

**INSTRUCTION
MANUAL**

**7503
OSCILLOSCOPE**

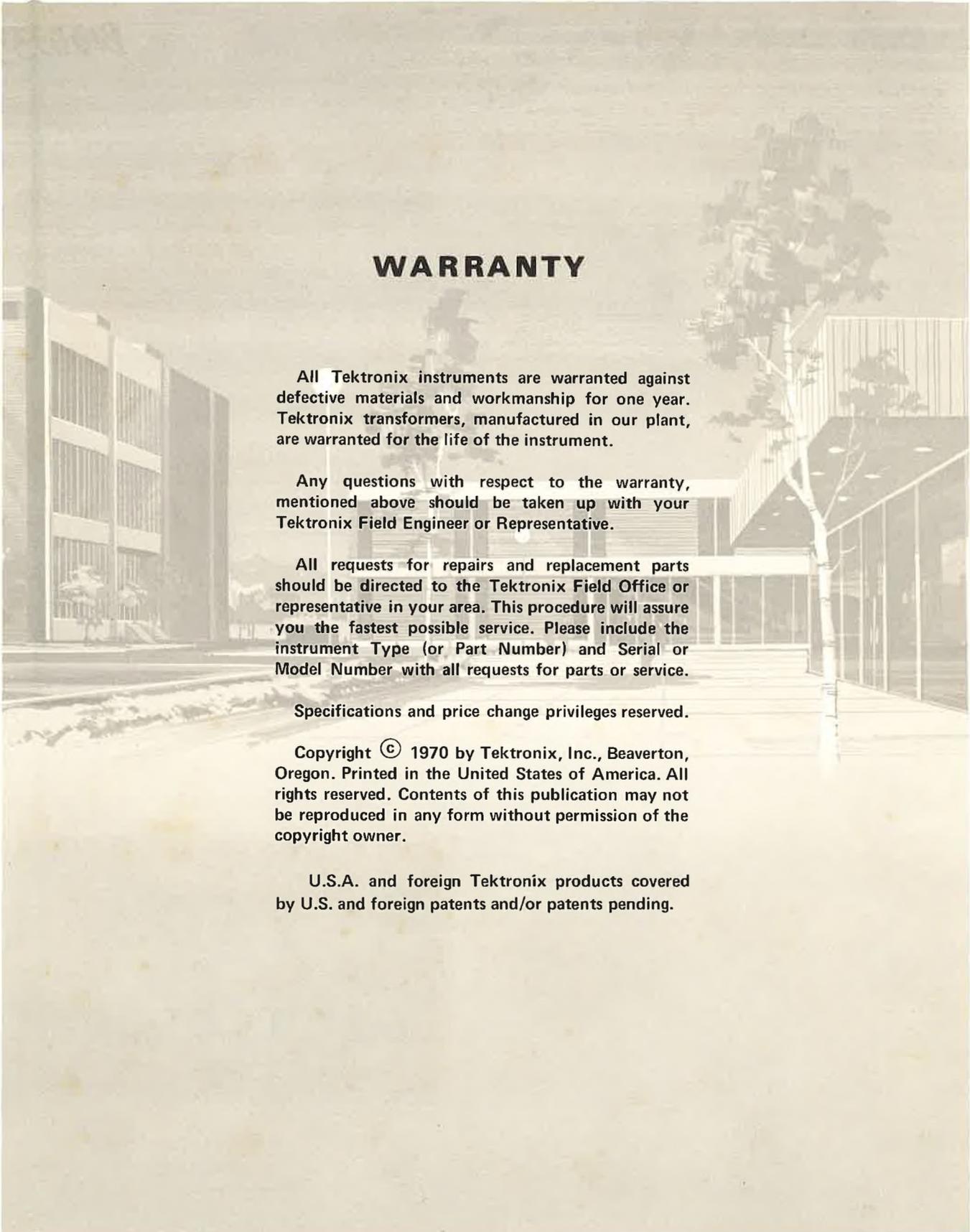


MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

INSTRUCTION MANUAL

Serial Number B100935

7503
OSCILLOSCOPE



WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our plant, are warranted for the life of the instrument.

Any questions with respect to the warranty, mentioned above should be taken up with your Tektronix Field Engineer or Representative.

All requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type (or Part Number) and Serial or Model Number with all requests for parts or service.

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Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

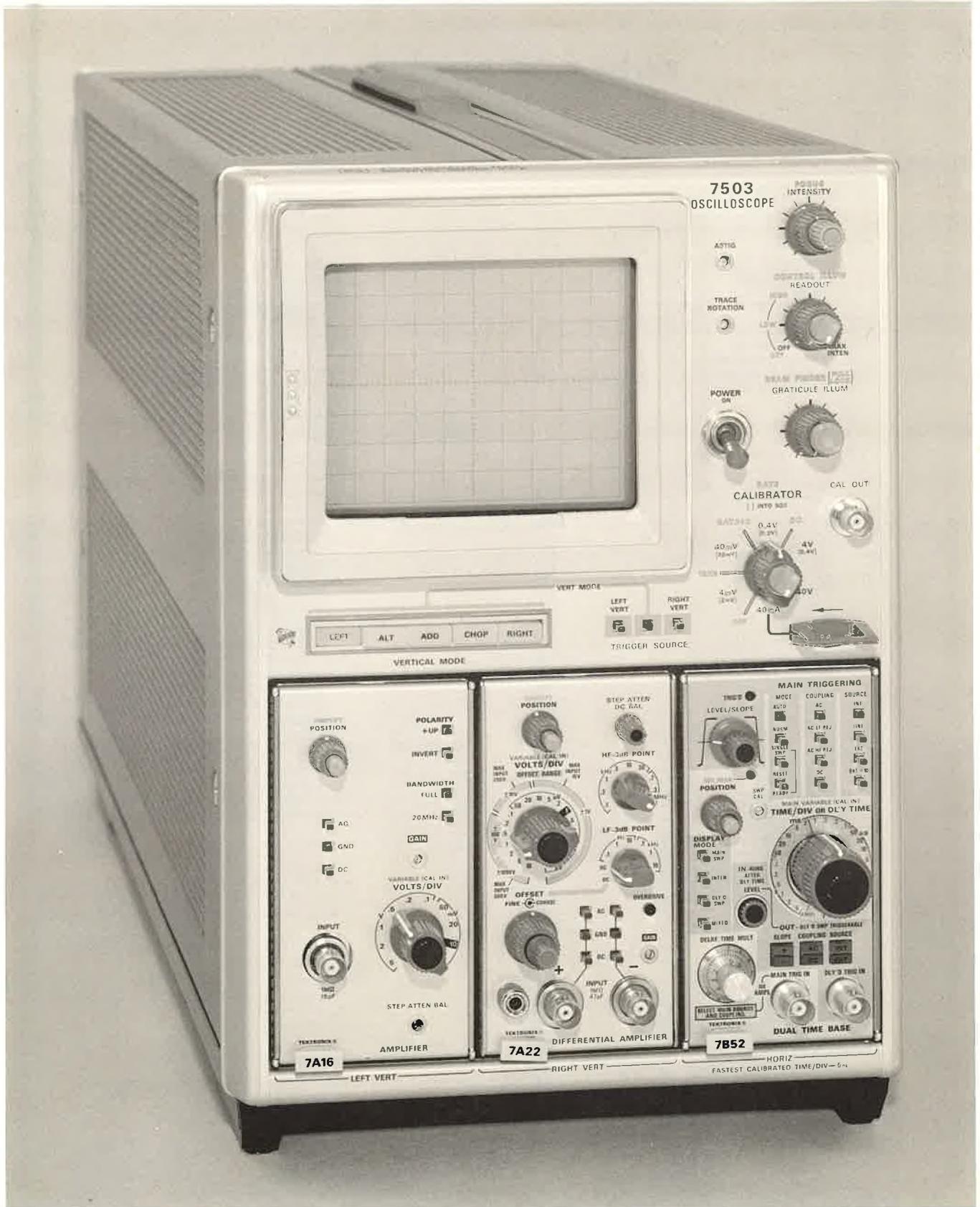


Fig. 1-1. 7503 Oscilloscope.

SECTION 1

7503 SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The Tektronix 7503 Oscilloscope is a solid-state, high performance instrument designed for general-purpose applications. This instrument accepts Tektronix 7-series plug-in units to form a complete measurement system. The flexibility of this plug-in feature and the variety of plug-in units available allow the system to be used for many measurement applications.

The 7503 has three plug-in compartments. The left and center plug-ins are connected to the vertical deflection system. The right plug-in is connected to the horizontal deflection system. Electronic switching between the plug-ins connected to the vertical deflection system allows a dual-trace vertical display. This instrument features regulated DC power supplies to assure that performance is not affected by variations in line voltage and frequency, or by changes in load due to the varying power requirements of the plug-in units. Maximum power consumption of this instrument is about 260 watts (60 Hertz, 115-volt line).

The 7503 features a CRT with an 8 X 10 centimeter graticule area with small spot size and high writing rate.

Additionally, the instrument includes a readout system providing CRT display of alpha-numeric information from the plug-ins, including deflection factor, sweep rate and other encoded parameters.

This instrument will meet the electrical characteristics listed in Table 1-1 following complete calibration as given in Section 5. The performance check procedure given in Section 5 provides a convenient method of checking instrument performance without making internal checks or adjustments. The following electrical characteristics apply over a calibration interval of 1000 hours and an ambient temperature range of 0°C to +50°C, except as otherwise indicated. Warmup time for given accuracy is 20 minutes.

NOTE

Many of the measurement capabilities of this instrument are determined by the choice of plug-in units. The following characteristics apply to the 7503 only. See the system specification later in this section for characteristics of the complete system.

TABLE 1-1
ELECTRICAL

Characteristic	Performance
VERTICAL DEFLECTION SYSTEM	
Deflection Factor	Compatible with all 7-series plug-in units.
Deflection Accuracy	Less than 1% difference between compartments.
Low-Frequency Linearity	0.1 division or less compression or expansion of a center-screen two-division signal when positioned to the top and bottom of the graticule area.
Isolation Between Compartments	At least 100:1 from DC to 75 megahertz.
Chopped Mode Repetition Rate	One megahertz $\pm 20\%$.

