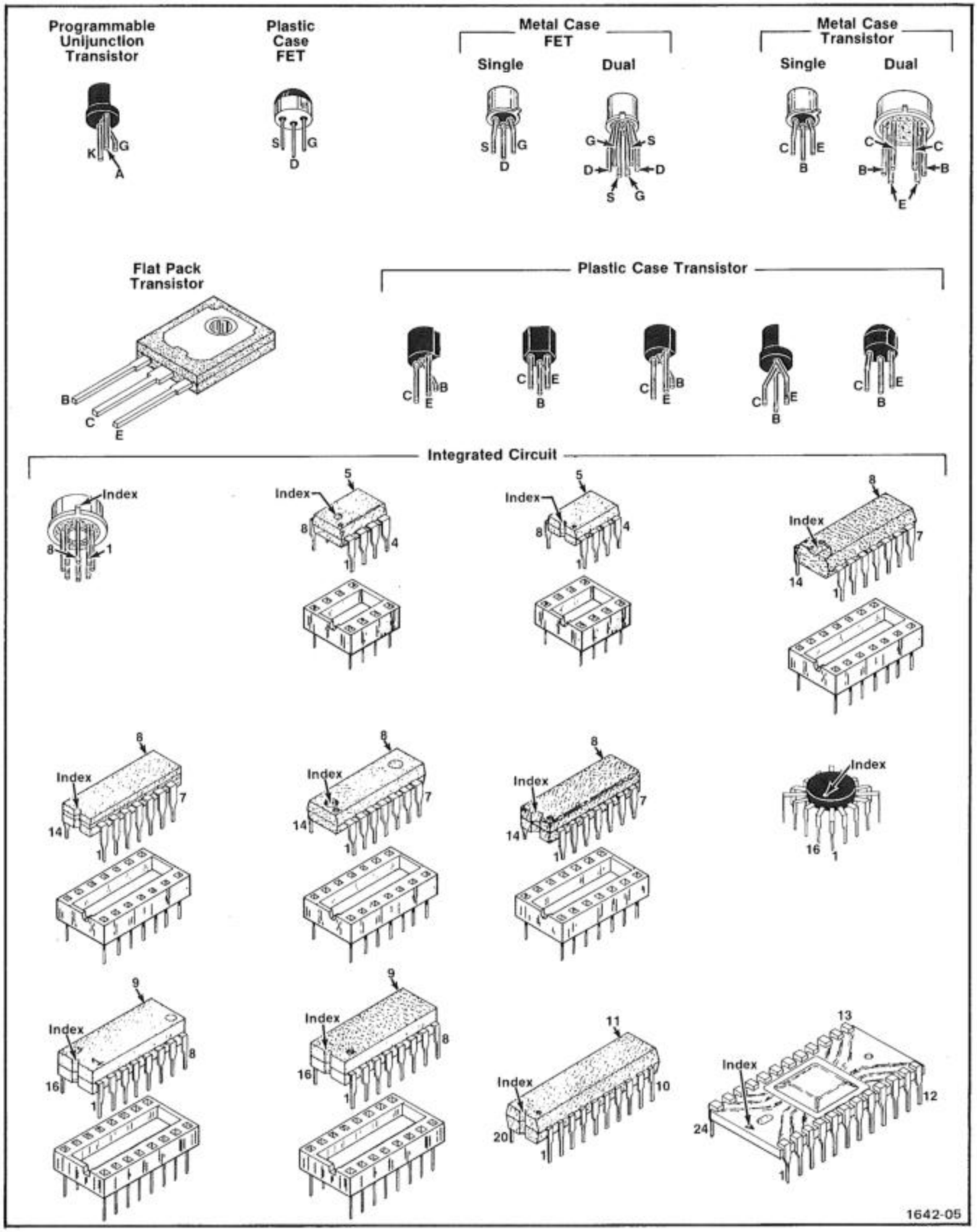


Fig. 4-1. Electrode configuration for semiconductors used in the RSS.

CALIBRATION

Calibration Interval

To ensure continued instrument measurement accuracy, Tektronix, Inc. recommends that the calibration of the J20/7J20 Rapid-Scanning Spectrometer system be checked every 1000 hours of operation, or every six months if used infrequently. Normal preventive maintenance and any corrective maintenance deemed necessary should be performed prior to the recalibration procedure.

Tektronix Field Service

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

Using This Procedure

The following calibration information is given in the form of two separate procedures. One procedure is given for the J20 Spectrometer, and the other for the 7J20 Spectrometer Plug-In. Because of the technical difficulties involved, Tektronix, Inc. recommends that calibration of certain portions of the J20 Spectrometer (such as optical component alignment and radiometric calibration) only be done at Tektronix Field Service Centers or the Tektronix Factory Service Center. Therefore, the calibration procedure for the J20 Spectrometer provides calibration information only for those portions of the J20 that are readily adjustable. Calibration of the J20 Spectrometer requires a correctly operating and calibrated 7J20 Spectrometer Plug-In. If the calibration status of the 7J20 to be used is unknown or suspect, a recalibration procedure should be performed on the 7J20 before attempting to calibrate the J20.

Test Equipment Required

There are two lists of test equipment required to accomplish the accompanying calibration procedures. The calibration procedures are based on the equipment recommended. When other equipment is substituted, control settings or calibration setups may need to be altered slightly to meet the requirements of the substitute equipment. Any test equipment substituted must meet the minimum requirements listed in the Equipment Required lists.

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

J20 SPECTROMETER TEST EQUIPMENT

Description	Minimum Specifications	Usage	Example
1. Test Oscilloscope	Bandwidth, dc to 10 MHz; deflection factor, 5 mV to 5 V; accurate within ±3%.	Check and adjust vidicon deflection signals.	Tektronix 465 Oscilloscope and one P6065A Probe.
2. Precision Digital Multimeter	Range, 0-300 V dc and 0-50 mA dc, accurate within ±0.1% dc volts and ±0.2% dc current; input impedance, at least 20,000 Ω/volt for dc voltage.	Check and adjust various dc levels in the J20.	Tektronix DM 501 with TM 503 Mainframe and test leads.
3. Low-Pressure Mercury Lamp		Wavelength alignment and checking.	Pen-Ray Lamp Model 11SC-1C with SCT-1 Power Supply.
4. Screwdriver	Four-inch shaft with 3/32" bit.	Used throughout procedure to adjust variable resistors.	Xcelite R3324

Preliminary Procedure

NOTE

The J20/7J20 Rapid-Scanning Spectrometer system should be calibrated at an ambient temperature of +25° C, ±5° C to achieve specified accuracies. For optimum results, the 7J20 Spectrometer Plug-In should be calibrated in the 7000-series oscilloscope in which it will primarily be operated.

1. Remove the J20 side panel that covers the circuit board.

CAUTION

The J20 Spectrometer side covers should be removed only in a room having a clean atmosphere (no smoke, dust, etc).

2. Connect the J20 Spectrometer to the 7J20 Spectrometer Plug-In, using the cable provided with the instrument for this purpose.

3. If the 7J20 Spectrometer Plug-In is to be recalibrated, remove its side panels and install the plug-in in its oscilloscope using the 067-0616-00 Flexible Plug-In Extender calibration fixtures (two required). If the 7J20 is not being recalibrated, install it directly into the oscilloscope.

4. Preset the Rapid-Scanning Spectrometer controls as given under Preliminary Control Settings.

5. Connect the oscilloscope to an appropriate power source and turn the oscilloscope on. Allow a minimum of 20 minutes warmup before proceeding.

6. Connect all test equipment to an appropriate power source and allow its specified amount of warmup before starting calibration.

Preliminary Control Settings

Preset the instrument controls to the settings given below when starting the calibration procedure.

7J20

ATTEN BAL	As is
VERTICAL GAIN	1
TIME/SCAN	20 ms
MARKER	Centered
VERT POSITION	Centered
ABSORBANCE ZERO	Centered
OFFSET	Locked at 0.00
DISPLAY DISPERSION	A40/B4
DISPLAY TRIGGER MODE	FREE RUN
SPECTRAL NORMALIZER	OFF
MARKER INTENSITY	As is
HORIZ POS	As is
HORIZ CAL	As is

J20

SLIT WIDTH (μm)	200
WAVELENGTH SPAN	B 40 nm
FILTER	OPEN
GRATING A WAVELENGTH INTERVAL	300-700 nm
GRATING B WAVELENGTH	500 nm on indicator tape

INDEX TO J20 SPECTROMETER CALIBRATION

J20 SPECTROMETER CALIBRATION

1. Adjust Vidicon Horizontal Centering And Plate Potential

a. Connect the negative meter lead from the DVM to ground and the positive meter lead to H1 test point TP1352 on the Horizontal Amplifier circuit board. See Fig. 5-1.

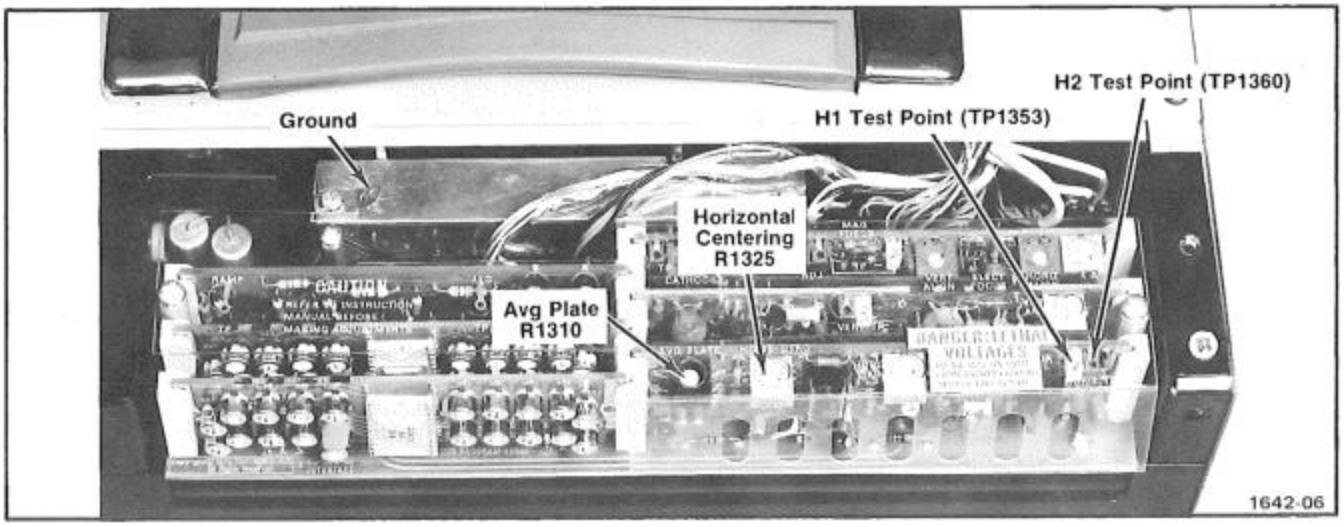


Fig. 5-1. Location of the J20 Horizontal Amplifier test points and adjustments.

b. Note the meter reading at H1 test point TP1352.

c. Remove the positive meter lead from H1 test point TP1352 and attach it to H2 test point TP1360. See Fig. 5-1. Note the meter reading at H2 test point TP1360.

d. CHECK—Meter readings taken at H1 test point TP1352 and H2 test point TP1360 should match within 0.5 V.

e. ADJUST—Horizontal Centering R1325 for equal voltage readings at H1 test point TP1352 and H2 test point TP1360.

f. CHECK—After adjusting for matching voltage readings, the voltage reading at either test point referenced to ground should be +250 V, ±1 V.

g. ADJUST—Avg. Plate R1310 (see Fig. 5-1) for a meter reading of +250 V, ±1 V.

h. Move the positive meter lead to pin 4 of plug P1395 on the Interface Circuit board. See Fig. 5-2.

i. CHECK—Meter reading of +265 V, ±2 V.

j. Remove the meter leads from the J20.

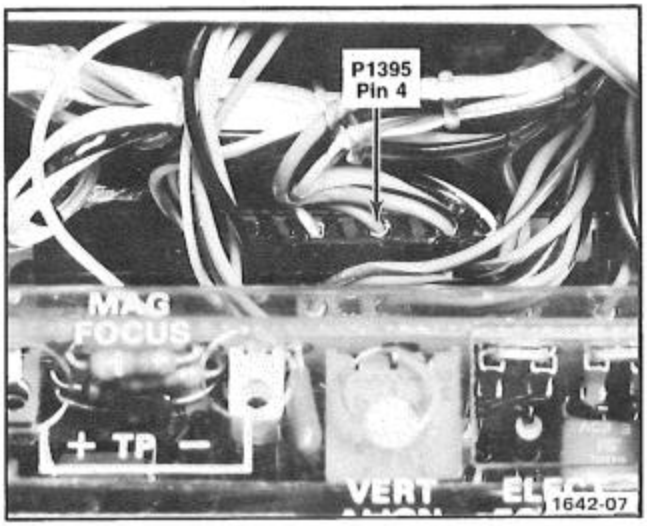


Fig. 5-2. Location of +265 V test point.

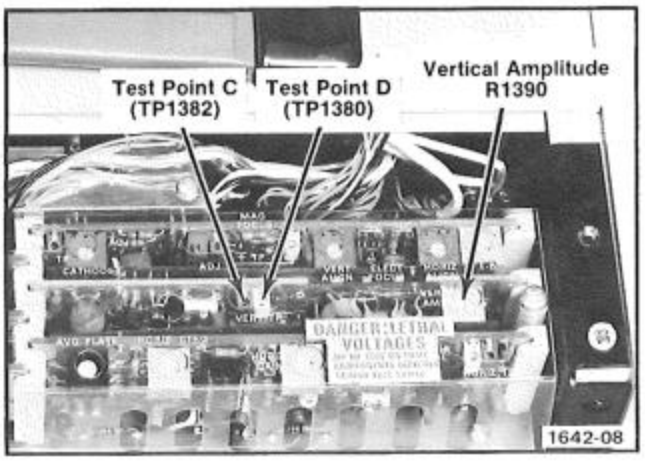


Fig. 5-3. Location of Vertical Oscillator test points and adjustments.

2. Adjust Vidicon Vertical Deflection Signal Amplitude

a. Connect the negative meter lead from the DVM to ground and the positive meter lead to test point C (TP1382) on the Vertical Oscillator Board. See Fig. 5-3.

b. CHECK—Meter reading of approximately +248 V.

c. Remove the meter leads from the J20.

d. Connect a X10 probe from the test oscilloscope to test point C (TP1382) on the Vertical Oscillator Board. See Fig. 5-3.

e. CHECK—Test oscilloscope crt display for a sinewave frequency of 1 MHz, ±25%, with an amplitude of 68 V, ±3 V.

f. ADJUST—Vertical Amplitude R1390 for a test oscilloscope display of 68 V, ±3 V.

g. Move the X10 probe from the test point C (TP1382) to test point D (TP1380) on the Vertical Oscillator Board. See Fig. 5-3.

h. CHECK—Test oscilloscope crt display for a sinewave frequency of 1 MHz, ±25%, with an amplitude of 68 V, ±3 V.

i. Remove the X10 probe from test point D (TP 1380).

3. Adjust Vidicon Focus, Alignment, And Cathode Currents

a. Remove the side cover from the J20 over the vidicon.

b. The vidicon has a tag on it that lists values of current in milliamperes for the focusing coil, the horizontal alignment coil, the vertical alignment coil, and the vidicon cathode current. These values are called I_F, I_H, I_V, and I_{OP} respectively. Record these values on a separate piece of paper and replace the side cover over the vidicon.

c. Set the DVM to measure dc volts and connect the meter leads to the Mag Focus test points (minus lead to TP1498 and plus lead to TP1497). See Fig. 5-4.

d. CHECK—The Mag Focus current, called I_F and listed for the specific vidicon installed, is adjusted by measuring the voltage developed across a precision 100 Ω resistor. For example, 30 mA of focusing coil current would result in a voltage reading of 3 V, 35 mA equals 3.5 V, etc. Check for a meter reading equivalent to the listed focusing current for the vidicon installed in the J20.

e. ADJUST—Mag Focus R1495 (see Fig. 5-4) for a meter reading exactly equal to the recommended focusing current.

f. Remove the DVM meter leads from the J20.

g. Connect the plus meter lead of the DVM to the I_K test point TP1485 and the negative meter lead to ground. See Fig. 5-4.

h. CHECK—The vidicon cathode current, called I_{OP}, listed for the specific vidicon installed is adjusted by measuring the voltage developed across a precision 100 Ω resistor. For example, 1 mA of cathode current would result in a voltage reading of 100 mV, 1.3 mA equals 130 mV, 1.5 mA equals 150 mV, etc. Check for a meter reading equivalent to the recommended cathode current for the vidicon installed in the J20.

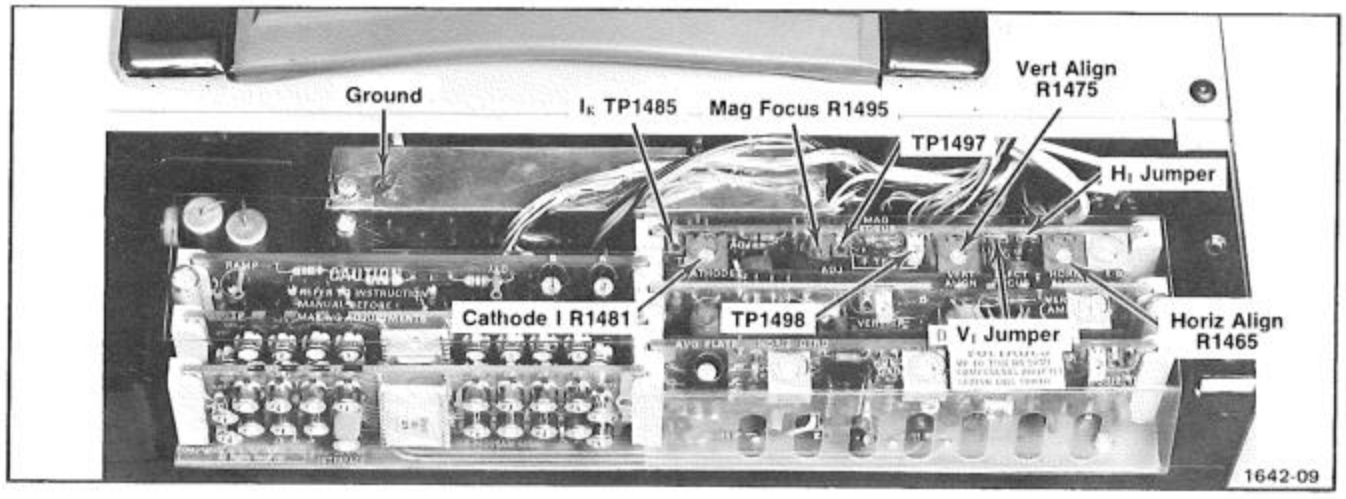


Fig. 5-4. Location of Vidicon Regulator test points and adjustments.

i. ADJUST—Cathode Current R1481 (see Fig. 5-4) for a meter reading exactly equal to the recommended cathode current.

j. Remove the meter leads from the J20.

k. Remove the H_I jumper (see Fig. 5-4) from the Vidicon Regulator Board. Set up the DVM to measure dc current and install the meter leads in the empty H_I connectors (plus meter lead to the + connector and the minus meter lead to the − connector).

l. CHECK—Meter reading of the proper value and polarity of horizontal alignment current (I_H).

m. ADJUST—Horiz Align R1465 (see Fig. 5-4) for a meter reading exactly equal to the listed value of horizontal alignment current (I_H) for the vidicon installed in the J20.

n. Move the DVM meter leads from the H_I connectors to the V_I connectors on the Vidicon Regulator Board. Be sure to remove the V_I jumper and reinstall the H_I jumper.

o. CHECK—Meter reading of the proper value and polarity of vertical alignment current (V_I).

p. ADJUST—Vert Align R1475 (see Fig. 5-4) for a meter reading exactly equal to the listed value of vertical alignment current (V_I) for the vidicon installed in the J20.

q. Remove the DVM meter leads from the J20 and reinstall the V_I jumper on the Vidicon Regulator Board.

4. Adjust 7J20 HORIZ CAL, HORIZ POS, And Vertical Gain

a. Press the BASELINE RESTORE pushbutton on the 7J20 for three seconds and then release.

b. Rotate the MARKER control on the 7J20 fully clockwise and then fully counterclockwise.

c. CHECK—The spectrometer display for ten horizontal major graticule divisions of movement of the intensified wavelength marker. The intensified wavelength marker should align with the extreme right and extreme left vertical graticule lines at the extremes of rotation of the MARKER control.

d. ADJUST—HORIZ POS R385 and HORIZ CAL R435 so the intensified wavelength marker aligns with the extreme right and extreme left vertical graticule lines at the extremes of rotation of the MARKER control.

e. Set the 7J20 MARKER control to the fully clockwise position.

f. Set the 7J20 VERTICAL GAIN switch to the GAIN position and the DISPLAY DISPERSION switch to one of the expanded-display positions.

g. Using the Vertical POSITION control, align the intensified wavelength marker in the display with the horizontal crt graticule line one major division up from the bottom.

h. Rotate the MARKER control fully counterclockwise.

i. CHECK—The intensified wavelength marker should be one major division down from the top horizontal crt graticule line (a total of six divisions of deflection) within 1% (0.06 major crt graticule division).

j. ADJUST—Vertical GAIN R275 on the 7J20 for exactly six major crt graticule divisions of vertical deflection of the intensified wavelength marker when rotating the MARKER control from fully clockwise to fully counterclockwise.

5. Adjust Grating A Display Wavelength Alignment

a. Set the 7J20 DISPLAY DISPERSION switch to A40/B4 position and the VERTICAL GAIN switch to 5.

b. On the J20, set the WAVELENGTH SPAN control to A400 nm, the GRATING A WAVELENGTH INTERVAL switch to 400-800 nm, and the SLIT WIDTH switch to 20 μm.

c. Place a Low-Pressure Mercury lamp in front of the J20 Spectrometer entrance slit and turn on lamp power. Allow two minutes warm-up for the lamp.

d. While observing the spectrometer display, position the mercury lamp to obtain maximum signal amplitude in the display.

e. Rotate the MARKER control to obtain a wavelength readout of 593 nm.

f. CHECK—Spectrometer display for 8.9 major crt divisions, ±0.1 division between the 405 nm and 761 nm spectral lines.

g. ADJUST—Horizontal Gain R1315 for exactly 8.9 major crt divisions between the 405 nm and the 761 nm spectral lines.

h. CHECK—The intensified wavelength marker in the spectrometer display should align with the peak of the 593 nm spectral line.

i. ADJUST—Remove the plastic plug from the front panel of the J20 Spectrometer. Using a 3/32" Allen wrench, reach through the hole in the front panel and adjust Grating A to align the peak of the 593 nm spectral line with the intensified wavelength marker in the spectrometer display.

j. Rotate the MARKER control to align the intensified wavelength marker with the peak of the 405 nm spectral line.

k. CHECK—Marker readout should read 405 nm, ±10 nm.

l. Rotate the MARKER control to align the intensified wavelength marker with the peak of the 761 nm spectral line.

m. CHECK—Marker readout should read 761 nm, ± 10 nm.

n. Set the GRATING A WAVELENGTH INTERVAL switch to the 300-700 nm position and rotate the MARKER control to align the intensified wavelength marker with the peak of the 507 nm spectral line.

o. CHECK—Marker readout should read 507 nm, ±10 nm.

p. Set the GRATING A WAVELENGTH INTERVAL switch to the 500-900 nm position and rotate the MARKER control to align the intensified wavelength marker with the peak of the 730 nm spectral line.

q. CHECK—Marker readout should read 730 nm, ±10 nm.

r. Set the GRATING A WAVELENGTH INTERVAL switch to the 600-1000 nm position and rotate the MARKER control to align the intensified wavelength marker with the peak of the 809 nm spectral line.

s. CHECK—Marker readout should read 809 nm, ±10 nm.

t. Set the GRATING A WAVELENGTH INTERVAL switch to the 700-1100 nm position and rotate the MARKER control to align the intensified wavelength marker with the peak of the 872 nm spectral line.

u. CHECK—Marker readout should read 872 nm, ±10 nm.

v. Leave the test set-up in place for the following step.

6. Adjust Grating B Display Wavelength Alignment

a. Set the WAVELENGTH SPAN control to the B 40 nm position.

b. Rotate the GRATING B WAVELENGTH control to align the 302 nm spectral line with the center vertical graticule line in the spectrometer display.

c. Rotate the MARKER control to align the intensified wavelength marker with the peak of the 302 nm spectral line.

d. CHECK—Marker readout should read 302 nm, ±3 nm.

e. ADJUST—Loosen the setscrews (use 1/16" Allen wrench) in the gear on the rear of the GRATING B WAVELENGTH INTERVAL potentiometer R1630 and move the gear away from the potentiometer to disengage the gear from the remainder of the gear train. See Fig. 5-5. Using a pair of needle-nose pliers, turn the shaft that extends out of the rear of R1630 until the wavelength marker readout reads 302 nm. Re-engage the gear with the gear train and tighten the gear setscrews.

f. Rotate the GRATING B WAVELENGTH control to align the 1014 nm spectral line with the center vertical graticule line in the spectrometer display. Set the FILTER switch to position 5 to ensure a display of only the 1014 nm spectral line.

g. Rotate the MARKER control to align the intensified wavelength marker with the peak of the 1014 nm spectral line.

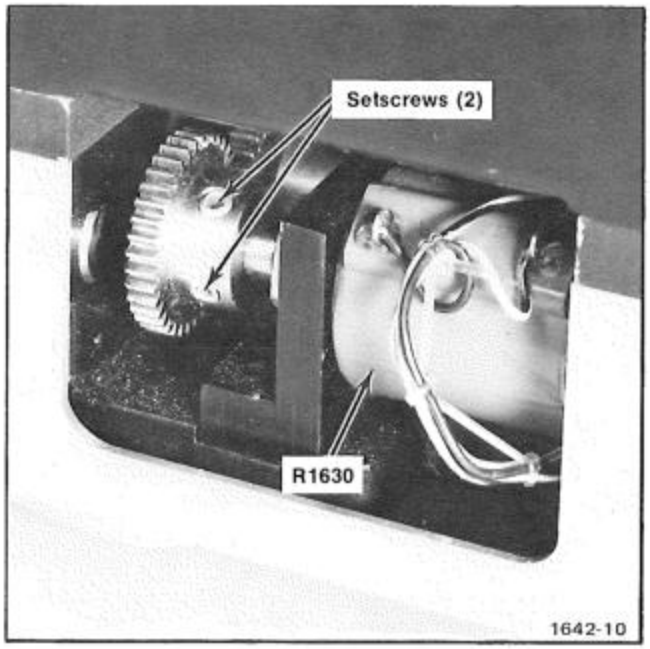


Fig. 5-5. Location of gear-train adjustment for Grating B wavelength.

h. CHECK—Marker wavelength readout should read 1014 nm, ±3 nm.

i. ADJUST—λ-B R1505 (see Fig. 5-6) on the Vidicon Regulator Board for a marker wavelength readout of exactly 1014 nm.

j. CHECK—There is interaction between the calibration adjustments at 302 nm and 1014 nm. Repeat this procedure as necessary to achieve calibrated operation.

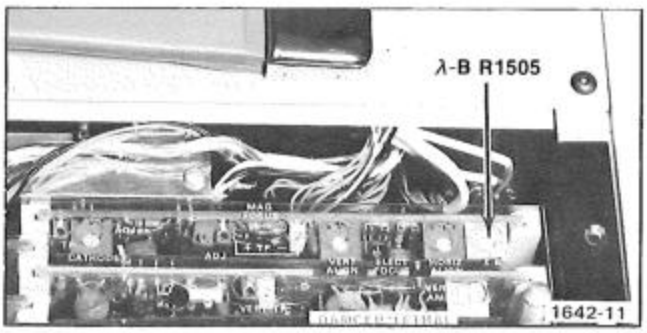


Fig. 5-6. Location of λ-B adjustment.

k. Set the FILTER switch to the OPEN position and rotate the GRATING B WAVELENGTH control to align the 730 nm spectral line with the intensified wavelength marker.

l. CHECK—The Grating B readout dial tape should match the digital wavelength marker readout within 10 nm.

m. ADJUST—Using a 5/64" Allen wrench, remove the bottom plate from the J20 Spectrometer. Loosen the two setscrews (use a .050" Allen wrench) in the front coupler to the tape-drive unit. Hold the grating-drive side of the coupler while turning the GRATING B WAVELENGTH knob to make the indicator tape read the same as the digital wavelength marker readout. Re-tighten the two setscrews in the tape-drive coupler and replace the bottom plate on the J20.

7. Check Grating A And Grating B Resolution

a. Rotate the GRATING B WAVELENGTH control to align the 546 nm spectral line with the center vertical graticule line in the spectrometer display.

b. Position the Low-Pressure Mercury lamp in front of the entrance slit to obtain maximum amplitude and sharpness of peak of the 546 nm spectral line. To achieve proper results in this check, the amplitude of the spectral line should be between 100 nA and 300 nA. Signal current per division equals 100 nA divided by the relative gain setting selected by the VERTICAL GAIN switch. If the amplitude of the signal is too high, move the mercury lamp away from the J20 slightly and reposition for maximum amplitude and sharpness of peak until the proper amplitude is obtained.

c. Set the DISPLAY DISPERSION switch to the A4/B.4 position.

d. CHECK—The spectral line displayed should be ≤ one division in width at the 50% amplitude level.

e. Set the WAVELENGTH SPAN control to the A 400 position, the GRATING A WAVELENGTH INTERVAL switch to the 300-700 nm position, the DISPLAY DISPERSION switch to the A40/B4 position, and rotate the MARKER CONTROL to align the intensified wavelength marker with the peak of the 546 nm spectral line.

f. Set the DISPLAY DISPERSION switch to A4/B.4 position.

g. Reposition the mercury lamp in the manner explained in step b to obtain the correct signal amplitude.

h. CHECK—The spectral line displayed should be one division in width at the 50% amplitude level.

This completes the calibration of the J20 Spectrometer. If the instrument still exhibits uncalibrated operation, the problem may lie in the optical components of the J20. Return the complete J20/7J20 RSS system to the Tektronix, Inc. Factory Service Center for service or repair.

7J20 SPECTROMETER PLUG-IN CALIBRATION TEST EQUIPMENT

Description	Minimum Specifications	Usage	Examples
1. Test Oscilloscope	Bandwidth, dc to 10 mHz; deflection factor, 5 mV to 1 V per div; deflection accuracy, within ±3%; capable of alternate vertical and delayed sweep operation; +B Gate output signal TTL compatible.	Check and adjust various voltages and waveforms throughout the instrument.	Tektronix 465 Oscilloscope and two P6062A probes.
2. Precision Digital Multimeter	Range, 0—400 V dc and 0-2 mA dc; accuracy, within ±0.1% dc volts and ±0.2% dc current; display 4 1/2 digit.	Check and adjust various levels in 7J20.	Tektronix DM 501 with test leads.
3. Universal Counter	Interval range, 4 ms to 1000 ms.	Check and adjust time/scan function.	Tektronix DC 503.
4. Signal Generator	Output signal, approximately 1 kHz squarewave with adjustable amplitude (2 mV to 1 V); frequency adjustable.	Vertical aplifier signal source.	Tektronix FG 501.
5. Power Module	Capable of powering DM 501, DC 503, and FG 501.		Tektronix TM 503.
6. Standard Amplitude Calibrator	Approximately 1 kHz square-wave output signal with amplitude switchable from 1 V to 2 mV in 1-2-5 steps; amplitude accuracy, within ±0.25%.	Checking and adjusting amplifier gains.	Tektronix calibration fixture. Tektronix Part Number 067-0502-01.
7. Interconnect Cable	Impedance, 50 Ω; connectors, one BNC and one special Tektronix, Inc. interconnect.	Connecting signals to the input to vertical amplifier system.	Tektronix calibration fixture. Tektronix Part Number 067-0502-01.
8. T Connector	Connectors, BNC.	Used for signal interconnection.	Tektronix Part Number 103-0030-00.
9. Adapter	BNC female to alligator clips.	Used for signal interconnection.	Tektronix Part Number 013-0076-00.
10. Termination	Connectors, BNC; impedance, 50 Ω; accuracy, within ±3%.	Used for signal interconnection.	Tektronix Part Number 013-0076-00.
11. Attenuator	Connectors, BNC; impedance, 50 Ω; attenuation, 5X.	Checking and adjusting gains.	Tektronix Part Number 011-0060-01.
12. Attenuator (two required)	Connectors, BNC; impedance, 50 Ω; attenuation, 10X.	Checking and adjusting gains.	Tektronix Part Number 011-0059-02.

7J20 SPECTROMETER PLUG-IN CALIBRATION TEST EQUIPMENT (cont)

Description	Minimum Specifications	Usage	Examples
13. Cable (three required)	Length, 42 inches; impedance, 50 Ω, connectors, BNC.	Used for signal interconnection.	Tektronix Part Number 012-0057-01.
14. Screwdriver	Three-inch shaft, 3/32-inch bit.	Used throughout procedure to adjust variable resistors.	Tektronix Part Number 003-0192-00.
15. Flexible Plug-In Extender (two required)		Used throughout procedure to connect 7J20 to oscilloscope.	Tektronix calibration fixture. Tektronix Part Number 067-0616-00.

INDEX TO 7J20 SPECTROMETER PLUG-IN CALIBRATION

7J20 SPECTROMETER PLUG-IN CALIBRATION

1. Check And Adjust DC Power Supply Levels

a. Turn instrument off and remove the cover over the High Voltage Circuit Board.

b. Turn instrument power on and connect the DVM test leads between the +8 V power suppy test point and the ground test point TP 1044 on the High Voltage Circuit Board. See Fig. 5-7.

c. CHECK—Meter reading of +8 V, ±0.04 V.

d. ADJUST—+8 V Adj R1110 (see Fig. 5-8) on the Horizontal Circuit Board for a meter reading of exactly +8 V.

e. CHECK—Refer to the following chart and check the listed power supplies to be within the required tolerances. See Fig. 5-7 for the location of the power supply test points.

SUPPLY	TOLERANCE
+350 V	±3.5 V
+15 V	±0.5 V
+6.3 V*	±0.2 V
+5 V	±0.2 V
−15 V	±0.5 V
+50 V	±1 V

***The J20 Spectrometer should be connected to the 7J20 to provide proper power supply loading.**

f. Remove the DVM test leads from the 7J20. Turn instrument power off and replace the cover over the High Voltage Circuit Board. Turn instrument power on.

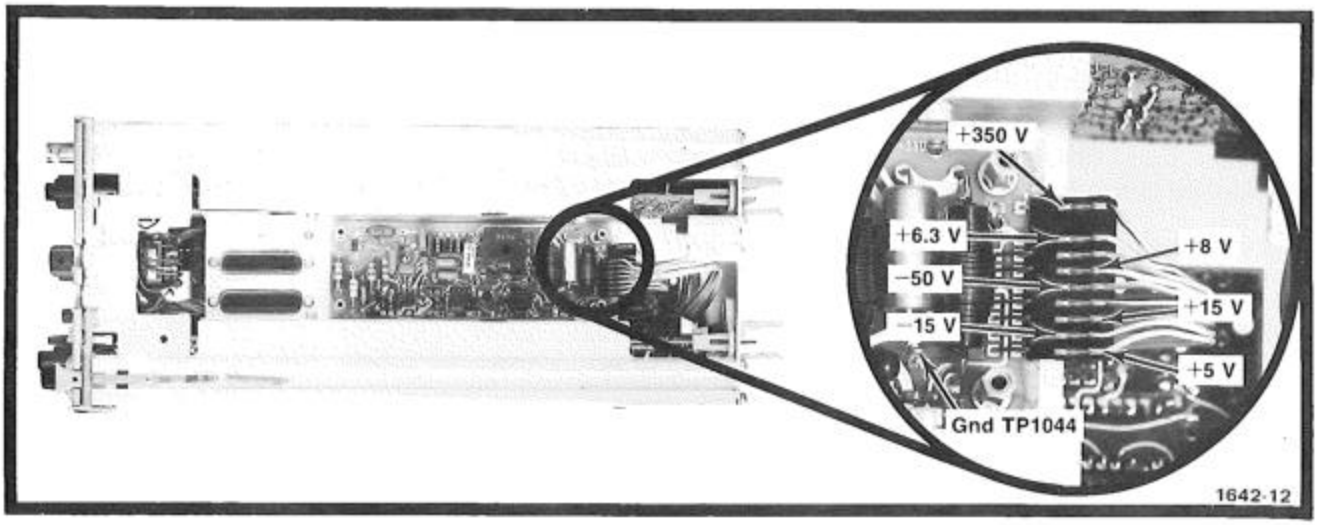


Fig. 5-7. Location of power supply test points.