Characteristic	Performance
Time segment from each compartment	0.4 to 0.6 microsecond.
Delay Line	Permits viewing of leading edge of triggering signal.
Vertical Display Modes (selected by front-panel VERTICAL MODE switch)	LEFT: Left vertical only. ALT: Dual-trace, alternate between vertical units. ADD: Added algebraically. CHOP: Dual-trace, chopped between vertical units. RIGHT: Right vertical only.

Specification—7503

Characteristic	Performance
TRIGGERING	
Trigger Source (selected by front-panel TRIGGER SOURCE switch)	VERT MODE: Determined by vertical mode. LEFT VERT: From left vertical unit only. RIGHT VERT: From right vertical unit only.

HORIZONTAL DEFLECTION SYSTEM	
Deflection Factor	Compatible with all 7-series plug-in units.
Fastest Calibrated Sweep Rate	Five nanoseconds/division.
Phase Shift Between Vertical and Horizontal Deflection Systems With phase correction	Adjustable to less than 2° from DC to two megahertz.

CALIBRATOR	
Wave Shape	Square wave.
Polarity	Positive going with baseline at zero volts.
Output Voltage (selected by front-panel CALIBRATOR switch)	
Open circuit	Four millivolts to 40 volts in five decade steps.
Into 50 ohms	Two millivolts to 0.4 volts in four steps.
Output Current	40 milliamperes through current loop.
Amplitude Accuracy (Voltage and Current)	
+15°C to +35°C	Within 1%.
0°C to +50°C	Within 2%.

Characteristic	Performance	
Repetition Rates (selected by front-panel RATE switch)	One kilohertz. One-half repetition rate of sweep gate. DC.	
One-Kilohertz Accuracy	+15°C to +35°C	0°C to +50°C
	Within 0.25%	Within 0.5%
Duty Cycle	50% ± 0.5%.	
Risetime and Faltime 4 mV through 4 V and 40 mA	Less than 0.25 microsecond.	
40 V	Less than two microseconds with 10 pF load.	

EXTERNAL Z-AXIS INPUTS	
High Sensitivity Input Sensitivity	Two volts peak-to-peak provides trace modulation over full intensity range.
Useful input voltage vs. repetition frequency	Two volts peak-to-peak, DC to two megahertz; reducing to 0.4 volts peak-to-peak at 10 megahertz.
Polarity of operation	Positive-going signal decreases trace intensity; negative-going signal increases trace intensity.
Minimum pulse width that provides intensity modulation	40 nanoseconds at two volts.
Input resistance	500 ohms ± 10%.
Maximum input voltage	15 volts (DC + peak AC).
High Speed Input Sensitivity	60 volts peak-to-peak provides trace modulation over full intensity range from DC to 75 megahertz.
Polarity of operation	Positive-going signal decreases trace intensity; negative-going signal increases trace intensity.

Characteristic	Performance
Minimum pulse width that provides intensity modulation	Five nanoseconds at 60 volts.
Input resistance at DC	18 kilohms \pm 15%.
Maximum input voltage	60 volts (DC + peak AC), 60 volts peak-to-peak AC.

SIGNAL OUTPUTS

+ Sawtooth	
Polarity	Positive-going with baseline at zero volts \pm one volt (into one megohm).
Output voltage	
Rate of rise	
Into 50 ohms	50 millivolts/unit of time \pm 15%. ¹
Into one megohm	One volt/unit of time \pm 10%. ¹
Peak voltage	
Into 50 ohms	Greater than 500 millivolts.
Into one megohm	Greater than 10 volts.
Output resistance	950 ohms \pm 2%.
+ Gate	
Source (selected by Gate switch)	MAIN GATE from displayed time-base; DELAYED GATE from delaying time-base unit; or AUX GATE from dual-sweep time-base unit.
Output voltage	
Into 50 ohms	0.5 volt \pm 10%.
Into one megohm	10 volts \pm 10%.
Risetime into 50 ohms	20 nanoseconds or less.
Output resistance	950 ohms \pm 2%

¹Unit of time selected by time-base time/division switch.

Characteristic	Performance
Vertical Signal Output	
Source	Determined by TRIGGER SOURCE switch.
Output voltage	
Into 50 ohms	25 millivolts/division of vertical deflection \pm 25%.
Into one megohm	0.5 volt/division of vertical deflection \pm 25%.
Output resistance	950 ohms \pm 2%.

POWER SUPPLY

Line Voltage Range (AC, RMS)	<i>Line voltage and range selected by Line Voltage Selector assembly on rear panel.</i>
115-volts nominal	90 to 110 volts. 104 to 126 volts. 112 to 136 volts.
230-volts nominal	180 to 220 volts. 208 to 252 volts. 224 to 272 volts.
Line Frequency	48 to 440 hertz.
Maximum Power Consumption	258 watts, 3.0 amperes at 60 hertz, 115-volt line.

CATHODE-RAY TUBE (CRT)

Graticule	
Type	Internal with variable edge lighting.
Area	Eight divisions vertical by ten divisions horizontal. Each division equals one centimeter.
Resolution	
Horizontal	At least 15 lines/division.
Vertical	At least 15 lines/division.
Geometry	0.1 division or less total bowing of a displayed horizontal or vertical line.
Beam Finder	Limits display within graticule area.

Specification—7503

Characteristic	Performance
Photographic Writing Speed (without film fogging techniques)	
Tektronix C-51 Camera with f1.2 lens and 1:0.5 object-to-image ratio	At least 2250 centimeters/microsecond with Polaroid ² Type 410 film (10,000 ASA) and P31 CRT phosphor.
Tektronix C-27 Camera with f1.5 lens and 1:0.5 object-to-image ratio	At least 1500 centimeters/microsecond with Polaroid Type 410 film (10,000 ASA) and P31 CRT phosphor.

**TABLE 1-2
ENVIRONMENTAL**

Characteristic	Performance
----------------	-------------

NOTE

This instrument will meet the electrical characteristics given in Table 1-1 over the following environmental limits. Complete details on environmental test procedures, including failure criteria, etc., can be obtained from Tektronix, Inc. Contact your local Tektronix Field Office or representative.

Temperature Range	
Operating	0°C to +50°C.
Non-operating	-55°C to +75°C.
Altitude	
Operating	15,000 feet.
Non-operating	Test limit 50,000 feet.

² Registered trademark of the Polaroid Corporation.

Characteristic	Performance
Electro-magnetic Interference (EMI) as tested in MIL-I 6181 D (when equipped with EMI modification only)	
Radiated interference	Interference radiated from the instrument under test within the given limits from 150 kilohertz to 1000 megahertz.
Conducted interference	Interference conducted out of the instrument under test through the power cord within the given limits from 150 kilohertz to 25 megahertz.
Transportation (packaged instruments, without plug-ins)	Qualifies under National Safe Transit Committee test procedure 1A.

**TABLE 1-3
PHYSICAL**

Characteristic	Performance
Ventilation	Safe operating temperature is maintained by convection cooling. Automatic resetting thermal cutout protects instrument from overheating.
Warmup Time	20 minutes for rated accuracy.
Finish	Anodized front panel. Blue-vinyl painted aluminum cabinet.
Overall Dimensions (measured at maximum points)	
Height	13.5 inches (34.2 centimeters).
Width	9.2 inches (23.4 centimeters).
Length	24.6 inches (62.2 centimeters).
Net Weight (instrument only)	47 pounds (21.3 kilograms).

STANDARD ACCESSORIES

Standard accessories supplied with the 7503 are listed on the last pull-out page of the Mechanical Parts List illustrations. For optional accessories available for use with this instrument, see the Tektronix, Inc. catalog.

INSTRUMENT OPTIONS

General

The following options are available for the 7503 and can be installed as part of the instrument when ordered, or they can be installed at a later time. Complete information on all options for this instrument is given in this manual. For further information on instrument options, see your Tek-

tronix, Inc. catalog, or contact your local Tektronix Field Office or representative.

Option 1

This option deletes the Readout System. Operation of the instrument is unchanged except that there is no alphanumeric display on the CRT and the READOUT control is non-functional. The Readout System can be added at any time by ordering the readout conversion kit.

Option 2

With option 2 installed, the instrument will meet the EMI interference specifications given in Table 1-2.

SYSTEM SPECIFICATIONS

Your 7000-Series oscilloscope system will provide exceptional flexibility in operation with a wide variety of general and special purpose plug-in amplifiers and time bases. The Type number of a particular plug-in identifies it thus: the first digit (7) denotes the oscilloscope system (7000); the second character describes the use of the plug-in—A for amplifier, B for "real time" time base, J or K for spectrum analyzer, L for single-unit spectrum analyzer (a double-width plug-in). M for miscellaneous, S for sampling unit, and T for sampling time base. The third and fourth digits in the plug-in title are sequence numbers. The table following lists specifications that are dependent upon the system as a whole.

7000-SERIES OSCILLOSCOPE SYSTEM SPECIFICATION

Plug-In Unit	7500-Series			7700-Series		Vertical System Deflection Factor Accuracy*			SIG OUT		Horizontal System
	Probe	BW	T _r	BW	T _r	EXT CAL 0-50°C	INT CAL 15°-35°C	INT CAL 0-50°C	BW	T _r	
7A11	Integral	90 MHz	3.9 ns	150 MHz	2.4 ns	2%	3%	4%	60 MHz	5.9 ns	Horizontal System bandwidth with 2 units of the same type operated X-Y with phase correction is 2 MHz for the 7500-Series, 3 MHz for the 7700-Series unless otherwise stated. Without phase correction the 7700-Series horizontal bandwidth upper 10% down point is 3 MHz; that of the 7500-Series is 5 MHz, unless otherwise indicated. X-Y phase shift with correction is 2° at 2 MHz for both Series unless otherwise stated.
7A12	None	75 MHz	4.7 ns	105 MHz	3.4 ns	2%	3%	4%	55 MHz	6.4 ns	
	P6053	75 MHz	4.7 ns	105 MHz	3.4 ns	3%	4%	5%	55 MHz	6.4 ns	
7A13	None	75 MHz	4.7 ns	100 MHz	3.5 ns	1 1/2%	2 1/2%	3 1/2%	55 MHz	6.4 ns	
	P6053	75 MHz	4.7 ns	100 MHz	3.5 ns	1 1/2%	2 1/2%	3 1/2%	55 MHz	6.4 ns	
7A14	P6021	45 MHz	7.8 ns	50 MHz	7.0 ns	2%	3%	4%	40 MHz	8.8 ns	
	P6022	75 MHz	4.7 ns	105 MHz	3.4 ns	2%	3%	4%	50 MHz	7.0 ns	
7A16	None	90 MHz	3.9 ns	150 MHz	2.4 ns	2%	3%	4%	60 MHz	5.9 ns	
	P6053	90 MHz	3.9 ns	150 MHz	2.4 ns	3%	4%	5%	60 MHz	5.9 ns	
7A22	None or	1.0 MHz	350 ns	1 MHz	350 ns	2%	3%	4%	1.0 MHz	350 ns	
	Any	±10%	±9%	±10%	±9%				±10%	±9%	

*Deflection Factor accuracy is checked as follows:

EXT CAL 0°C to 50°C, plug-in gain is set at a temperature within 10°C of operating temperature, using an external calibrator whose accuracy is within .25%.

INT CAL 15°C to 35°C, plug-in gain is set while operating within a temperature range of +15°C to +35°C, using the oscilloscope calibrator.

INT CAL 0°C to 50°C, plug-in gain is set using the oscilloscope calibrator (within 10°C of the operating temperature) in a temperature range between 0°C and +50°C.

PLUG-IN OPTIONS MAJOR CHARACTERISTICS AMPLIFIERS

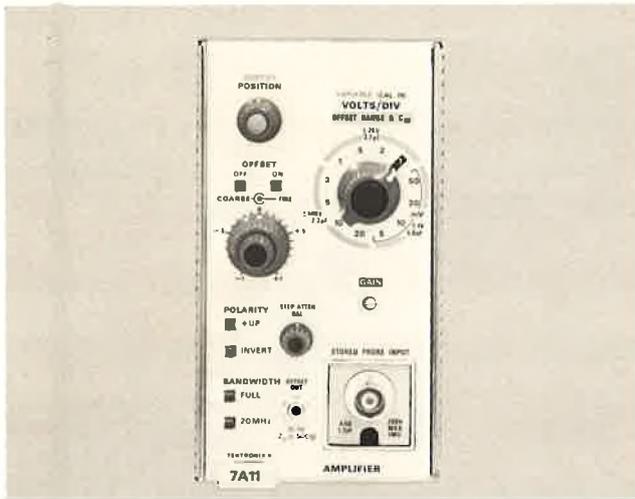


Fig. 1. 7A11 FET Probe Wide Band Amplifier (All specifications at Probe tip).

7A11 FET Probe Wide Band Amplifier (All specifications at Probe tip)

Deflection Factor	5 mV/div to 20 V/div
Input Resistance	1 M Ω within 1%
Input Capacitance	2 to 6 pF depending on Volts/div setting
DC Offset	Up to 400 V referred to input

Attenuation via integral FET Probe and/or amplifier from X1 through X400 controlled automatically by Volts/div switch to prevent display from overscanning screen.

7A12 Dual Trace Wide Band Amplifier

Deflection Factor	5 mV/div to 5 V/div, pushbutton selected
Input Resistance	1 M Ω within 2%
Input Capacitance	24 pF within 1 pF for all deflection factors
DC Offset	Equivalent to at least 1000 div
Operating Modes	CH 1 Only, CH 2 Only, Chopped, Alternate and Added. Either channel can be inverted for differential measurements.

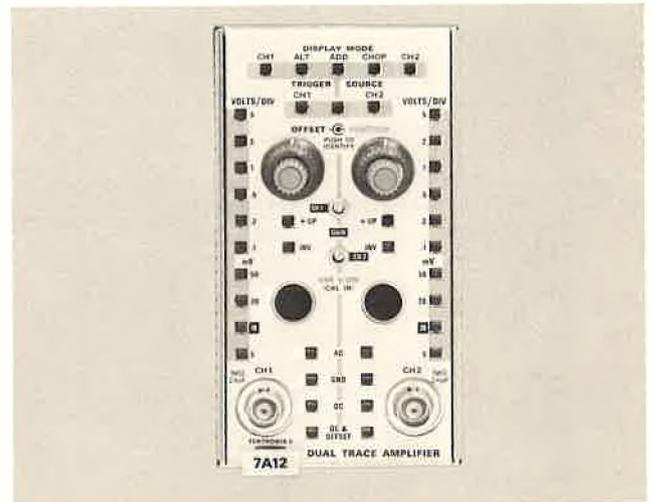


Fig. 2. 7A12 Dual Trace Wide Band Amplifier.

AMPLIFIERS (Cont)

7A13 Differential Comparator & Differential Amplifier

Deflection Factor	1 mV/div to 5 V/div
Calibrated Comparison Voltages	0 to +10 Volts or 0 to -10 Volts
Input Resistance	1 M Ω within 0.15%
Input Capacitance	20 pF within 0.4 pF

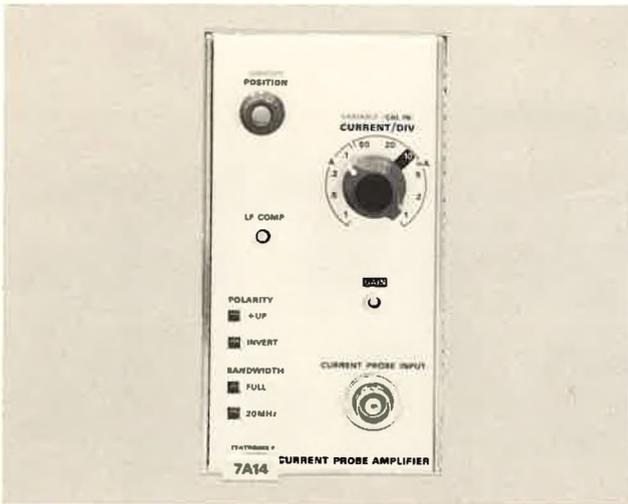


Fig. 4. 7A14 Current Probe Amplifier.

7A16 Wide Band Amplifier

Deflection Factor	5 mV/div to 5 V/div
Input Resistance	1 M Ω within 2%
Input Capacitance	15 pF within 0.5 pF
Bandwidth	(See System Specification) Maintains full bandwidth capabilities of system over complete range of deflection factors



Fig. 3. 7A13 Differential Comparator and Differential Amplifier.

7A14 Current Probe Amplifier

Deflection Factor	1 mA/div to 1 A/div
Input Connector	Special BNC connector senses type of probe in use and switches internal compensation circuit so no gain adjustment is needed.

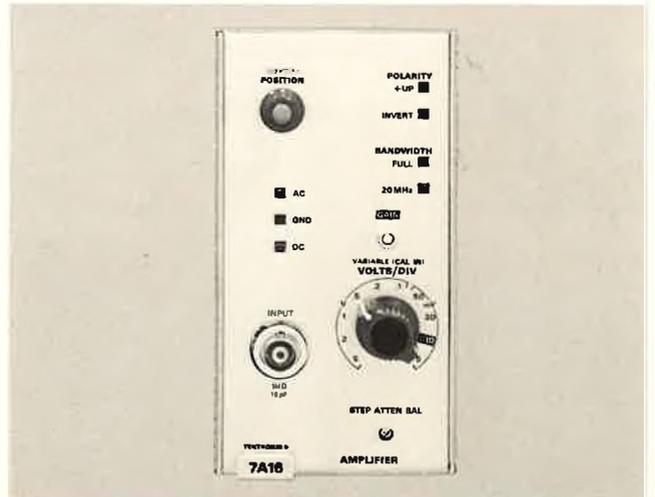


Fig. 5. 7A16 Wide Band Amplifier.

AMPLIFIERS (Cont)

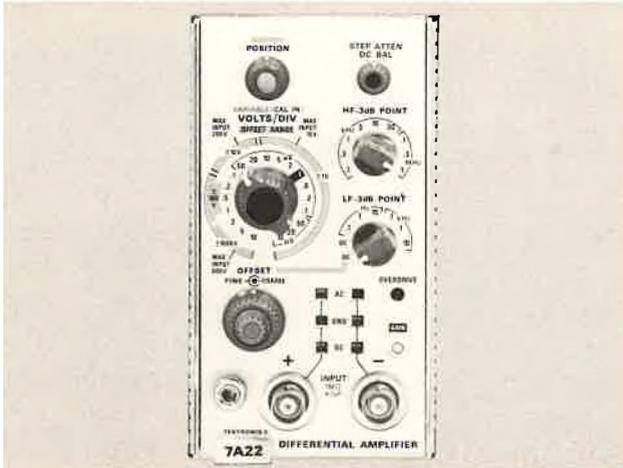


Fig. 6. 7A22 High-Gain Differential Amplifier.

7A22 High-Gain Differential Amplifier

Deflection Factor	10 μ V/div to 10 V/div
Input Resistance	1 M Ω within 1%
Input Capacitance	47 pF within 2.5 pF
Displayed Noise	16 μ V at 10 μ V/div at maximum bandwidth, tangentially measured.

REAL TIME TIME BASES

7B50 Time Base

Sweep Rate	5 s/div to 50 ns/div (5 ns/div with X10 MAGNIFIER) in 25 calibrated steps
Triggering	To 100 MHz or vertical amplifier bandwidth, whichever is less. Sweep free runs providing bright baseline in the absence of adequate triggering signal in P-P AUTO and AUTO triggering modes
Internal Trigger Jitter	1 ns or less at 75 MHz
Display Mode	Time-Base for normal sweep operation. Amplifier for X-Y operation

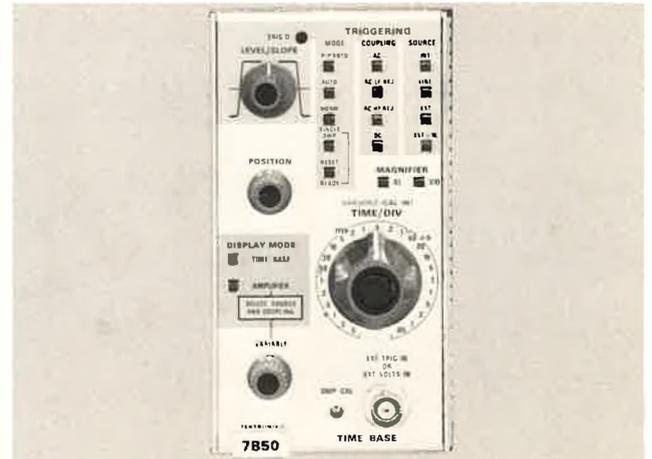


Fig. 7. 7B50 Time Base.