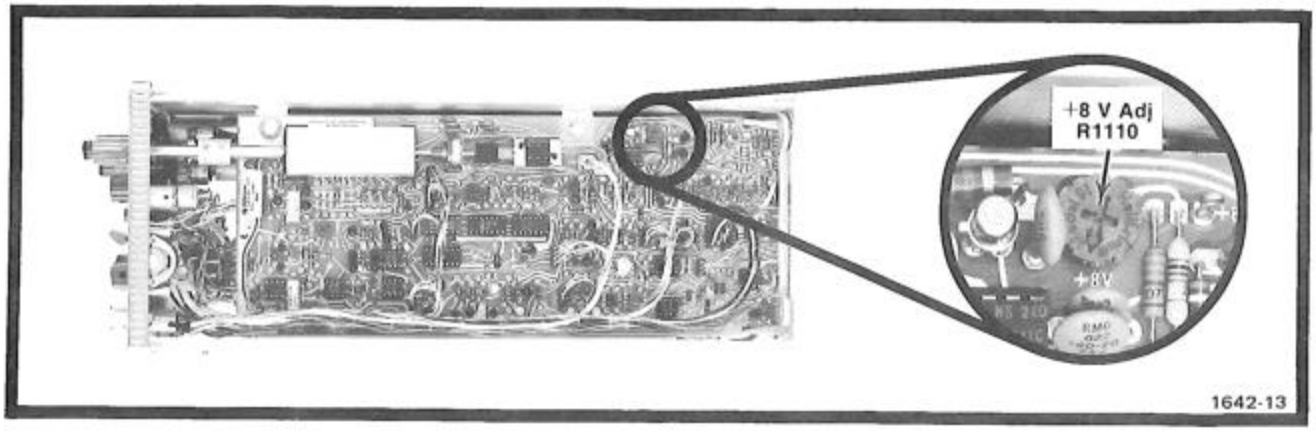


Fig. 5-8. Location of +8 V Adj R1110.

2. Adjust Scan Timing And Check TIME/SCAN VARIABLE

a. Connect a 42-inch, 50 Ω, BNC coaxial cable to the Channel B input of the DC 503, Universal Counter.

b. Connect a BNC female to alligator clip adaptor to the end of the 42-inch BNC cable.

c. Connect the red alligator clip to the Ramp test point TP378 (see Fig. 5-9) and the black alligator clip to ground.

d. Set the following DC 503 controls to the positions indicated.

Chan B Atten	X10
Chan B Level	For flashing Gate light
Chan B Slope	—
Avg'd Over N Cycles of B	10
Function	Period B

e. CHECK—DC 503 display for a reading of 20 ms, ±0.2 ms.

f. ADJUST—Ramp Timing R345 (see Fig. 5-9) for a reading of exactly 20 ms.

g. Set the VARIABLE TIME/SCAN control to the uncalibrated (button out) position and rotate fully clockwise.

h. CHECK—DC 503 display for a reading of 8 ms or less.

i. Set the VARIABLE TIME/SCAN control to the calibrated (button in) position.

j. Set the TIME/SCAN switch to the 50 ms position.

k. CHECK—DC 503 display for a reading of 50 ms, ±1.5 ms.

l. ADJUST—Int Timing R320 (see Fig. 5-9) for a reading of exactly 50 ms.

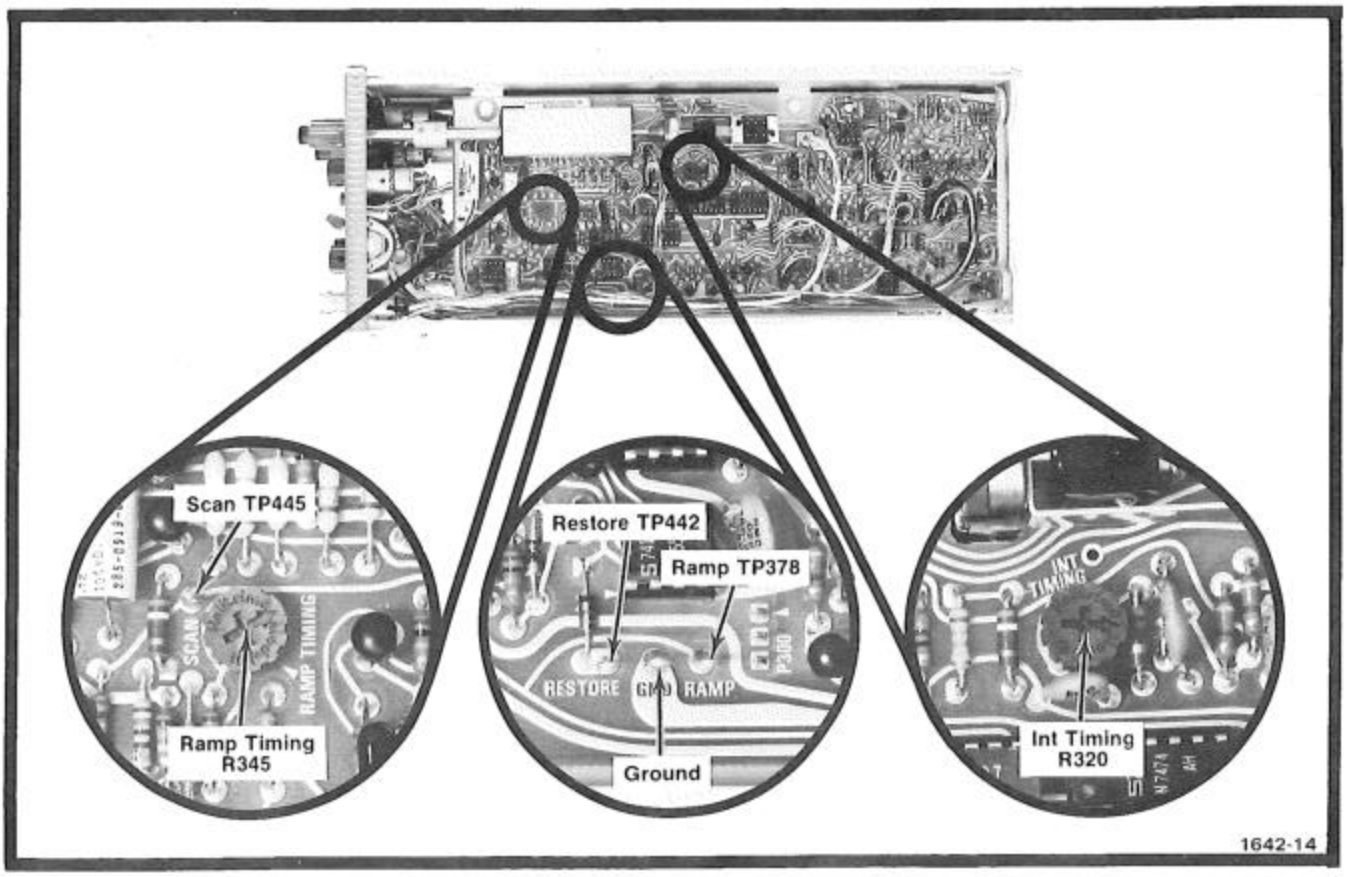


Fig. 5-9. Location of ramp timing adjustments and test points.

m. Refer to the following chart and check each position of the TIME/SCAN switch for the indicated scan time accuracies.

TIME/SCAN	TOLERANCE
10 ms	±0.1 ms
20 ms	±0.2 ms
50 ms	±1.5 ms
100 ms	±3 ms
200 ms	±6 ms
500 ms	±15 ms
1000 ms	±30 ms

n. Remove the test setup from the 7J20.

3. Check DISPLAY DISPERSION Switch Accuracy

a. Set the TIME/SCAN switch to 20 ms.

b. Connect the output of the FG 501 Function Generator to the Channel 1 vertical input connector of the test oscilloscope via a BNC T and a 42-inch 50 Ω, BNC coaxial cable.

c. Connect the unused output of the BNC T to J10 on the Vertical Circuit Board in the 7J20 via a 067-0709-00 Interconnect Cable. See Fig. 5-10.

d. Connect the +B Gate output connector of the test oscilloscope to the Scan Control test point TP 447 (see Fig. 5-11) on the Horizontal Circuit Board of the 7J20 via a 42-inch, 50 Ω, BNC coaxial cable and a BNC to alligator clips adapter. Connect the red alligator clip to TP 447 and the black clip to a convenient ground point.

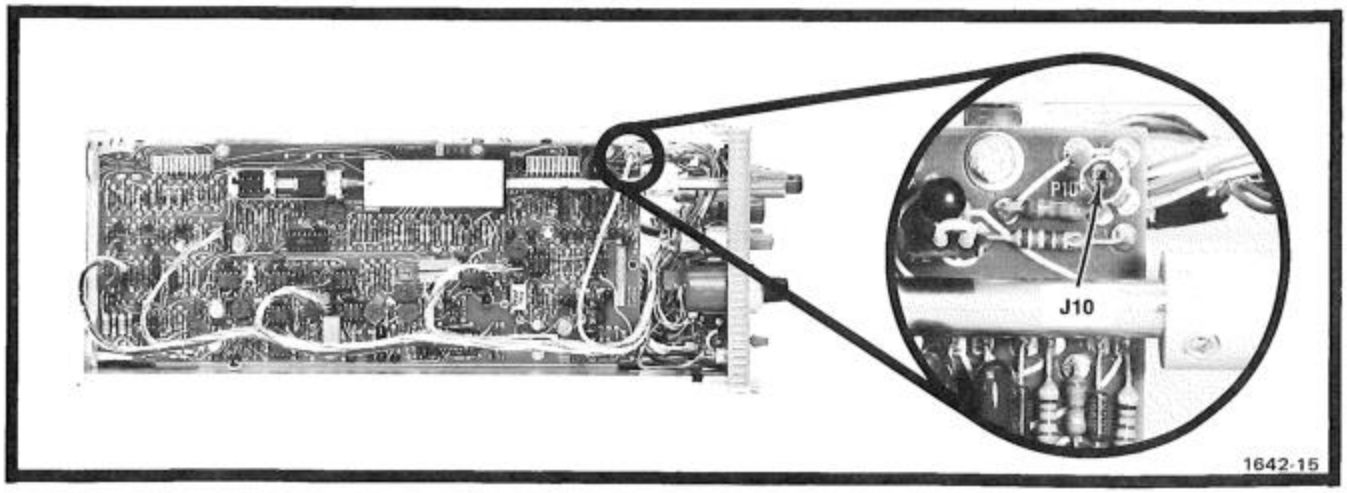


Fig. 5-10. Location of J10 on Vertical Circuit Board.

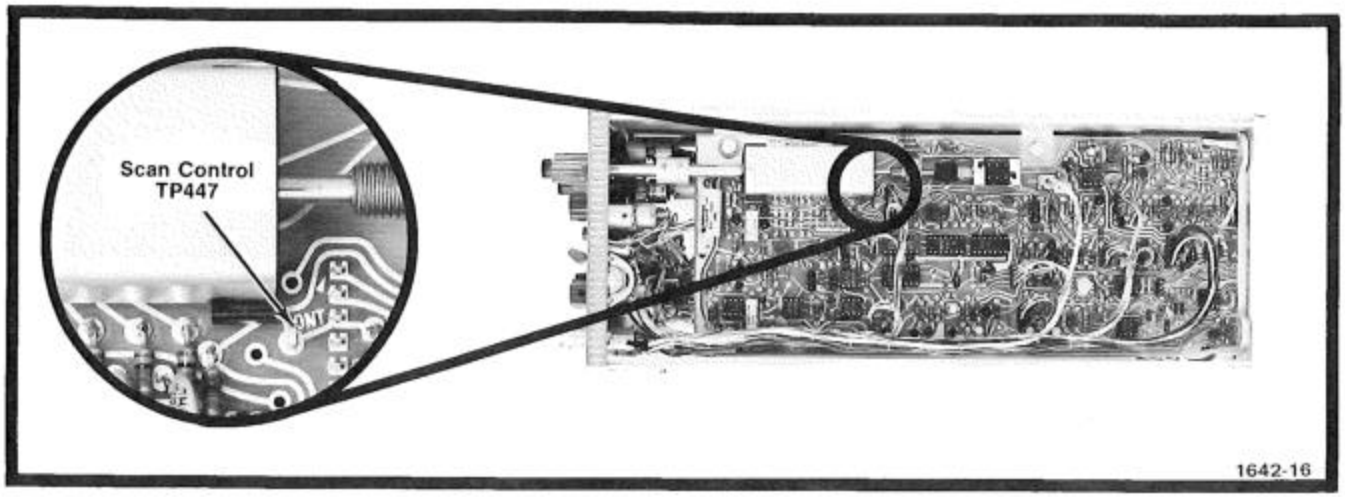


Fig. 5-11. Location of Scan Control test point TP447.

e. Set the test oscilloscope vertical sensitivity to 0.5 V/div, the A Time/Div to 2 ms, the B Time/Div to .2 ms, the Horizontal Display Mode to Mix, and the Delay Time control fully clockwise.

f. Set the FG 501 for a square-wave output with a frequency of approximately 1 kHz and an amplitude of approximately 1 V (most negative excursion to 0 V; most positive excursion to +1 V).

g. Trigger the A Time Base of the test oscilloscope on the positive-going slope of the signal from the FG 501.

h. Set the test oscilloscope B Triggering controls to Starts After Delay.

i. Adjust the frequency of the FG 501 for exactly 2 cycles per division in the spectrometer display. Rotate the Delay Time control on the test oscilloscope to align the rising portions of the square-wave signal with the vertical graticule lines in the spectrometer display.

j. Set the DISPLAY DISPERSION switch to the 20 (2) nm/div position.

k. CHECK—Spectrometer display for 1 cycle per division, ±2% over the eight horizontal divisions. Rotate the MARKER control to provide horizontal positioning in the display.

l. Set the DISPLAY DISPERSION switch to the 10 (1) nm/div position.

m. CHECK—Spectrometer display for 1 cycle per 2 divisions, ±2%, over the center eight horizontal divisions.

n. Set the DISPLAY DISPERSION switch to the 4 (.4) nm/div position.

o. CHECK—Spectrometer display for 1 cycle per 5 divisions, ±2% within the center eight horizontal divisions.

p. Remove the test setup from the 7J20 and set the DISPLAY DISPERSION switch to the 40 (4) nm/div position.

4. Check Scanning Ramp DC Levels

a. Connect a X10 probe between one of the vertical inputs of the test oscilloscope and the Ramp test point TP 378 on the Horizontal Circuit Board in the 7J20. See Fig. 5-9.

b. Set the test oscilloscope for a vertical deflection factor of 200 mV/div. Trigger the test oscilloscope on the negative slope at a sweep rate of 5 ms/div.

c. Set the 7J20 TIME/SCAN switch to 20 ms.

d. Set the input coupling switch on the test oscilloscope to ground and position the free-running trace in the test oscilloscope display to the center horizontal graticule line.

e. Set the input coupling switch on the test oscilloscope to dc.

f. CHECK—Test oscilloscope display to see that the most negative excursion of the scanning ramp goes to a dc level between −0.1 V and −0.3 V.

g. Change the vertical sensitivity of the test oscilloscope to 1 V/div.

h. Remove the X10 probe from the Ramp test point and connect the tip of it to a 4 V calibrator signal from the oscilloscope in which the 7J20 is installed.

i. Vertically position the top of the 4 V calibrator signal 1 major division up from the bottom of the test oscilloscope crt graticule.

j. Remove the X10 probe from the 4 V calibrator signal and reconnect it to the Ramp test point TP 378.

k. Horizontally position the ramp waveform in the test oscilloscope display to align with the center vertical graticule line.

l. CHECK—Test oscilloscope display to see that the peak of the ramp waveform rises to an amplitude of at least 5 divisions but no more than 5.5 divisions up from the bottom of the test oscilloscope crt graticule. This indicates a peak dc level of +8 V to +8.5 V.

m. Leave the X10 probe connected to the Ramp test point for the following step.

5. Check Ramp Reset Time And Holdoff-Reset Time

a. Make sure the X10 probe connected to the Ramp test point connects to the Channel 2 Vertical Input connector on the test oscilloscope.

b. Connect a X10 probe from the Channel 1 Vertical Input connector of the test oscilloscope to the Scan test point TP 445 (see Fig. 5-9) on the Horizontal Circuit Board in the 7J20.

c. Set the test oscilloscope for alternate sweep operation with the trigger source switch set to the Channel 1 position.

d. Set the test oscilloscope time base for a 10 μs/div sweep rate.

e. Adjust the test oscilloscope triggering controls for a stable display triggered on the negative-going slope of the Scan pulse.

f. Set the test oscilloscope channel 2 input coupling switch to the ground position and vertically position this channel's ground reference line to the center horizontal graticule line.

g. Set the test oscilloscope channel 2 input coupling switch to dc and the channel 1 vertical sensitivity to 1 V/div.

h. CHECK—Test oscilloscope crt display to see that the negative-going slope of the Ramp waveform reaches a 0 V dc level in 25 μs or less after the negative-going slope of the Scan waveform.

i. CHECK—Test oscilloscope crt display to see that the Scan pulse is a negative-going rectangular pulse approximately 4 V in amplitude with a pulse width of 57 μs to 63 μs.

j. Leave the probes connected to the 7J20 for the following step.

6. Check Restore Pulse

a. Remove the X10 probe from the Ramp test point and connect it to the Restore pulse test point TP 442 (see Fig. 5-9).

b. CHECK—Test oscilloscope crt display to see that the positive-going slope of the Restore pulse occurs 24 μs, ±2.5 μs after the negative-going edge of the Scan pulse. Duration of the Restore pulse must be 30 μs, ±3 μs.

c. Remove the test setup from the 7J20.

7. Adjust Wavelength Marker Readout Circuit Reference Current

a. Rotate the MARKER control so the last 2 digits displayed in the wavelength marker readout are 95 (i.e., 395, 495, 595, etc).

b. Connect the negative lead from the DVM to ground test point TP901 (see Fig. 5-12) and the positive meter lead to the decoupled +15 V supply side of Reference Current R925 (see Fig. 5-12).

c. Note the meter reading of the decoupled +15 V supply as accurately as possible.

d. Move the positive meter lead of the DVM from the decoupled +15 V supply to the I Cal test point TP 903 (see Fig. 5-12) and set the DVM to measure dc current.

e. Set the Cal/Norm switch S901 (see Fig. 5-12) to the Cal position.

f. CHECK—The amount of reference current measured depends on the exact level of the decoupled +15 V power supply measured in step c. If the supply is exactly +15.00 V, the reference current measured should be exactly 1.000 mA. For each 15 mV of variation in supply voltage, the reference current should vary by 1 μA. For example, if the supply voltage is +15.105 V, the reference current should measure 1.007 mA.

g. ADJUST—Reference Current R925 (see Fig. 5-12) for the correct reference current as determined in step f.

h. Set the Cal/Norm switch S901 to the Norm position and remove the DVM test leads from the 7J20.

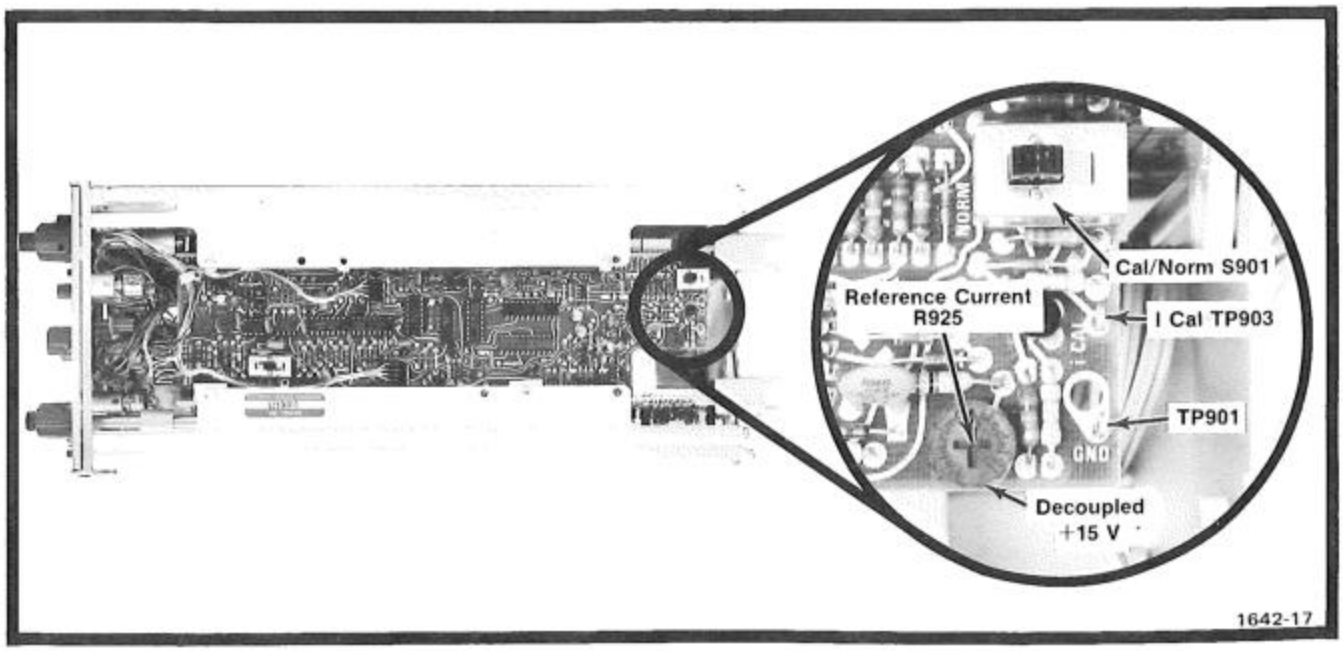


Fig. 5-12. Location of Wavelength Marker Circuit reference current test points and adjustment.

8. Adjust Wavelength Marker Readout Circuit Calibration

a. Rotate the MARKER control fully counterclockwise.

b. Set switch S964 (see Fig. 5-13) to the ground position.

c. CHECK—Wavelength marker readout in the crt display should read 100 nm.

d. ADJUST—Zero adjust R962 (see Fig. 5-13) for a wavelength marker readout of 100 nm. Center the adjustment within the small range that provides 100 nm readout.

e. Rotate the MARKER control fully clockwise and set switch S964 to the +8 V position.

f. CHECK—Wavelength marker readout in the crt display should read 1300 nm.

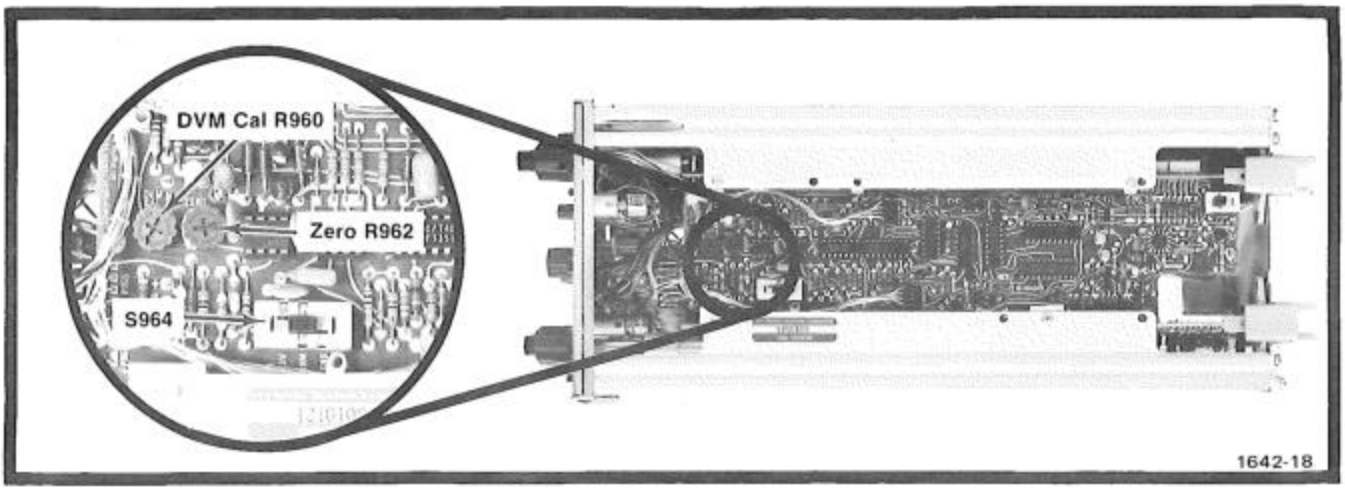


Fig. 5-13. Location of Wavelength Marker Circuit calibration adjustments.

g. ADJUST—DVM Cal R960 (see Fig. 5-13) for a wavelength marker readout of 1300 nm.

h. Rotate the MARKER control fully counterclockwise.

i. CHECK—Wavelength marker readout in the crt display should read 900 nm.

j. Rotate the MARKER control fully clockwise and set switch S964 to the ground position.

k. CHECK—Wavelength marker readout in the crt display should read 500 nm.

l. If all of the readout checks were satisfactory, set switch S964 to the Norm position and proceed to the next step. If, however, all of the readout checks were not satisfactory, repeat the procedure as necessary to achieve calibrated operation.

CALIBRATION NOTE

Once DVM Cal adjust R960 is set to provide the 1300 nm readout correctly, it will probably not be necessary to readjust R960 to get the other readout checks to read correctly. If the 500 nm and 900 nm readouts are slighlty off, adjust Zero R962 for correct readout.

9. Check Display Center Wavelength Readout

a. Turn instrument power off and connect the J20 Spectrometer to the 7J20 Spectrometer Plug-In with the cable provided with the instrument for this purpose. Turn instrument power on.

b. Set the J20 switches to the following positions:

WAVELENGTH SPAN	A400 nm
GRATING A WAVE-LENGTH INTERVAL	300 to 700 nm

c. Rotate the 7J20 MARKER control to obtain a wavelength marker readout of 500 nm.

d. CHECK—Rotate the GRATING A WAVELENGTH INTERVAL switch through all of its positions and check to see that the readout indicates as follows:

SWITCH POSITION	READOUT
300 to 700 nm	500 nm
400 to 800 nm	600 nm
500 to 900 nm	700 nm
600 to 1000 nm	800 nm
700 to 1100 nm	900 nm

e. Leave the J20 connected to the 7J20 for the following step.

10. Check Vertical Sensitivity Readout

a. Set the following controls to the positions indicated:

7J20

TIME/SCAN	20 ms
VERTICAL GAIN	500
SPECTRAL NORMALIZER	INT
DISPLAY DISPERSION	40 (4) nm/div

J20

SLIT WIDTH	OPEN
FILTER	OPEN
WAVELENGTH SPAN	A400 nm

b. CHECK—VERT UNCAL light is not on.

c. CHECK—Refer to the following list of control settings and check for proper vertical sensitivity readout displayed.

VERTICAL GAIN	SLIT WIDTH	WAVE-LENGTH SPAN	FILTER	READOUT
500	OPEN	A400	OPEN	X.4 pW
500	10 μm	A400	OPEN	40 pW
200	10 μm	A400	OPEN	100 pW
100	10 μm	A400	OPEN	200 pW
50	10 μm	A400	OPEN	400 pW
20	10 μm	A400	OPEN	1000 pW
10	10 μm	A400	OPEN	2000 pW
5	10 μm	A400	OPEN	4.0 nW
5	20 μm	A400	OPEN	2.0 nW
5	50 μm	A400	OPEN	.8 nW
5	100 μm	A400	OPEN	.4 nW
2	100 μm	A400	OPEN	1.0 nW
2	50 μm	A400	OPEN	2.0 nW
2	20 μm	A400	OPEN	5.0 nW
2	10 μm	A400	OPEN	10.0 nW
1	10 μm	A400	OPEN	20.0 nW
1	10 μm	B40	OPEN	200 nW
1	10 μm	B40	1	2000 nW
1	10 μm	B40	2	20.0 μW
.1 A	10 μm	B40	2	.1 A
.2 A	10 μm	B40	2	.2 A
.5 A	10 μm	B40	2	.5 A
1 dB	10 μm	B40	2	1 dB
2 dB	10 μm	B40	2	2 dB
5 dB	10 μm	B40	2	5 dB

d. Turn instrument power off and disconnect the J20 from the 7J20. Set the VERTICAL GAIN switch to the 1 position, the SPECTRAL NORMALIZER switch to OFF, and turn instrument power on.

11. Adjust HORIZ POS And HORIZ CAL

a. Alternately rotate the MARKER control fully clockwise and then fully counterclockwise.

b. CHECK—CRT display to see that the intensified marker aligns with the extreme right and left graticule edges when the MARKER control is fully clockwise and fully counterclockwise, respectively.

c. ADJUST—HORIZ CAL and HORIZ POS to align the intensified marker with the left and right graticule edges at the rotational extremes of the MARKER control.

12. Check Wavelength Marker Balance And Width And Adjust Intensity

a. Rotate the MARKER control fully clockwise and set the DISPLAY DISPERSION switch to the 20 (2) nm/div position.

b. CHECK—Rotate the DISPLAY DISPERSION switch from 20 (2) nm/div to 4 (.4) nm/div and check for no more than 0.2 major divisions of horizontal movement of the marker.

c. CHECK—Marker width should be no more than 0.3 major division with the DISPLAY DISPERSION switch set to 4 (.4) nm/div.

d. Set the DISPLAY DISPERSION switch to the 40 (4) nm/div position and rotate the MARKER control to the middle of its range.

e. ADJUST—MARKER INTENSITY (located on instrument front panel) for a visible, well-focused spot that does not exhibit blooming.

13. Check DISPLAY TRIGGER MODE Switch Operation

a. Set the DISPLAY TRIGGER MODE switch to the FREE RUN position.

b. CHECK—There should be a crt display and the TRIG'D light should be off.

c. Connect the center conductor of the DISPLAY TRIGGER IN connector to the outer shell (ground) of the connector via a short piece of bare wire.

d. CHECK—There should still be a crt display but additionally the TRIG'D light should be on.

e. Set the DISPLAY TRIGGER MODE switch to the TRIG'D position.

f. CHECK—When the center conductor of the DISPLAY TRIGGER IN connector is not connected to ground there should be no crt display and the READY light should be on. When the center conductor of the connector is connected to ground, there should be a crt display and the TRID'D light should be on.

g. Remove the wire from the DISPLAY TRIGGER IN connector.

h. Set the DISPLAY TRIGGER MODE switch to the SINGLE SCAN position. Momentarily hold the switch in the RESET position and then allow it to return to the SINGLE SCAN position.

i. CHECK—There should no be crt display and the READY light should be on.

j. CHECK—Momentarily connect the center conductor of the DISPLAY DISPERSION TRIGGER IN connector to ground and check to see that there is one and only one scan presented in the display. The READY light should go out and the TRIG'D light should come on. When the center conductor of the connector is no longer connected to ground, both the TRIG'D and READY lights should be out.

k. Set the DISPLAY TRIGGER MODE switch to the FREE RUN position.

14. Check Interface Connector Scan Control Input

a. Connect pin 10 of the Interface connector to ground.

b. CHECK—There should be no spectrometer display.

c. Remove the ground connection from pin 10 of the INTERFACE connector.

d. CHECK—There should again be a spectrometer display.

15. Adjust Input Vertical Amplifier Balances

a. Set the DVM to measure dc volts on the most sensitive scale.

b. Connect the negative meter lead of the DVM to the ground test point TP 75 (see Fig. 5-14) on the Vertical Circuit Board, and the positive meter lead to the I Out test point TP 33 (see Fig. 5-14) on the Vertical Circuit Board.

c. CHECK—DVM for a meter reading of 0 V, ±2 mV.

d. ADJUST—Balance R25 (see Fig. 5-14) for a meter reading of exactly 0 V.

e. Move the positive DVM meter lead from test point TP 33 to the X test point TP 101 (see Fig. 5-14).

f. CHECK—Press the BASELINE RESTORE pushbutton and hold. Check the DVM for a meter reading of 0 V, ±2 mV.

g. ADJUST—X Zero R100 (see Fig. 5-14) while pressing the BASELINE RESTORE pushbutton for a meter reading of exactly 0 V.

h. Release the BASELINE RESTORE pushbutton and remove the meter leads from the 7J20.

16. Adjust VERTICAL GAIN Switch Balances

a. Set the VERTICAL GAIN Switch to 100.

b. CHECK—Spectrometer display for 0.4 major crt graticule division or less trace shift as the VERTICAL GAIN switch is switched from 100 to 500.

c. ADJUST—ATTEN BAL R220 (located on instrument front panel) for no trace shift as the VERTICAL GAIN switch is switched from 100 to 500.

d. CHECK—Spectrometer display for 0.4 major crt graticule division or less trace shift as the VERTICAL GAIN switch is switched from 100 to 50.

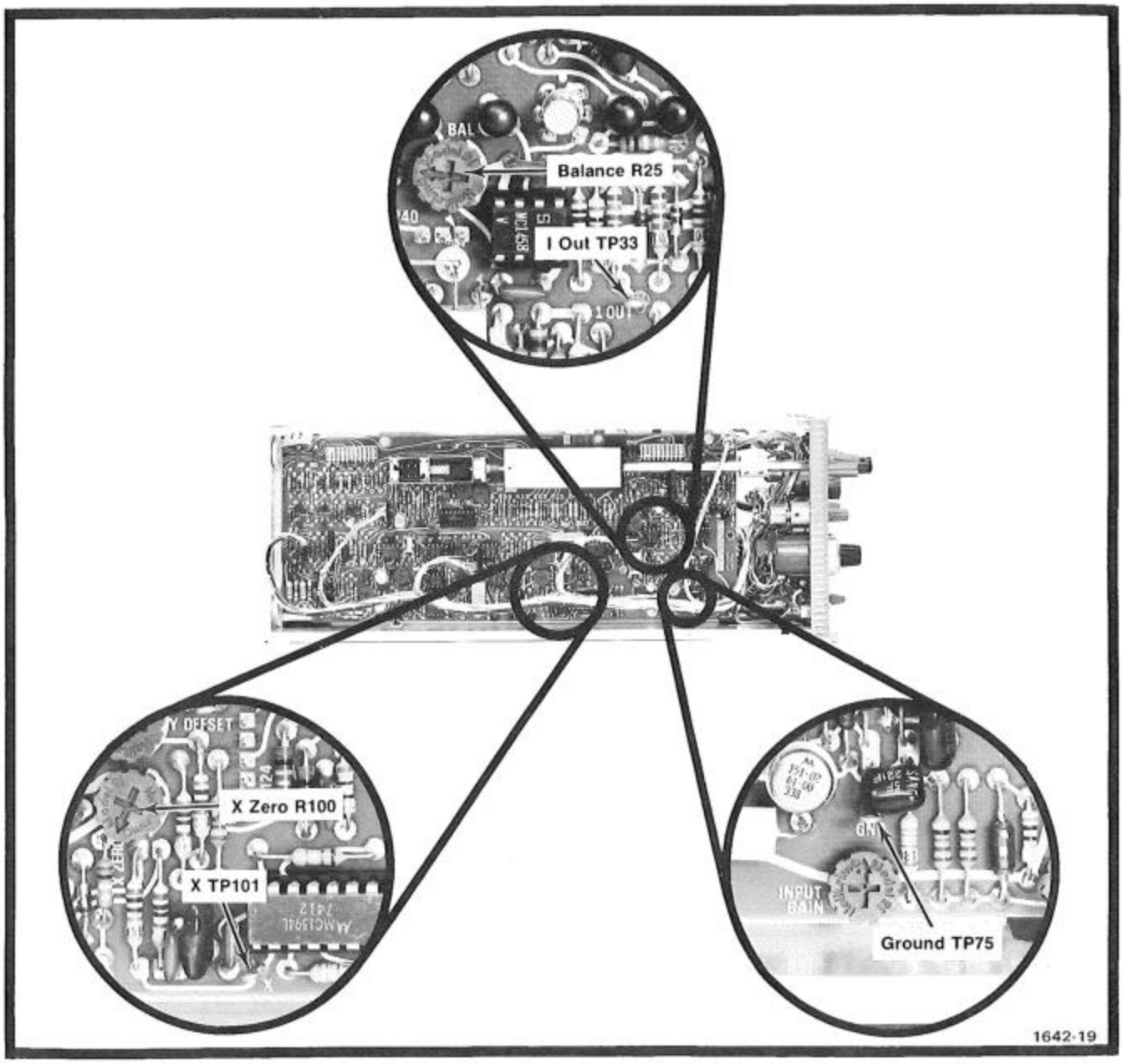


Fig. 5-14. Location of Input Vertical Amplifier balance test points and adjustments.

e. ADJUST—X10 Bal R230 (see Fig. 5-15) for no trace shift as the VERTICAL GAIN switch is switched from 100 to 50.

17. Adjust Vertical GAIN

a. Set the VERTICAL GAIN switch to the GAIN position and the DISPLAY DISPERSION switch to the 20 (2) nm/div position.

b. Rotate the MARKER control fully counterclockwise and vertically position the intensified wavelength marker spot in the display to the graticule line one division down from the top edge of the crt graticule.

c. Rotate the MARKER control fully clockwise.

d. CHECK—The intensified wavelength marker spot in the spectrometer display should have been vertically deflected downward 6 divisions, ±0.06 division.

e. ADJUST—Vertical GAIN R275 (located on the instrument front panel) for exactly 6 divisions of vertical deflection of the intensified wavelength marker spot in the spectrometer display as the MARKER SPOT is rotated from one extreme to the other.

f. Set the VERTICAL GAIN switch to 1 and the DISPLAY DISPERSION switch to the 40 (4) nm/div position.

18. Check OFFSET Control Accuracy

a. Connect the positive meter lead of the DVM to test point TP 211 (see Fig. 5-16) and the negative meter lead to the ground test point TP 227 (see Fig. 5-16).

b. Set the OFFSET control to read 2.00 and press the BASELINE RESTORE pushbutton for 3 seconds.

c. CHECK—Refer to the following list of control settings and meter readings and check the OFFSET control for correct operation.

OFFSET SETTING	VOLTMETER READING
2.00	−400 mV, ±12 mV
4.00	−800 mV, ±20 mV
6.00	−1.2 V, ±28 mV
8.00	−1.6 V, ±36 mV
10.00	−2.0 V, ±44 mV

d. Reset the OFFSET control to 0.00 and remove the DVM test leads from the 7J20.

19. Adjust Vertical Input Amplifier Gain And Check VARIABLE VERTICAL GAIN Range

a. Connect a 50 Ω 5X BNC attenuator to the output signal connector of the FG 501.

b. Connect a 50 Ω BNC feedthrough termination to the 5X attenuator.

c. Connect a BNC T to the 50 Ω termination.

d. Connect one output of the BNC T to the Unknown Input connector of the Standard Amplitude Calibrator via a 42-inch 50 Ω BNC coaxial cable.

e. Connect the remaining output of the BNC T to J20 (see Fig. 5-10) on the Vertical Circuit Board in the 7J20 via a 067-0709-00 Interconnect Cable.

f. Connect the Output connector of the Standard Amplitude Calibrator to the Channel 1 vertical input connector on the test oscilloscope via a 42-inch 50 Ω BNC coaxial cable.

g. Connect the +B Gate output connector of the test oscilloscope to the Scan Control test point TP 447 (see Fig. 5-11) via a 42-inch, 50 Ω BNC coaxial cable and a BNC female to alligator clips adapter. Connect the red alligator clip to TP 447 and the black alligator clip to a convenient ground point.

h. Set the test oscilloscope vertical sensitivity to .2 V/div, the A Time/Div to 2 ms, the B Time/Div to .2 ms/div, the Horizontal Display Mode to Mix, and the Delay Time control fully clockwise.

i. Set the Standard Amplitude Calibrator Amplitude switch to .1 V and the Mode switch to square wave with chopped operation.

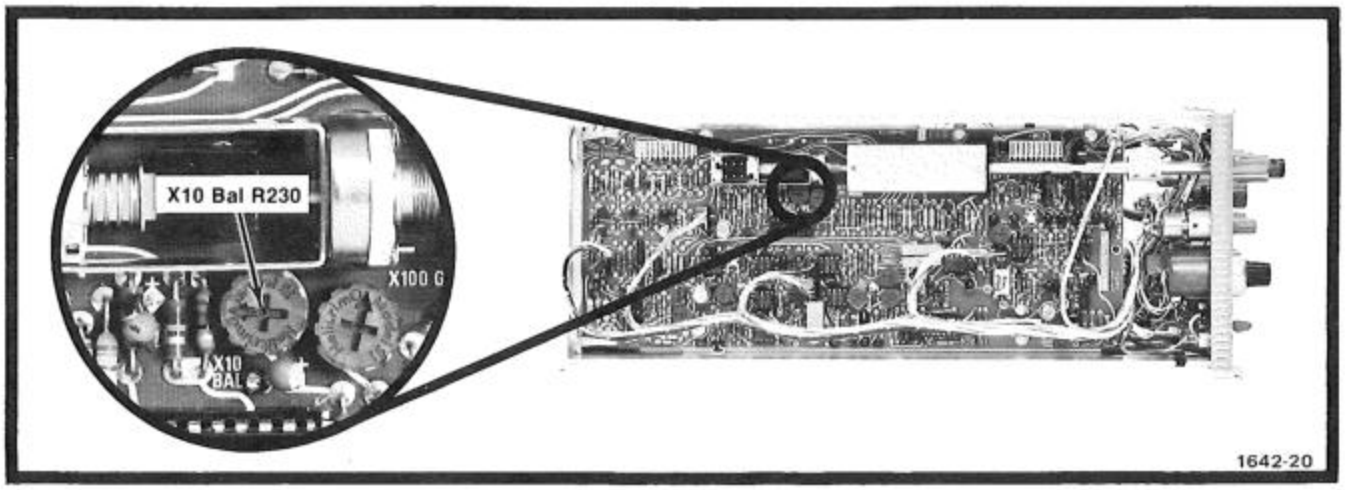


Fig. 5-15. Location of X10 Bal R230.

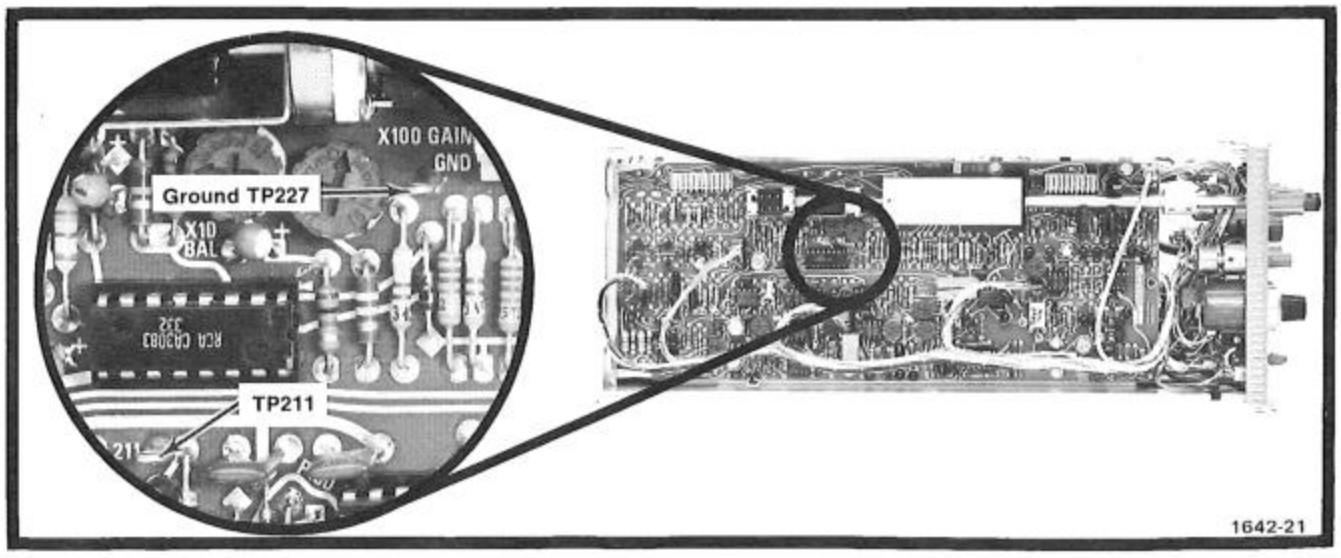


Fig. 5-16. Location of OFFSET control test points.

j. Set the test oscilloscope B Triggering controls to Starts After Delay and the A Triggering controls to trigger on the positive slope of the signal displayed.

k. Adjust the FG 501 for an approximately 1 kHz square-wave output signal with an amplitude of 100 mV (most negative excursion to 0 V; most positive excursion to +100 mV). Observe the test oscilloscope display while adjusting the FG 501 and match the amplitude and the dc levels of the FG 501 output signal to that of the output signal from the Standard Amplitude Calibrator.

l. Set the VERTICAL GAIN switch to 10, the TIME/SCAN switch to 20 ms, and push the BASELINE RESTORE pushbutton briefly.

m. Set the output signal lever switch on the Standard Amplitude Calibrator to the Unknown position.

n. CHECK—Spectrometer display for a square wave signal 5 divisions, ±1% (±0.05 division) in amplitude.

o. ADJUST—Input Gain R75 (see Fig. 5-17) for exactly 5 divisions of vertical deflection.

p. Set the VARIABLE VERTICAL GAIN control to the uncalibrated (button out) position and rotate the control fully clockwise.

q. CHECK—Spectrometer display for a signal amplitude of 2 divisions or less. This indicates a variable range of at least 2.5:1.

r. Set the VARIABLE VERTICAL GAIN control to the calibrated (button in) position.

s. Change the VERTICAL GAIN switch to 100 and change the Amplitude switch on the Standard Amplitude Calibrator to 10 mV.

t. Set the output signal lever switch on the Standard Amplitude Calibrator to Chop and adjust the output signal from the FG 501 for 10 mV amplitude in the same manner used in step k. Add attenuators to the FG 501 output signal as necessary to obtain the correct output signal amplitude.

u. Set the output signal lever switch on the Standard Amplitude Calibrator to the Unknown position.

v. CHECK—Spectrometer display for a signal amplitude of 5 divisions, ±1% (±0.05 division).

w. ADJUST—X100 Gain R235 (see Fig. 5-17) for exactly 5 divisions of signal amplitude in the spectrometer display.

x. Leave the test set up in place for the following step.

20. Check VERTICAL GAIN Linear Deflection Accuracy

a. CHECK—Use the test equipment setup given in the previous step and check each linear-deflection gain position (1 through 500) of the VERTICAL GAIN switch for correct deflection accuracy. Refer to the following chart for required signal amplitudes and the resultant display deflections.

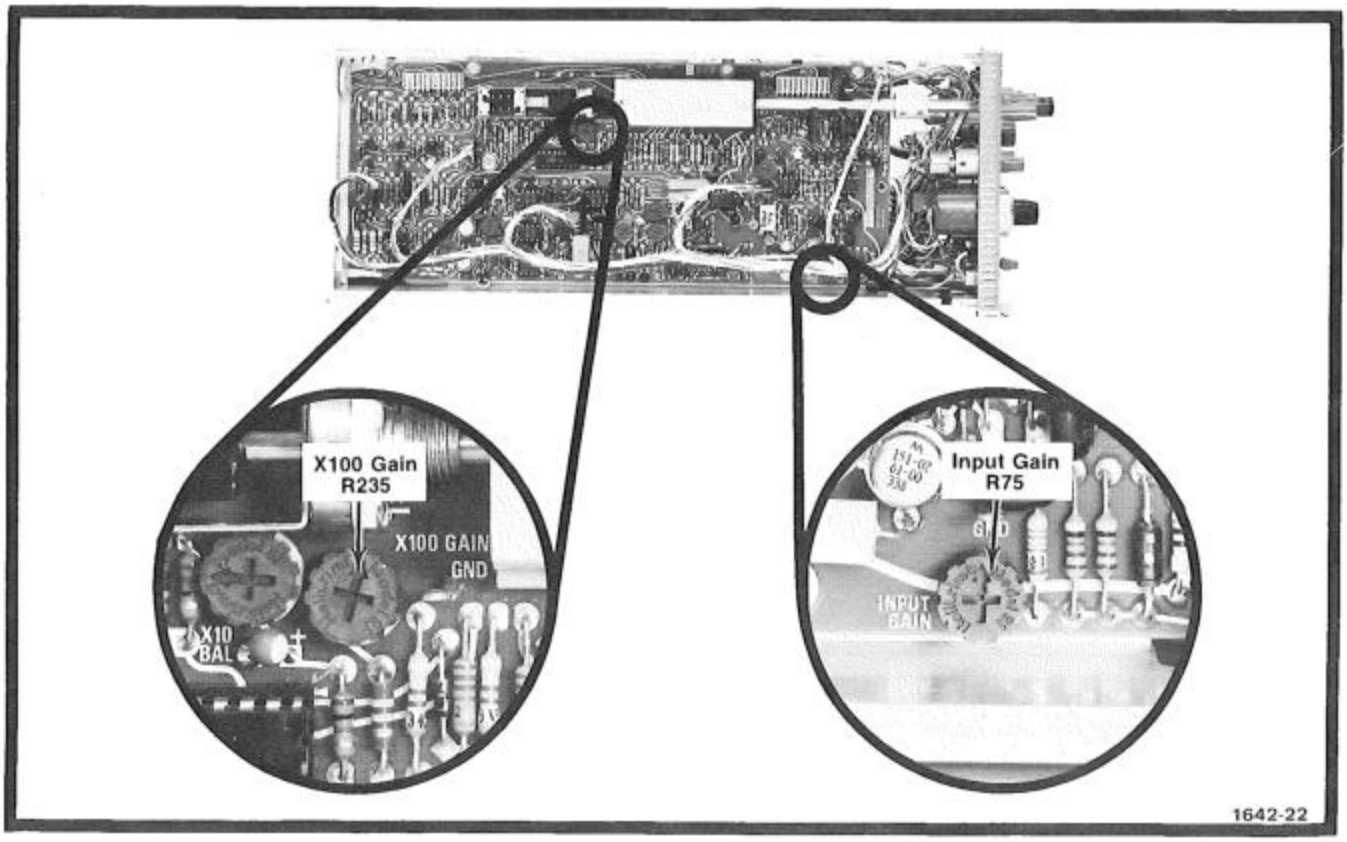


Fig. 5-17. Location of Input Amplifier gain adjustments.

VERTICAL GAIN	INPUT SIGNAL	DISPLAY DEFLECTION	TOLERANCE
1	1 V	5 divisions	±0.05 division
2	0.5 V	5 divisions	±0.05 division
5	0.2 V	5 divisions	±0.05 division
10	0.1 V	5 divisions	±0.05 division
20	50 mV	5 divisions	±0.05 division
50	20 mV	5 divisions	±0.05 division
100	10 mV	5 divisions	±0.05 division
200	5 mV	5 divisions	±0.05 division
500	2 mV	5 divisions	±0.05 division

b. Remove the test equipment setup from the 7J20.

21. Adjust Logarithmic Amplifier Offset And Zero

a. Connect the negative meter lead of the DVM to the ground test point TP270 (see Fig. 5-18) and the positive meter lead to the junction of CR166, R164, and R166 (see Fig. 5-18) on the Vertical Circuit Board.

b. Set the VERTICAL GAIN switch to 5 dB/DIV LOG, the TIME/SCAN switch to 10 ms, and the SPECTRAL NORMALIZER switch to off.

c. Press the BASELINE RESTORE pushbutton briefly and release.

d. CHECK—DVM for a meter reading of ±6.2 mV, ± 1mV.

e. ADJUST—Log In Offset R160 (see Fig. 5-18) for a meter reading of exactly +6.2 mV.

f. Move the positive meter lead to the Log Zero test point TP 166 (see Fig. 5-18).

g. Press the BASELINE RESTORE pushbutton briefly and release.

h. CHECK—DVM for a meter reading of 0 V, ±2 mV.

i. ADJUST—Log Zero R190 (see Fig. 5-18) for a meter reading of exactly 0 V.

j. Remove the DVM test leads from the 7J20.

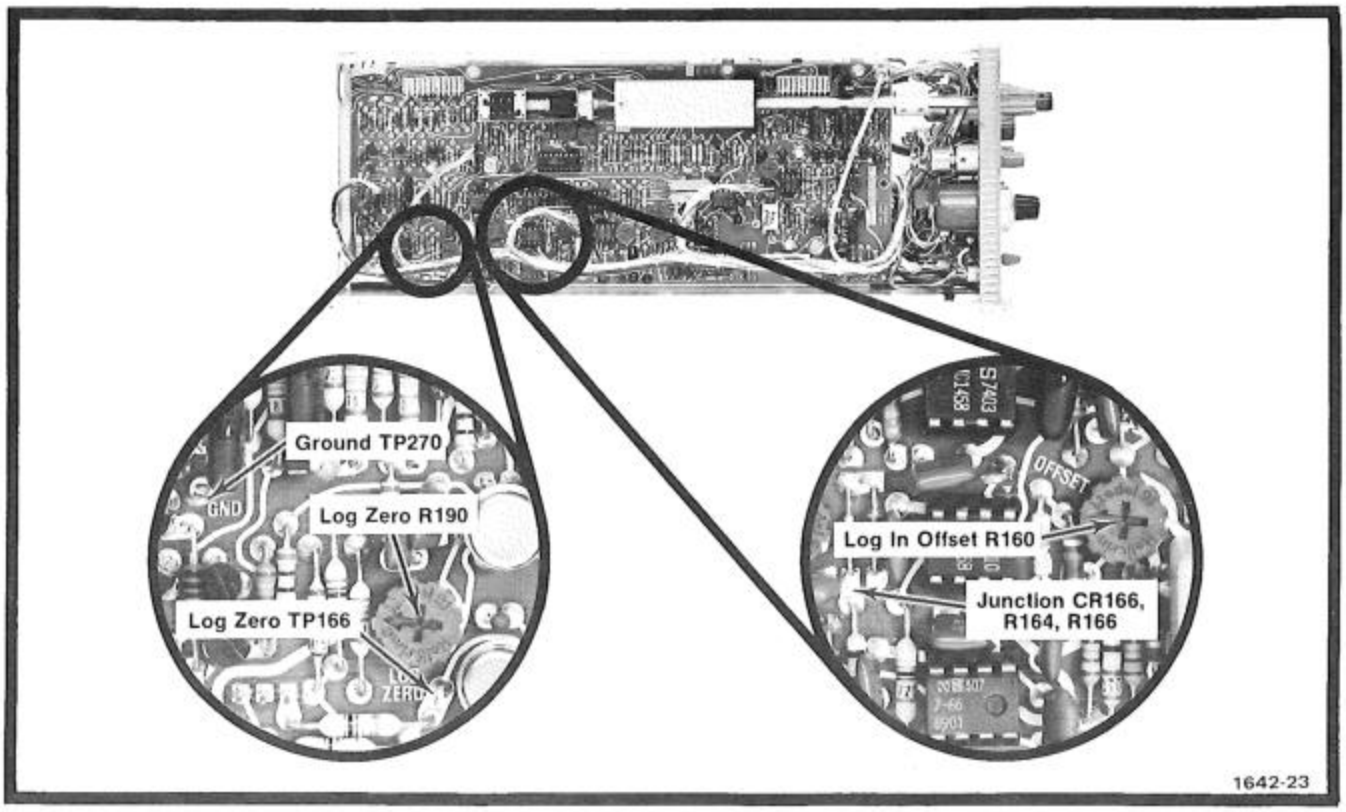


Fig. 5-18. Location of Logarithmic Amplifier balance test points and adjustments.

22. Adjust Logarithmic Gain And Check Absorbance Gain

a. With the VERTICAL GAIN switch set to the 2 dB/DIV LOG position, remove jumper P165 (see Fig. 5-19) from the Vertical Circuit Board and install the jumper on the square pins between ±8 V and R169 (7.5 kΩ; see Fig. 5-19).

b. Press the BASELINE RESTORE pushbutton briefly and release.

c. Using the OFFSET control, vertically position the trace in the spectrometer display to the horizontal graticule line 1 division down from the top of the crt graticule.

d. Remove the jumper from R169 (7.5 kΩ) and install it on the square pins between +8 V and R168 (75 kΩ; see Fig. 5-19).

e. CHECK—Spectrometer display to see that the trace has moved down 5 divisions, ±0.15 division (±3%).

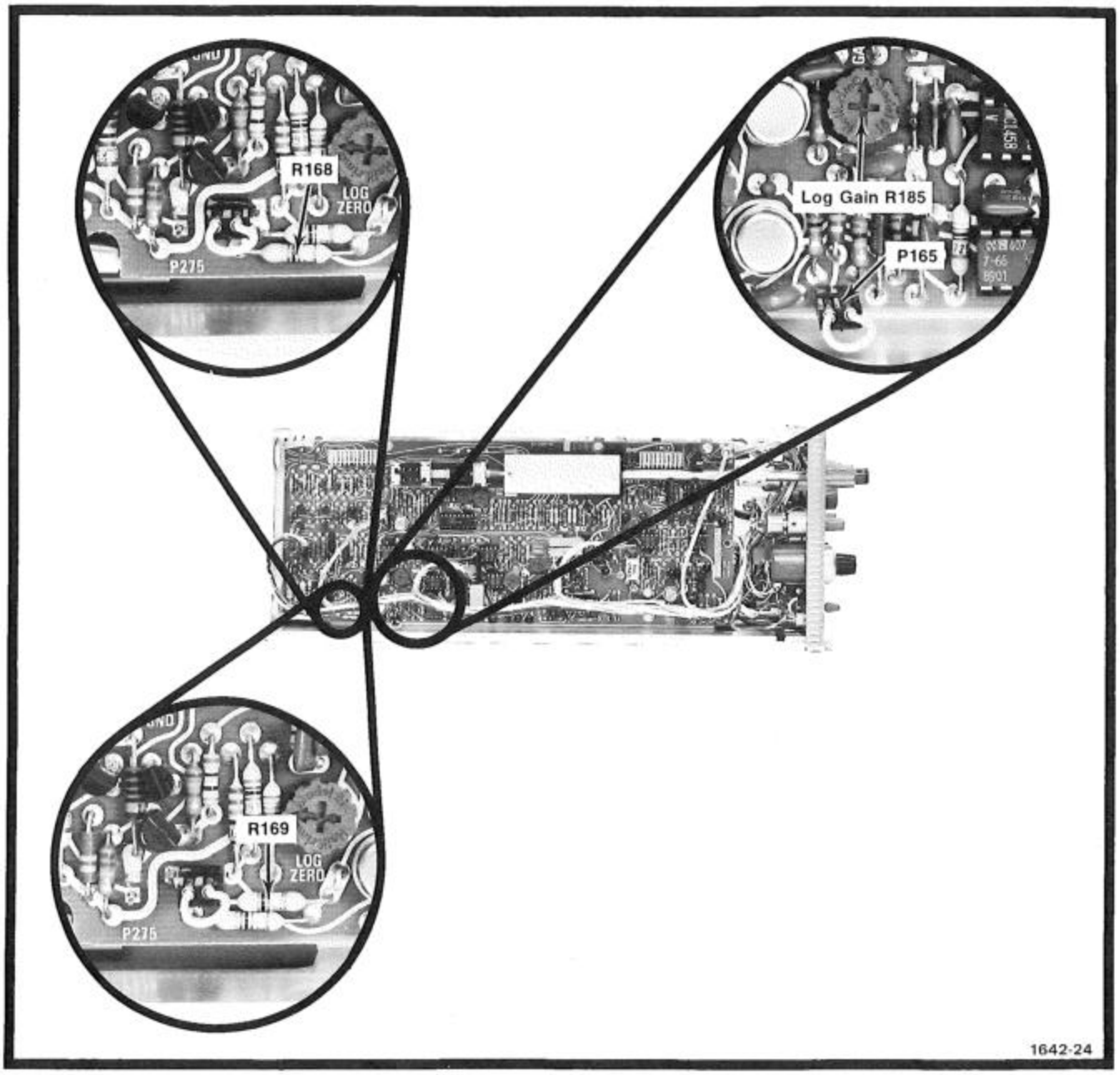


Fig. 5-19. Location of Logarithmic Amplifier gain test points and adjustments.

f. ADJUST—Log Gain R185 (see Fig. 5-19) for exactly 5 divisions of trace deflection between jumper positions.

g. Set the VERTICAL GAIN switch to the .2 ABSORBANCE UNITS/DIV position.

h. Press the BASELINE STORE pushbutton briefly and release.

i. Using the OFFSET control, vertically position the trace in the spectrometer display to the horizontal graticule line 1 division down from the top of the crt graticule.

j. Remove the jumper from R168 (75 kΩ; and install it on the square pins between +8 V and R169 (7.5 kΩ; see Fig. 5-19).

k. CHECK—Spectrometer display to see that the trace has moved down 5 divisions, ±0.15 division (±3%).

l. Replace jumper P165 on the original square pins from which it was removed in step a and set the VERTICAL GAIN switch to the 1 position.

m. Set the OFFSET control to 0.00.

23. Adjust Multiplier Circuit Balances And Gain

a. Set the SPECTRAL NORMALIZER switch to the INT position and the VERTICAL GAIN switch to 200.

b. CHECK—Spectrometer display for no trace shift while intermittently shorting test points TP 108 and TP 109 (see Fig. 5-20) together.

c. ADJUST—X Offset R105 (see Fig. 5-20) for no trace shift in the spectrometer display while intermittently shorting test points TP108 and TP109 together.

d. Set the TIME/SCAN switch to 20 ms.

e. Connect the output of the FG 501 Function Generator to the Channel 1 vertical input connector of the test oscillscope via a BNC T and 42-inch 50 Ω, BNC coaxial cable.

f. Connect the unused output of the BNC T to J10 (see Fig. 5-10) on the Vertical Circuit Board in the 7J20 via a 067-0709-00 Interconnect Cable.

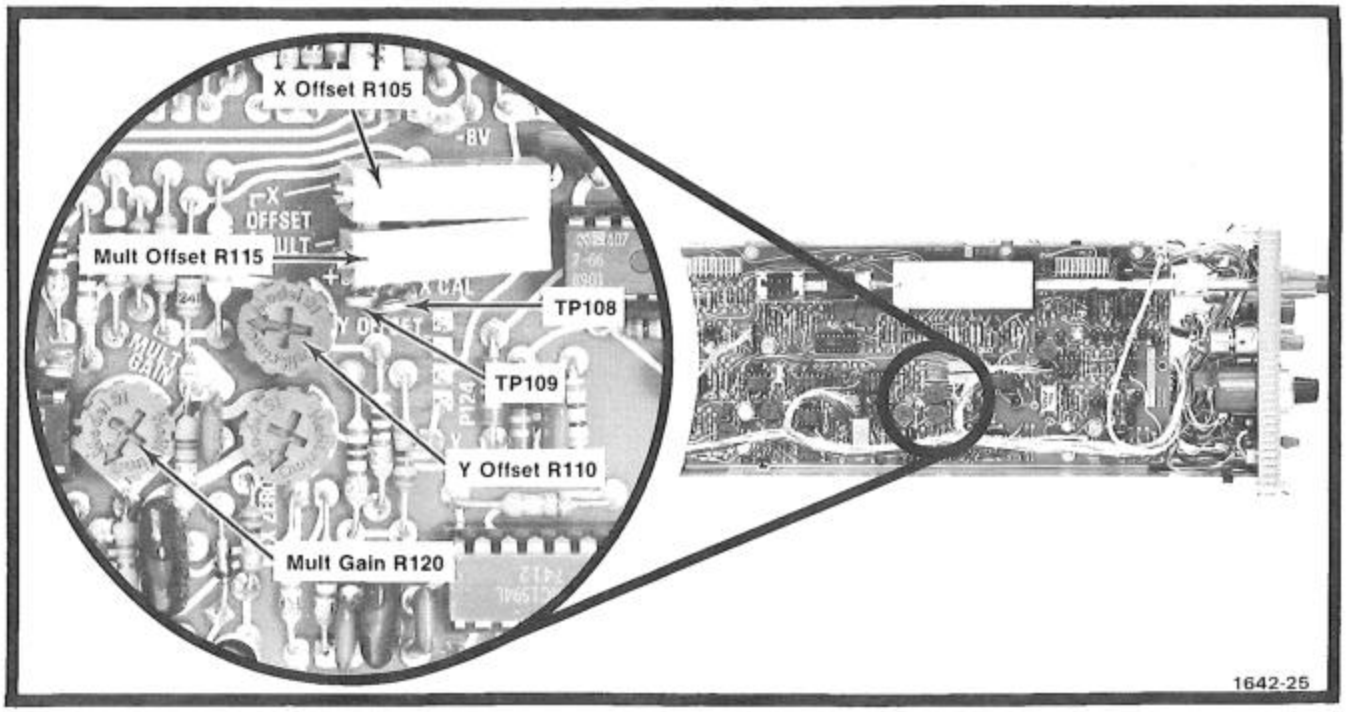


Fig. 5-20. Location of Multiplier Circuit balance and gain test points and adjustments.

g. Connect the +B Gate output connector of the test oscilloscope to the Scan Control test point TP 447 (see Fig. 5-11) on the Horizontal Circuit Board of the 7J20 via a 42-inch, 50 Ω, BNC coaxial cable and a BNC to alligator clips adapter. Connect the red alligator clip to TP 447 and the black clip to a convenient ground point.

h. Set the test oscilloscope vertical sensitivity to 50 mV/div, the A Time/Div to 2 ms, the B Time/Div to .2 ms, the Horizontal Display Mode to Mix, and the Delay Time control fully clockwise.

i. Trigger the A Time Base of the test oscilloscope on the positive-going slope of the signal from the FG 501 and adjust the FG 501 for a square-wave output with a frequency of approximately 1 kHz and an amplitude of 100 mV (most negative excursion to 0 V; most positive excursion to +100 mV).

j. Set the test oscilloscope B Triggering controls to Starts After Delay.

k. Short test points TP 108 and TP 109 together.

l. CHECK—Spectrometer display for no more than 0.5 major division of signal amplitude.

m. ADJUST—Y Offset R110 (see Fig. 5-20) for minimum signal amplitude in the spectrometer display.

n. Remove the short circuit between test points TP 108 and TP 109.

o. Set the VERTICAL GAIN switch to 10 and adjust the FG 501 output signal amplitude for exactly 4 divisions of vertical deflection in the spectrometer display.

p. CHECK—Switch the SPECTRAL NORMALIZER switch back and forth between INT and OFF and check the spectrometer display for no more than 1% difference in display amplitude.

q. ADJUST—Mult Gain R120 (see Fig. 5-20) for no difference in display amplitude when switching the SPECTRAL NORMALIZER switch back and forth between INT and OFF.

r. Remove the input signal from J10 on the Vertical Circuit Board and set the VERTICAL GAIN swtich to 200.

s. CHECK—Spectrometer display for no more than 0.5 major division of trace shift when switching the SPECTRAL NORMALIZER switch back and forth between INT and OFF.

t. ADJUST—Mult Offset R115 (see Fig. 5-20) for no trace shift when switching the SPECTRAL NORMALIZER switch back and forth between INT and OFF.

u. There is interaction between the Mult Gain (R120) and the Mult Offset (R115) adjustments. Repeat their adjustment as necessary to achieve calibrated operation.

v. Remove the test setup completely from the 7J20. Do not reconnect the signal lead from the Spectrometer connector J100 to J10 yet.

24. Check Displayed Noise

a. Set the VERTICAL GAIN switch to 200, the TIME/SCAN switch to 20 ms, and the SPECTRAL NORMALIZER switch to OFF.

b. Connect the Calibration Fixture Interconnect Cable 067-0709-00 to J10 (see Fig. 5-10) on the Vertical Circuit Board with a BNC 50 Ω feedthrough termination connected to the BNC end of the cable.

c. CHECK—Spectrometer crt display for 0.4 division or less of displayed noise.

d. Set the SPECTRAL NORMALIZER switch to INT.

e. CHECK—Spectrometer display for 0.4 division or less of displayed noise.

f. Remove the Calibration Fixture Interconnect Cable 067-0709-00 from J10 on the Vertical Circuit Board and connect the normal internal signal lead back to J10.

This concludes the calibration procedure for the 7J20.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

SPECIAL NOTES AND SYMBOLS

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

ITEM NAME

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

ABBREVIATIONS

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

CROSS INDEX MFR. CODE NUMBER TO MANUFACTURER

MFR.CODE	MANUFACTURER	ADDRESS	CITY,STATE,ZIP
0000A	Lemo USA	2015 2nd St.	Berkley, CA 94710
00779	AMP, Inc.	P. O. Box 3608	Harrisburg, PA 17105
00853	Sangamo Electric Co., S. Carolina Div.	P. O. Box 128	Pickens, SC 29671
01121	Allen-Bradley Co.	1201 2nd St. South	Milwaukee, WI 53204
01295	Texas Instruments, Inc., Semiconductor Group	P. O. Box 5012	Dallas, TX 75222
03508	General Electric Co., Semi-Conductor Products Dept.	Electronics Park	Syracuse, NY 13201
04713	Motorola, Inc., Semiconductor Products Div.	5005 E. McDowell Rd.	Phoenix, AZ 85036
07263	Fairchild Semiconductor, A Div. of Fairchild Camera and Instrument Corp.	464 Ellis St.	Mountain View, CA 94042
07910	Teledyne Semiconductor	12515 Chadron Ave.	Hawthorne, CA 90250
11237	CTS Keene, Inc.		Paso Robles, CA 93446
12040	National Semiconductor Corp.	Commerce Drive	Danbury, CT 06810
12697	Clarostat Mfg. Co., Inc.	Lower Washington St.	Dover, NH 03820
14099	Semtech Corp.	652 Mitchell Road	Newbury Park, CA 91320
15818	Teledyne Semiconductor	1300 Terra Bella Ave.	Mountain View, CA 94040
18324	Signetics Corp.	811 E. Arques	Sunnyvale, CA 94086
18583	Curtis Instruments, Inc.	200 Kisco Ave.	Mount Kisco, NY 10549
21845	Solitron Devices, Inc., Transistor Div.	1177 Blue Heron Blvd.	Riviera Beach, FL 33404
24731	General Supply and Machine Co.	208 19th Ave.	Meridian, MS 39301
27014	National Semi-Conductor Corp.	2900 San Ysidro Way	Santa Clara, CA 95051
50157	N. L. Industries, Inc., Electronics Dept.	P. O. Box 787	Muskegon, MI 49443
50522	Monsanto Co., Electronic Special Products	10131 Bubb Rd.	Cupertino, CA 95014
56289	Sprague Electric Co.		North Adams, MA 01247
63743	Ward Leonard Electric Co., Inc.	31 South St.	Mount Vernon, NY 10550
72136	Electro Motive Corp., Sub of International Electronics Corp.	South Park and John Streets	Willimantic, CT 06226
72982	Erie Technological Products, Inc.	644 W. 12th St.	Erie, PA 16512
73138	Beckman Instruments, Inc., Helipot Div.	2500 Harbor Blvd.	Fullerton, CA 92634
75042	TRW Electronic Components, IRC Fixed Resistors, Philadelphia Division	401 N. Broad St.	Philadelphia, PA 19108
79727	C-W Industries	550 Davisville Rd.	Warminster, PA 18974
80009	Tektronix, Inc.	P. O. Box 500	Beaverton, OR 97077
80294	Bourns, Inc., Instrument Div.	6135 Magnolia Ave.	Riverside, CA 92506
81483	International Rectifier Corp.	9220 Sunset Blvd.	Los Angeles, CA 90069
82104	Standard Grigsby Co., Div. of Sun Chemical Corp.	920 Rathbone Ave.	Aurora, IL 60507
86684	RCA Corp., Electronic Components	415 S. 5th St.	Harrison, NJ 07029
90201	Mallory Capacitor Co., Div. of P. R. Mallory Co., Inc.	3029 E. Washington St.	Indianapolis, IN 46206
91637	Dale Electronics, Inc.	P. O. Box 609	Columbus, NB 68601
93790	Cornell-Dublilier Electronics Division Federal Pacific Electric Corp.	1605 Rodney French Blvd.	New Bedford, MA 02741
97979	Reon Resistor Corp.	63 Lincoln Hwy.	Fraser, PA 19355