7B51 Delaying Time Base

Used singly in 7500-Series oscilloscope as conventional time base, or in combination with Type 7B50 as delaying sweep time base.

Sweep Rate and Triggering	Same as Type 7B50
Delay Time Multiplier Range	0 to 10 times the time/div setting
Accuracy	5 s/div to 1 s/div within 2% 0.5 s/div to 1 μ s/div within 1%.
Multiplier Incremental Linearity	Within 0.2%
Jitter	1 part or less in 50,000 of 10X the TIME/DIV setting

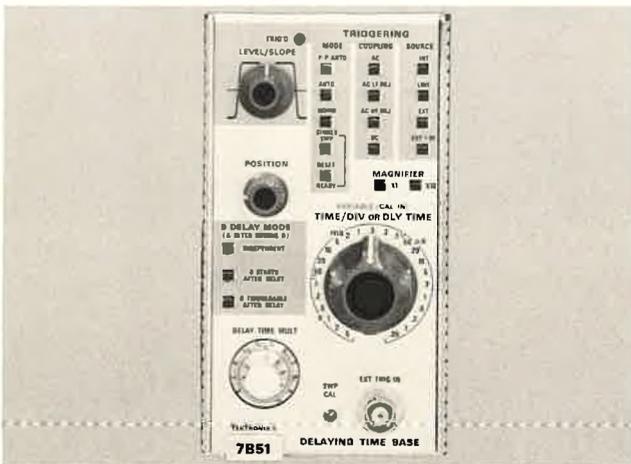


Fig. 8. 7B51 Delaying Time Base.

REAL TIME TIME BASES (Cont)

7B52 Dual Time Base Unit

Designed specifically for the 7500-Series Oscilloscopes but is compatible with all the 7000-Series.

- Sweep Rate** 0.05 μ s/div to 5 s/div (5 ns/div with 10X MAGnifier) in 25 calibrated steps.
- Triggering** To 100 MHz or vertical amplifier bandwidth, whichever is less. Main sweep free runs in Auto Mode, providing bright trace in the absence of a triggering signal. Delayed sweep is triggerable after delay.
- Display Mode** Main Sweep, Manix Sweep intensified during Delayed Sweep, Delayed Sweep only, and Mixed (display of Main Sweep and Delayed Sweep). Horizontal Amplifier can be used for X-Y operation.

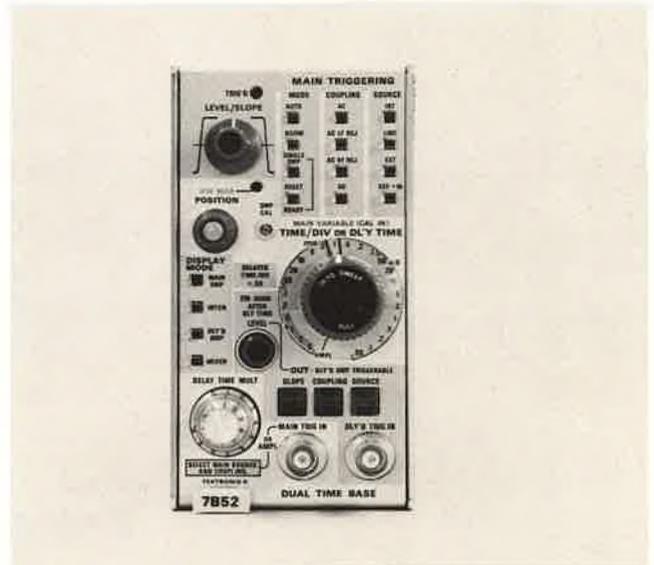


Fig. 9. 7B52 Dual Time Base.

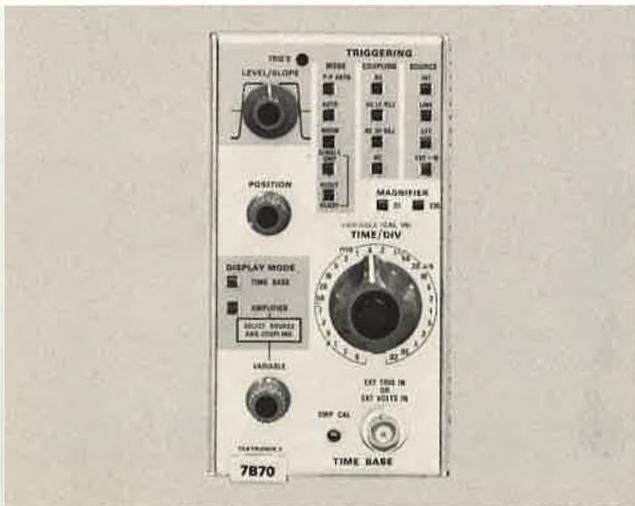


Fig. 10. 7B70 Time Base.

7B70 Time Base

- Sweep Rate** 0.02 μ s/div to 5 s/div (2 ns/div with X10 MAGNIFIER) in 26 calibrated steps
- Triggering** To 200 MHz or vertical amplifier bandwidth, whichever is less. Sweep free runs providing bright base line in the absence of adequate triggering signal in P-P AUTO and AUTO triggering modes.
- Display Mode** Time-Base for normal sweep operation. Amplifier for X-Y operation and phase measurements.

REAL TIME TIME BASES (Cont)



Fig. 11. 7B71 Delaying Time Base.

7B71 Delaying Time Base

Used singly in 7700-Series oscilloscope as conventional time base, or in combination with Type 7B70 as delaying sweep time base.

Sweep Rate and Triggering	Same as Type 7B70
Delay Time Multiplier Range	0 to 10 times TIME/DIV setting
Accuracy	5 s/div to 1 s/div within 2%
	0.5 s/div to 1 μ s/div within 1%
Multiplier Incremental Linearity	within 0.2%
Jitter	1 part or less in 50,000 of 10X TIME/DIV setting.

SAMPLING UNIT

7S11 Sampling Unit

Single channel sampling unit accepting all Tektronix sampling heads. Vertical characteristics set by the sampling head in use.

DC Offset	± 1 volt
Units/Div	2 to 200
Polarity	Display normal or inverted
Output connectors	Offset & Vertical Signal

Internal Trigger circuits operate with sampling heads containing trigger pickoff circuitry. Will operate with a second 7S11 for dual-trace sampling, both controlled by a 7T11 Sampling Sweep Unit.

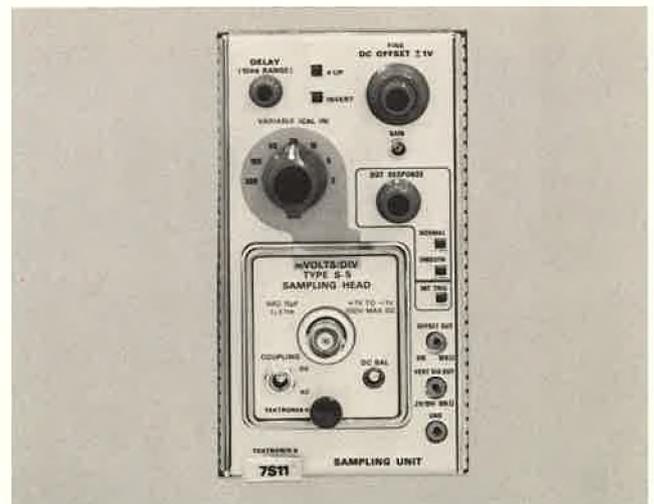


Fig. 12. 7S11 Sampling Unit.

SAMPLING SWEEP

7T11 Sampling Sweep Unit

Automatically provides equivalent time or real time sampling process. Random mode or sequential mode available during equivalent time sampling. Operates with one or two 7S11 Sampling Units.

Sweep Rates	Equivalent time, 5 μ s/Div to 10 ps/Div Real time, 5 ms/Div to 0.1 μ s/Div
Time Position Ranges	Equivalent time, 50 ns to 50 μ s Real time, 0.5 ms to 50 ms
Triggering	Internal (except with S-3 plug-in head) or External.
Modes	Frequency Range
Internal	DC to 500 MHz
External, 50 Ω Input	DC to 500 MHz
External, 1 M Ω Input	DC to 100 MHz
External, 50 Ω Input HF sync	500 MHz to 12.4 GHz
Frequency coverage	DC coupled through 12.4 GHz HF Sync
Sensitivity	5 mV to 2 V P-P (50 mV internal)
Dot Density	Variable, 50 to 1000 dots/Div



Fig. 13. 7T11 Sampling Sweep Unit.

DELAY LINE

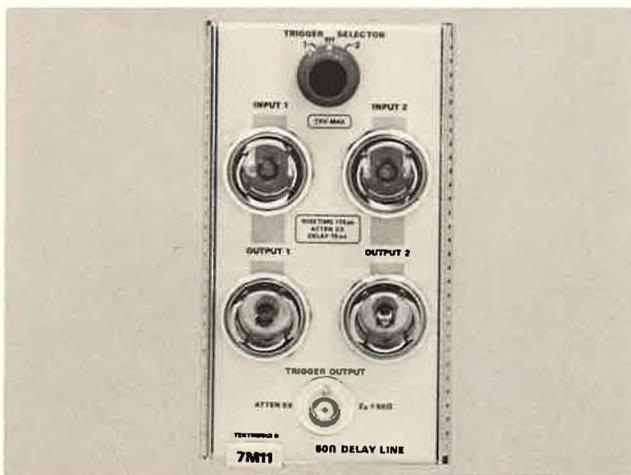


Fig. 14. 7M11 50 Ω Delay Line, Dual channel.

7M11 50 Ω Delay Line, Dual Channel

Signal Delay	75 ns, 30 ps or less time difference between channels
Risetime	175 ps or less
Attenuation	2X
Trigger Pickoff	Selectable from either channel

An accessory for sequential sampling systems without internal delay lines, or for random sampling systems operated at low signal repetition rates requiring a pretrigger.

SAMPLING HEADS

Signal Input Heads

S-1 Sampling Head

Input Resistance 50 Ω
 Risetime 350 ps
 Random noise less than
 2 mV

S-2 Sampling Head

Input Resistance 50 Ω
 Risetime 50 ps
 Random noise Less than
 6 mV

S-3 Sampling Head (with attached probe)

Input Resistance 100 k Ω
 Input Capacitance 2.3 pF
 Risetime 350 ps
 Random noise Less than
 3 mV

S-4 Sampling (3 mm input connector)

Input Resistance 50 Ω
 Risetime 25 ps
 Random noise Less than
 5 mV

S-5 Sampling Head

Input Resistance 1 M Ω
 Risetime 1 ns
 (with 10X probe)
 Noise Less than
 500 μ V

Special Purpose Heads

S-50 Pulse Generator Head (3 mm output connector)

Pulse Risetime 25 ps
 Pulse Amplitude +400 mV
 Pulse Duration 100 ns, with pre-
 trigger out

S-51 Trigger Countdown Head (3 mm input connector)

Trigger Countdown 1 to 18 GHz
 Input Signal Volt- 100 mV P-P to
 age 5 V P-P

SECTION 2

OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

General

To effectively use the 7503, the operation and capabilities of the instrument must be known. This section describes the operation of the front-, rear-, and side-panel controls and connectors and gives first time and general operating information.

PRELIMINARY INFORMATION

Operating Voltage

WARNING

This instrument is designed for operation from a power source with its neutral at or near earth (ground) potential with a separate safety-earth conductor. It is not intended for operation from two phases of a multi-phase system, or across the legs of a single-phase, three-wire system.

The 7503 can be operated from either a 115-volt or a 230-volt nominal line voltage source. The Line Voltage Selector assembly on the rear panel converts this instrument from one operating voltage to the other. In addition, this assembly changes the primary connections of the power transformer to allow selection of one of three regulating ranges. The assembly also includes the two line fuses to provide the correct protection for the instrument as the line voltage is changed. Use the following procedure to obtain correct instrument operation from the line voltage available.

1. Disconnect the instrument from the power source.
2. Loosen the two captive screws which hold the cover onto the selector assembly; then pull to remove the cover.
3. To convert from 115-volts to 230-volts nominal line voltage, or vice versa, pull out the Voltage Selector switch bar (see Fig. 2-1); turn it around 180° and plug it back into the remaining holes. Change the line-cord plug to match the power-source receptacle or use a 115-to 230-volt adapter.

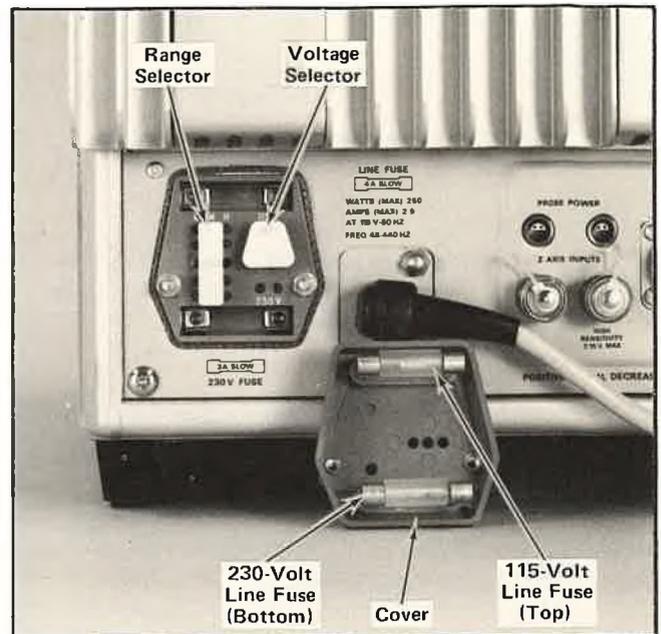


Fig. 2-1. Line Voltage Selector assembly on rear panel (shown with cover removed).

NOTE

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

Line	Black
Neutral	White
Safety earth (ground)	Green

4. To change regulating ranges, pull out the Range Selector switch bar (see Fig. 2-1); slide it to the desired position and plug it back in. Select a range which is centered about the average line voltage to which the instrument is to be connected (see Table 2-1).
5. Re-install the cover and tighten the captive screws.
6. Before applying power to the instrument, check that the indicating tabs on the switch bars are protruding through the correct holes for the desired nominal line voltage and regulating range.

TABLE 2-1
Regulating Ranges

Range Selector Switch Position	Regulating Range	
	115-volts nominal	230-volts nominal
LO (switch bar in left holes)	90 to 110 volts	180 to 220 volts
M (switch bar in middle holes)	104 to 126 volts	208 to 252 volts
HI (switch bar in right holes)	112 to 136 volts	224 to 272 volts

CAUTION

This instrument may be damaged if operated with the Line Voltage Selector assembly set to incorrect positions for the line voltage applied.

The 7503 is designed to be used with a three-wire AC power system. If the three- to two-wire adapter is used to connect this instrument to a two-wire AC power system, be sure to connect the ground lead of the adapter to earth (ground). Failure to complete the ground system may allow the chassis of this instrument to be elevated above ground potential and pose a shock hazard.

Operating Temperature

The 7503 can be operated where the ambient air temperature is between 0° C and +50° C. This instrument can be stored in ambient temperatures between -55° C and +75° C. After storage at temperatures beyond the operating limits, allow the chassis temperature to come within the operating limits before power is applied.

The 7503 is cooled by convection air flow through the instrument. Components which require the most cooling are mounted externally on a heat radiator at the rear of this instrument. Adequate clearance must be provided on all sides to allow heat to be dissipated from the instrument. Do not block or restrict the air flow through the holes in the cabinet or the heat radiator on the rear. Maintain the clearance provided by the feet on the bottom and allow about two inches clearance on the top, sides, and rear (more if possible).

A thermal cutout in this instrument provides thermal protection and disconnects the power to the instrument if the internal temperature exceeds a safe operating level. Power is automatically restored when the temperature returns to a safe level. Operation in confined areas or in close proximity to heat-producing instruments may cause the thermal cutout to open more frequently.

Operating Position

A bail-type stand is mounted on the bottom of this instrument. This stand permits the 7503 to be tilted up about 10° for more convenient viewing (see Fig. 2-2).

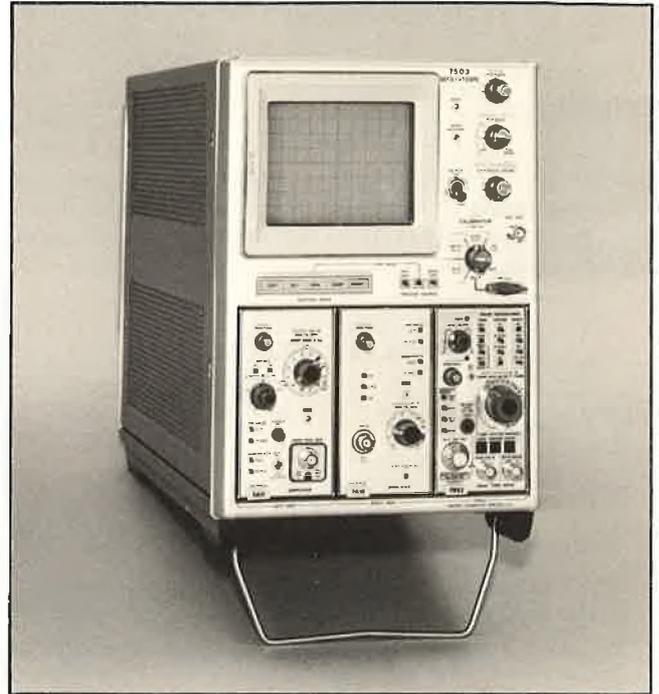


Fig. 2-2. Instrument positioned on bail-type stand.

PLUG-IN UNITS

General

The 7503 is designed to accept up to three Tektronix 7-series plug-in units. This plug-in feature allows a variety of display combinations and also allows selection of bandwidth, sensitivity, display mode, etc. to meet the measurement requirements. In addition, it allows the oscilloscope system to be expanded to meet future measurement requirements. The overall capabilities of the resultant system are in large part determined by the characteristics of the plug-in selected. A list of the currently available plug-ins along with their major specifications, is given in Section 1. For more complete information, see the current Tektronix, Inc. catalog.

Installation

To install a plug-in unit into one of the plug-in compartments, align the slots in the top and bottom of the plug-in with the associated guide rails in the plug-in compartment. Push the plug-in unit firmly into the compartment until it locks into place. To remove a plug-in, pull the release latch on the plug-in unit to disengage it and pull the unit out

of the compartment. Plug-in units can be removed or installed without turning off the instrument power. However, installation of the plug-ins with the power on may on without turning off the instrument power. However, installation of the plug-ins with the power on may on occasion cause the power-supply protection circuits of the 7503 to interrupt the power to the instrument. This is due to the sudden surge of current that is demanded as a plug-in is connected to the power-supply circuits. If the 7503 is not operating after the plug-ins are inserted, turn off the POWER switch momentarily and return it to ON.

It is not necessary that all of the plug-in compartments be filled to operate the instrument; only the plug-ins needed for the measurement to be made are necessary. However, at environmental extremes, interference may be radiated into this instrument through the open plug-in compartment; also, the instrument may radiate interference into other equipment. Blank plug-in panels are available from Tektronix, Inc. to cover the unused compartment; order Tektronix Part No. 016-0155-00.

When the 7503 is calibrated in accordance with the calibration procedure given in this instruction manual, the vertical and horizontal gain are normalized. This allows calibrated plug-in units to be changed from one plug-in compartment to another without recalibration. However, the basic calibration of the individual plug-in units should be checked when they are installed in this system to verify their measurement accuracy. See the operating instructions section of the plug-in unit instruction manual for verification procedure.

The plug-in feature of the 7503 allows a variety of display modes with many different plug-ins. Specific information for obtaining these displays is given later in this section. However, the following information is provided here to aid in plug-in installation.