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				7J20		
A1	670-2264-00	B010100	B010117	CKT BOARD ASSY:--VERTICAL	80009	670-2264-00
A1	670-2264-01			CKT BOARD ASSY:--VERTICAL	80009	670-2264-01
A2	670-2265-00			CKT BOARD ASSY:--HORIZONTAL	80009	670-2265-00
A3	670-2281-00			CKT BOARD ASSY:--READOUT	80009	670-2281-00
A4	670-2662-00			CKT BOARD ASSY:--HIGH VOLTAGE	80009	670-2662-00
C3	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C10	283-0670-00			CAP.,FXD,MICA D:375PF,1%,500V	00853	D15-5F3750F0
C14	283-0634-00			CAP.,FXD,MICA D:65PF,5%,500V	00853	D15-1E650F0
C15	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C16	283-0624-00			CAP.,FXD,MICA D:1300PF,2%,500V	72136	DM19E132G0
C17	283-0624-00			CAP.,FXD,MICA D:1300PF,2%,500V	72136	DM19E132G0
C18	285-0808-00			CAP.,FXD,PLSTC:0.1UF,10%,50V	56289	LP66A1A104K004
C19	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C28	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C52	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C73	283-0604-00			CAP.,FXD,MICA D:304PF,2%,300V	00853	D15-3F3040G0
C74	283-0625-00			CAP.,FXD,MICA D:220PF,1%,500V	93790	CD10FD221F03
C83	285-0809-00			CAP.,FXD,PLSTC:1UF,10%,50V	56289	LP66A1A105K
C94	283-0094-00			CAP.,FXD,CER DI:27PF,10%,200V	56289	40C627
C101	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131-050651104M
C102	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C107	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C112	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131-050651104M
C114	283-0604-00			CAP.,FXD,MICA D:304PF,2%,300V	00853	D15-3F3040G0
C115	283-0630-00			CAP.,FXD,MICA D:110PF,1%,100V	00853	D15-1E111F0
C117	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C150	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C163	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C167	283-0094-00			CAP.,FXD,CER DI:27PF,10%,200V	56289	40C627
C177	283-0032-00			CAP.,FXD,CER DI:470PF,5%,500V	72982	831-000Z5D0471J
C178	283-0094-00			CAP.,FXD,CER DI:27PF,10%,200V	56289	40C627
C192	281-0501-00			CAP.,FXD,CER DI:4.7PF,+/-1PF,500V	72982	301-000S2H0479F
C198	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C211	283-0604-00			CAP.,FXD,MICA D:304PF,2%,300V	00853	D15-3F3040G0
C216	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C232	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C242	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C260	283-0630-00			CAP.,FXD,MICA D:110PF,1%,100V	00853	D15-1E111F0
C261	283-0604-00			CAP.,FXD,MICA D:304PF,2%,300V	00853	D15-3F3040G0
C281	283-0604-00			CAP.,FXD,MICA D:304PF,2%,300V	00853	D15-3F3040G0
C301	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C302	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C303	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C338	295-0168-00			CAP.SET,MTCHD:0.22UF AND 2UF	80009	295-0168-00
C339	295-0168-00			CAP.SET,MTCHD:0.22UF AND 2UF	80009	295-0168-00
C351	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C362	285-0919-00			CAP.,FXD,PLSTC:0.22UF,10%,100V	56289	LP66A1B224K002
C368	283-0666-00			CAP.,FXD,MICA D:890PF,2%,100V	00853	D151F891G0
C369	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C390	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C396	283-0180-00			CAP.,FXD,CER DI:5600PF,20%,200V	72982	8121N204E562M
C440	283-0666-00			CAP.,FXD,MICA D:890PF,2%,100V	00853	D151F891G0
C441	283-0666-00			CAP.,FXD,MICA D:890PF,2%,100V	00853	D151F891G0
C442	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C446	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C507	283-0060-00			CAP.,FXD,CER DI:100PF,5%,200V	72982	855-535U2J101J
C533	283-0032-00			CAP.,FXD,CER DI:470PF,5%,500V	72982	831-000Z5D0471J
C546	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C558	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C562	283-0028-00			CAP.,FXD,CER DI:0.0022UF,20%,50V	56289	55C144
C565	283-0109-00			CAP.,FXD,CER DI:27PF,5%,1000V	56289	20C376
C710	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C713	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C728	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C736	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C773	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C914	290-0526-00			CAP.,FXD,ELCTLT:6.8UF,20%,6V	90201	TDC685M006EL
C918	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C920	283-0077-00			CAP.,FXD,CER DI:330PF,5%,500V	56289	40C94A3
C922	290-0526-00			CAP.,FXD,ELCTLT:6.8UF,20%,6V	90201	TDC685M006EL
C923	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C924	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C933	283-0077-00			CAP.,FXD,CER DI:330PF,5%,500V	56289	40C94A3
C934	283-0077-00			CAP.,FXD,CER DI:330PF,5%,500V	56289	40C94A3
C944	283-0077-00			CAP.,FXD,CER DI:330PF,5%,500V	56289	40C94A3
C951	283-0164-00			CAP.,FXD,CER DI:2.2UF,20%,25V	72982	8141N038651225M
C957	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1001	290-0312-00			CAP.,FXD,ELCTLT:47UF,10%,35V	56289	150D476X9035S2
C1004	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1005	283-0010-00			CAP.,FXD,CER DI:0.05UF,+100-20%,50V	56289	273C20
C1008	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1016	283-0010-00			CAP.,FXD,CER DI:0.05UF,+100-20%,50V	56289	273C20
C1022	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075E224M
C1023	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1024	283-0008-00			CAP.,FXD,CER DI:1UF,500V	72982	8151N501E104M
C1025	283-0008-00			CAP.,FXD,CER DI:0.1UF,500V	72982	8151N501E104M
C1026	285-0919-00			CAP.,FXD,PLSTC:0.22UF,10%,100V	56289	LP66A1B224K002
C1028	283-0208-00			CAP.,FXD,CER DI:0.22UF,10%,200V	72982	8151N230C224K
C1029	283-0208-00			CAP.,FXD,CER DI:0.22UF,10%,200V	72982	8151N230C224K
C1032	290-0532-00			CAP.,FXD,ELCTLT:150UF,20%,6V	90201	TDC157M006CL
C1033	290-0524-00			CAP.,FXD,ELCTLT:4.7UF,20%,10V	90201	TDC475M010EL
C1034	290-0420-00			CAP.,FXD,ELCTLT:.68UF,20%,75V	56289	1500684X0075A2
C1036	283-0008-00			CAP.,FXD,CER DI:0.1UF,500V	72982	8151N501E104M
C1039	283-0008-00			CAP.,FXD,CER DI:0.1UF,500V	72982	8151N501E104M
C1075	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1076	290-0530-00			CAP.,FXD,ELCTLT:68UF,20%,6V	90201	TDC686M006FL
C1077	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1079	290-0524-00			CAP.,FXD,ELCTLT:4.7UF,20%,10V	90201	TDC475M010EL
C1080	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1081	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1083	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1084	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1086	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1087	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1088	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1089	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1091	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C1092	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1094	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1095	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1098	290-0524-00			CAP.,FXD,ELCTLT:4.7UF,20%,10V	90201	TDC475M010EL
C1101	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1102	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1103	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1105	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C1106	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1121	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1122	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1131	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1132	290-0530-00			CAP.,FXD,ELCTLT:68UF,20%,6V	90201	TDC686M006FL
C1133	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1137	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1138	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1139	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1140	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1145	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	72982	5835-515E223Z
C1147	290-0532-00			CAP.,FXD,ELCTLT:150UF,20%,6V	90201	TDC157M006CL
C1201	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1202	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1204	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1205	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1208	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1209	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1212	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1213	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1216	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1217	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1220	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1221	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1223	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1224	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1227	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1228	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1232	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1233	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1236	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1237	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1240	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1241	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8131-050W5R223K
C1242	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1246	290-0572-00			CAP.,FXD,ELCTLT:0.1UF,20%,50V	56289	196D104X0050HA1
CR33	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	07263	FDH6012
CR34	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	07263	FDH6012
CR71	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR72	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR92	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR93	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR114	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR120	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR130	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR164	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR166	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR172	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	07263	FDH6012
CR173	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	07263	FDH6012
CR234	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR236	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR316	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR317	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR318	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR319	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR370	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR413	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR414	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR442	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR509	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR522	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR528	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR529	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR542	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR574	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR586	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR646	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR647	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR648	152-0322-00			SEMICOND DEVICE:SILICON,15V	01295	A1108
CR653	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR657	152-0322-00			SEMICOND DEVICE:SILICON,15V	01295	A1108
CR663	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR667	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR668	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR669	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR670	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR701	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR702	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR704	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR705	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR710	152-0322-00			SEMICOND DEVICE:SILICON,15V	01295	A1108
CR726	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR736	152-0322-00			SEMICOND DEVICE:SILICON,15V	01295	A1108
CR739	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR750	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR757	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR766	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR767	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR773	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR781	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR783	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR785	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR786	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR787	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR791	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR837	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR838	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR843	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR844	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR902	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR903	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR905	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR907	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR908	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR910	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR924	152-0322-00			SEMICOND DEVICE:SILICON,15V	01295	A1108
CR946	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR947	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR950	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR954	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1012	152-0107-03			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-03
CR1013	152-0107-03			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-03
CR1014	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1015	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1026	152-0107-03			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-03
CR1027	152-0107-03			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-03
CR1028	152-0107-03			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-03
CR1029	152-0107-03			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-03
CR1030	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	07263	FDH6012
CR1031	152-0333-00			SEMICOND DEVICE:SILICON,55V,200MA	07263	FDH6012
CR1047	152-0107-03			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-03
CR1075	152-0107-03			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-03
CR1077	152-0107-03			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-03
DS312	150-0048-01			LAMP,INCAND:5V,60MA,SELECTED	80009	150-0048-01
DS314	150-0048-01			LAMP,INCAND:5V,60MA,SELECTED	80009	150-0048-01
DS500	150-0048-01			LAMP,INCAND:5V,60MA,SELECTED	80009	150-0048-01
DS594	150-0048-01			LAMP,INCAND:5V,60MA,SELECTED	80009	150-0048-01
DS674	150-0048-01			LAMP,INCAND:5V,60MA,SELECTED	80009	150-0048-01
J130	131-1011-00			CONN,RCPT,ELEC:4 CONTACT,FEMALE	0000A	RA-1304TPX
J200	131-1461-00			CONN,RCPT,ELEC:50 FEMALE CONTACT	00779	205207-1
J500	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	24731	28JR200-1
K92	108-0499-00			COIL,RF:REED DRIVE,6V SINGLE	80009	108-0499-00
K120[1]	148-0035-00			RELAY,ARMATURE:SPDT,15VDC,600 OHM	80009	148-0035-00
L1001	108-0473-00			COIL,RF:150UH	80009	108-0473-00
L1002	108-0473-00			COIL,RF:150UH	80009	108-0473-00
L1007	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1031	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1075	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1076	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1077	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1078	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1079	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1131	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1132	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1133	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1147	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1201	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1202	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1242	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00

[1]Furnished as a unit with S120.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
P10	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
P502	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
Q2	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q8	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q12	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q16	151-0341-00	B010100	B010117	TRANSISTOR:SILICON,NPN	07263	2N3565
Q16	151-0192-00	B010118		TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q18	151-0341-00	B010100	B010117	TRANSISTOR:SILICON,NPN	07263	2N3565
Q18	151-0192-00	B010118		TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q20	151-1025-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	01295	SBA8129
Q22A,B	151-1049-00			TRANSISTOR:Sl,JFE,N-CHAN,SEL FROM 2N3822	80009	151-1049-00
Q24	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q26	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q28	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q54	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q58	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q72A,B	151-0261-00			TRANSISTOR:SILICON,PNP,DUAL	12040	NS7410
Q74	151-1078-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	151-1078-00
Q82	151-1037-00			TRANSISTOR:SILICON,JFE,N CHANNEL	21845	ED1553
Q86	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q92	151-1004-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	15818	U1489
Q114	151-1078-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	151-1078-00
Q120	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q124	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q128	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q182A,B	151-0309-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0309-00
Q244A,B	151-0261-00			TRANSISTOR:SILICON,PNP,DUAL	12040	NS7410
Q254	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q262	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q268	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q282	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q284	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q310	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q312	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q314	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q316	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q318	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q328	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q330	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q332	151-0508-00			TRANSISTOR:SILICON,NPN,UNIJUNCTION	03508	X13T520
Q344	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q362	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q364	151-0190-00			TRANSISTOR:SILICON,NPN	07263	2N3904
Q370	151-0254-00			TRANSISTOR:SILICON,NPN	03508	2N5308
Q398	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q400	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q420	151-1021-00			TRANSISTOR:SILICON,JFE,N CHANNEL	50522	MAN73
Q424	151-1021-00			TRANSISTOR:SILICON,JFE,N CHANNEL	50522	MAN73
Q426	151-1021-00			TRANSISTOR:SILICON,JFE,N CHANNEL	50522	MAN73
Q436	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q502	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q504	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q510	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q514	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565

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Q518	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q524	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q534	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q538	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q550	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q554	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q570	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q572	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q576	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q582	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q586	151-0188-00			TRANSISTOR:SILICON,PNP	04713	2N3906
Q590	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q592	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q656	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q666	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q668	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q670	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q674	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q676	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q726	151-1021-00			TRANSISTOR:SILICON,JFE,N CHANNEL	50522	MAN73
Q736	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q750	151-1021-00			TRANSISTOR:SILICON,JFE,N CHANNEL	50522	MAN73
Q768	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q784	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q786	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q794	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q798	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q836	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q842	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q846	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q908	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q918	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q932	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q934	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q938	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q940	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q946	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q970	151-1021-00			TRANSISTOR:SILICON,JFE,N CHANNEL	50522	MAN73
Q974	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q976	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q1002	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q1008	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q1012	153-0611-00			TRANSISTOR:SILICON,NPN,MATCHED PAIR	80009	153-0611-00
Q1014	153-0611-00			TRANSISTOR:SILICON,NPN,MATCHED PAIR	80009	153-0611-00
Q1042	151-0350-00			TRANSISTOR:SILICON,PNP	04713	SPS6700
Q1044	151-0350-00			TRANSISTOR:SILICON,PNP	04713	SPS6700
Q1106	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q1246	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
R1	321-0277-03			RES.,FXD,FILM:7.5K OHM,0.25%,0.125W	91637	MFF1816D7000C
R2	321-0626-01			RES.,FXD,FILM:2.51K OHM,0.5%,0.125W	75042	CEAT0-2511D
R3	315-0272-00			RES.,FXD,COMP:2.7K OHM,5%,0.25W	01121	CB2725
R4	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	75042	CEAT0-4021F
R6	321-0221-00			RES.,FXD,FILM:1.96K OHM,1%,0.125W	75042	CEAT0-1961F

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R7	315-0201-00			RES.,FXD,COMP:200 OHM,5%,0.25W	01121	CB2015
R8	321-0234-00			RES.,FXD,FILM:2.67K OHM,1%,0.125W	75042	CEAT0-2671F
R9	321-0221-00			RES.,FXD,FILM:1.96K OHM,1%,0.125W	75042	CEAT0-1961F
R11	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R12	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	75042	CEAT0-4021F
R13	321-0249-00			RES.,FXD,FILM:3.83K OHM,1%,0.125W	75042	CEAT0-3831F
R14	321-0249-00			RES.,FXD,FILM:3.83K OHM,1%,0.125W	75042	CEAT0-3831F
R16	321-0249-00			RES.,FXD,FILM:3.83K OHM,1%,0.125W	75042	CEAT0-3831F
R17	321-0249-00			RES.,FXD,FILM:3.83K OHM,1%,0.125W	75042	CEAT0-3831F
R18	315-0153-00			RES.,FXD,COMP:15K OHM,5%,0.25W	01121	CB1535
R19	315-0153-00			RES.,FXD,COMP:15K OHM,5%,0.25W	01121	CB1535
R21	315-0104-00	B010100	B010117	RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R21	315-0224-00	B010118		RES.,FXD,COMP:220K OHM,5%,0.25W	01121	CB2245
R22	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	75042	CEAT0-1212F
R23	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	75042	CEAT0-1212F
R24	315-0224-00	XB010118		RES.,FXD,COMP:220K OHM,5%,0.25W	01121	CB2245
R25	311-1560-00			RES.,VAR,NONWIR:5K OHM,5%,0.50W	73138	91A-5000M
R26	315-0223-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2235
R27	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R28	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R32	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	75042	CEAT2-1002C
R33	321-0626-01			RES.,FXD,FILM:2.51K OHM,0.5%,0.125W	75042	CEAT0-2511D
R34	321-0626-01			RES.,FXD,FILM:2.51K OHM,0.5%,0.125W	75042	CEAT0-2511D
R37	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	75042	CEAT2-1002C
R38	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R50	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	75042	CEAT0-4991F
R51	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	75042	CEAT0-4991F
R52	315-0622-00			RES.,FXD,COMP:6.2K OHM,5%,0.25W	01121	CB6225
R53	315-0303-00			RES.,FXD,COMP:30K OHM,5%,0.25W	01121	CB3035
R54	315-0303-00			RES.,FXD,COMP:30K OHM,5%,0.25W	01121	CB3035
R57	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R58	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R71	321-0510-00			RES.,FXD,FILM:2M OHM,1%,0.125W	75042	CEAT0-2004F
R72	321-0510-00			RES.,FXD,FILM:2M OHM,1%,0.125W	75042	CEAT0-2004F
R73	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	75042	CEAT0-4021F
R74	321-0262-00			RES.,FXD,FILM:5.23K OHM,1%,0.125W	75042	CEAT0-5231F
R75	311-1560-00			RES.,VAR,NONWIR:5K OHM,5%,0.50W	73138	91A-5000M
R76	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	75042	CEAT0-4021F
R81	315-0223-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2235
R82	315-0303-00			RES.,FXD,COMP:30K OHM,5%,0.25W	01121	CB3035
R83	315-0471-00			RES.,FXD,COMP:470 OHM,5%,0.25W	01121	CB4715
R84	315-0471-00			RES.,FXD,COMP:470 OHM,5%,0.25W	01121	CB4715
R86	321-0234-00			RES.,FXD,FILM:2.67K OHM,1%,0.125W	75042	CEAT0-2671F
R87	315-0201-00			RES.,FXD,COMP:200 OHM,5%,0.25W	01121	CB2015
R88	321-0193-03			RES.,FXD,FILM:1K OHM,0.25%,0.125W	75042	CEAT2-1001C
R89	321-0193-03			RES.,FXD,FILM:1K OHM,0.25%,0.125W	75042	CEAT2-1001C
R92	315-0475-00			RES.,FXD,COMP:4.7M OHM,5%,0.25W	01121	CB4755
R93	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R94	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R96	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R97	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R100	311-1556-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	73138	91A-50001M
R101	321-0309-00			RES.,FXD,FILM:16.2K OHM,1%,0.125W	75042	CEAT0-1622F
R102	321-0182-09			RES.,FXD,FILM:768 OHM,1%,0.125W	91637	MFF1816C768R0F
R103	321-0298-00			RES.,FXD,FILM:12.4K OHM,1%,0.125W	75042	CEAT0-1242F

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R105	311-1336-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	80294	3006P-1-104
R106	321-0283-00			RES.,FXD,FILM:8.66K OHM,1%,0.125W	75042	CEAT0-8661F
R107	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	75042	CEAT2-1002C
R108	321-0236-00			RES.,FXD,FILM:2.8K OHM,1%,0.125W	75042	CEAT0-2801F
R109	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.25W	75042	CEAT2-1002C
R110	311-1560-00			RES.,VAR,NONWIR:5K OHM,5%,0.50W	73138	91A-5000M
R111	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEAT0-3742F
R112	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	75042	CEAT0-6651F
R113	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R114	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R115	311-1336-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	80294	3006P-1-104
R116	321-0646-00			RES.,FXD,FILM:200K OHM,0.5%,0.125W	75042	CEAT2-2003D
R117	321-0298-00			RES.,FXD,FILM:12.4K OHM,1%,0.125W	75042	CEAT0-1242F
R118	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	75042	CEAT0-9091F
R120	311-1560-00			RES.,VAR,NONWIR:5K OHM,5%,0.50W	73138	91A-5000M
R122	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R124	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R126	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R128	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R130	315-0153-00			RES.,FXD,COMP:15K OHM,5%,0.25W	01121	CB1535
R150	311-1685-00			RES.,VAR,WW:50K OHM,3%,2W	80294	3500S-D14-503
R151	321-0318-02			RES.,FXD,FILM:20K OHM,0.5%,0.125W	75042	CEAT2-2002D
R152	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	75042	CEAT2-1002C
R153	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	75042	CEAT2-1002C
R154	321-0816-03			RES.,FXD,FILM:5K OHM,0.25%,0.125W	75042	CEAT2-5KC
R156	321-0992-01			RES.,FXD,FILM:33.33K OHM,0.5%,0.125W	91637	MFF1816G3331D
R157	321-0992-01			RES.,FXD,FILM:33.33K OHM,0.5%,0.125W	91637	MFF1816G3331D
R158	321-0755-03			RES.,FXD,FILM:65K OHM,0.25%,0.125W	75042	CEAT2-6502C
R159	315-0182-00			RES.,FXD,COMP:1.8K OHM,5%,0.25W	01121	CB1825
R160	311-1555-00			RES.,VAR,NONWIR:100K OHM,20%,0.5W	73138	91A-10002M
R161	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	75042	CEAT0-9091F
R162	315-0475-00			RES.,FXD,COMP:4.7M OHM,5%,0.25W	01121	CB4755
R163	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R164	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	75042	CEAT0-9091F
R165	315-0226-00			RES.,FXD,COMP:22M OHM,5%,0.25W	01121	CB2265
R166	321-0221-00			RES.,FXD,FILM:1.96K OHM,1%,0.125W	75042	CEAT0-1961F
R167	315-0203-00			RES.,FXD,COMP:20K OHM,5%,0.25W	01121	CB2035
R168	321-0373-03			RES.,FXD,FILM:75K OHM,0.25%,0.125W	91637	MFF1816D75001C
R169	321-0277-03			RES.,FXD,FILM:7.5K OHM,0.25%,0.125W	91637	MFF1816D7000C
R170	315-0275-00			RES.,FXD,COMP:2.7M OHM,5%,0.25W	01121	CB2755
R171	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	75042	CEAT0-8061F
R172	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	75042	CEAT0-8061F
R173	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R176	321-0277-03			RES.,FXD,FILM:7.5K OHM,0.25%,0.125W	91637	MFF1816D7000C
R177	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R178	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R185	311-1563-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	73138	91A-10000M
R186	321-0214-00			RES.,FXD,FILM:1.65K OHM,1%,0.125W	75042	CEAT0-1651F
R187	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEAT0-1001F
R188	321-0116-00			RES.,FXD,FILM:158 OHM,1%,0.125W	75042	CEAT0-1580F
R190	311-1563-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	73138	91A-10000M
R193	321-0745-03			RES.,FXD,FILM:25.05K OHM,0.25%,0.125W	75042	CEAT2-25051C
R194	321-0816-03			RES.,FXD,FILM:5K OHM,0.25%,0.125W	75042	CEAT2-5KC

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R196	321-0816-03			RES.,FXD,FILM:5K OHM,0.25%,0.125W	75042	CEAT2-5KC
R197	321-0745-03			RES.,FXD,FILM:25.05K OHM,0.25%,0.125W	75042	CEAT2-25051C
R198	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R199	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R200	311-0580-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	11237	41695
R211	321-0816-07			RES.,FXD,FILM:5K OHM,0.1%,0.125W	75042	CEAT9-5001B
R212	321-0913-03			RES.,FXD,FILM:2.22K OHM,0.25%,0.124W	91637	MFF1816D22200C
R213	315-0201-00			RES.,FXD,COMP:200 OHM,5%,0.25W	01121	CB2015
R214	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R216	321-0234-00			RES.,FXD,FILM:2.67K OHM,1%,0.125W	75042	CEAT0-2671F
R217	321-0913-03			RES.,FXD,FILM:2.22K OHM,0.25%,0.124W	91637	MFF1816D22200C
R218	315-0220-00			RES.,FXD,COMP:22 OHM,5%,0.25W	01121	CB2205
R219	315-0153-00			RES.,FXD,COMP:15K OHM,5%,0.25W	01121	CB1535
R220	311-0580-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	11237	41695
R222	321-0193-03			RES.,FXD,FILM:1K OHM,0.25%,0.125W	75042	CEAT2-1001C
R223	315-0430-00			RES.,FXD,COMP:43 OHM,5%,0.25W	01121	CB4305
R224	321-1254-03			RES.,FXD,FILM:4.37K OHM,0.25%,0.125W	91637	MFF1816D43700C
R226	315-0914-00			RES.,FXD,COMP:910K OHM,5%,0.25W	01121	CB9145
R228	321-0222-03			RES.,FXD,FILM:2K OHM,0.25%,0.125W	75042	CEAT22KC
R229	321-0126-03			RES.,FXD,FILM:200 OHM,0.25%,0.125%	75042	CEAT2-200R0C
R230	311-1565-00			RES.,VAR,NONWIR:250 OHM,20%,0.50W	73138	91A250R0M
R231	321-0632-00			RES.,FXD,FILM:9.41K OHM,0.5%,0.125W	75042	CEAT2-9411C
R232	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R233	321-0632-00			RES.,FXD,FILM:9.41K OHM,0.5%,0.125W	75042	CEAT2-9411C
R234	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R235	311-1550-00			RES.,VAR,NONWIR:2M OHM,20%,0.50W	73138	91A-20003M
R236	315-0244-00			RES.,FXD,COMP:240K OHM,5%,0.25W	01121	CB2445
R239	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R242	315-0182-00			RES.,FXD,COMP:1.8K OHM,5%,0.25W	01121	CB1825
R243	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	75042	CEAT0-6651F
R244	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	75042	CEAT0-7500F
R245[1]	311-1158-00			RES.,VAR,NONWIR:2K OHM,10%,5W	12697	381-CH-40378
R246	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	75042	CEAT0-6651F
R250	321-0229-00			RES.,FXD,FILM:2.37K OHM,1%,0.125W	75042	CEAT0-2371F
R251	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEAT0-2492F
R252	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	75042	CEAT0-1003F
R253	321-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.125W	75042	CEAT0-2151F
R255	311-0095-00			RES.,VAR,NONWIR:500 OHM,10%	11237	41022
R256	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	75042	CEAT0-2491F
R260	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	75042	CEAT0-6651F
R262	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R264	322-0210-00			RES.,FXD,FILM:1.5K OHM,1%,0.25W	75042	CEBT0-1501F
R266	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEAT0-1000F
R267	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEAT0-1000F
R270	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEAT0-1000F
R271	322-0202-00			RES.,FXD,FILM:1.24K OHM,1%,0.25W	75042	CEBT0-1241F
R275	311-0169-00			RES.,VAR,NONWIR:100 OHM,20%,0.50W	01121	W7564B
R280	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	75042	CEAT0-6651F
R282	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R283	322-0202-00			RES.,FXD,FILM:1.24K OHM,1%,0.25W	75042	CEBT0-1241F
R284	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEAT0-1000F
R287	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEAT0-1000F
R288	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEAT0-1000F

[1]Furnished as a unit with S245A,B.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R289	322-0210-00			RES.,FXD,FILM:1.5K OHM,1%,0.25W	75042	CEBT0-1501F
R301	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R302	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R303	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R304	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R310	315-0471-00			RES.,FXD,COMP:470 OHM,5%,0.25W	01121	CB4715
R314	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R315	315-0392-00			RES.,FXD,COMP:3.9K OHM,5%,0.25W	01121	CB3925
R316	321-0354-00			RES.,FXD,FILM:47.5K OHM,1%,0.125W	75042	CEAT0-4752F
R317	315-0302-00			RES.,FXD,COMP:3K OHM,5%,0.25W	01121	CB3025
R318	321-0333-00			RES.,FXD,FILM:28.7K OHM,1%,0.125W	75042	CEAT0-2872F
R320	311-1561-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	73138	91A-25000M
R322	315-0682-00			RES.,FXD,COMP:6.8K OHM,5%,0.25W	01121	CB6825
R323	315-0392-00			RES.,FXD,COMP:3.9K OHM,5%,0.25W	01121	CB3925
R325[1]	311-1158-00			RES.,VAR,NONWIR:2K OHM,10%,5W	12697	381-CM-40378
R326	315-0162-00			RES.,FXD,COMP:1.6K OHM,5%,0.25W	01121	CB1625
R327	315-0133-00			RES.,FXD,COMP:13K OHM,5%,0.25W	01121	CB1335
R330	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R331	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R332	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R333	321-0481-00			RES.,FXD,FILM:1M OHM,1%,0.125W	75042	CEAT0-1004F
R334	321-0452-00			RES.,FXD,FILM:499K OHM,1%,0.125W	75042	CEAT0-4993F
R336	321-0452-00			RES.,FXD,FILM:499K OHM,1%,0.125W	75042	CEAT0-4993F
R338	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R339	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R342	315-0333-00			RES.,FXD,COMP:33K OHM,5%,0.25W	01121	CB3335
R343	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R344	315-0333-00			RES.,FXD,COMP:33K OHM,5%,0.25W	01121	CB3335
R345	311-1560-00			RES.,VAR,NONWIR:5K OHM,5%,0.50W	73138	91A-5000M
R346	315-0184-00			RES.,FXD,COMP:180K OHM,5%,0.25W	01121	CB1845
R348	315-0361-00			RES.,FXD,COMP:360 OHM,5%,0.25W	01121	CB3615
R349	321-1263-02			RES.,FXD,FILM:5.42K OHM,0.5%,0.125W	75042	CEAT2-5421D
R350	321-0603-00			RES.,FXD,FILM:15K OHM,0.25%,0.125W	75042	CEAT2-1502C
R351	321-0637-00			RES.,FXD,FILM:9.9K OHM,0.5%,0.125W	75042	CEAT2-9901D
R353	315-0752-00			RES.,FXD,COMP:7.5K OHM,5%,0.25W	01121	CB7525
R355	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R357	321-0643-00			RES.,FXD,FILM:22.1K OHM,0.25%,0.125W	75042	CEAT9-2212C
R358	315-0121-00			RES.,FXD,COMP:120 OHM,5%,0.25W	01121	CB1215
R360	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R361	315-0753-00			RES.,FXD,COMP:75K OHM,5%,0.25W	01121	CB7535
R363	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R364	315-0392-00			RES.,FXD,COMP:3.9K OHM,5%,0.25W	01121	CB3925
R365	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R367	321-0364-00			RES.,FXD,FILM:60.4K OHM,1%,0.125W	75042	CEAT0-6042F
R370	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R372	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEAT0-1002F
R373	321-0314-00			RES.,FXD,FILM:18.2K OHM,1%,0.125W	75042	CEAT0-1822F
R375	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R377	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R378	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	75042	CEAT2-1002C
R379	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	75042	CEAT2-1002C
R382	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R385	311-0546-00			RES.,VAR,NONWIR:10K OHM,20%,0.75W	97979	TK0546G

[1]Furnished as a unit with S325A,B.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R386	315-0243-00			RES.,FXD,COMP:24K OHM,5%,0.25W	01121	CB2435
R387	321-0756-04			RES.,FXD,FILM:50K OHM,0.1%,0.125W	75042	CEAT2-5002B
R388	321-0756-04			RES.,FXD,FILM:50K OHM,0.1%,0.125W	75042	CEAT2-5002B
R390	311-1197-00			RES.,VAR,NONWIR:20K OHM,10%,1W	12697	381-CM39696
R391	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R395	315-0133-00			RES.,FXD,COMP:13K OHM,5%,0.25W	01121	CB1335
R397	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R398	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R399	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R402	315-0302-00			RES.,FXD,COMP:3K OHM,5%,0.25W	01121	CB3025
R405	311-0580-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	11237	41695
R406	321-0290-00			RES.,FXD,FILM:10.2K OHM,1%,0.125W	75042	CEAT0-1022F
R408	321-0309-00			RES.,FXD,FILM:16.2K OHM,1%,0.125W	75042	CEAT0-1622F
R410	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEAT0-1001F
R412	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEAT0-1001F
R413	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	75042	CEAT0-4021F
R414	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R416	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEAT0-1002F
R418	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	75042	CEAT0-6651F
R420	315-0224-00			RES.,FXD,COMP:220K OHM,5%,0.25W	01121	CB2245
R421	315-0224-00			RES.,FXD,COMP:220K OHM,5%,0.25W	01121	CB2245
R423	315-0224-00			RES.,FXD,COMP:220K OHM,5%,0.25W	01121	CB2245
R425	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R428	321-0250-00			RES.,FXD,FILM:3.92K OHM,1%,0.125W	75042	CEAT0-3921F
R429	315-0180-00			RES.,FXD,COMP:18 OHM,5%,0.25W	01121	CB1805
R432	321-0221-00			RES.,FXD,FILM:1.96K OHM,1%,0.125W	75042	CEAT0-1961F
R435	311-0095-00			RES.,VAR,NONWIR:500 OHM,10%	11237	41022
R436	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R437	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R438	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R440	315-0243-00			RES.,FXD,COMP:24K OHM,5%,0.25W	01121	CB2435
R441	315-0303-00			RES.,FXD,COMP:30K OHM,5%,0.25W	01121	CB3035
R445	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R446	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R447	315-0510-00			RES.,FXD,COMP:51 OHM,5%,0.25W	01121	CB5105
R455	315-0510-00			RES.,FXD,COMP:51 OHM,5%,0.25W	01121	CB5105
R456	315-0510-00			RES.,FXD,COMP:51 OHM,5%,0.25W	01121	CB5105
R502	315-0180-00			RES.,FXD,COMP:18 OHM,5%,0.25W	01121	CB1805
R504	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R506	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R507	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R508	302-0103-00			RES.,FXD,COMP:10K OHM,10%,0.50W	01121	EB1031
R510	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R511	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R514	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R516	315-0153-00			RES.,FXD,COMP:15K OHM,5%,0.25W	01121	CB1535
R518	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R521	315-0682-00			RES.,FXD,COMP:6.8K OHM,5%,0.25W	01121	CB6825
R522	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R524	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R531	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R533	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R534	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R535	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R538	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R542	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R546	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R550	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R552	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R553	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R554	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R556	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R557	315-0471-00			RES.,FXD,COMP:470 OHM,5%,0.25W	01121	CB4715
R561	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R562	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R563	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R564	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R565	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R566	315-0682-00			RES.,FXD,COMP:6.8K OHM,5%,0.25W	01121	CB6825
R567	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R571	315-0752-00			RES.,FXD,COMP:7.5K OHM,5%,0.25W	01121	CB7525
R573	315-0752-00			RES.,FXD,COMP:7.5K OHM,5%,0.25W	01121	CB7525
R576	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R578	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R582	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R583	315-0182-00			RES.,FXD,COMP:1.8K OHM,5%,0.25W	01121	CB1825
R584	315-0752-00			RES.,FXD,COMP:7.5K OHM,5%,0.25W	01121	CB7525
R586	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R587	315-0153-00			RES.,FXD,COMP:15K OHM,5%,0.25W	01121	CB1535
R588	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R591	315-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R592	315-0180-00			RES.,FXD,COMP:18 OHM,5%,0.25W	01121	CB1805
R632	315-0753-00			RES.,FXD,COMP:75K OHM,5%,0.25W	01121	CB7535
R634	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEAT0-2492F
R636	315-0513-00			RES.,FXD,COMP:51K OHM,5%,0.25W	01121	CB5135
R637	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEAT0-3742F
R638	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEAT0-2492F
R640	315-0513-00			RES.,FXD,COMP:51K OHM,5%,0.25W	01121	CB5135
R641	315-0513-00			RES.,FXD,COMP:51K OHM,5%,0.25W	01121	CB5135
R642	315-0513-00			RES.,FXD,COMP:51K OHM,5%,0.25W	01121	CB5135
R644	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R646	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEAT0-4992F
R647	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R648	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R649	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R650	321-0371-00			RES.,FXD,FILM:71.5K OHM,1%,0.125W	75042	CEAT0-7152F
R652	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R654	315-0123-00			RES.,FXD,COMP:12K OHM,5%,0.25W	01121	CB1235
R656	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R658	321-0325-00			RES.,FXD,FILM:23.7K OHM,1%,0.125W	75042	CEAT0-2372F
R660	321-0319-00			RES.,FXD,FILM:20.5K OHM,1%,0.125W	75042	CEAT0-2052F
R662	321-0371-00			RES.,FXD,FILM:71.5K OHM,1%,0.125W	75042	CEAT0-7152F
R664	315-0512-00			RES.,FXD,COMP:5.1K OHM,5%,0.25W	01121	CB5125
R666	315-0332-00			RES.,FXD,COMP:3.3K OHM,5%,0.25W	01121	CB3325
R667	315-0332-00			RES.,FXD,COMP:3.3K OHM,5%,0.25W	01121	CB3325
R668	321-0342-00			RES.,FXD,FILM:35.7K OHM,1%,0.125W	75042	CEAT0-3572F

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R669	321-0333-00			RES.,FXD,FILM:28.7K OHM,1%,0.125W	75042	CEAT0-2872F
R670	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R672	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R674	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R676	315-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R678	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R680	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R682	315-0123-00			RES.,FXD,COMP:12K OHM,5%,0.25W	01121	CB1235
R686	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	75042	CEAT2-1002C
R688	321-0318-02			RES.,FXD,FILM:20K OHM,0.5%,0.125W	75042	CEAT2-2002D
R689	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R701	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R706	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R708	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R710	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEAT0-3742F
R712,A-N	307-0387-00			RES.,FXD,FILM:13 RESISTOR NETWORK	73138	899-1-R8.2K
R714	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEAT0-1002F
R726	315-0153-00			RES.,FXD,COMP:15K OHM,5%,0.25W	01121	CB1535
R730	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEAT0-4992F
R732	315-0153-00			RES.,FXD,COMP:15K OHM,5%,0.25W	01121	CB1535
R736	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEAT0-3742F
R738	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R744	315-0682-00			RES.,FXD,COMP:6.8K OHM,5%,0.25W	01121	CB6825
R746	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R756	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R760	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEAT0-3742F
R762	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEAT0-4992F
R764	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R765	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R766	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R768	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R770	315-0753-00			RES.,FXD,COMP:75K OHM,5%,0.25W	01121	CB7535
R771	315-0822-00			RES.,FXD,COMP:8.2K OHM,5%,0.25W	01121	CB8225
R772	315-0822-00			RES.,FXD,COMP:8.2K OHM,5%,0.25W	01121	CB8225
R773	315-0822-00			RES.,FXD,COMP:8.2K OHM,5%,0.25W	01121	CB8225
R774	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	75042	CEAT0-2001F
R776	321-0373-00			RES.,FXD,FILM:75K OHM, 1%,0.125W	75042	CEAT0-7502F
R778	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R780	321-0371-00			RES.,FXD,FILM:71.5K OHM,1%,0.125W	75042	CEAT0-7152F
R782	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R784	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R785	315-0153-00			RES.,FXD,COMP:15K OHM,5%,0.25W	01121	CB1535
R786	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R787	315-0153-00			RES.,FXD,COMP:15K OHM,5%,0.25W	01121	CB1535
R788	315-0822-00			RES.,FXD,COMP:8.2K OHM,5%,0.25W	01121	CB8225
R789	315-0822-00			RES.,FXD,COMP:8.2K OHM,5%,0.25W	01121	CB8225
R790	321-0315-00			RES.,FXD,FILM:18.7K OHM,1%,0.125W	75042	CEAT0-1872F
R792	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEAT0-1002F
R794	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	75042	CEAT0-4991F
R795	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEAT0-2002F
R796	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R798	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R801	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEAT0-2492F