To produce a single-trace display, install a single-channel vertical unit (or dual-channel unit set for single-channel operation) in either of the vertical compartments. For dual-trace displays, either install a dual-channel vertical unit in one of the vertical compartments or install a single-channel vertical unit in each vertical compartment. A combination of a single-channel and dual-channel vertical unit allows a three-trace display; likewise, a combination of two dual-channel vertical units allows a four-trace display.

For time-base displays, a 7B-series plug-in is placed in the Horizontal compartment.

X-Y displays can be obtained in two ways with the 7503 system. If a 7B-series time-base plug-in is available which

has an amplifier feature, the X signal can be routed through one of the vertical units via the internal-trigger pickoff circuitry to the horizontal system. Then, the vertical (Y) signal is connected to the remaining vertical unit. Also, a 7A-series amplifier plug-in can be installed in the horizontal compartment for X-Y operation.

Special purpose plug-ins may have specific restrictions regarding the plug-in compartments in which they can be installed. This information will be given in the instruction manuals for these plug-ins.

CONTROLS AND CONNECTORS

General

The major controls and connectors for operation of the 7503 are located on the front panel of the instrument. Several auxiliary functions are provided on the side and rear panels. Fig. 2-3 shows the front, side, and rear panels of the 7503. To make full use of the capabilities of this instrument, the operator should be familiar with the function and use of each of these controls and connectors. A brief description of each control and connector is given here. More detailed operating information is given under General Operating Information.

Cathode-Ray Tube (CRT)

ASTIG	Screwdriver adjustment used in conjunction with the FOCUS control to obtain a well-defined display. Does not require readjustment in normal use.
INTENSITY	Controls brightness of the trace. Control is inoperative when the HORIZ compartment is vacant.
FOCUS	Provides adjustment for optimum display definition.
BEAM FINDER (PULL LOCK)	Compresses display within graticule area independent of display position or applied signals. Momentary actuation provided when button is pressed; display remains compressed when knob is pulled outward to lock it in the "find" position.
READOUT	Controls brightness of the readout portion of the CRT display. In the fully counterclockwise position, the Readout System is inoperative.

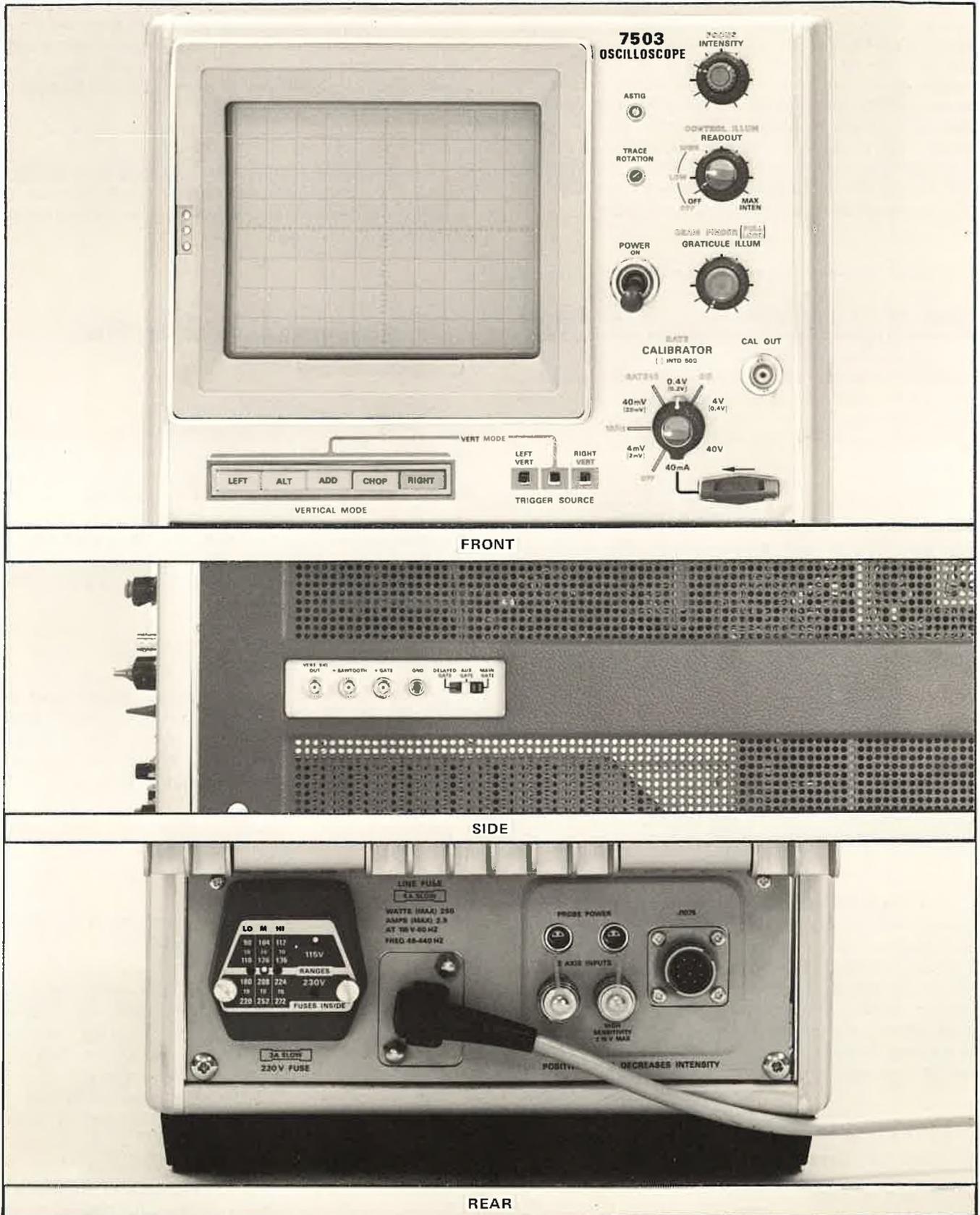


Fig. 2-3. Front-, side- and rear-panel controls and connectors.

CONTROL ILLUM Controls illumination level of push-button switches on the 7503 and the associated plug-ins.

OFF: All pushbutton lights off.

LOW: All pushbuttons illuminated at low intensity.

HIGH: Pushbuttons illuminated at maximum intensity.

TRACE ROTATION Screwdriver adjustment to align trace with horizontal graticule lines.

GRATICULE ILLUM Controls graticule illumination.

Mode Selectors

VERTICAL MODE Selects vertical mode of operation.

LEFT: Signal from plug-in unit in LEFT VERT compartment is displayed.

ALT: Signals from plug-in units in both LEFT VERT and RIGHT VERT compartments are displayed. Display switched between vertical plug-ins after each sweep.

ADD: Signals from plug-in units in both LEFT VERT and RIGHT VERT compartments are algebraically added and the algebraic sum displayed on the CRT.

CHOP: Signals from plug-in units in both LEFT VERT and RIGHT VERT compartments are displayed. Display switched between vertical plug-ins at a one-megahertz repetition rate.

RIGHT: Signal from plug-in unit in RIGHT VERT compartment is displayed.

TRIGGER SOURCE Selects source of internal trigger signal for time-base unit in the Horizontal compartment.

VERT MODE: Trigger signal automatically follows the vertical display except in CHOP; then the trigger signal is the same as for ADD.

LEFT VERT: Trigger signal is obtained from plug-in unit in LEFT VERT compartment.

RIGHT VERT: Trigger signal is obtained from plug-in unit in RIGHT VERT compartment.

Calibrator

CALIBRATOR

Selects amplitude of output at CAL OUT connector or 40 mA current through current loop. Outputs available from four millivolts to 40 volts, into high-impedance load, in decade steps, or from two millivolts to 0.4 volt into 50-ohm load (output into 50 ohms shown in brackets on panel).

RATE

Selects the mode and repetition rate of the output from the Calibrator.

OFF: Calibrator is disabled. No current through current loop and no voltage at CAL OUT connector.

1 kHz: Calibrator operates at one-kilohertz rate. 40-milliampere square-wave current through current loop or square-wave voltage (amplitude determined by CALIBRATOR switch) at CAL OUT connector.

GATE ÷2: Calibrator operates at one-half the repetition rate of the gate signal from the time-base unit in the Horizontal compartment. 40-milliampere square-wave current through current loop or square-wave voltage (amplitude determined by CALIBRATOR switch) at CAL OUT connector.

DC: DC voltage available at CAL OUT connector (amplitude determined by CALIBRATOR switch), or 40 milliampere DC current through current loop.

Outputs

CAL OUT

Provides positive-going calibrator output when voltage operation is selected.

40 mA Current Loop

Probe loop providing calibrator current output when CALIBRATOR switch is set to 40 mA position.

Side Panel

VERT SIG OUT

Provides output signal from the vertical plug-ins. Source of the output signal at the VERT SIG OUT connector is selected by the TRIGGER SOURCE switch.

Operating Instructions—7503

+ SAWTOOTH	Positive-going sample of sawtooth signal from a time-base unit in the HORIZ compartment.
+ GATE	Positive-going gate signal from a time-base unit in the HORIZ compartment. Switch allows selection of one of three gate signals: MAIN GATE, coincident with the sweep being displayed; AUX GATE, depends upon type of time-base unit; DELAYED GATE, coincident with the delay period (delaying sweep time-base units only).
GND	Binding post to establish common ground between the 7503 and any associated equipment.

Rear Panel

Line Voltage Selector (not labeled) Switching assembly to select the nominal operating voltage and the line voltage range. The assembly also includes the line fuses.

Voltage Selector: Selects nominal operating voltage range (115 or 230 volts).

Range Selector: Selects line voltage range (low, medium, high).

PROBE POWER Power source for active probe systems.

Z-AXIS INPUTS Input connectors for intensity modulation of the CRT display.

HIGH SPEED: Input connector for high-amplitude Z-axis signals; usable over full frequency range of instrument.

HIGH SENSITIVITY: Input connector for low-amplitude Z-axis signals; usable for signals with repetition rates of DC to 10 megahertz; input voltage derating necessary between two and 10 megahertz.

J1075 Nine-pin connector which provides remote single-sweep reset and ready indication for the time-base unit in the HORIZ compartment (with compatible time-base units only).