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R804	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R805	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEAT0-4992F
R806	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEAT0-3742F
R807	315-0753-00			RES.,FXD,COMP:75K OHM,5%,0.25W	01121	CB7535
R809	315-0753-00			RES.,FXD,COMP:75K OHM,5%,0.25W	01121	CB7535
R810	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R812	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R813	315-0753-00			RES.,FXD,COMP:75K OHM,5%,0.25W	01121	CB7535
R816	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEAT0-4992F
R817	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEAT0-4992F
R818	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEAT0-2492F
R820	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R821	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEAT0-4992F
R822	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R823	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R825	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R826	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEAT0-3742F
R827	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R830	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEAT0-4992F
R831	315-0753-00			RES.,FXD,COMP:75K OHM,5%,0.25W	01121	CB7535
R832	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	75042	CEAT0-3012F
R833	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R835	315-0332-00			RES.,FXD,COMP:3.3K OHM,5%,0.25W	01121	CB3325
R836	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R837	321-0354-00			RES.,FXD,FILM:47.5K OHM,1%,0.125W	75042	CEAT0-4752F
R840	315-0393-00			RES.,FXD,COMP:39K OHM,5%,0.25W	01121	CB3935
R841	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R842	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R843	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R901	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R902	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R903	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R905	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R906	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R907	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R908	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R909	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R910	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R912	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R914	315-0680-00			RES.,FXD,COMP:68 OHM,5%,0.25W	01121	CB6805
R915	315-0272-00			RES.,FXD,COMP:2.7K OHM,5%,0.25W	01121	CB2725
R917	302-0221-00			RES.,FXD,COMP:220 OHM,10%,0.50W	01121	EB2211
R920	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R921	315-0224-00			RES.,FXD,COMP:220K OHM,5%,0.25W	01121	CB2245
R922	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R924	321-0303-00			RES.,FXD,FILM:14K OHM,1%,0.125W	75042	CEAT0-1402F
R925	311-1561-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	73138	91A-25000M
R931	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R933	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R934	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R935	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R937	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R938	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725

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R940	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R941	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R942	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R944	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R945	315-0153-00			RES.,FXD,COMP:15K OHM,5%,0.25W	01121	CB1535
R946	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R948	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R949	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R950	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R951	321-0281-06			RES.,FXD,FILM:8.25K OHM,0.25%,0.125W	75042	CEAT0-8251C
R952	321-0281-06			RES.,FXD,FILM:8.25K OHM,0.25%,0.125W	75042	CEAT0-8251C
R953	321-0281-06			RES.,FXD,FILM:8.25K OHM,0.25%,0.125W	75042	CEAT0-8251C
R954	321-0281-06			RES.,FXD,FILM:8.25K OHM,0.25%,0.125W	75042	CEAT0-8251C
R955	321-0644-00			RES.,FXD,FILM:100K OHM,0.25%,0.125W	75042	CEAT9-1003C
R956	321-0644-00			RES.,FXD,FILM:100K OHM,0.25%,0.125W	75042	CEAT9-1003C
R957	315-0683-00			RES.,FXD,COMP:68K OHM,5%,0.25W	01121	CB6835
R959	321-0720-03			RES.,FXD,FILM:60K OHM,0.25%,0.125W	91637	MFF1816D6002C
R960	311-1560-00			RES.,VAR,NONWIR:5K OHM,5%,0.50W	73138	91A-5000M
R962	311-1559-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	73138	91A-10001M
R963	321-0289-07			RES.,FXD,FILM:10K OHM,0.1%,0.125W	75042	CEAT9-1002B
R964	321-0289-07			RES.,FXD,FILM:10K OHM,0.1%,0.125W	75042	CEAT9-1002B
R965	321-0720-03			RES.,FXD,FILM:60K OHM,0.25%,0.125W	91637	MFF1816D6002C
R966	321-0604-00			RES.,FXD,FILM:30K OHM,0.25%,0.125W	75042	CEAT2-3002C
R967	321-1296-07			RES.,FXD,FILM:12K OHM,0.1%,0.125W	75042	CEAT9-1202B
R968	321-0184-00			RES.,FXD,FILM:806 OHM,1%,0.125W	75042	CEAT0-8060F
R971	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R973	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R975	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R976	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R977	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEAT0-2002F
R1002	307-0104-00			RES.,FXD,COMP:3.3 OHM,5%,0.25W	01121	CB33G5
R1003	315-0392-00			RES.,FXD,COMP:3.9K OHM,5%,0.25W	01121	CB3925
R1004	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R1006	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R1008	315-0224-00			RES.,FXD,COMP:220K OHM,5%,0.25W	01121	CB2245
R1009	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R1016	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R1017	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
R1022	315-0473-00			RES.,FXD,COMP:47K OHM,5%,0.25W	01121	CB4735
R1023	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.25W	01121	CB2235
R1032	323-0481-03			RES.,FXD,FILM:1M OHM,0.25%,0.50W	75042	CECT2-1004C
R1033	321-0643-00			RES.,FXD,FILM:22.1K OHM,0.25%,0.125W	75042	CEAT9-2212C
R1034	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R1036	308-0421-00			RES.,FXD,WW:3K OHM,5%,3W	63743	36216
R1038	321-0370-00			RES.,FXD,FILM:69.8K OHM,1%,0.125W	75042	CEAT0-6982F
R1039	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R1040	322-0481-00			RES.,FXD,FILM:1M OHM,1%,0.25W	75042	CEBT0-1004F
R1041	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R1047	315-0105-00			RES.,FXD,COMP:1M OHM,5%,0.25W	01121	CB1055
R1100	315-0122-00			RES.,FXD,COMP:1.2K OHM,5%,0.25W	01121	CB1225
R1101	315-0182-00			RES.,FXD,COMP:1.8K OHM,5%,0.25W	01121	CB1825
R1106	301-0471-00			RES.,FXD,COMP:470 OHM,5%,0.5W	01121	EB4715
R1108	321-0222-09			RES.,FXD,FILM:2K OHM,1%,0.125W	75042	CEAT9-2001F

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R1110	311-1563-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	73138	91A-10000M
R1112	321-0278-00			RES.,FXD,FILM:7.68K OHM,1%,0.125W	75042	CEATO-7681F
R1121	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R1122	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R1202	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1236	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1237	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1240	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1241	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1244	321-0288-00			RES.,FXD,FILM:9.76K OHM,1%,0.125W	75042	CEATO-9761F
R1245	321-0262-00			RES.,FXD,FILM:5.23K OHM,1%,0.125W	75042	CEATO-5231F
R1246	315-0222-00			RES.,FXD,COMP:2.2K OHM,5%,0.25W	01121	CB2225
RT187	307-0127-00			RES.,THERMAL:1K OHM,1%	50157	2D1596
S92	260-1237-00			SWITCH,REED:SPST	80009	260-1237-00
S95	260-1548-00			SWITCH,PUSH:BASELINE RESTORE	80009	260-1548-00
S120[1]						
S130	260-0931-00			SWITCH,LEVER:SPECTRAL NORMALIZER	82104	OBD
S190[1]	263-1034-00			ACTR ASSY,CAM S:VERTICAL GAIN	80009	263-1034-00
S245A,B[3]						
S325A,B[4]						
S350	263-1035-00			ACTR ASSY,CAM S:TIME/SCAN	80009	263-1035-00
S420	260-1549-00			SWITCH,ROTARY:DISPLAY DISPERSION	80009	260-1549-00
S520	260-1550-00			SWITCH,LEVER:DISPLAY TRIGGER MODE	80009	260-1550-00
S901	260-0723-00			SWITCH,SLIDE:DPDT,0.5A,125VAC	80009	260-0723-00
S964	260-0984-00			SWITCH,SLIDE:DP3POSN,0.5A,125VAC-DC	79727	G128S-PC/MOD7140
T1020	120-0896-00			XFMR,POWER:	80009	120-0896-00
U32	156-0158-00			MICROCIRCUIT LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U48	156-0067-00			MICROCIRCUIT LI:OPERATIONAL AMPLIFIER	07263	UA741
U98	156-0105-00			MICROCIRCUIT LI:OPERATIONAL AMPLIFIER	07263	U9T7101393
U102	156-0461-00			MICROCIRCUIT DI:4 QUAD ANALOG MULT	04713	MC1594L
U120	156-0158-00			MICROCIRCUIT LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U150	156-0158-00			MICROCIRCUIT LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U164	156-0158-00			MICROCIRCUIT LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U178	156-0105-00			MICROCIRCUIT LI:OPERATIONAL AMPLIFIER	07263	U9T7101393
U190	156-0060-00			MICROCIRCUIT LI:VOLTAGE FOLLOWER	12040	LM302H
U192	156-0105-00			MICROCIRCUIT LI:OPERATIONAL AMPLIFIER	07263	U9T7101393
U196	156-0158-00			MICROCIRCUIT LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U212	156-0259-00			MICROCIRCUIT LI:5 TRANSISTOR ARRAY	86684	CA3083
U346	156-0158-00			MICROCIRCUIT LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U360	156-0067-02			MICROCIRCUIT LI:OPNL AMPLIFIER,SELECTED	80009	156-0067-02
U368	156-0402-00			MICROCIRCUIT DI:TIMER,8 PIN DIP	18324	NE555V
U388	156-0158-00			MICROCIRCUIT LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U392	156-0096-00			MICROCIRCUIT LI:VOLTAGE COMPARATOR	27014	LM311H
U410	156-0067-00			MICROCIRCUIT LI:OPERATIONAL AMPLIFIER	07263	UA741
U416	156-0158-00			MICROCIRCUIT LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U440	156-0402-00			MICROCIRCUIT DI:TIMER,8 PIN DIP	18324	NE555V
U448	156-0030-00			MICROCIRCUIT DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U450	156-0178-00			MICROCIRCUIT DI:TRIPLE 3-INPUT NOR GATE	01295	SN7427N
U540	156-0043-00			MICROCIRCUIT DI:2-INPUT NOR GATE	01295	SN7402N
U560	156-0041-00			MICROCIRCUIT DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U710	155-0104-00			MICROCIRCUIT:MONOLITHIC,LEGEND GEN	80009	155-0104-00

[1]Furnished as a unit with K120.
[2]See Mechanical Parts List for replacement parts.
[3]Furnished as a unit with R245.
[4]Furnished as a unit with R325.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U712	155-0014-01			MICROCIRCUIT DI:ML,ANALOG TO DECIMAL CONV	80009	155-0014-01
U734	156-0047-00			MICROCIRCUIT DI:3-INPUT NAND GATE	01295	SN7410N
U736	155-0105-00			MICROCIRCUIT:MONOLITHIC,LEGEND GEN	27014	LM301AN
U774	155-0014-01			MICROCIRCUIT DI:ML,ANALOG TO DECIMAL CONV	80009	155-0014-01
U920	155-0090-00			MICROCIRCUIT DI:MONOLITHIC,4 DECADE COUNTER	80009	155-0090-00
U942	156-0030-00			MICROCIRCUIT DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U950	156-0158-00			MICROCIRCUIT LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U962	156-0067-02			MICROCIRCUIT LI:OPNL AMPLIFIER,SELECTED	80009	156-0067-02
U1008	156-0402-00			MICROCIRCUIT DI:TIMER,8 PIN DIP	18324	NE555V
U1022	156-0067-02			MICROCIRCUIT LI:OPNL AMPLIFIER,SELECTED	80009	156-0067-02
U1102	156-0067-02			MICROCIRCUIT LI:OPNL AMPLIFIER,SELECTED	80009	156-0067-02
VR57	152-0304-00			SEMICOND DEVICE:ZENER,0.4W,20V,5%	04713	1N968B
VR913	152-0175-00			SEMICOND DEVICE:ZENER,0.4W,5.6V,5%	04713	1N752A
VR1016	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	1N753A
VR1044	152-0295-00			SEMICOND DEVICE:ZENER,1W,82V,5%	04713	1N3042B
VR1046	152-0295-00			SEMICOND DEVICE:ZENER,1W,82V,5%	04713	1N3042B
VR1047	152-0295-00			SEMICOND DEVICE:ZENER,1W,82V,5%	04713	1N3042B
VR1100	152-0317-00			SEMICOND DEVICE:ZENER,0.25W,6.2V,5%	81483	1N3497

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				J20		
A5	670-2275-00			CKT BOARD ASSY:--INTERFACE	80009	670-2275-00
A6	670-3012-00			CKT BOARD ASSY:--HORIZONTAL AMPL	80009	670-3012-00
A7	670-3014-00			CKT BOARD ASSY:--VIDICON SOCKET	80009	670-3014-00
A8	670-3011-00			CKT BOARD ASSY:--VERTICAL OSCILLATOR	80009	670-3011-00
A9	670-2274-00			CKT BOARD ASSY:--PREAMPLIFIER	80009	670-2274-00
A10	670-3013-00			CKT BOARD ASSY:--VIDICON REGUALTOR	80009	670-3013-00
A11	670-2271-00			CKT BOARD ASSY:--NORMALIZER DRIVER	80009	670-2271-00
A12	670-2270-00			CKT BOARD ASSY:--40NM NORMALIZER PROGRAMMER	80009	670-2270-00
A13	670-2270-00			CKT BOARD ASSY:--400NM NORMALIZER PROGRAMMER	80009	670-2270-00
C1325	290-0526-00			CAP.,FXD,ELCTLT:6.8UF,20%,6V	90201	TDC685M006EL
C1328	283-0180-00			CAP.,FXD,CER DI:5600PF,20%,200V	72982	8121N204E562M
C1331	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1337	283-0180-00			CAP.,FXD,CER DI:5600PF,20%,200V	72982	8121N204E562M
C1340	281-0610-00			CAP.,FXD,CER DI:2.2PF,+/-0.1PF,500V	72982	374-001C0J0229B
C1342	281-0564-00			CAP.,FXD,CER DI:24PF,5%,500V	72982	301-000C0G0240J
C1344	281-0564-00			CAP.,FXD,CER DI:24PF,5%,500V	72982	301-000C0G0240J
C1346	281-0610-00			CAP.,FXD,CER DI:2.2PF,+/-0.1PF,500V	72982	374-001C0J0229B
C1351	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C1355	283-0187-00			CAP.,FXD,CER DI:0.047UF,10%,400V	72982	8131-400X5R473K
C1357	283-0187-00			CAP.,FXD,CER DI:0.047UF,10%,400V	72982	8131-400X5R473K
C1373	283-0008-00			CAP.,FXD,CER DI:1UF,500V	72982	8151N501E104M
C1378	283-0187-00			CAP.,FXD,CER DI:0.047UF,10%,400V	72982	8131-400X5R473K
C1383	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039E105Z
C1384	283-0060-00			CAP.,FXD,CER DI:100PF,5%,200V	72982	855-535U2J101J
C1385	281-0656-00			CAP.,FXD,CER DI:22PF,5%,500V	72982	374-000C0G0220J
C1388	283-0115-00			CAP.,FXD,CER DI:47PF,5%,200V	72982	805-509C0G470J
C1390	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C1396	283-0268-00			CAP.,FXD,CER DI:0.015UF,10%,50V	72982	8131N075W5R153K
C1401	290-0135-00			CAP.,FXD,ELCTLT:15UF,20%,20V	56289	150D156X0020B2
C1403	283-0008-00			CAP.,FXD,CER DI:1UF,500V	72982	8151N501E104M
C1404	283-0008-00			CAP.,FXD,CER DI:1UF,500V	72982	8151N501E104M
C1406	283-0008-00			CAP.,FXD,CER DI:1UF,500V	72982	8151N501E104M
C1407	290-0397-00			CAP.,FXD,ELCTLT:1UF,+50-10%,450V	56289	34D105F450EE4
C1408	283-0008-00			CAP.,FXD,CER DI:1UF,500V	72982	8151N501E104M
C1416	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C1430	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C1432	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1447	281-0721-00			CAP.,FXD,CER DI:72PF,5%,500V	72982	301-000P3K720J
C1461	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131-050651104M
C1466	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131-050651104M
C1468	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039E105Z
C1471	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131-050651104M
C1476	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131-050651104M
C1478	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039E105Z
C1486	283-0203-00			CAP.,FXD,CER DI0.47UF,20%,50V0V	72982	8131-050651474M
C1488	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	72982	301-000C0G0100F
C1495	283-0010-00			CAP.,FXD,CER DI:0.05UF,+100-20%,50V	56289	273C20
C1498	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1587	283-0178-00			CAP.,FXD,CER DI:0.1UF,+80-20%,100V	72982	8131-100651104Z

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C1627	283-0178-00			CAP.,FXD,CER DI:0.1UF,+80-20%,100V	72982	8131-100651104Z
C1650	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1651	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1653	290-0572-00			CAP.,FXD,ELCTLT:0.1UF,20%,50V	56289	196D104X0050HA1
C1654	290-0572-00			CAP.,FXD,ELCTLT:0.1UF,20%,50V	56289	196D104X0050HA1
C1656	290-0572-00			CAP.,FXD,ELCTLT:0.1UF,20%,50V	56289	196D104X0050HA1
C1657	290-0572-00			CAP.,FXD,ELCTLT:0.1UF,20%,50V	56289	196D104X0050HA1
C1659	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1661	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1662	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0025HA1
C1664	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1666	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1667	290-0530-00			CAP.,FXD,ELCTLT:68UF,20%,6V	90201	TDC686M006FL
C1668	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1670	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1671	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C1673	290-0266-00			CAP.,FXD,ELCTLT:290UF,15V	56289	600D297G015DG4
C1674	290-0266-00			CAP.,FXD,ELCTLT:290UF,15V	56289	600D297G015DG4
CR1306	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1374	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1384	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1390	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1461	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1466	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1471	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1476	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1484	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1532	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1534	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1538	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1544	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1672	152-0066-01			SEMICOND DEVICE:SILICON,400V,750MA	14099	SC4
CR1673	152-0066-01			SEMICOND DEVICE:SILICON,400V,750MA	14099	SC4
L1629	108-0775-00			COIL,RF:FOCUS	80009	108-0775-00
L1630	108-0776-00			COIL,RF:ALIGNMENT	80009	108-0776-00
L1661	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
L1662	108-0245-00			COIL,RF:3.9UH	80009	108-0245-00
M1401	149-0030-00			METER,T TOTAL:CIRCUIT BOARD MOUNT,DC	18583	120-LC
P1405	131-1468-00			CONTACT,ELEC:VIDICON	80009	131-1468-00
P1410	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
P1450	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
Q1302	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q1312	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q1334	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q1342	151-0347-00			TRANSISTOR:SILICON,NPN	04713	2N5551
Q1344	151-0347-00			TRANSISTOR:SILICON,NPN	04713	2N5551
Q1350	151-0347-00			TRANSISTOR:SILICON,NPN	04713	2N5551
Q1352	151-0347-00			TRANSISTOR:SILICON,NPN	04713	2N5551
Q1358	151-0347-00			TRANSISTOR:SILICON,NPN	04713	2N5551
Q1360	151-0347-00			TRANSISTOR:SILICON,NPN	04713	2N5551
Q1374	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q1378	151-0347-00			TRANSISTOR:SILICON,NPN	04713	2N5551
Q1382	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q1386	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q1388	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q1420A,B	151-1071-00			TRANSISTOR:SILICON,JFE,N CHANNEL,DUAL	17856	DN1120
Q1424	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q1426	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q1436	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q1438	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q1440	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q1446	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q1448	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q1462	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q1466	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q1472	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q1476	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q1482	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q1484	151-1059-00			TRANSISTOR:SILICON,JFE,N CHANNEL	15818	U1897E
Q1488	151-1059-00			TRANSISTOR:SILICON,JFE,N CHANNEL	15818	U1897E
Q1490	151-0350-00			TRANSISTOR:SILICON,PNP	04713	SPS6700
Q1498	151-0254-00			TRANSISTOR:SILICON,NPN	03508	2N5308
Q1532	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q1534	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q1538	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
Q1544	151-0410-00			TRANSISTOR:SILICON,PNP	04713	SPS6765
R716	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R718	315-0511-00			RES.,FXD,COMP:510 OHM,5%,0.25W	01121	CB5115
R720	315-0511-00			RES.,FXD,COMP:510 OHM,5%,0.25W	01121	CB5115
R722	315-0511-00			RES.,FXD,COMP:510 OHM,5%,0.25W	01121	CB5115
R724	315-0511-00			RES.,FXD,COMP:510 OHM,5%,0.25W	01121	CB5115
R740	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	75042	CEAT0-1212F
R742	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEAT0-1002F
R758	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEAT0-1002F
R1302	321-0603-07			RES.,FXD,FILM:15K OHM,0.1%,0.125W	75042	CEAT9-1502B
R1306	315-0272-00			RES.,FXD,COMP:2.7K OHM,5%,0.25W	01121	CB2725
R1308	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEAT0-1001F
R1310	311-1239-00			RES.,VAR,NONWIR:2.5KOHM,10%,0.50W	73138	72Y-26-0-252K
R1312	321-0603-07			RES.,FXD,FILM:15K OHM,0.1%,0.125W	75042	CEAT9-1502B
R1315	311-1198-00			RES.,VAR,NONWIR:20K OHM,20%,0.50W	80294	3389H
R1317	321-0346-00			RES.,FXD,FILM:39.2K OHM,1%,0.125W	75042	CEAT0-3922F
R1319	321-0648-04			RES.,FXD,FILM:500K OHM,0.1%,0.125W	91637	MFF1816D500028
R1321	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R1322	315-0392-00			RES.,FXD,COMP:3.9K OHM,5%,0.25W	01121	CB3925
R1324	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEAT0-4992F
R1325	311-1198-00			RES.,VAR,NONWIR:20K OHM,20%,0.50W	80294	3389H
R1327	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEAT0-4992F
R1328	315-0391-00			RES.,FXD,COMP:390 OHM,5%,0.25W	01121	CB3915
R1329	315-0752-00			RES.,FXD,COMP:7.5K OHM,5%,0.25W	01121	CB7525
R1331	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R1333	315-0123-00			RES.,FXD,COMP:12K OHM,5%,0.25W	01121	CB1235
R1335	315-0183-00			RES.,FXD,COMP:18K OHM,5%,0.25W	01121	CB1835
R1337	315-0391-00			RES.,FXD,COMP:390 OHM,5%,0.25W	01121	CB3915
R1338	315-0752-00			RES.,FXD,COMP:7.5K OHM,5%,0.25W	01121	CB7525

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R1340	321-0648-04			RES.,FXD,FILM:500K OHM,0.1%,0.125W	91637	MFF1816D500028
R1342	315-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R1344	315-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R1346	321-0648-04			RES.,FXD,FILM:500K OHM,0.1%,0.125W	91637	MFF1816D500028
R1350	315-0334-00			RES.,FXD,COMP:330K OHM,5%,0.25W	01121	CB3345
R1351	315-0153-00			RES.,FXD,COMP:15K OHM,5%,0.25W	01121	CB1535
R1352	315-0334-00			RES.,FXD,COMP:330K OHM,5%,0.25W	01121	CB3345
R1355	315-0364-00			RES.,FXD,COMP:360K OHM,5%,0.25W	01121	CB3645
R1357	315-0364-00			RES.,FXD,COMP:360K OHM,5%,0.25W	01121	CB3645
R1359	315-0334-00			RES.,FXD,COMP:330K OHM,5%,0.25W	01121	CB3345
R1370	321-0481-01			RES.,FXD,FILM:1M OHM,0.5%,0.125W	75042	CEAT0-1004D
R1371	321-0481-01			RES.,FXD,FILM:1M OHM,0.5%,0.125W	75042	CEAT0-1004D
R1373	322-0524-01			RES.,FXD,FILM:2.8M OHM,0.5%,0.25W	91637	MFF1412G28003D
R1376	315-0185-00			RES.,FXD,COMP:1.8M OHM,5%,0.25W	01121	CB1855
R1377	315-0333-00			RES.,FXD,COMP:33K OHM,5%,0.25W	01121	CB3335
R1378	321-0481-01			RES.,FXD,FILM:1M OHM,0.5%,0.125W	75042	CEAT0-1004D
R1379	321-0364-00			RES.,FXD,FILM:60.4K OHM,1%,0.125W	75042	CEAT0-6042F
R1381	315-0203-00			RES.,FXD,COMP:20K OHM,5%,0.25W	01121	CB2035
R1382	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R1383	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R1385	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R1387	315-0331-00			RES.,FXD,COMP:330 OHM,5%,0.25W	01121	CB3315
R1388	315-0272-00			RES.,FXD,COMP:2.7K OHM,5%,0.25W	01121	CB2725
R1389	315-0752-00			RES.,FXD,COMP:7.5K OHM,5%,0.25W	01121	CB7525
R1390	311-1198-00			RES.,VAR,NONWIR:20K OHM,20%,0.50W	80294	3389H
R1392	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R1393	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEAT0-4992F
R1394	321-0376-00			RES.,FXD,FILM:80.6K OHM,1%,0.125W	75042	CEAT0-8062F
R1396	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R1401	315-0475-00			RES.,FXD,COMP:4.7M OHM,5%,0.25W	01121	CB4755
R1404	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R1408	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R1415	315-0105-00			RES.,FXD,COMP:1M OHM,5%,0.25W	01121	CB1055
R1420	321-0135-00			RES.,FXD,FILM:249 OHM,1%,0.125W	75042	CEAT0-2490F
R1421	323-0204-00			RES.,FXD,FILM:1.3K OHM,1%,0.50W	75042	CECT0-1301F
R1422	321-0135-00			RES.,FXD,FILM:249 OHM,1%,0.125W	75042	CEAT0-2490F
R1424	315-0512-00			RES.,FXD,COMP:5.1K OHM,5%,0.25W	01121	CB5125
R1426	315-0512-00			RES.,FXD,COMP:5.1K OHM,5%,0.25W	01121	CB5125
R1430	321-0248-00			RES.,FXD,FILM:3.74K OHM,1%,0.125W	75042	CEAT0-3741F
R1431	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.125W	01121	CB2235
R1432	315-0562-00			RES.,FXD,COMP:5.6K OHM,5%,0.25W	01121	CB5625
R1437	315-0331-00			RES.,FXD,COMP:330 OHM,5%,0.25W	01121	CB3315
R1438	315-0331-00			RES.,FXD,COMP:330 OHM,5%,0.25W	01121	CB3315
R1439	315-0362-00			RES.,FXD,COMP:3.6K OHM,5%,0.25W	01121	CB3625
R1440	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R1443	323-0512-01			RES.,FXD,FILM:2.1M OHM,0.5%,0.50W		
R1444	315-0163-00			RES.,FXD,COMP:16K OHM,5%,0.25W	01121	CB1635
R1446	315-0752-00			RES.,FXD,COMP:7.5K OHM,5%,0.25W	01121	CB7525
R1447	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R1448	315-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R1461	315-0432-00			RES.,FXD,COMP:4.3K OHM,5%,0.25W	01121	CB4325
R1462	321-0129-00			RES.,FXD,FILM:215 OHM,1%,0.125W	75042	CEAT0-2150F
R1463	315-0223-00			RES.,FXD,COMP: 22K OHM,5%,0.125W	01121	CB2235

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R1465	311-1241-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	80294	3386H-M33-104
R1466	315-0432-00			RES.,FXD,COMP:4.3K OHM,5%,0.25W	01121	CB4325
R1467	321-0129-00			RES.,FXD,FILM:215 OHM,1%,0.125W	75042	CEAT0-2150F
R1468	315-0151-00			RES.,FXD,COMP:150 OHM,5%,0.25W	01121	CB1515
R1471	315-0432-00			RES.,FXD,COMP:4.3K OHM,5%,0.25W	01121	CB4325
R1472	321-0129-00			RES.,FXD,FILM:215 OHM,1%,0.125W	75042	CEAT0-2150F
R1473	315-0223-00			RES.,FXD,COMP:22K OHM,5%,0.125W	01121	CB2235
R1475	311-1241-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	80294	3386H-M33-104
R1476	315-0432-00			RES.,FXD,COMP:4.3K OHM,5%,0.25W	01121	CB4325
R1477	321-0129-00			RES.,FXD,FILM:215 OHM,1%,0.125W	75042	CEAT0-2150F
R1478	315-0151-00			RES.,FXD,COMP:150 OHM,5%,0.25W	01121	CB1515
R1480	315-0683-00			RES.,FXD,COMP:68K OHM,5%,0.25W	01121	CB6835
R1481	311-1237-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	80294	3386H-T07-102
R1482	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R1483	315-0272-00			RES.,FXD,COMP:2.7K OHM,5%,0.25W	01121	CB2725
R1484	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R1485	321-0097-07			RES.,FXD,FILM:100 OHM,0.1%,0.125W	75042	CEAT9-1000B
R1486	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R1487	315-0203-00			RES.,FXD,COMP:20K OHM,5%,0.25W	01121	CB2035
R1488	315-0104-00			RES.,FXD,COMP:100K OHM,5%,0.25W	01121	CB1045
R1489	315-0822-00			RES.,FXD,COMP:8.2K OHM,5%,0.25W	01121	CB8225
R1491	315-0272-00			RES.,FXD,COMP:2.7K OHM,5%,0.25W	01121	CB2725
R1492	315-0392-00			RES.,FXD,COMP:3.9K OHM,5%,0.25W	01121	CB3925
R1495	311-1339-00			RES.,VAR,NONWIR:5K OHM,10%,0.50W	01121	43P502
R1496	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R1497	321-0097-07			RES.,FXD,FILM:100 OHM,0.1%,0.125W	75042	CEAT9-1000B
R1505	311-1246-00			RES.,VAR,NONWIR:50K OHM,10%,0.50W	80294	3386H-M33-503
R1506	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R1507	315-0471-00			RES.,FXD,COMP:470 OHM,5%,0.25W	01121	CB4715
R1521	321-0264-00			RES.,FXD,FILM:5.49K OHM,1%,0.125W	75042	CEAT0-5491F
R1523	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R1524	321-1296-07			RES.,FXD,FILM:12K OHM,1%,0.125W	75042	CEAT9-1202B
R1526	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEAT0-1002F
R1527	321-0268-00			RES.,FXD,FILM:6.04K OHM,1%,0.125W	75042	CEAT0-6041F
R1528	321-0268-00			RES.,FXD,FILM:6.04K OHM,1%,0.125W	75042	CEAT0-6041F
R1529	321-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.125W	75042	CEAT0-2212F
R1531	315-0224-00			RES.,FXD,COMP:220K OHM,5%,0.25W	01121	CB2245
R1532	321-0389-00			RES.,FXD,FILM:110K OHM,1%,0.125W	75042	CEAT0-1103F
R1533	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEAT0-1002F
R1535	311-1239-00			RES.,VAR,NONWIR:2.5K OHM,10%,0.50W	73138	72Y-26-0-252K
R1536	315-0302-00			RES.,FXD,COMP:3K OHM,5%,0.25W	01121	CB3025
R1540	311-1239-00			RES.,VAR,NONWIR:2.5K OHM,10%,0.50W	73138	72Y-26-0-252K
R1542	315-0302-00			RES.,FXD,COMP:3K OHM,5%,0.25W	01121	CB3025
R1550	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1552	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1554	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1556	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1558	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1560	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1562	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1564	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1566	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1568	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R1570	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1572	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1574	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1576	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1578	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1580	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1582	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1584	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1586	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1587	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R1588	311-1267-00			RES.,VAR,NONWIR:5K OHM,10%,0.50W	73138	62PT-3500-502K
R1590	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1592	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1594	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1596	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1598	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1600	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1602	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1604	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1606	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1608	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1610	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1612	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1614	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1616	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1618	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1620	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1622	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1624	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1626	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1627	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R1628	311-1267-00			RES.,VAR,NONWIR:5K OHM,10%,0.50W	73138	62PT-3500-502K
R1630	311-0342-00			RES.,VAR,WW:50K OHM,3%	80294	35005-110-503
R1632	321-0289-07			RES.,FXD,FILM:10K OHM,0.1%,0.125W	75042	CEAT9-1002B
R1633	321-0816-07			RES.,FXD,FILM:5K OHM,0.1%,0.125W	75042	CEAT9-5001B
R1634	321-0816-07			RES.,FXD,FILM:5K OHM,0.1%,0.125W	75042	CEAT9-5001B
R1635	321-0816-07			RES.,FXD,FILM:5K OHM,0.1%,0.125W	75042	CEAT9-5001B
R1636	321-0816-07			RES.,FXD,FILM:5K OHM,0.1%,0.125W	75042	CEAT9-5001B
R1637	321-0289-07			RES.,FXD,FILM:10K OHM,0.1%,0.125W	75042	CEAT9-1002B
R1650	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1651	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1659	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1664	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1666	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1668	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1670	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1671	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R1672	301-0331-00			RES.,FXD,COMP:330 OHM,5%,0.50W	01121	EB3315
S715A,B	260-1540-00			SWITCH,ROTARY:SLIT WIDTH	80009	260-1540-00
S742	260-1541-00			SWITCH,ROTARY:FILTER	80009	260-1541-00
S1632	260-1543-00			SWITCH,ROTARY:WAVELENGTH INTERVAL	80009	260-1543-00
S1640	260-1542-00			SWITCH,ROTARY:WAVELENGTH SPAN	80009	260-1542-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
T1380	120-0897-00			XFMR:POWER	80009	120-0897-00
U1328	156-0095-00			MICROCIRCUIT LI::DUAL 20MHZ DIFF AMPL	86684	CA3051
U1394	156-0067-00			MICROCIRCUIT LI:OPERATIONAL AMPLIFIER	07263	UA741
U1488	156-0105-00			MICROCIRCUIT LI:OPERATIONAL AMPLIFIER	07263	U9T7101393
U1496	156-0067-00			MICROCIRCUIT LI:OPERATIONAL AMPLIFIER	07263	UA741
U1522	156-0067-02			MICROCIRCUIT LI:OPNL AMPLIFIER,SELECTED	80009	156-0067-02
U1524	156-0158-00			MICROCIRCUIT LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U1534	156-0158-00			MICROCIRCUIT LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U1542	156-0158-00			MICROCIRCUIT LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U1550	155-0106-00			MICROCIRCUIT:MONOLITHIC,NORM CKT	80009	155-0106-00
U1590	155-0106-00			MICROCIRCUIT:MONOLITHIC,NORM CKT	80009	155-0106-00
V1405	154-0707-01			ELECTRON TUBE:CRT	80009	154-0707-01
VR1306	152-0411-00			SEMICOND DEVICE:ZENER,0.25W,9V,5%	04713	1N937
VR1341	152-0427-00			SEMICOND DEVICE:ZENER,0.4W,100V,5%	04713	1N985B
VR1345	152-0427-00			SEMICOND DEVICE:ZENER,0.4W,100V,5%	04713	1N985B
VR1490	152-0317-00			SEMICOND DEVICE:ZENER,0.25W,6.2V,5%	81483	1N3497

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).
Resistors = Ohms (Ω).

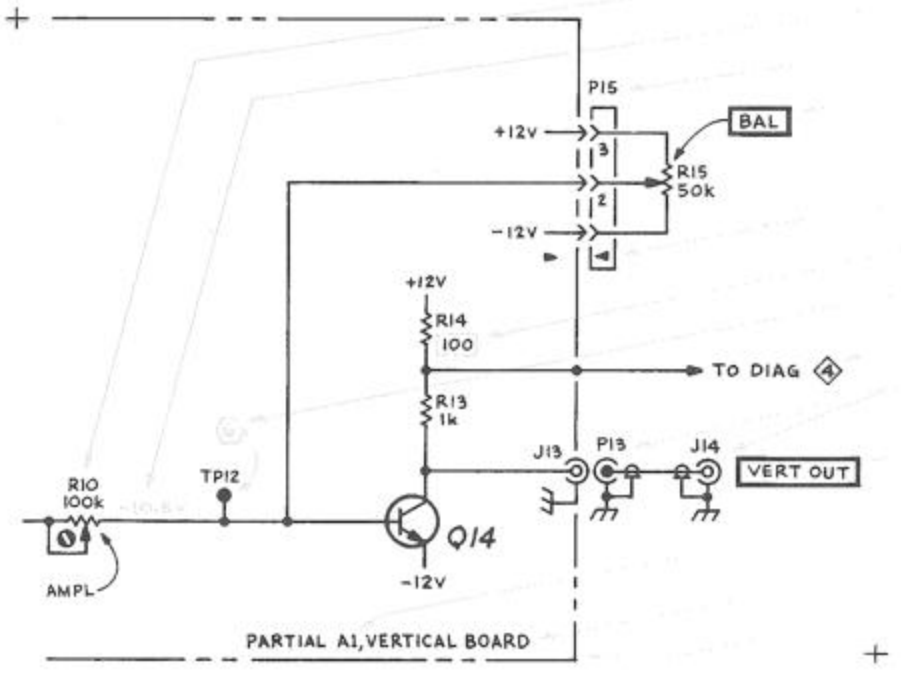
Symbols used on the diagrams are based on ANSI Standard Y32.2-1970.

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 following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)	H	Heat dissipating device (heat sink, heat radiator, etc.)	RT	Thermistor
AT	Attenuator, fixed or variable	HR	Heater	S	Switch
B	Motor	HY	Hybrid circuit	T	Transformer
BT	Battery	J	Connector, stationary portion	TC	Thermocouple
C	Capacitor, fixed or variable	K	Relay	TP	Test point
CB	Circuit breaker	L	Inductor, fixed or variable	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	V	Electron tube
DL	Delay line	M	Meter	VR	Voltage regulator (zener diode, etc.)
DS	Indicating device (lamp)	P	Connector, movable portion	Y	Crystal
E	Spark Gap	Q	Transistor or silicon-controlled rectifier	Z	Phase shifter
F	Fuse				
FL	Filter	R	Resistor, fixed or variable		

The following special symbols are used on the diagrams:



VERTICAL AMPLIFIER 2 GAB 673

Internal Screwdriver Adjustment

Test Voltage

Plug to E.C. Board

Panel Adjustment

Plug Index

Modified Component—See Parts List

Refer to Waveform

Refer to Diagram Number

Coaxial Connector

Panel Connector

Assembly Number

Board Name

Etched Circuit Board Outlined in Blue

Schematic Name and Number

Voltage Test Conditions

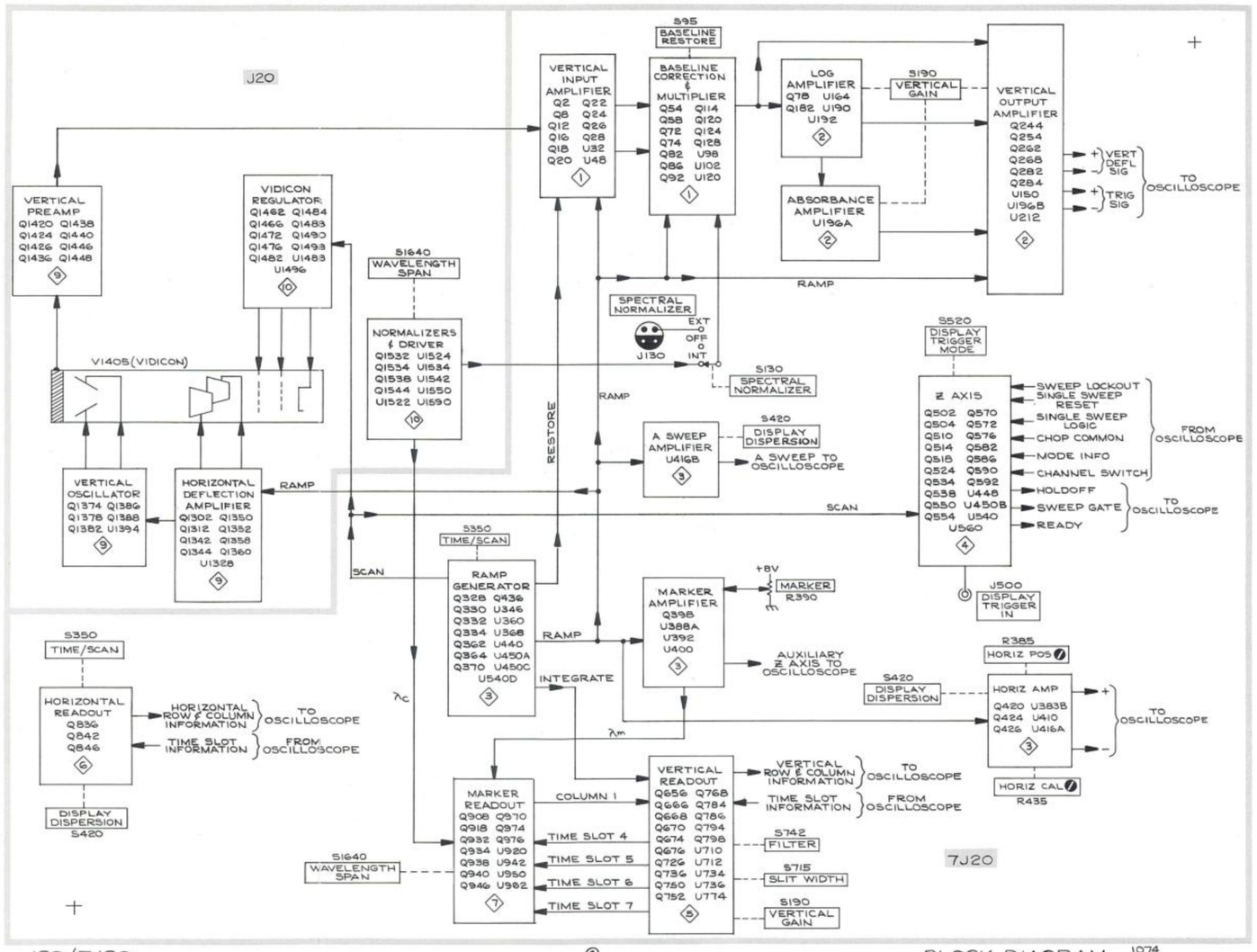
Typical voltage measurements were obtained under the following conditions using a 7D13 digital Multimeter operated in a Tektronix 7000-series oscilloscope. The voltages given on the diagrams are not absolute and can vary between instruments because of component tolerances and differing calibration settings.

J20 Spectrometer

WAVELENGTH SPAN	A 400 nm
SLIT WIDTH	10 μm
FILTER	OPEN
GRATING A WAVELENGTH INTERVAL	300-700 nm
GRATING B WAVELENGTH	500 nm indicated on tape

7J20 Spectrometer Plug-In

VERTICAL GAIN	1
VARIABLE VERTICAL GAIN	Calibrated (button in)
ABSORBANCE ZERO	Fully counterclockwise
OFFSET	Locked at 0.00
SPECTRAL NORMALIZER	OFF
MARKER	Fully counterclockwise
DISPLAY DISPERSION	40 (4) nm/div
TIME/SCAN	20 ms
VARIABLE TIME/SCAN	Calibrated (button in)
DISPLAY TRIGGER MODE	FREE RUN
VERT POSITION	Trace centered in display



J20/7J20 @ BLOCK DIAGRAM 1074 GR5

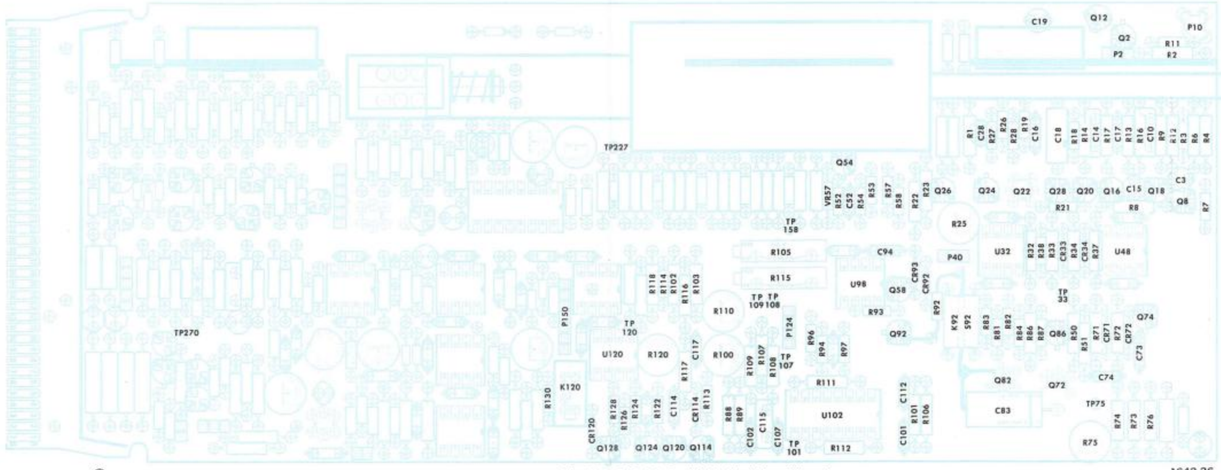
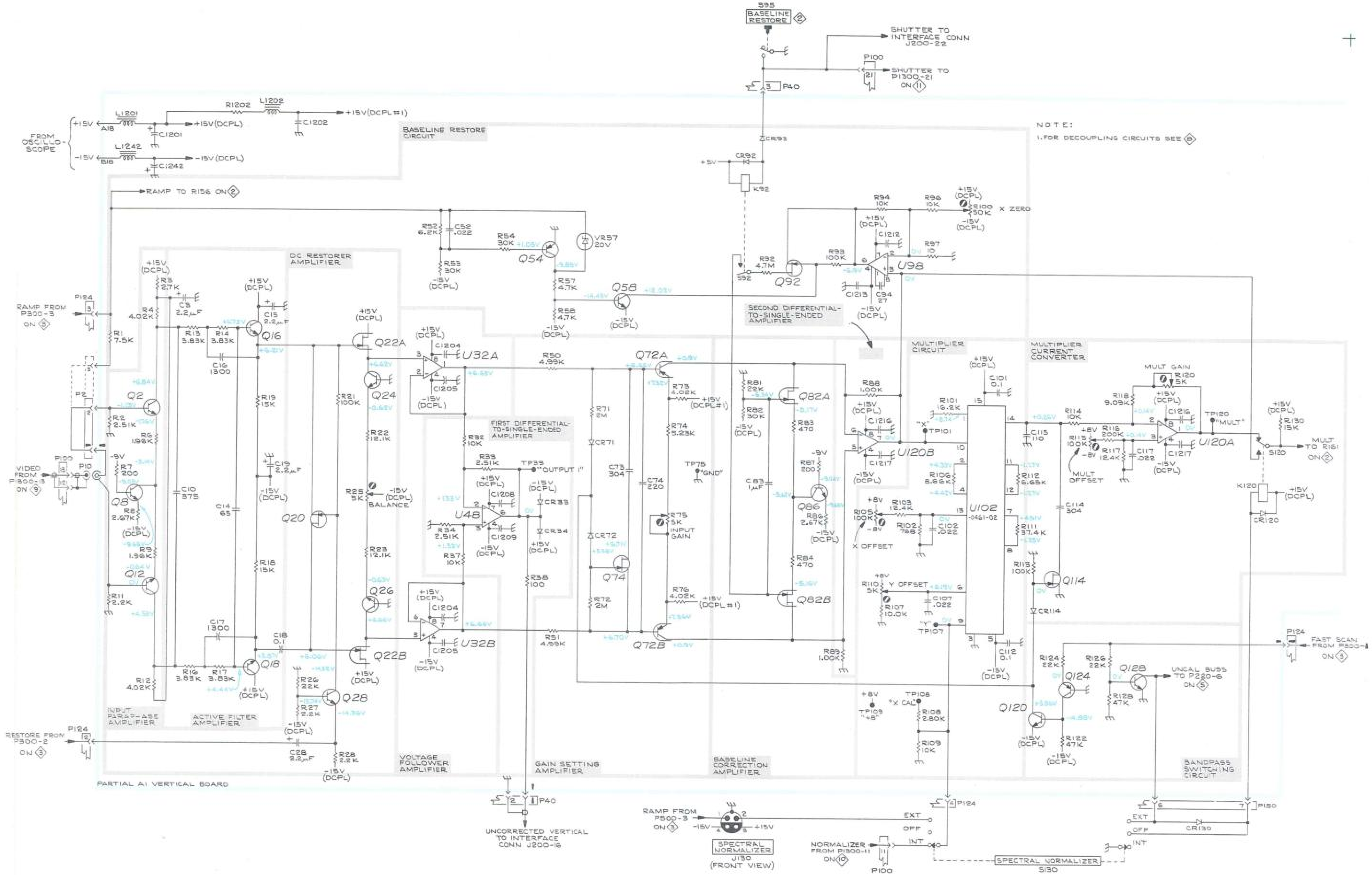


Fig. 7-1. P/O A1. Partial Vertical circuit board.

1642-26



7J20

@

VERTICAL AMPLIFIER ① 1074

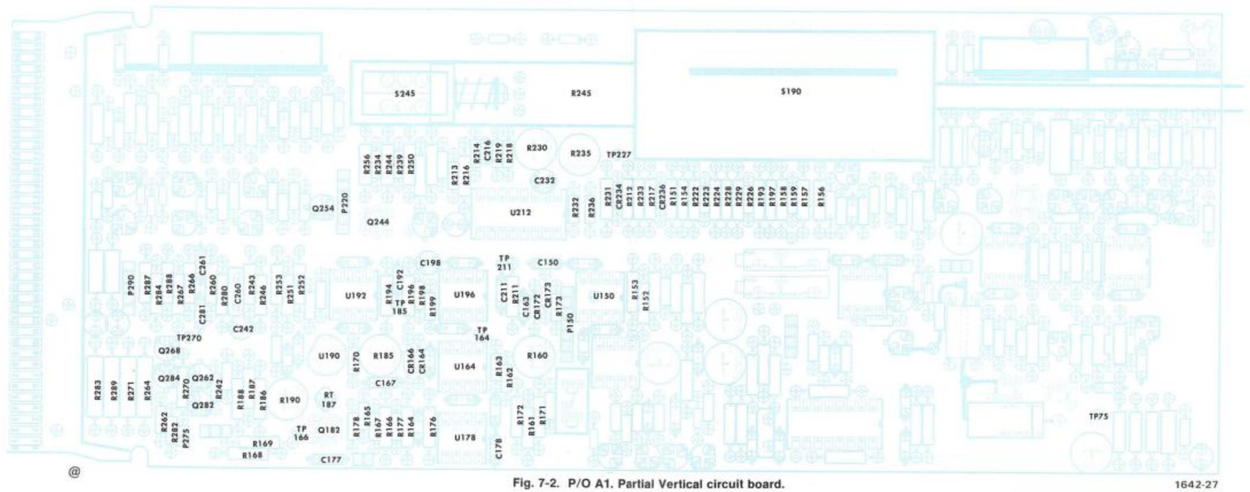
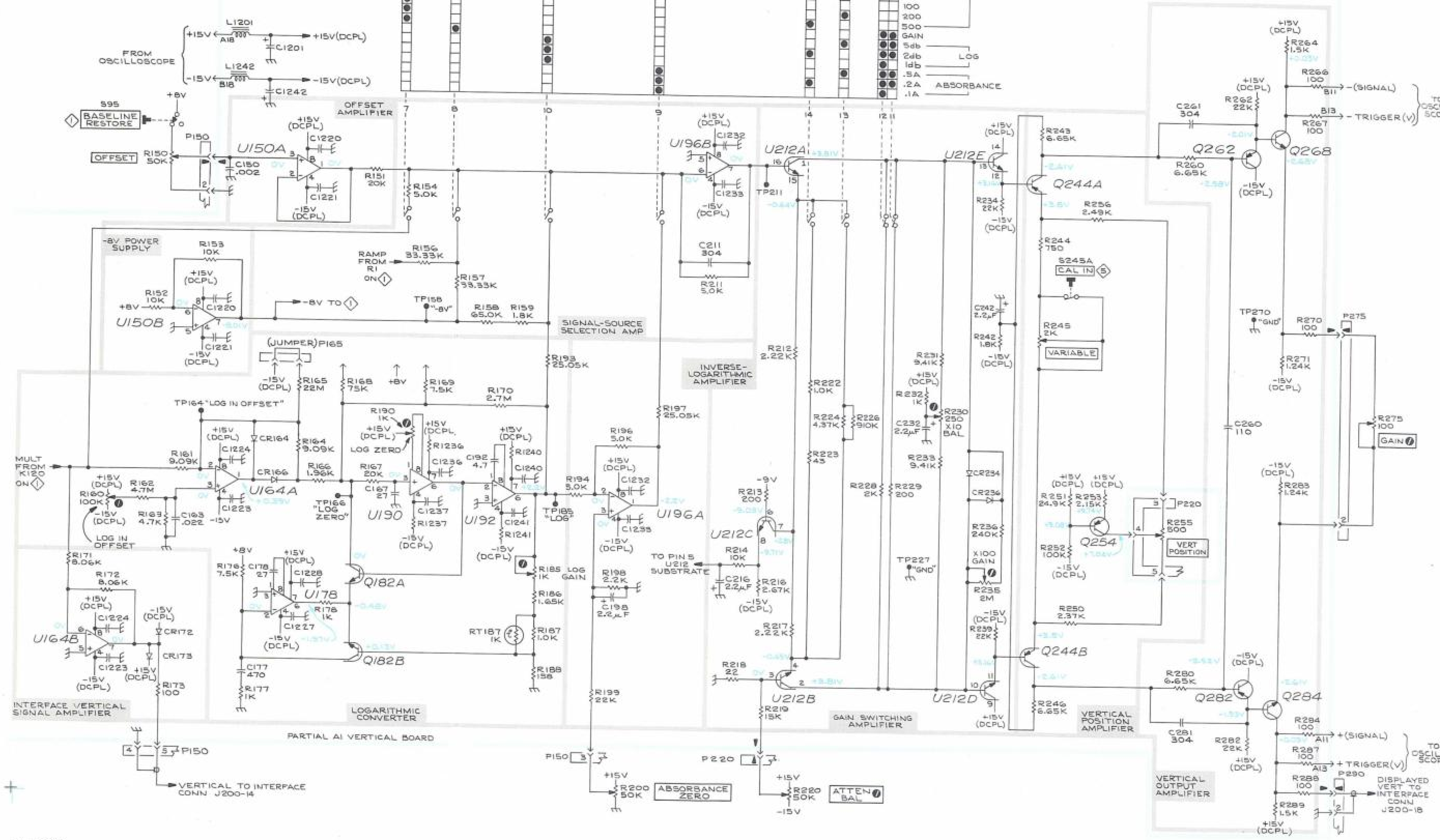


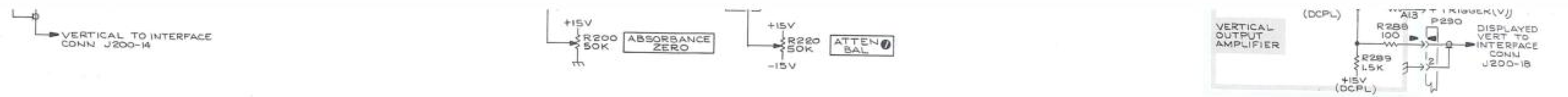
Fig. 7-2. P/O A1. Partial Vertical circuit board.

1642-27



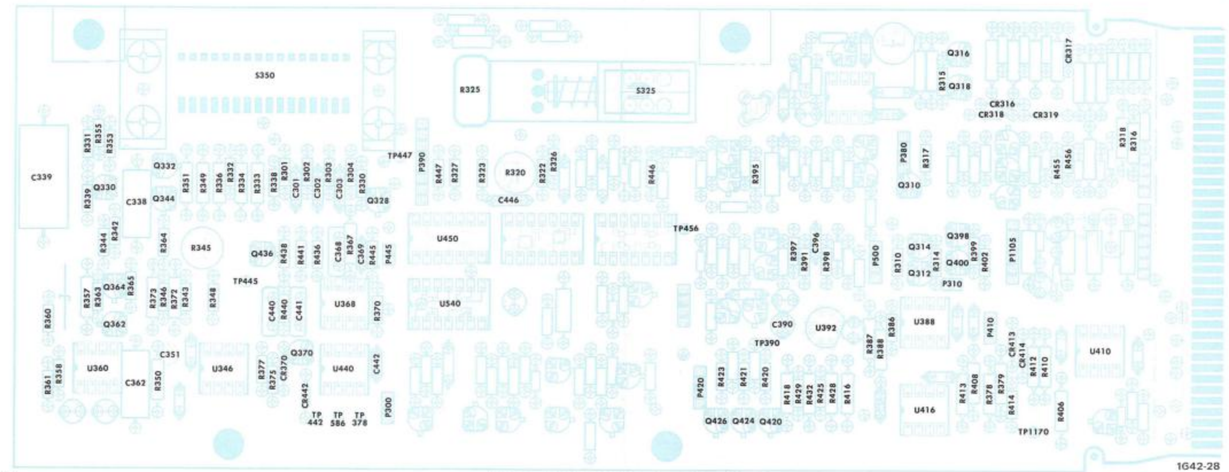
7J20

VERTICAL OUTPUT AMPLIFIER ② 1074 GRS



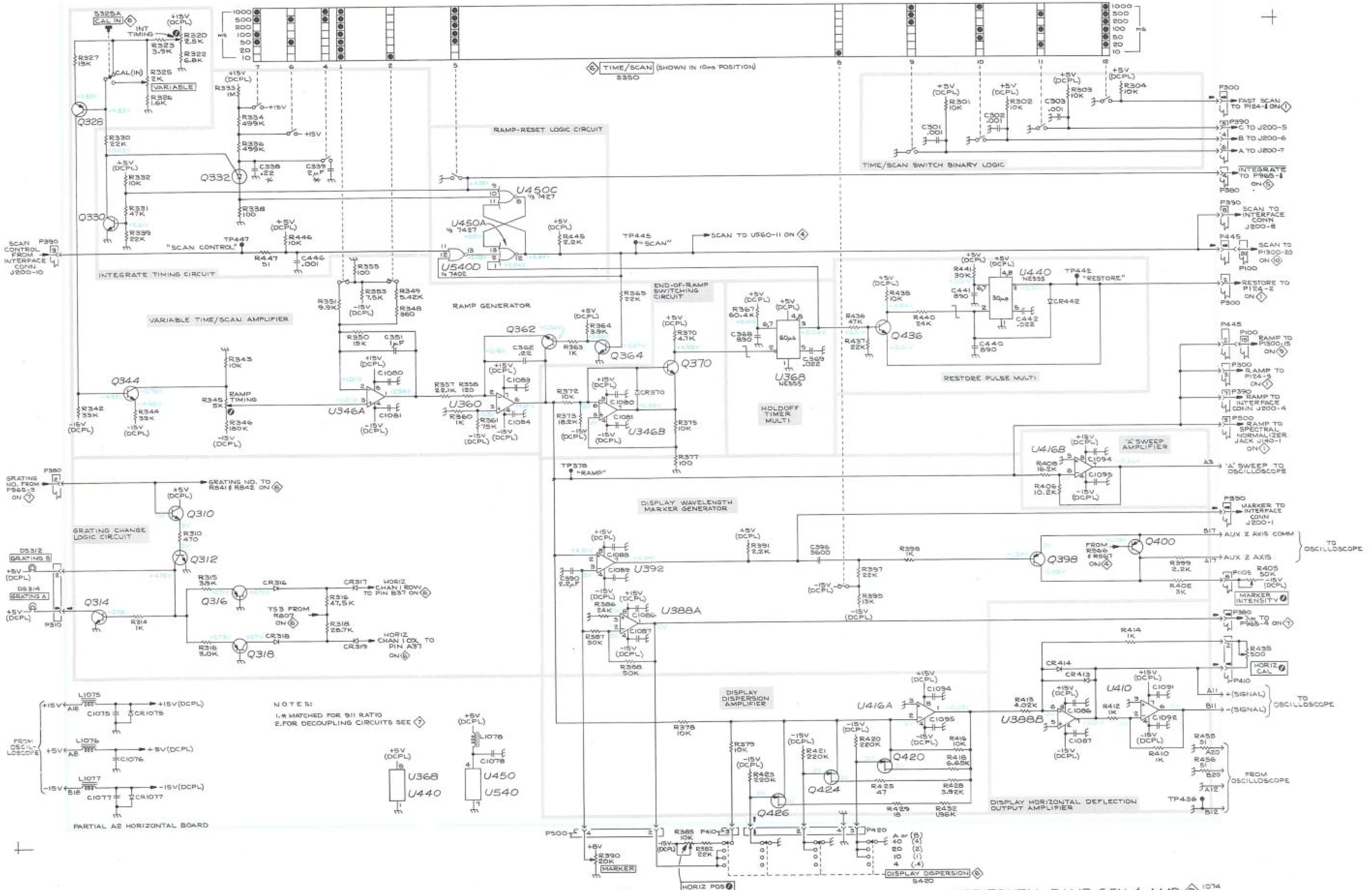
7J20

VERTICAL OUTPUT AMPLIFIER ② 1074 GRS



1642-28

Fig. 7-3. P/O A2. Partial Horizontal circuit board.



7J20

HORIZONTAL RAMP GEN & AMP ③

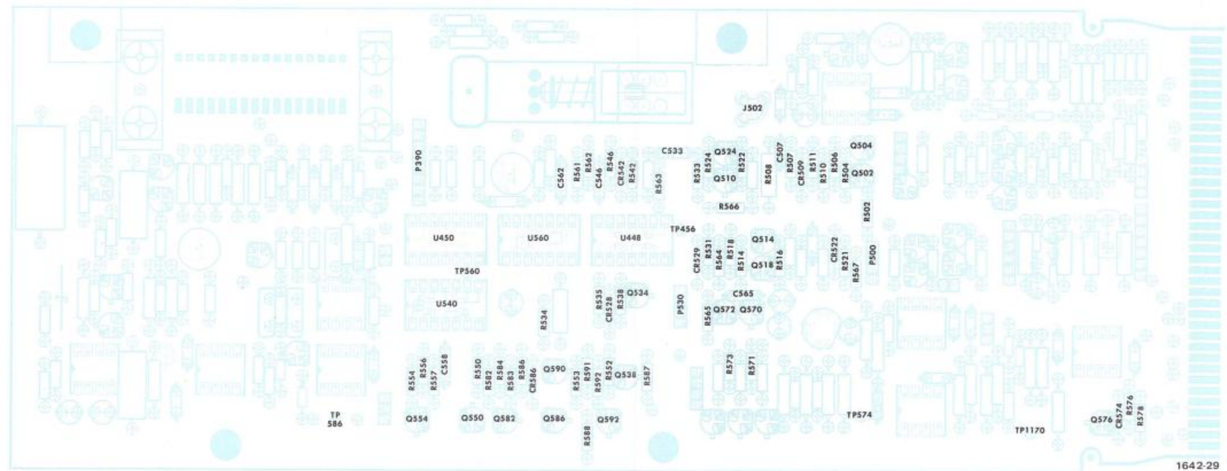
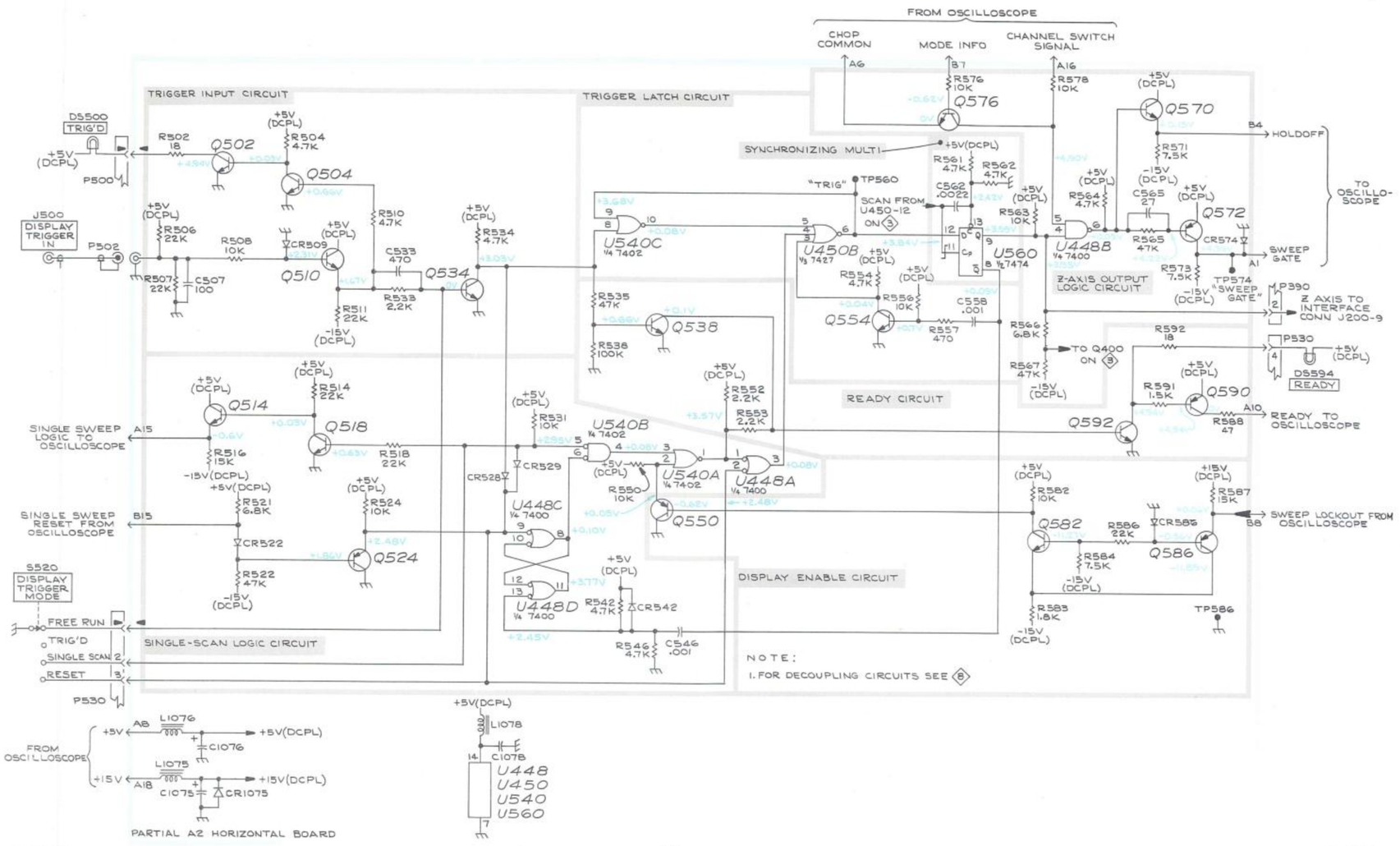


Fig. 7-4. P/O A2. Partial Horizontal circuit board.


FROM OSCILLOSCOPE
CHOP COMMON
MODE INFO
CHANNEL SWITCH SIGNAL
TRIGGER INPUT CIRCUIT
TRIGGER LATCH CIRCUIT
SYNCHRONIZING MULTI
READY CIRCUIT
DISPLAY ENABLE CIRCUIT
SINGLE-SCAN LOGIC CIRCUIT
Z-AXIS OUTPUT LOGIC CIRCUIT
D5500 TRIG'D
J500 DISPLAY TRIGGER IN
P500
P502
S520 DISPLAY TRIGGER MODE
FREE RUN
TRIG'D
SINGLE SCAN
RESET
P530
SINGLE SWEEP LOGIC TO OSCILLOSCOPE
SINGLE SWEEP RESET FROM OSCILLOSCOPE
"TRIG"
SCAN FROM U450-12 ON 3
TO Q400 ON 3
HOLDOFF
TO OSCILLO-SCOPE
SWEEP GATE
TP574 "SWEEP GATE"
Z AXIS TO INTERFACE CONN J200-9
D5594 READY
READY TO OSCILLOSCOPE
SWEEP LOCKOUT FROM OSCILLOSCOPE
TP586
NOTE:
1. FOR DECOUPLING CIRCUITS SEE 8
FROM OSCILLOSCOPE
PARTIAL A2 HORIZONTAL BOARD
U448
U450
U540
U560

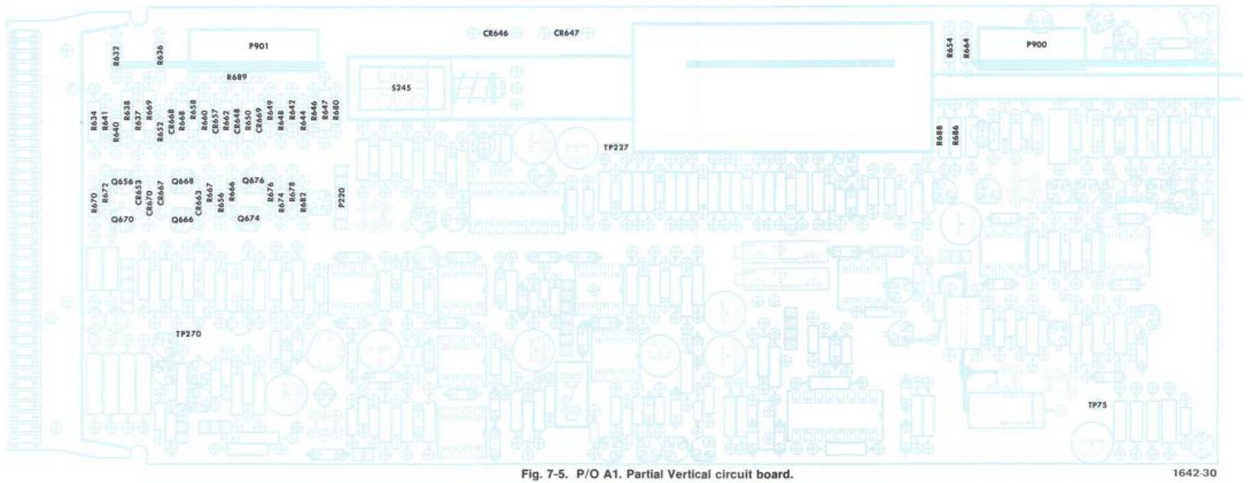


Fig. 7-5. P/O A1. Partial Vertical circuit board.

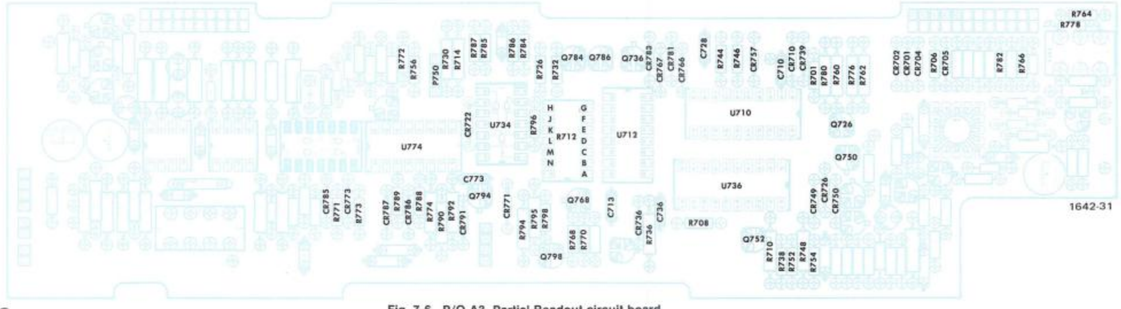
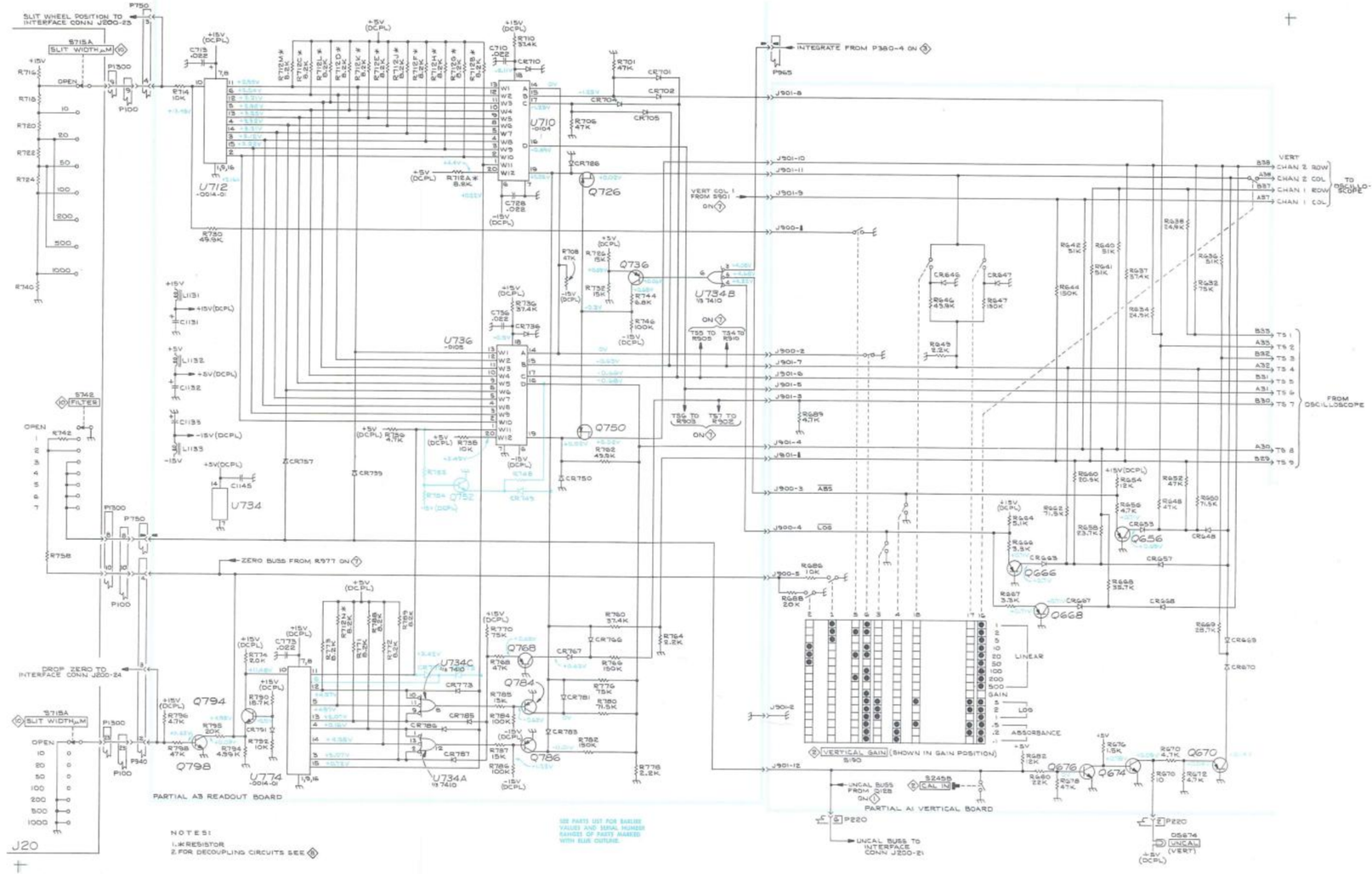


Fig. 7-6. P/O A3. Partial Readout circuit board.