FIRST-TIME OPERATION

General

The following steps demonstrate the use of the controls and connectors of the 7503. It is recommended that this procedure be followed completely for familiarization with this instrument.

Set-up Information

1. Set the front-panel controls as follows:

INTENSITY	Counterclockwise
FOCUS	Midrange
BEAM FINDER	Released
READOUT	OFF
CONTROL ILLUM	HIGH
GRATICULE ILLUM	Counterclockwise
POWER	OFF
CALIBRATOR	4 V
RATE	1 kHz
VERTICAL MODE	LEFT
TRIGGER SOURCE	VERT MODE

2. Connect the 7503 to a power source that meets the voltage and frequency requirements of this instrument. If the available line voltage is outside the limits of the Line Voltage Selector switch (on rear panel), see Operating Voltage in this section.

3. Insert Tektronix 7A-series amplifier units into both the LEFT VERT and RIGHT VERT compartments. Insert a Tektronix 7B-series time-base unit into the HORIZ compartment.

4. Set the POWER switch to ON. Allow several minutes warmup so the instrument reaches a normal operating temperature before proceeding.

5. Set both vertical units for a vertical deflection factor of two volts/division and center the vertical position controls.

6. Set the time-base unit for a sweep rate of 0.5 millisecond/division in the auto, internal trigger mode.

7. Advance the INTENSITY control until the trace is at the desired viewing level (near midrange).

8. Connect the CAL OUT connector to the input connector of the left vertical unit with a BNC-to-BNC patch cord (supplied accessory).

9. Adjust the FOCUS control for a sharp, well-defined display over the entire trace length. (If focused display cannot be obtained, see Astigmatism Adjustment in this section.)

10. Disconnect the input signal and position the trace with the left vertical unit position control so it coincides with the center horizontal line of the graticule.

11. If the trace is not parallel with the center horizontal line, see Trace Alignment Adjustment in this section.

12. Rotate the GRATICULE ILLUM control throughout its range and notice that the graticule lines are illuminated as the control is turned clockwise (most obvious with tinted filter installed). Set control so graticule lines are illuminated as desired.

Calibration

13. Connect the CAL OUT connector to the input connectors of both vertical units with the BNC-to-BNC jumper leads.

14. The display should be two divisions in amplitude with five complete cycles shown horizontally. An incorrect display indicates that the plug-ins need to be recalibrated. See the instruction manual of the applicable unit for complete information.

Vertical Mode

15. Notice that the position control of only the left vertical unit has any effect on the displayed trace. Position the start of the trace to the farthest left line of the graticule with the time-base unit position control, and move the trace to the upper half of the graticule with the left vertical unit position control.

16. Press the RIGHT button of the VERTICAL MODE switch.

17. Notice that the position control of only the right vertical unit has any effect on the displayed trace. Move the display to the bottom half of the graticule with the right vertical unit position control.

18. Press the ALT button of the VERTICAL MODE switch. Notice that two traces are displayed on the CRT. The top trace is produced by the left vertical unit, and the bottom trace is produced by the right vertical unit. Reduce the sweep rate of the time-base unit to 50 milliseconds/

division. Notice that the display alternates between the left and right vertical units after each sweep. Turn the time-base sweep rate switch throughout its range. Notice that the display alternates between vertical units at all sweep rates.

19. Press the CHOP button of the VERTICAL MODE switch. Turn the time-base unit sweep rate switch throughout its range. Notice that a dual-trace display is presented at all sweep rates, but unlike ALT, both vertical units are displayed on a time-sharing basis. Return the time-base unit sweep rate switch to 0.5 millisecond/division.

20. Press the ADD button of the VERTICAL MODE switch. The display should be four divisions in amplitude. Notice that the position control of either vertical unit moves the display. Return the VERTICAL MODE switch to the LEFT position.

Triggering

21. Center the display on the CRT with the left vertical unit position control. Disconnect the input signal from the right vertical unit input connector. Press all of the VERTICAL MODE switch buttons in sequence. Notice that a stable display is obtained in all positions of the VERTICAL MODE switch (straight line in RIGHT position).

22. Press the LEFT VERT button of the TRIGGER SOURCE switch. Again, press all of the VERTICAL MODE buttons in sequence. Notice that the display is again stable in all positions, as in the previous step.

23. Press the RIGHT VERT button of the TRIGGER SOURCE switch. Press all the VERTICAL MODE switch buttons in Sequence and notice that a stable display cannot be obtained in any position. This is because there is no input signal connected to the right vertical unit.

Control Illumination

24. Notice that the selected switch buttons of the 7503 and the plug-in units are illuminated.

25. Change the CONTROL ILLUM switch to the LOW position. Notice that the selected buttons of the 7503 and the plug-ins are illuminated at a reduced intensity.

26. Change the CONTROL ILLUM switch to the OFF position. Notice that none of the buttons are illuminated.

Readout

27. Turn the READOUT control clockwise until a digital display is visible within the top or bottom division of

Operating Instructions—7503

the CRT. Change the deflection factor of the vertical unit selected for display. Notice that the readout display changes as the deflection factor is changed. Change the sweep rate of the time-base unit. Notice that the readout display for the time-base unit changes also as the sweep rate is changed.

28. Set the time-base unit for magnified operation. Notice that the readout display changes to indicate the correct magnified sweep rate. If a readout-coded 10X probe is available for use with the vertical unit, connect it to the input connector of the vertical plug-in. Notice that the deflection factor indicated by the readout is increased by 10 times when the probe is added. Return the time-base unit to normal sweep operation and disconnect the probe.

29. Press all of the VERTICAL MODE switch buttons in sequence. Notice that the readout from a particular plug-in occupies a specific location on the display area. If either of the vertical units is a dual-trace unit, notice that the readout for channel 2 appears within the lower division of the CRT.

Beam Finder

30. Set the vertical deflection factor of the vertical plug-in which is displayed to 0.1 volt/division. Notice that no square wave display is visible, since the deflection exceeds the scan area of the CRT.

31. Press the BEAM FINDER button. Notice that the display is returned to the viewing area in compressed form. Release the BEAM FINDER switch and note that the display again disappears from the viewing area. Pull the BEAM FINDER outward so it locks in the "find" position. Notice that the display is again returned to the viewing area in compressed form, but that in this position it remains on the viewing area as long as the BEAM FINDER switch is locked in the outward position.

32. With the BEAM FINDER switch locked in the outward position, increase the vertical and horizontal deflection factors until the display is reduced to about two divisions vertically and horizontally (when the time-base unit is in the time-base mode, change only the deflection factor of the vertical unit). Adjust the position controls of the vertical unit and time-base unit to center the compressed display about the center lines of the graticule. Press the BEAM FINDER switch in and release. Notice that the display remains within the viewing area.

Calibrator

33. Set the RATE switch to the GATE÷2 position. Notice that the display appears as two horizontal lines. The

repetition rate of the displayed signal is one-half that of the gate signal produced by the time-base unit (approximately 10 times the setting of the sweep rate switch). Notice that two individual lines can be obtained alternately when the time-base unit sweep rate switch is set to the slower rates. Also notice that the vertical deflection (separation between the lines) is adjustable with the CALIBRATOR switch.

34. Set the RATE switch to DC. Establish a ground reference level on the CRT (such as center horizontal line of graticule). Set the vertical unit for DC input coupling. Notice that the display is a straight line deflected from the ground reference line by the amplitude selected by the CALIBRATOR switch.

35. If a current-probe amplifier plug-in is available, the current function of the Calibrator can be demonstrated. Install the current-probe amplifier plug-in in the 7503 and press the VERTICAL MODE button which will display this unit. Set the RATE switch to the 1 kHz position and the CALIBRATOR switch to the 40 mA position. Connect the current probe to the 40 mA current loop (observe current direction shown by arrow). Set the deflection factor of the current-probe amplifier to display several divisions of the calibrator waveform. Set the RATE switch to the GATE ÷2 position. Notice that the display is the same amplitude as obtained previously, but that the repetition rate is variable with the time-base unit sweep rate switch. Change the RATE switch to the DC position. Notice that there is no deflection on the CRT. The DC current function can be demonstrated only with a current-probe that is sensitive to DC current.

Z-Axis Input

36. If an external signal is available (five volts peak-to-peak minimum), the function of the Z-AXIS INPUTS can be demonstrated. Remove the BNC caps from both Z-AXIS INPUTS (on rear panel). Connect the external signal to both the input connector of the displayed vertical unit and the HIGH SENSITIVITY connector. Set the sweep rate of the time base to display about five cycles of the waveform. Adjust the amplitude of the signal generator until intensity modulation is visible on the display (change the vertical deflection factor as necessary to produce an on-screen display). The positive peaks of the waveform should be blanked out and the negative peaks intensified. Notice that the setting of the INTENSITY control determines the amount of intensity modulation that is visible.

37. Disconnect the external signal from the HIGH SENSITIVITY connector and reconnect it to the HIGH SPEED connector. Increase the amplitude of the signal generator again until trace modulation is apparent on the displayed waveform. Notice that a higher amplitude signal is necessary to produce trace modulation. Again, the positive peaks

of the waveform should be blanked out and the negative peaks intensified. Also, notice that the setting of the INTENSITY control affects the amount of trace modulation. The major difference between these two methods of obtaining trace modulation is that the HIGH SENSITIVITY input is more sensitive, but the HIGH SPEED input has a higher usable frequency range. Replace the BNC caps on both Z-AXIS INPUTS.

This completes the description of the basic operating procedure for the 7503. Instrument operations not explained here, or operations which need further explanation are discussed under General Operating Information.

TEST SET-UP CHART

General

Fig. 2-4 shows the front, side- and rear-panels of the 7503. This chart may be reproduced and used as a test-setup record for special measurements, applications or procedures, or training purposes.

GENERAL OPERATING INFORMATION

Simplified Operating Instructions

General. The following information is provided to aid in quickly obtaining the correct setting for the 7503 to present a display. The operator should be familiar with the complete function and operation of the instrument as described in this section before using this procedure. For detailed operating information for the plug-in units, see the instruction manuals for the applicable units.

Single-Trace Display. The following procedure will provide a display of a single-trace vertical unit against the time-base unit. For simplicity of explanation, the vertical unit is installed in the LEFT VERT compartment and a time-base unit is installed in the HORIZ compartment. Other compartments can be used if the following procedure is changed accordingly.