@



7J20

VERTICAL READOUT 1074 SR5

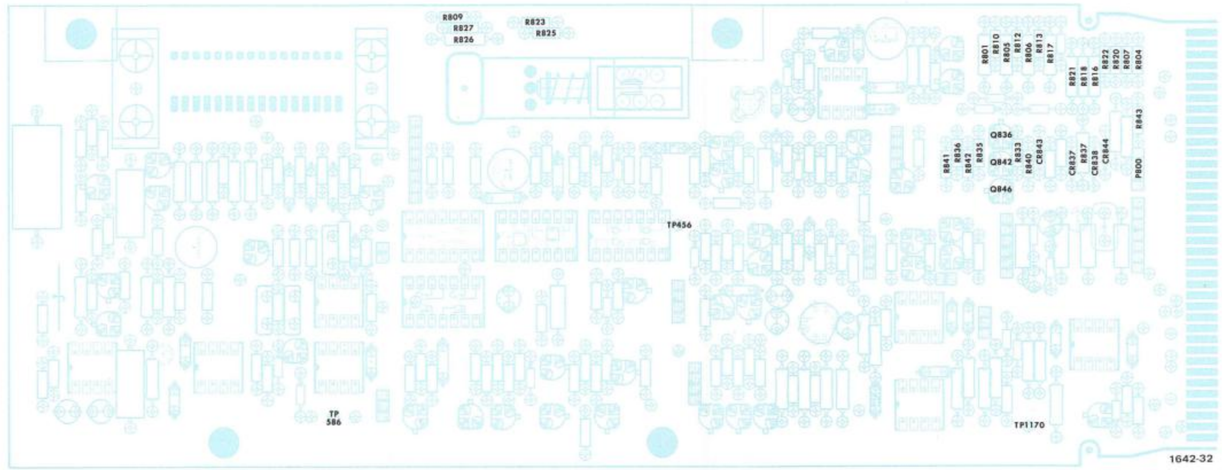
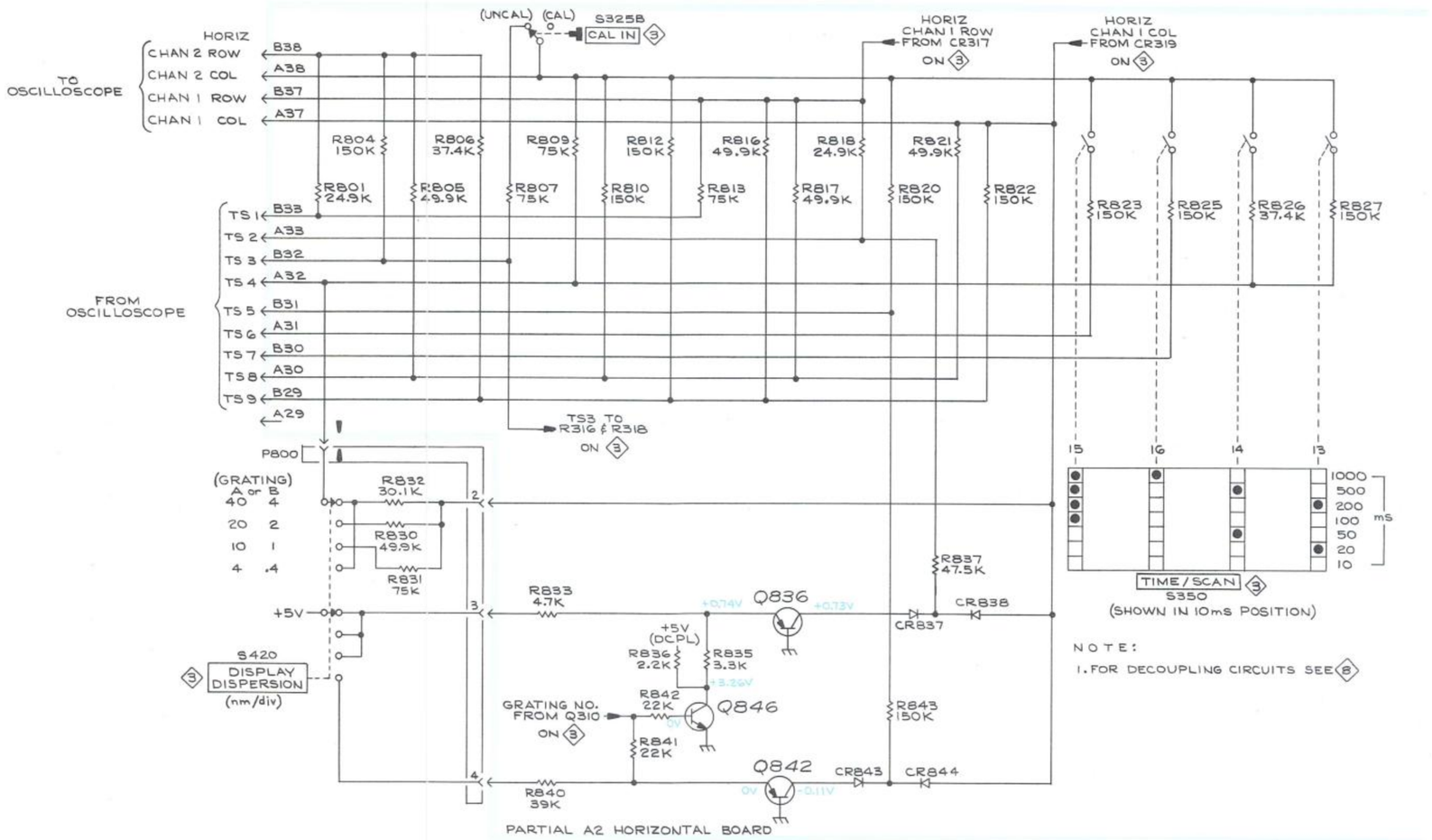


Fig. 7-7. P/O A2. Partial Horizontal circuit board.


HORIZ
CHAN 2 ROW
CHAN 2 COL
CHAN 1 ROW
CHAN 1 COL
TO OSCILLOSCOPE
B38
A38
B37
A37
(UNCAL) (CAL)
S325B
CAL IN
HORIZ CHAN 1 ROW FROM CR317 ON 3
HORIZ CHAN 1 COL FROM CR319 ON 3
R804 150K
R806 37.4K
R809 75K
R812 150K
R816 49.9K
R818 24.9K
R821 49.9K
R822 150K
R823 150K
R825 150K
R826 37.4K
R827 150K
R801 24.9K
R805 49.9K
R807 75K
R810 150K
R813 75K
R817 49.9K
R820 150K
TS 1
TS 2
TS 3
TS 4
TS 5
TS 6
TS 7
TS 8
TS 9
B33
A33
B32
A32
B31
A31
B30
A30
B29
A29
FROM OSCILLOSCOPE
TS3 TO R316 & R318 ON 3
P800
(GRATING) A or B
40 4
20 2
10 1
4 .4
R832 30.1K
R830 49.9K
R831 75K
+5V
S420
DISPLAY DISPERSION
(nm/div)
R833 4.7K
+0.74V
Q836
+0.73V
CR838
CR837
R837 47.5K
+5V (DCPL)
R836 2.2K
R835 3.3K
+3.26V
R842 22K
Q846
0V
GRATING NO. FROM Q310 ON 3
R841 22K
R843 150K
Q842
CR843
CR844
0V
-0.11V
R840 39K
15
16
14
13
1000
500
200
100
50
20
10
ms
TIME/SCAN
S350
(SHOWN IN 10ms POSITION)
NOTE:
1. FOR DECOUPLING CIRCUITS SEE 8
PARTIAL A2 HORIZONTAL BOARD

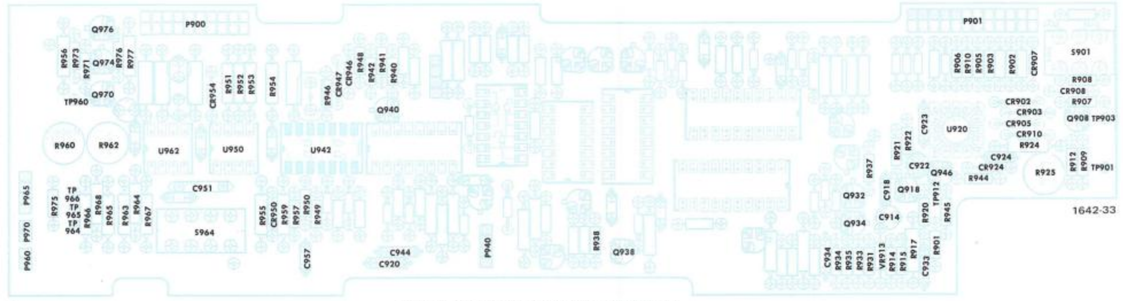
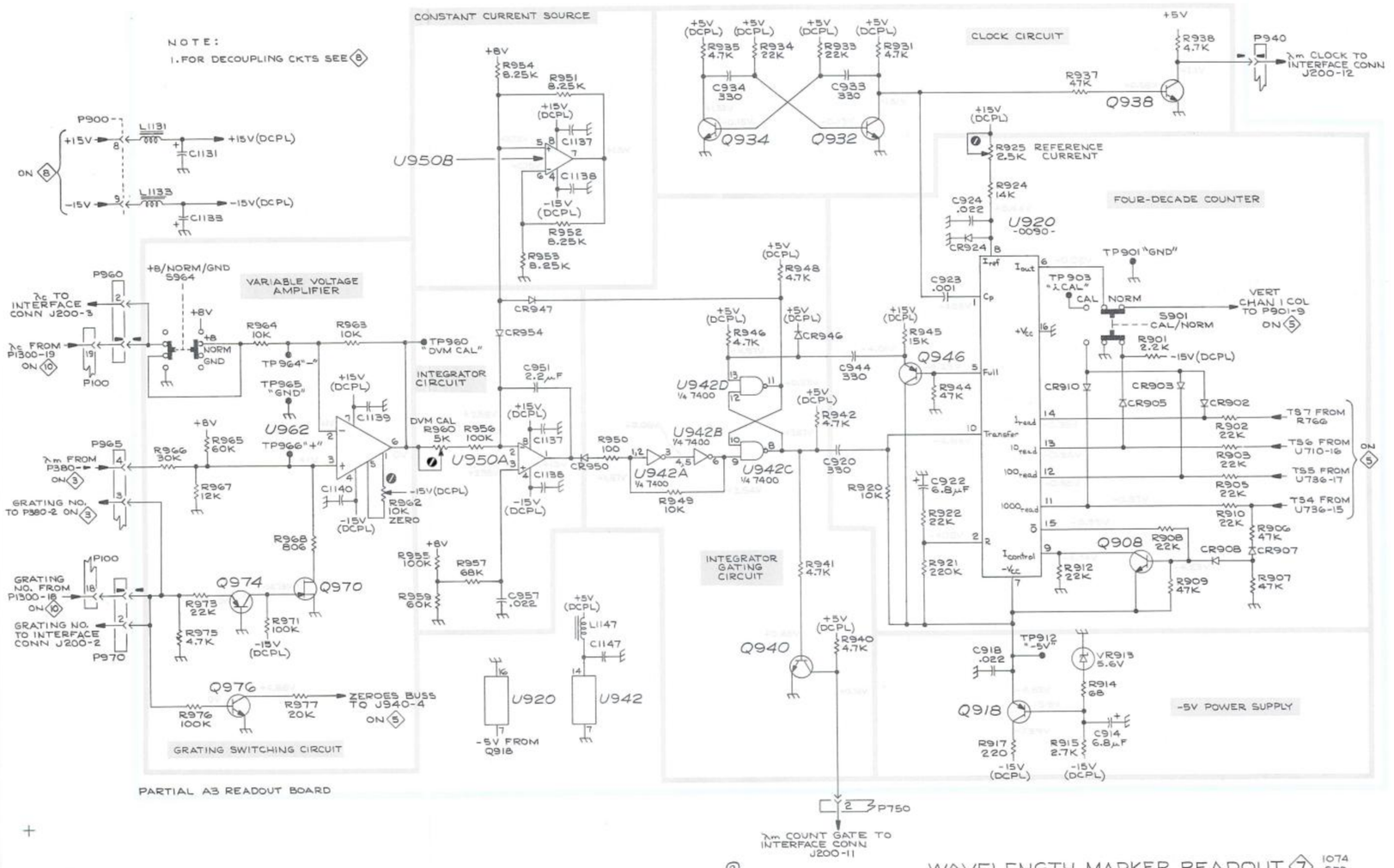
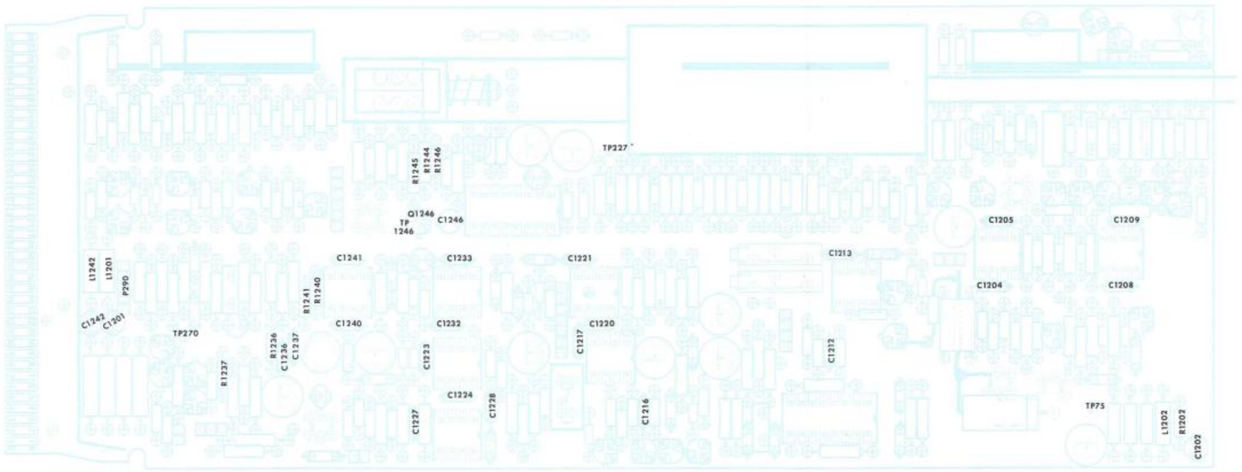


Fig. 7-8. P/O A3. Partial Readout circuit board.



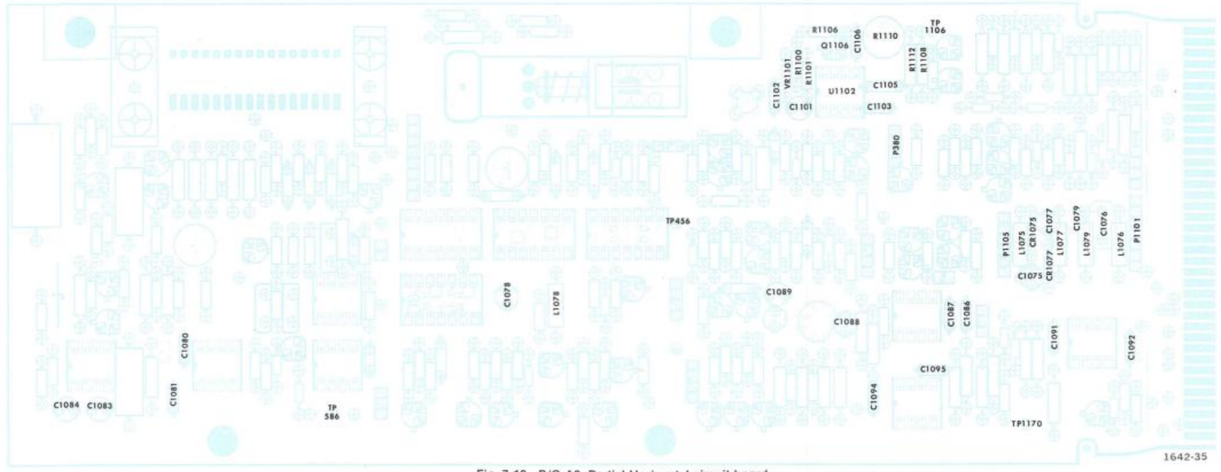
7J20

WAVELENGTH MARKER READOUT 7 1074 GRS



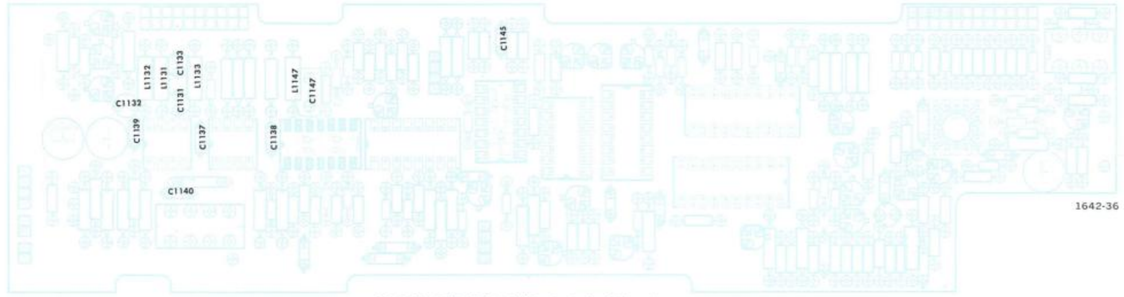
1642-34

Fig. 7-9. P/O A1. Partial Vertical circuit board.



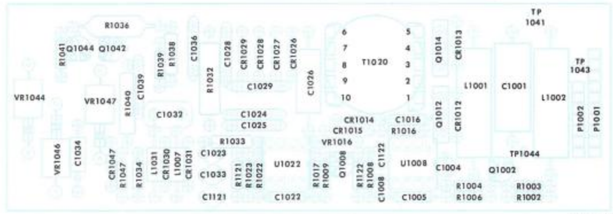
1642-35

Fig. 7-10. P/O A2. Partial Horizontal circuit board.



1642-36

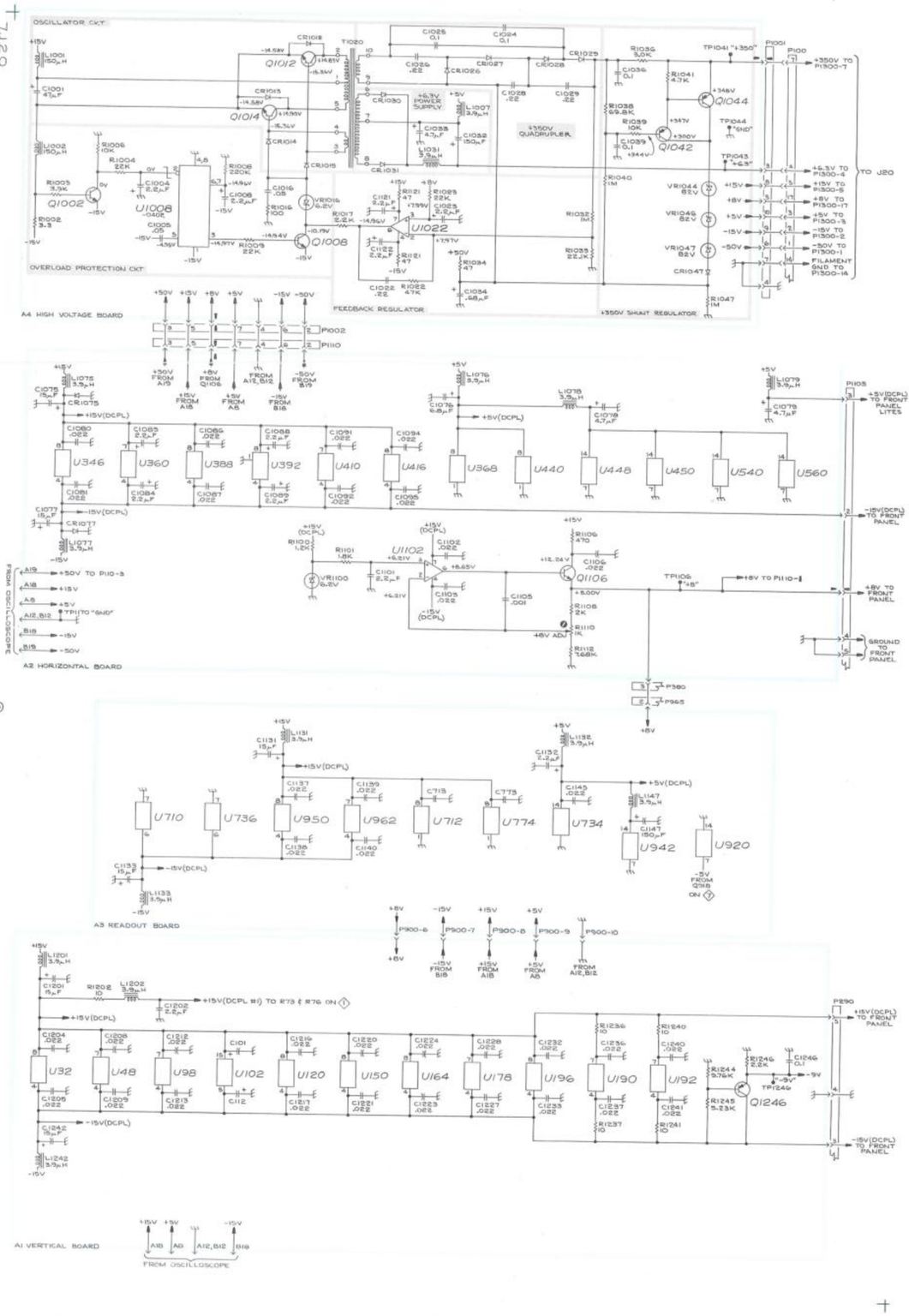
Fig. 7-11. P/O A3. Partial Readout circuit board.



1642-37

Fig. 7-12. A4. High Voltage circuit board.

@


OSCILLATOR CKT
OVERLOAD PROTECTION CKT
FEEDBACK REGULATOR
+350V SHUNT REGULATOR
+350V QUADRUPLER
+6.3V POWER SUPPLY
TO J20
A4 HIGH VOLTAGE BOARD
A2 HORIZONTAL BOARD
A3 READOUT BOARD
A1 VERTICAL BOARD
FROM OSCILLOSCOPE
+5V(DCPL) TO FRONT PANEL LITES
-15V(DCPL) TO FRONT PANEL
+8V TO FRONT PANEL
GROUND TO FRONT PANEL
+15V(DCPL) TO FRONT PANEL
-15V(DCPL) TO FRONT PANEL
DECOUPLING, DISTRIBUTION & HIGH VOLTAGE SUPPLY

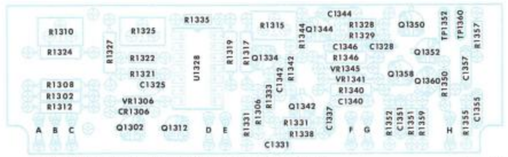


Fig. 7-13. A6. Horizontal Amplifier circuit board. 1642-38

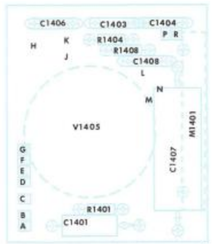


Fig. 7-14. A7. Vidicon Socket circuit board. 1642-39

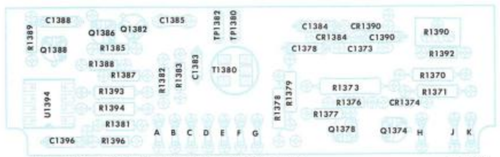


Fig. 7-15. A8. Vertical Oscillator circuit board. 1642-40

@ Fig. 7-16. P/O A9. Partial Preamplifier circuit board. 1642-41

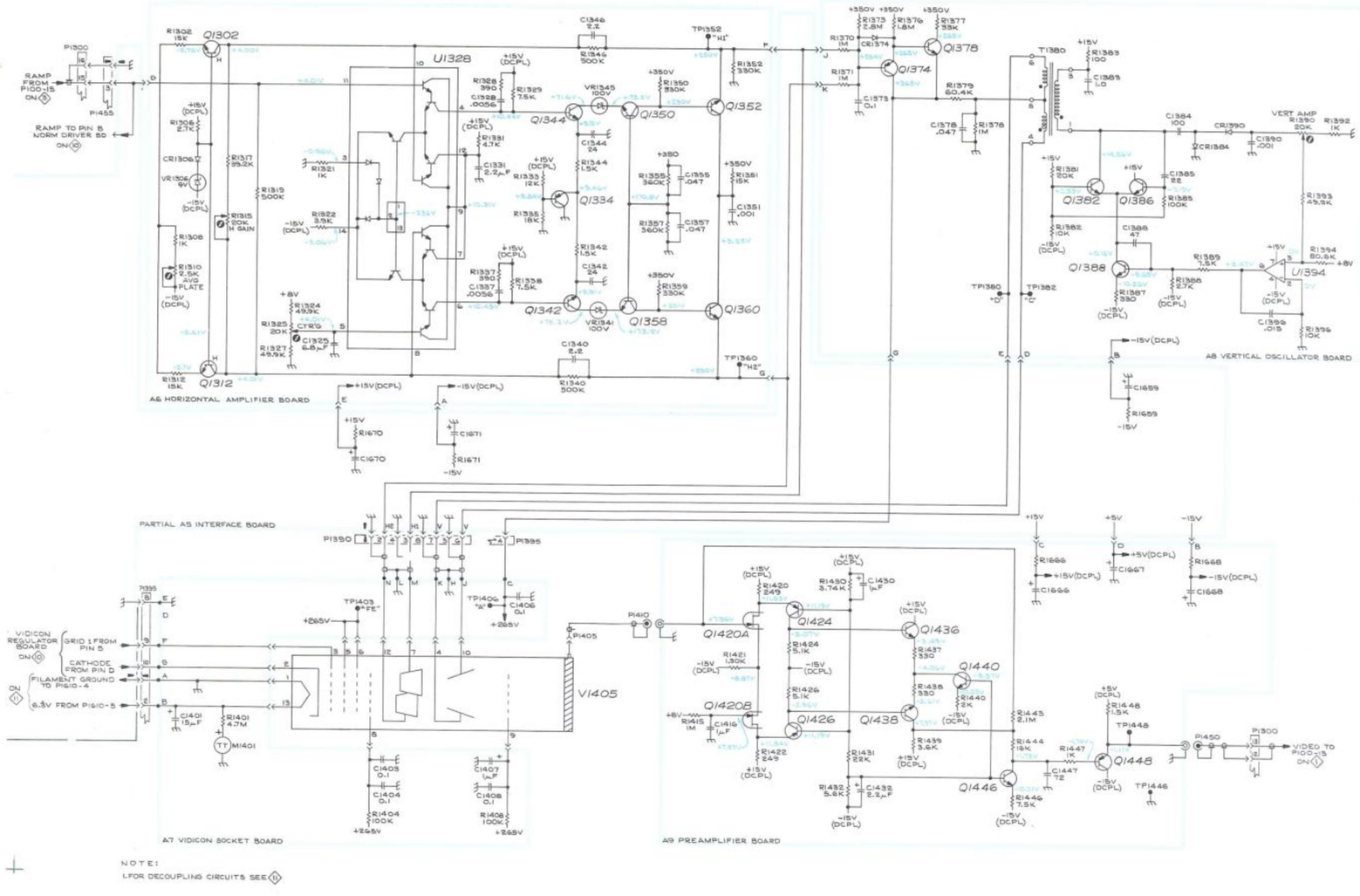

A6 HORIZONTAL AMPLIFIER BOARD
A8 VERTICAL OSCILLATOR BOARD
PARTIAL A5 INTERFACE BOARD
A7 VIDICON SOCKET BOARD
A9 PREAMPLIFIER BOARD
U1328
Q1302
Q1312
Q1334
Q1342
Q1344
Q1350
Q1352
Q1358
Q1360
Q1374
Q1378
Q1382
Q1386
Q1388
U1394
Q1420A
Q1420B
Q1424
Q1426
Q1436
Q1438
Q1440
Q1446
Q1448
V1405
RAMP FROM P100-15 ON 6
RAMP TO PIN 8, NORM DRIVER B5 ON 10
VIDICON REGULATOR BOARD ON 10
GRID 1 FROM PIN 8
CATHODE FROM PIN D
FILAMENT GROUND TO P1610-4
6.3V FROM P1610-5
ON 1
VIDEO TO P100-13 ON 1
NOTE:
1. FOR DECOUPLING CIRCUITS SEE 11
J20
@
VIDICON DEFLECTION CIRCUITS 9 1074 GR5

Fig. 7-17. P/O A10. Partial Vidicon Regulator circuit board. 1642-42

Fig. 7-18. P/O A11. Partial Normalizer Driver circuit board. 1642-43

Fig. 7-19. A12. 40 nm Normalizer circuit board. 1642-44

Fig. 7-20. A13. 400 nm Normalizer circuit board. 1642-45

@

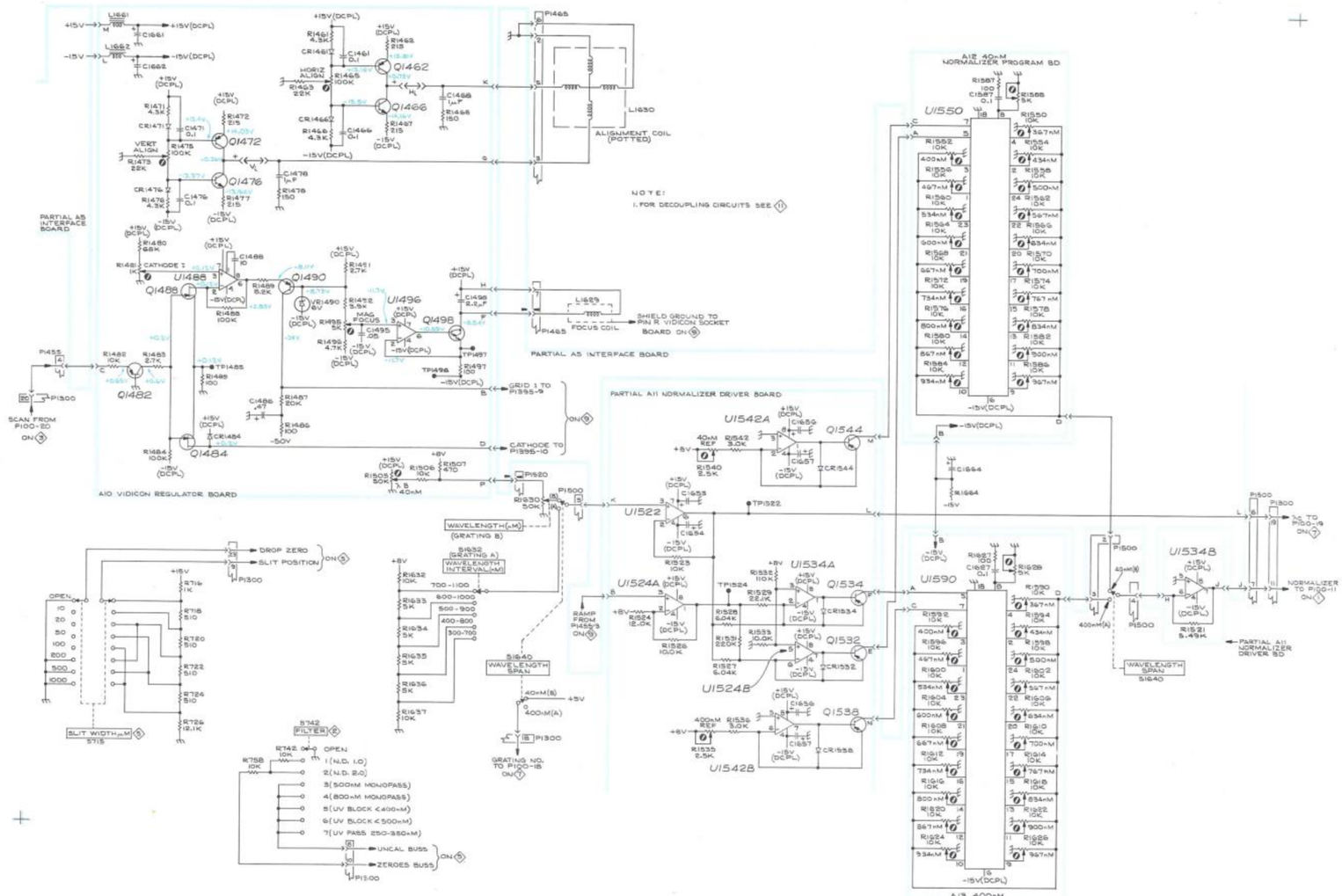

A10 VIDICON REGULATOR BOARD
PARTIAL AS INTERFACE BOARD
PARTIAL AS INTERFACE BOARD
PARTIAL A11 NORMALIZER DRIVER BOARD
A12 40nM NORMALIZER PROGRAM BD
A13 400nM NORMALIZER PROGRAM BD
ALIGNMENT COIL (POTTED)
FOCUS COIL
SHIELD GROUND TO PIN R VIDICON SOCKET BOARD ON 9
NOTE:
1. FOR DECOUPLING CIRCUITS SEE 11
SCAN FROM P100-20 ON 3
GRID 1 TO PI395-9 ON 9
CATHODE TO PI395-10
RAMP FROM PI453 ON 9
WAVELENGTH (nM) (GRATING B)
WAVELENGTH INTERVAL (nM) (GRATING A)
WAVELENGTH SPAN
GRATING NO. TO P100-18 ON 7
DROP ZERO
SLIT POSITION ON 5
SLIT WIDTH, nM 5115
FILTER 6
UNCAL BUSS
ZEROES BUSS ON 5
1 (N.D. 1.0)
2 (N.D. 2.0)
3 (500nM MONOPASS)
4 (800nM MONOPASS)
5 (UV BLOCK <400nM)
6 (UV BLOCK <500nM)
7 (UV PASS 250-350nM)
NORMALIZER TO P100-11 ON 7
PARTIAL A11 NORMALIZER DRIVER BD
U1488
U1490
U1496
U1498
U1482
U1484
U1522
U1524A
U1524B
U1542A
U1542B
U1534A
U1534B
U1550
U1590
Q1462
Q1466
Q1472
Q1476
Q1488
Q1490
Q1498
Q1482
Q1484
Q1544
Q1534
Q1532
Q1538

Fig. 7-21. A5. Interface circuit board. 1642-46

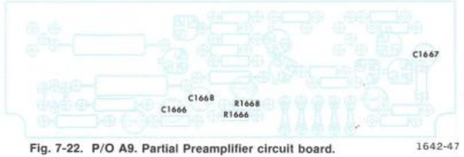


Fig. 7-22. P/O A9. Partial Preamplifier circuit board. 1642-47

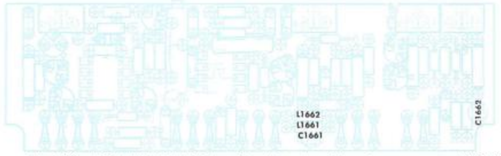


Fig. 7-23. P/O A10. Partial Vidicon Regulator circuit board. 1642-48

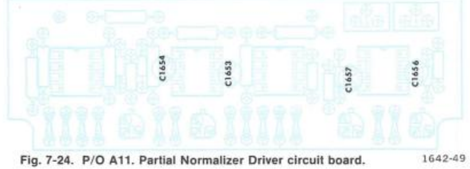
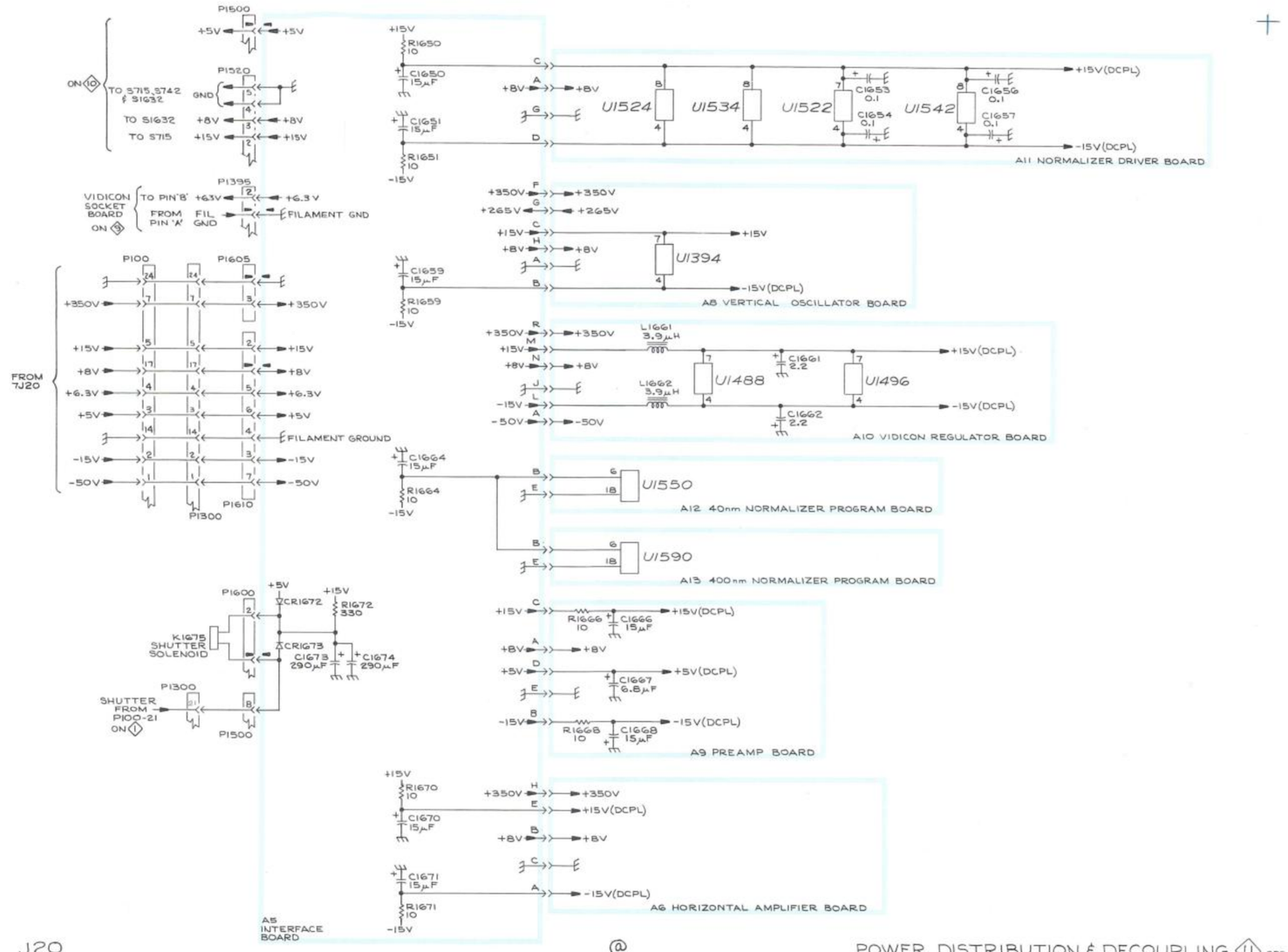


Fig. 7-24. P/O A11. Partial Normalizer Driver circuit board. 1642-49



J20 @ POWER DISTRIBUTION & DECOUPLING 11 GR5 1074

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

SPECIAL NOTES AND SYMBOLS

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

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
- - - * - - -
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
- - - * - - -
Parts of Detail Part
Attaching parts for Parts of Detail Part
- - - * - - -

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

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

ABBREVIATIONS

"	INCH
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	COVER
CPLG	COUPLING
CRT	CATHODE RAY TUBE
DEG	DEGREE
DWR	DRAWER
ELCTRN	ELECTRON
ELEC	ELECTRICAL
ELCTLT	ELECTROLYTIC
ELEM	ELEMENT
EPL	ELECTRICAL PARTS LIST
EQPT	EQUIPMENT
EXT	EXTERNAL
FIL	FILLISTER HEAD
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FR	FRAME or FRONT
FSTNR	FASTENER
FT	FOOT
FXD	FIXED
GSKT	GASKET
HDL	HANDLE
HEX	HEXAGON
HEX HD	HEXAGONAL HEAD
HEX SOC	HEXAGONAL SOCKET
HLCPS	HELICAL COMPRESSION
HLEXT	HELICAL EXTENSION
HV	HIGH VOLTAGE
IC	INTEGRATED CIRCUIT
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IMPLR	IMPELLER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATOR
INTL	INTERNAL
LPHLDR	LAMPHOLDER
MACH	MACHINE
MECH	MECHANICAL
MTG	MOUNTING
NIP	NIPPLE
NON WIRE	NOT WIRE WOUND
OBD	ORDER BY DESCRIPTION
OD	OUTSIDE DIAMETER
OVH	OVAL HEAD
PH BRZ	PHOSPHOR BRONZE
PL	PLAIN or PLATE
PLSTC	PLASTIC
PN	PART NUMBER
PNH	PAN HEAD
PWR	POWER
RCPT	RECEPTACLE
RES	RESISTOR
RGD	RIGID
RLF	RELIEF
RTNR	RETAINER
SCH	SOCKET HEAD
SCOPE	OSCILLOSCOPE
SCR	SCREW
SE	SINGLE END
SECT	SECTION
SEMICOND	SEMICONDUCTOR
SHLD	SHIELD
SHLDR	SHOULDERED
SKT	SOCKET
SL	SLIDE
SLFLKG	SELF-LOCKING
SLVG	SLEEVING
SPR	SPRING
SQ	SQUARE
SST	STAINLESS STEEL
STL	STEEL
SW	SWITCH
T	TUBE
TERM	TERMINAL
THD	THREAD
THK	THICK
TNSN	TENSION
TPG	TAPPING
TRH	TRUSS HEAD
V	VOLTAGE
VAR	VARIABLE
W/	WITH
WSHR	WASHER
XFMR	TRANSFORMER
XSTR	TRANSISTOR

CROSS INDEX MFR. CODE NUMBER TO MANUFACTURER

MFR.CODE	MANUFACTURER	ADDRESS	CITY,STATE,ZIP
0000A	Lemo USA	2015 2nd St.	Berkley, CA 94710
00779	AMP, Inc.	P. O. Box 3608	Harrisburg, PA 17105
01295	Texas Instruments, Inc., Semiconductor Group	P. O. Box 5012	Dallas, TX 75222
05129	Kilo Engineering Co.	2015 D	La Verne, CA 91750
05820	Wakefield Engineering, Inc.	Audubon Road	Wakefield, MA 01880
08261	Spectra-Strip Corp.	7100 Lampson Ave.	Garden Grove, CA 92642
09133	Kierulff Electronics, Inc.	2585 Commerce Way	Los Angeles, CA 90015
12136	Philadelphia Handle) 6., Inc.	1643 Haddon Ave.	Camden, NJ 08103
13257	Amerace Ltd.	10 Esna Park Dr.	Markham, Ontario, Canada
22526	Berg Electronics, Inc.	Youk Expressway	New Cumberland, PA 17070
23499	Gavitt Wire and Cable, Division of RSC Industries, Inc.	455 N. Quince St.	Escondido, CA 92025
24931	Specialty Connector Co., Inc.	3560 Madison Ave.	Indianapolis, IN 46227
26365	Gries Reproducer Co., Div. of Coats and Clark Inc.	125 Beechwood Ave.	New Rochelle, NY 10802
34114	Oak Industries Inc.	S. Main St.	Crystal Lake, IL 60014
50293	General Electric Co., Installation and Service Engineering Dept.	1 River Rd.	Schenectady, NY 12306
70276	Allen Mfg. Co.	P. O. Drawer 570	Hartford, CT 06101
70278	Allied Steel and Conveyors, Div. of Sparton Corp.	17333 Healy	Detroit, MI 48212
71590	Centralab Electronics, Div. of Globe-Union, Inc.	5757 N. Green Bay Ave.	Milwaukee, WI 53201
73743	Fischer Special Mfg. Co.	446 Morgan St.	Cincinnati, OH 45206
74445	Holo-Krome Co.	31 Brook St. West	Hartford, CT 06110
76854	Oak Industries, Inc., Switch Div.	S. Main St.	Crystal Lake, IL 60014
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
79727	C-W Industries	550 Davisville Rd.	Warminster, PA 18974
80009	Tektronix, Inc.	P. O. Box 500	Beaverton, OR 97077
82104	Standard Grigsby Co., Div. of Sun Chemical Corp.	920 Rathbone Ave.	Aurora, IL 60507
82647	Texas Instruments, Inc., Control Products Div.	34 Forest St.	Attleboro, MA 02703
83385	Central Screw Co.	2530 Crescent Dr.	Broadview, IL 60153
83594	Burroughs Corp., Electronic Components Division	P. O. Box 1226	Plainfield, NJ 07061
87308	N. L. Industries, Inc., Southern Screw Div.	P. O. Box 1360	Statesville, NC 28677
88245	Litton Systems, Inc., USECO Div.	13536 Saticoy St.	Van Nuys, CA 91409
95760	Protective Closures Co., Inc.	2150 Elmwood Ave	Buffalo, NY 14207
98291	Sealectro Corp.	225 Hoyt	Mamaroneck, NY 10544

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
						7J20		
1-1	337-1064-04			2		SHIELD,ELEC:SIDE	80009	337-1064-04
-2	366-1166-00			2		KNOB:RED W/SETSCREW	80009	366-1166-00
	----- -----			-		. EACH KNOB INCLUDES:		
	213-0153-00			1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-3	366-1057-00			2		KNOB:GRAY	80009	366-1057-00
	----- -----			-		. EACH KNOB INCLUDES:		
	213-0153-00			2		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-4	366-0392-00			2		KNOB:GRAY	80009	366-0392-00
-5	366-0497-00			1		KNOB:GRAY WITH SETSCREWS	80009	366-0497-00
	----- -----			-		. KNOB INCLUDES:		
	213-0153-00			1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-6	366-1190-01			1		KNOB:GRAY	80009	366-1190-01
	----- -----			-		. KNOB INCLUDES:		
	213-0153-00			2		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-7	331-0247-00			1		DIAL,CONTROL:10 TURN	05129	77131
-8	131-1011-00			1		CONNECTOR,RCPT,:4 CONTACT,FEMALE	0000A	RA-1304TPX
-9	366-1058-49			1		KNOB:LATCH	80009	366-1058-49
						(ATTACHING PARTS)		
-10	214-1095-00			1		PIN,SPG,SPLIT:0.094 OD X 0.187 INCH LONG	13257	52-022-094-0187
						- - - * - - -		
-11	214-1280-00			1		SPRING,HLCPS:0.14 OD X 1.126"L,0.16"DIA W	80009	214-1280-00
-12	105-0076-00			1		REL BAR,LATCH:PLUG-IN UNIT	80009	105-0076-00
-13	366-0215-02			2		KNOB:LEVER SWITCH	80009	366-0215-02
-14	348-0115-01			2		GROMMET,PLASTIC:	80009	348-0115-01
-15	131-0955-00			1		CONNECTOR,RCPT,:BNC,FEMALE	24931	28JR200-1
-16	426-0681-00			3		FR,PUSH BUTTON:GRAY PLASTIC	80009	426-0681-00
-17	358-0378-00			5		BUSHING,SLEEVE:PRESS MOUNT	80009	358-0378-00
-18	358-0487-00			2		GROMMET,PLASTIC:	80009	358-0487-00
-19	333-1377-02			1		FRONT PANEL:	80009	333-1377-02
-20	348-0235-00			2		SHLD GSKT,ELEC:4.734 INCH LONG	80009	348-0235-00
-21	260-1550-00			1		SWITCH,LEVER:	80009	260-1550-00
						(ATTACHING PARTS)		
-22	220-0413-00			2		NUT,SLEEVE:4-40 X 0.562 INCH LONG	80009	220-0413-00
						- - - * - - -		
-23	----- -----			1		RESISTOR VAR:(SEE R385 EPL)		
						(ATTACHING PARTS)		
	213-0020-00			1		SETSCREW:6-32 X 0.125 INCH,HEX.SOC STL	70276	OBD
						- - - * - - -		
-24	----- -----			2		RESISTOR,VAR:(SEE R435 & R255 EPL)		
						(ATTACHING PARTS FOR EACH)		
	213-0020-00			1		SETSCREW:6-32 X 0.125 INCH,HEX.SOC STL	70276	OBD
						- - - * - - -		
-25	200-0935-00			4		BASE,LAMPHOLDER:0.29 OD X 0.19" L,BK PLSTC	80009	200-0935-00
-26	352-0277-00			2		LAMPHOLDER:	80009	352-0277-00
-27	378-0690-05			1		LENS,LIGHT:AMBER--READY	80009	378-0690-05
	378-0690-06			1		LENS,LIGHT:AMBER--TRIG'D	80009	378-0690-06
-28	----- -----			3		RESISTOR,VAR:(SEE R200, R220 & R405 EPL)		
						(ATTACHING PARTS FOR EACH)		
	213-0020-00			1		SETSCREW:6-32 X 0.125 INCH,HEX.SOC STL	70276	OBD
						- - - * - - -		
-29	378-0725-01			1		DIFFUSER,LIGHT:	80009	378-0725-01
						(ATTACHING PARTS)		
	213-0153-00			1		SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
						- - - * - - -		
-30	260-1549-00			1		SWITCH,ROTARY:	76854	5-24521-416
-31	352-0157-00			2		LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-32	407-1146-00			1		BRACKET,SWITCH:	80009	407-1146-00
						(ATTACHING PARTS)		
-33	129-0098-00			3		POST,ELEC-MECH:0.250 HEX.X0.406 INCH L,BRS	80009	129-0098-00
-34	166-0233-00			2		SPACER,SLEEVE:0.312 X 0.129 ID	34114	2295
						- - - * - - -		
-35	131-0775-00			1		TERMINAL,STUD:	88245	1601-A
-36	210-0202-00			1		TERMINAL,LUG:SE #6	78189	2104-06-00-2520N

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-31	----- -----			1	RESISTOR,VAR:(SEE R390 EPL)		
					(ATTACHING PARTS)		
-38	210-0583-00			1	NUT,PLAIN,HEX:0.25-25 X 0.312 INCH,BRS	73743	2X20319-402
					- - - * - - -		
-39	----- -----			1	RESISTOR,VAR:(SEE R275 EPL)		
					(ATTACHING PARTS)		
	213-0020-00			1	SETSCREW:6-32 X 0.125 INCH,HEX.SOC STL	70276	OBD
					- - - * - - -		
-40	200-0935-00			1	BASE,LAMPHOLDER:0.29 OD X 0.19" L,BK PLSTC	80009	200-0935-00
-41	378-0602-01			1	LENS,LIGHT:AMBER	80009	378-0602-01
-42	352-0157-00			1	LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-43	366-1257-00			1	PUSHBUTTON:	80009	366-1257-00
-44	260-1548-00			1	SWITCH,PUSH:	82104	OBD
					(ATTACHING PARTS)		
-45	211-0086-00			2	SCREW,MACHINE:4-40 X 0.75 "L,100 DEG FHS	83385	OBD
-46	361-0502-00			2	SPACER,SLEEVE:0.469"L X 0.115 ID	34114	10918-230
					- - - * - - -		
-47	----- -----			1	RESISTOR,VAR:(SEE R150 EPL)		
-48	260-0931-00			1	SWITCH,LEVER:	82104	OBD
					(ATTACHING PARTS)		
-49	220-0413-00			2	NUT,SLEEVE:4-40 X 0.562 INCH LONG	80009	220-0413-00
					- - - * - - -		
-50	386-1858-05			1	SUBPANEL,FRONT:	80009	386-1858-05
					(ATTACHING PARTS)		
-51	213-0192-00			8	SCR,TPG,THD FOR:6-32 X 0.50 INCH,PNH STL	87308	OBD
					- - - * - - -		
-52	343-0503-00			1	RETAINER,CABLE:INTERCONNECT	80009	343-0503-00
-53	384-1197-00			1	EXTENSION SHAFT:7.38"L X 0.50 OD	80009	384-1197-00
					(ATTACHING PARTS)		
	354-0392-00			1	RING RETAINING:	79136	5555-12MD
					- - - * - - -		
-54	384-1195-00			1	SHAFT,CAM SW:2.0 L X 0.248 OD	80009	384-1195-00
-55	376-0149-00			1	CPLG,SHAFT,RGD:0.625"L X 0.50 OD	80009	376-0149-00
	----- -----			-	. COUPLER INCLUDES:		
	213-0005-00			2	. SETSCREW:8-32 X 0.125 INCH HEX	70276	OBD
	672-0071-00			1	CKT BOARD ASSY:TIME/SCAN		
					(ATTACHING PARTS)		
-56	213-0316-00			4	THUMBSCREW:4-40 X 0.52 INCH LONG	80009	213-0316-00
					- - - * - - -		
-57	----- -----			1	. CKT BOARD ASSY:HORIZONTAL(SEE A2 EPL)		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-58	131-0604-00			16	. . CONTACT,ELEC:0.025 SQ X 0.365 INCH LONG	80009	131-0604-00
-59	131-0608-00			51	. . CONTACT,ELEC:0.365 INCH LONG	22526	47357
-60	131-1003-00			1	. . CONNECTOR BODY,:CKT BD MT,3 PRONG	80009	131-1003-00
-61	136-0252-04			45	. . CONTACT,ELEC:0.188 INCH LONG	22526	75060
-62	136-0514-00			8	. . SOCKET,PLUG-IN:MICROCIRCUIT,8 CONTACT	82647	C930802
-63	136-0269-02			4	. . SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C931402
-64	214-0579-00			11	. . TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-65	----- -----			1	. . RESISTOR,VAR:(SEE R325/S325 EPL)		
-66	361-0492-00			2	. . SPACER,PUSH SW:	71590	J64287
	263-1035-00			1	. ACTR ASSY CAM S:TIME SCAN		
					(ATTACHING PARTS)		
-67	211-0116-00			4	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	----- -----			-	. . ACTUATOR ASSY INCLUDES:		
-68	200-0996-00			1	. . COVER,CAM SW:	80009	200-0996-00
					(ATTACHING PARTS)		
-69	211-0022-00			2	. . SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL	83385	OBD
-70	210-0001-00			2	. . WASHER,LOCK:INTL,0.092 ID X 0.18"OD STL	78189	1202-00-00-0541C
					- - - * - - -		
-71	214-1126-02			1	. . SPRING,FLAT:RED COLORED	80009	214-1126-02
-72	214-1127-00			1	. . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-73	210-0405-00			2	. . NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	2X12157-402

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-74	210-0406-00			1	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-75	401-0058-00			1	. . BEARING,CAM SW:	80009	401-0058-00
					(ATTACHING PARTS)		
-76	354-0219-00			1	. . RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
					- - - * - - -		
-77	407-0714-00			1	. . BRACKET,CAM SW:	80009	407-0714-00
-78	105-0444-00			1	. . ACTUATOR,CAM SW:TIME/SCAN	80009	105-0444-00
-79	210-0405-00			1	. . NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	2X12157-402
-80	210-0406-00			1	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-81	401-0061-00			1	. . BEARING,CAM SW:	80009	401-0061-00
-82	337-1752-00			1	SHIELD,ELEC:	80009	337-1752-00
					(ATTACHING PARTS)		
-83	211-0007-00			4	SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		
-84	----- -----			1	CKT BOARD ASSY:HIGH VOLTAGE(SEE A4 EPL)		
					(ATTACHING PARTS)		
-85	129-0404-00			4	SPACER,POST:0.853 "L X 0.188 HEX	80009	129-0404-00
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-86	131-0589-00			16	. CONTACT,ELEC:0.46 INCH LONG	22526	47350
-87	136-0252-04			12	. CONTACT,ELEC:0.188 INCH LONG	22526	75060
-88	136-0514-00			2	. SOCKET,PLUG-IN:MICROCIRCUIT,8 CONTACT	82647	C930802
-89	214-0579-00			3	. TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-90	131-1461-00			2	CONNECTOR,BODY:	00779	205207-1
					(ATTACHING PARTS)		
-91	131-0976-00			2	CONN,SLIDING LO:	09133	D53018
					- - - * - - -		
-92	210-0201-00			2	TERMINAL,LUG:SE #4	78189	2104-04-00-2520N
					(ATTACHING PARTS FOR EACH)		
-93	213-0138-00			1	SCR,TPG,THD FOR:4-40 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		
-94	407-1141-00			1	BRACKET,CONN:PROBE	80009	407-1141-00
					(ATTACHING PARTS)		
-95	211-0595-01			4	SCREW,MACHINE:6-32 X 0.25 SOC HD CAP	80009	211-0595-01
					- - - * - - -		
-96	----- -----			1	CKT BOARD ASSY:READOUT(SEE A3 EPL)		
					(ATTACHING PARTS)		
-97	211-0007-00			4	SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		
	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-98	131-0589-00			17	. CONTACT,ELEC:0.46 INCH LONG	22526	47350
-99	131-1261-00			22	. CONTACT,ELEC:F-SHAPED	00779	1-380953-0
-100	136-0514-00			2	. SOCKET,PLUG-IN:MICROCIRCUIT,8 CONTACT	82647	C930802
-101	136-0269-02			2	. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C931402
-102	136-0252-04			77	. CONTACT,ELEC:0.188 INCH LONG	22526	75060
-103	136-0260-02			2	. SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	01295	C931602
-104	214-0579-00			6	. TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-105	260-0984-00			1	. SWITCH,SLIDE:DP3POSN,0.5A,125VAC-DC	79727	G128S-PC/MOD7140
-106	260-0723-00			1	. SWITCH,SLIDE:DPDT,0.5A,125VAC	80009	260-0723-00
-107	343-0088-00			1	CLAMP,LOOP:0.062 INCH DIA	80009	343-0088-00
-108	343-0213-00			1	CLAMP,LOOP:PRESS MT,PLASTIC	80009	343-0213-00
-109	384-1154-00			1	EXTENSION SHAFT:9.08" L X 0.1247 OD	80009	384-1154-00
					(ATTACHING PARTS)		
	354-0392-00			1	RING,RETAINING:	79136	5555-12MD
					- - - * - - -		
-110	384-1195-00			1	SHAFT,CAM SW:2" L X 0.248 OD	80009	384-1195-00
-111	376-0149-00			1	CPLG,SHAFT,RGD:0.625" L X 0.50 OD	80009	376-0149-00
	----- -----			-	. COUPLER INCLUDES:		
	213-0005-00			2	. SETSCREW:8-32 X 0.188 HEX SS CAD	74445	5305-21-855-3257
	672-0072-00			1	CKT BOARD ASSY:VERTICAL/GAIN	80009	672-0072-00
					(ATTACHING PARTS)		
-112	211-0007-00			5	SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-	----- -----			-	. CKT BOARD ASSY INCLUDES:		
-113	----- -----			1	. CKT BOARD ASSY:VERTICAL(SEE A1 EPL)		
-114	131-0157-00			3	. . CONTACT,ELEC:	98291	STSM1C2
-115	131-0604-00			18	. . CONTACT,ELEC:0.025 SQ X 0.365 INCH LONG	80009	131-0604-00
-116	131-0608-00			33	. . CONTACT,ELEC:0.365 INCH LONG	22526	47357
	131-0589-00			3	. . CONTACT,ELEC:0.46 INCH LONG	22526	47350
-117	131-1003-00			1	. . CONNECTOR BODY,:CKT BD MT,3 PRONG	80009	131-1003-00
-118	136-0252-04			136	. . CONTACT,ELEC:0.188 INCH LONG	22526	75060
-119	136-0499-06			2	. . CONNECTOR,RCPT:6 CONTACT	00779	3-380949-6
-120	136-0499-10			1	. . CONNECTOR,RCPT,:10 CONTACT	00779	4-380949-0
-121	136-0514-00			9	. . SOCKET,PLUG-IN:MICROCIRCUIT,8 CONTACT	82647	C930802
-122	136-0260-02			2	. . SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	01295	C931602
-123	214-0579-00			9	. . TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-124	----- -----			1	. . RESISTOR,VAR:(SEE R245/S245 EPL)		
-125	361-0492-00			2	. . SPACER,PUSH SW:	71590	J64287
	263-1034-00			1	. ACTR ASSY,CAM S:VERTICAL GAIN	80009	263-1034-00
					(ATTACHING PARTS)		
-126	211-0116-00			4	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
					- - - * - - -		
	----- -----			-	. ACTUATOR ASSY INCLUDES:		
-127	200-1219-00			1	. . COVER,CAM SW:	80009	200-1219-00
					(ATTACHING PARTS)		
-128	211-0022-00			2	. . SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL	83385	OBD
-129	210-0001-00			2	. . WASHER,LOCK:INTL,0.092 ID X 0.18"OD STL	78189	1202-00-00-0541C
					- - - * - - -		
-130	214-1126-02			1	. . SPRING,FLAT:RED COLORED	80009	214-1126-02
-131	214-1127-00			1	. . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-132	210-0405-00			1	. . NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	2X12157-402
-133	210-0406-00			2	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-134	401-0058-00			1	. . BEARING,CAM SW:	80009	401-0058-00
					(ATTACHING PARTS)		
-135	354-0219-00			1	. . RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
					- - - * - - -		
-136	407-0714-00			1	. . BRACKET,CAM SW:	80009	407-0714-00
-137	105-0445-00			1	. . ACTUATOR,CAM SW:VERT GAIN	80009	105-0445-00
-138	210-0405-00			1	. . NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	2X12157-402
-139	210-0406-00			2	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-140	401-0061-00			1	. . BEARING,CAM SW:	80009	401-0061-00
-141	351-0284-00			1	GUIDE,SLIDE:	80009	351-0284-00
					(ATTACHING PARTS)		
-142	213-0192-00			2	SCR,TPG,THD FOR:6-32 X 0.50 INCH,PNH STL	87308	OBD
					- - - * - - -		
-143	386-2755-00			1	PANEL,REAR:	80009	386-2755-00
					(ATTACHING PARTS)		
-144	213-0192-00			8	SCR,TPG,THD FOR:6-32 X 0.50 INCH,PNH STL	87308	OBD
-145	361-0326-00			1	SPACER,SLEEVE:0.18 ID X 0.25 OD X 0.10"L	80009	361-0326-00
					- - - * - - -		
-146	351-0217-00			2	GUIDE,CKT BOARD:PLASTIC	80009	351-0217-00
-147	391-0111-00			2	BLK,CRT BD MTG:	80009	391-0111-00
					(ATTACHING PARTS FOR EACH)		
-148	211-0007-00			1	SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		
-149	220-0547-01			3	NUT,BLOCK:0.38 X 0.25 X 0.282"OA	80009	220-0547-01
					(ATTACHING PARTS FOR EACH)		
-150	211-0007-00			1	SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		
-151	214-1061-00			1	SPRING,GROUND:FLAT	80009	214-1061-00
-152	426-0939-00			2	FR SECT,PLUG-IN:UPPER LEFT	80009	426-0939-00
-153	214-1054-00			1	SPRING,DETENT:LATCH	80009	214-1054-00
-154	105-0075-00			1	BOLT LATCH:	80009	105-0075-00
-155	426-0940-00			1	FR SECT,PLUG-IN:LOWER LEFT	80009	426-0940-00
-156	426-0938-00			1	FR SECT,PLUG-IN:LOWER RIGHT	80009	426-0938-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
1-157	012-0424-00			1	CABLE,INTERCON:	80009	012-0424-00
	----- -----			-	. CABLE INCLUDES;		
-158	354-0528-00			1	. RING,PROTECTOR:1.130 ID X 1.430" OD	80009	354-0528-00
-159	179-2082-00			1	WIRING HARNESS:CHASSIS		
	----- -----			-	. WIRING HARNESS INCLUDES:		
-160	131-0707-00			84	. CONTACT,ELEC:0.48"L,22-26 AWG WIRE	22526	47439
	131-0708-00			3	. CONTACT,ELEC:0.48"L,28-32 AWG WIRE	22526	47437
-161	352-0161-00			3	. HOLDER,TERM.CON:3 WIRE BLACK	80009	352-0161-00
-162	352-0162-00			9	. HOLDER,TERM.CON:4 WIRE BLACK	80009	352-0162-00
-163	352-0163-00			1	. HOLDER,TERM.CON:5 WIRE BLACK	80009	352-0163-00
-164	352-0164-00			2	. HOLDER,TERM.CON:6 WIRE BLACK	80009	352-0164-00
-165	352-0165-00			1	. HOLDER,TERM.CON:7 WIRE BLACK	80009	352-0165-00
-166	352-0166-00			1	. HOLDER,TERM.CON:8 WIRE BLACK	80009	352-0166-00
-167	352-0169-00			5	. HOLDER,TERM.CON:2 WIRE BLACK	80009	352-0169-00
-168	352-0168-00			1	HOLDER,TERM.CON:10 WIRE BLACK	80009	352-0168-00
-169	175-0832-00			FT	WIRE,ELECTRICAL:9 WIRE RIBBON	23499	TEK-175-0832-00
-170	175-0830-00			FT	WIRE,ELECTRICAL:7 WIRE RIBBON	08261	TEK-175-0830-00
	352-0165-00			2	HOLDER,TERM.CON:7 WIRE BLACK	80009	352-0165-00
-171	210-0775-00			2	EYELET,METALLIC:0.126 OD X 0.23 INCH L,BRS	80009	210-0775-00
-172	210-0774-00			2	EYELET,METALLIC:0.152 OD X 0.245 INCH L,BRS	80009	210-0774-00
-1	070-1642-00			1	MANUAL,TECH:INSTRUCTION(NOT SHOWN)	80009	070-1642-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
						J20		
2-1	200-1693-00			1		PLUG,HOLE:PRESS-IN MT,BLK PLSTC	95760	BPF
-2	213-0098-00			1		SCREW,MACHINE:0-80 X 0.128" LONG,PHS STL	87308	OBD
-3	014-0043-01			1		ADAPTER,ACCESS:	80009	014-0043-01
						(ATTACHING PARTS)		
-4	213-0214-00			3		SCREW,CAP SCH:2-56 X 0.375"HEX HD STL	70278	OBD
						- - - * - - -		
-5	333-1637-00			1		PANEL,FRONT:	80009	333-1637-00
-6	378-0713-00			1		FILTER,LIGHT:ND 1	80009	378-0713-00
	378-0714-00			1		FILTER,LIGHT:ND 2	80009	378-0714-00
	378-0715-00			1		FILTER,LIGHT:300 NM	80009	378-0715-00
	378-0716-00			1		FILTER,LIGHT:400 NM	80009	378-0716-00
	378-0717-00			1		FILTER,LIGHT:550 NM	80009	378-0717-00
	378-0718-00			1		FILTER,LIGHT:700 NM	80009	378-0178-00
-7	426-0922-00			1		FRAME SECTION:RIGHT	80009	426-0922-00
						(ATTACHING PARTS)		
-8	211-0626-00			2		SCREW,CAP.,SCH:6-32 X 0.312 INCH L,HEX.,STL	87308	OBD
						- - - * - - -		
-9	426-0921-00			1		FRAME SECTION:LEFT	80009	426-0921-00
						(ATTACHING PARTS)		
	211-0626-00			2		SCREW,CAP.,SCH:6-32 X 0.312 INCH L,HEX.,STL	87308	OBD
						- - - * - - -		
-10	344-0098-00			2		CLIP,DECORATIVE:	12136	OBD
						(ATTACHING PARTS)		
-11	212-0518-00			1		SCREW,MACHINE:10-32 X 0.312INCH,PNH STL	83385	OBD
						- - - * - - -		
-12	367-0037-00			1		HANDLE,LUGGAGE:DECORATIVE,TEK BLUE	12136	OBD
-13	426-0920-00			1		FRAME SECTION:TOP CENTER	80009	426-0920-00
						(ATTACHING PARTS)		
	211-0626-00			4		SCREW,CAP.,SCH:6-32 X 0.312 INCH L,HEX.,STL	87308	OBD
						- - - * - - -		
-14	200-1545-00			1		COVER,CONN:VIDICON	80009	200-1545-00
						(ATTACHING PARTS)		
-15	211-0040-00			2		SCREW,MACHINE:4-40 X 0.25",BDCH PLSTC	26365	921112
						- - - * - - -		
-16	361-0046-00			2		SPACER,NONMETAL:0.25 X 0.50 INCH L,BAKELITE	80009	361-0046-00
						(ATTACHING PARTS)		
-17	211-0040-00			1		SCREW,MACHINE:4-40 X 0.25",BDCH PLSTC	26365	921112
						- - - * - - -		
-18	----- -----			1		CKT BOARD ASSY:VIDICON SOCKET(SEE A7 EPL)		
-19	131-0608-00			2		. CONTACT,ELEC:0.365 INCH LONG	22526	47357
-20	136-0250-00			1		. SOCKET,PLUG-IN:READOUT TUBE,CKT BD MT,14 PIN	83594	SK-125
-21	----- -----			1		. METER:RUNNING TIME(SEE M1401 EPL)		
-22	337-1958-00			1		SHIELD,CKT BD:	80009	337-1958-00
						(ATTACHING PARTS)		
-23	211-0007-00			3		SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
						- - - * - - -		
-24	337-1691-00			1		SHIELD,ELEC:PREAMP,FRONT	80009	337-1691-00
						(ATTACHING PARTS)		
-25	213-0055-00			2		SCR,TPG,THD FOR:2-32 X 0.188 INCH,PNH STL	83385	OBD
-26	210-0201-00			1		TERMINAL,LUG:SE #4	78189	2104-04-00-2520N
						- - - * - - -		
-27	----- -----			1		CKT BOARD ASSY:PRE AMP(SEE A9 EPL)		
-28	131-1003-00			2		. CONNECTOR BODY,:CKT BD MT,3 PRONG	80009	131-1003-00
-29	136-0252-04			29		. CONTACT,ELEC:0.188 INCH LONG	22526	75060
-30	136-0328-02			5		. CONTACT,ELEC:HORIZONTAL	00779	86282-2
-31	214-0579-00			2		. TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-32	----- -----			1		CKT BOARD ASSY:HORIZ AMP(SEE A6 EPL)		
-33	337-1959-00			1		. SHIELD,CKT BD:HORIZ	80009	337-1959-00
-34	136-0269-02			1		. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C931402
-35	136-0252-04			27		. CONTACT,ELEC:0.188 INCH LONG	22526	75060
-36	136-0328-02			8		. CONTACT,ELEC:HORIZONTAL	00779	86282-2
-37	136-0544-00			1		. JACK,TIP:HORIZ CKT BD MT,WHITE	80009	136-0544-00
	136-0545-00			1		. JACK,TIP:HORIZ CKT BD,MT,RED	80009	136-0545-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-38	200-1167-00			1	. COVER,XSTR:TEMP STAB FOR 2 TO-18 CS STYLE	05820	259-18-40
-39	----- -----			1	CKT BOARD ASSY:VERTICAL OSC(SEE A8 EPL)		
-40	337-1959-00			1	. SHIELD,CKT BD:VERT OSC	80009	337-1959-00
-41	136-0514-00			1	. SOCKET,PLUG-IN:MICROCIRCUIT,8 CONTACT	82647	C930802
-42	136-0252-04			15	. CONTACT,ELEC:0.188 INCH LONG	22526	75060
-43	136-0328-02			10	. CONTACT,ELEC:HORIZONTAL	00779	86282-2
-44	136-0544-00			1	. JACK,TIP:HORIZ CKT BD MT,WHITE	80009	136-0544-00
	136-0545-00			1	. JACK,TIP:HORIZ CKT BD,MT,RED	80009	136-0545-00
-45	----- -----			1	CKT BOARD ASSY:VIDICON RGLTR(SEE A10 EPL)		
-46	136-0514-00			2	. SOCKET,PLUG-IN:MICROCIRCUIT,8 CONTACT	82647	C930802
-47	136-0252-04			27	. CONTACT,ELEC:0.188 INCH LONG	22526	75060
-48	136-0328-02			15	. CONTACT,ELEC:HORIZONTAL	00779	86282-2
-49	136-0544-00			1	. JACK,TIP:HORIZ CKT BD MT,WHITE	80009	136-0544-00
	136-0545-00			2	. JACK,TIP:HORIZ CKT BD,MT,RED	80009	136-0545-00
-50	348-0074-02			2	FOOT,CAB:RIGHT FRONT & LEFT REAR	80009	348-0074-02
	348-0073-02			2	FOOT,CAB:LEFT FRONT & RIGHT REAR	80009	348-0073-02
					(ATTACHING PARTS FOR EACH)		
-51	211-0541-00			2	SCREW,MACHINE:6-32 X 0.25"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-52	377-0119-00			4	INSERT,FOOT:0.352 X 0.832 X 0.934"L	80009	377-0119-00
-53	348-0245-00			1	FLIP-STAND,CAB:U-SHAPE,7.247 X 3.028 OA	80009	348-0245-00
-54	390-0283-00			1	CABINET,BOTTOM:	80009	390-0283-00
					(ATTACHING PARTS)		
-55	211-0626-00			6	SCREW,CAP:6-32 X 0.312 INCH L,HEX.,STL	87308	OBD
					- - - * - - -		
-56	366-1028-00			4	KNOB:W/SETSCREW	80009	366-1028-00
	213-0153-00			2	. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-57	366-1007-00			1	KNOB:W/SETSCREW	80009	366-1007-00
	213-0153-00			2	. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-58	200-0103-00			1	NUT,PLAIN,KNURL:0.25-28 X 0.375" OD,BRASS	80009	200-0103-00
-59	129-0076-03			1	STUD,SHOULDERED:0.938 INCH LONG	80009	129-0076-03
					(ATTACHING PARTS)		
-60	210-0410-00			1	NUT,PLAIN,HEX.:10-32 X 0.312INCH,BRS	73743	2X20003-402
-61	210-0010-00			1	WASHER,LOCK:INT,0.20 ID X0.376" OD,STL	78189	1210-00-00-0541C
					- - - * - - -		
-62	386-2335-00			1	PANEL,REAR:	80009	386-2335-00
					(ATTACHING PARTS)		
-63	211-0007-00			2	SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
					- - - * - - -		
-64	214-1881-00			1	PLUG,PIPE THD:0.125 NPT,STL SCD	50293	OBD
-65	378-0731-00			1	LENS,TAPE DIAL:	80009	378-0731-00
					(ATTACHING PARTS)		
-66	211-0105-00			2	SCREW,MACHINE:4-40 X 0.188"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-67	348-0145-00			1	GROMMET,PLASTIC:U-SHP,1.0 X 0.42 INCH	80009	348-0145-00

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up electronic developments by adding circuit and improvements to our instruments as soon as they oped and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.