1. Install a 7A-series vertical unit in the LEFT VERT compartment.

2. Press the LEFT button of the VERTICAL MODE switch.

3. Install a 7B-series time-base unit in the HORIZ compartment.

4. Press the VERT MODE button of the TRIGGER SOURCE switch.

5. Set the POWER switch to ON. Allow several minutes warmup.

6. Connect the signal to the input connector of the vertical unit.

7. Set the vertical unit for AC input coupling and calibrated deflection factor.

8. Set the time-base unit for auto mode, internal triggering at a calibrated sweep rate of one millisecond/division.

9. Advance the INTENSITY control until a display is visible. (If no display is visible with INTENSITY at about midrange, press the BEAM FINDER switch and adjust the vertical deflection factor until the display is reduced in size vertically; then center the compressed display with vertical and horizontal position controls. Release the BEAM FINDER.) Adjust the FOCUS control for a well-defined display.

10. Set the vertical deflection factor and vertical position control for a display which remains within the graticule area vertically.

11. If necessary, set the time-base triggering controls for a stable display.

12. Adjust the time-base position control so the display begins at the left line of the graticule. Set the time-base sweep rate to display the desired number of cycles.

Dual-Trace Display. The following procedure will provide a display of two single-trace vertical units.

1. Install 7A-series vertical units in both vertical plug-in compartments.

2. Press the LEFT button of the VERTICAL MODE switch.

3. Install a 7B-series time-base unit in the HORIZ compartment.

7503 TEST SETUP CHART

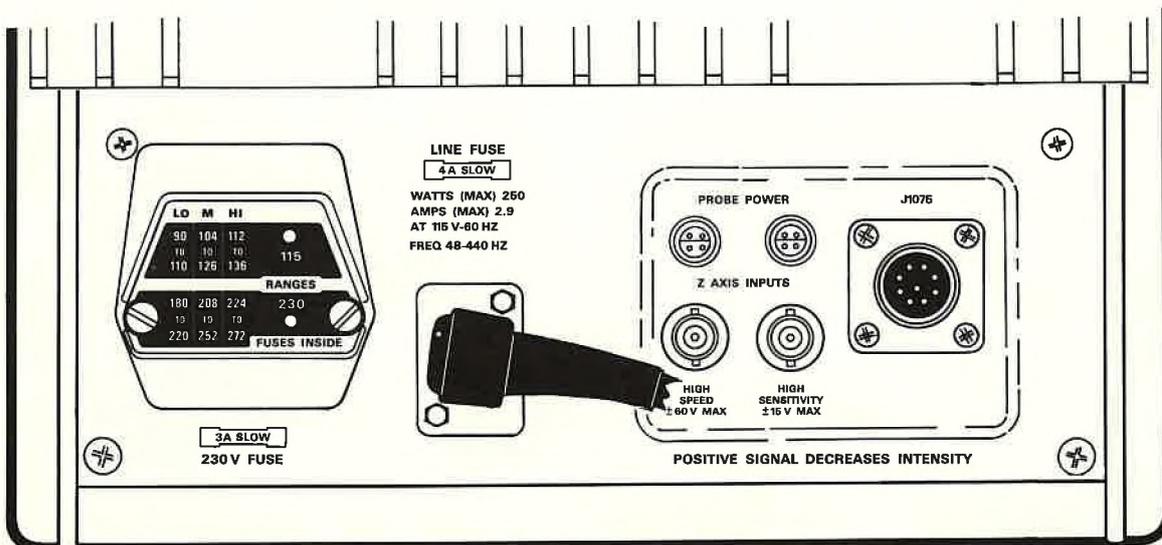
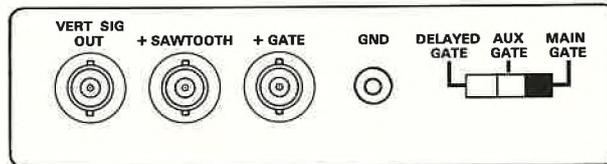
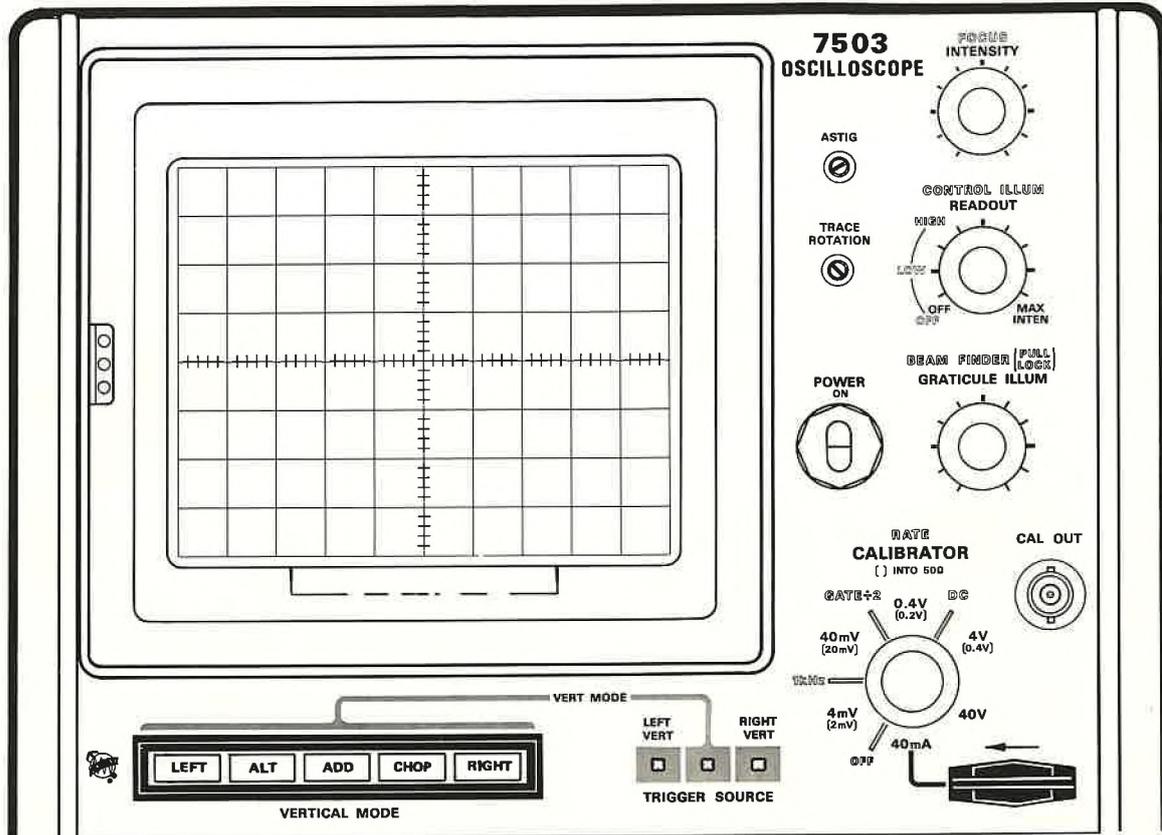


Fig. 2-4.

4. Press the VERT MODE button of the TRIGGER SOURCE switch.

5. Set the POWER switch to ON. Allow several minutes warmup.

6. Connect the signals to the input connectors of the vertical units.

7. Set the vertical units for AC input coupling and calibrated deflection factors.

8. Set the time-base unit for auto mode, internal triggering at a sweep rate of one millisecond/division.

9. Advance the INTENSITY control until a display is visible. (If no display is visible with INTENSITY at mid-range, press BEAM FINDER switch and adjust vertical deflection factor until display is reduced in size vertically; then center compressed display with vertical and horizontal position controls. Release the BEAM FINDER.) Set the FOCUS control for a well-defined display.

10. Set the left vertical unit deflection factor for a display about four divisions in amplitude. Adjust the left vertical position control to move this display to the top of the graticule area.

11. Press the RIGHT button of the VERTICAL MODE switch.

12. Set the right vertical unit deflection factor for a display which is about four divisions in amplitude (if display cannot be located, use BEAM FINDER switch). Position this display to the bottom of the graticule area with the right vertical position control.

13. Press the ALT or CHOP button of the VERTICAL MODE switch. A dual-trace display of the signal from the left vertical and right vertical plug-ins should be presented on the CRT. (For more information on choice of dual-trace mode, see Vertical Mode in this section.)

14. If necessary, adjust the time-base triggering controls for a stable display.

15. Adjust the time-base position control so the display begins at the left graticule line. Set the time-base sweep rate for the desired horizontal display.

X-Y Display. The following procedure will provide an X-Y display (one signal versus another, rather than against time).

NOTE

Some 7B-series time-base units have provisions for amplifier operation in the X-Y mode; see X-Y Operation in this section for details of operation in this manner.

1. Install 7A-series amplifier units in both the LEFT VERT and the HORIZ compartments.

2. Press the LEFT button of the VERTICAL MODE switch.

3. Set the POWER switch to ON. Allow several minutes warmup.

4. Connect the X-signal to the amplifier unit in the HORIZ compartment.

5. Connect the Y-signal to the amplifier unit in the LEFT VERT compartment.

6. Set both amplifier units for AC input coupling and calibrated deflection factors.

7. Advance the INTENSITY control until a display is visible. (If no display is visible, press BEAM FINDER switch and adjust the deflection factors of both amplifier units until display is reduced in size both vertically and horizontally; then center compressed display with the position controls. Release BEAM FINDER.)

8. Set the deflection factors of both amplifier units for the desired display and center the display with the position controls. The amplifier unit in the LEFT VERT compartment controls the vertical deflection.

Intensity Controls

The 7503 has two separate intensity controls. The INTENSITY control determines the brightness of the display produced by the plug-in unit in the HORIZ compartment. The READOUT intensity control determines the brightness of only the readout portion of the CRT display.

The setting of the intensity controls may affect the correct focus of the display. Slight re-adjustment of the

Operating Instructions—7503

FOCUS control may be necessary when the intensity level is changed. To protect the CRT phosphor, do not turn the intensity controls higher than necessary to provide a satisfactory display. The light filters reduce the observed light output from the CRT. When using these filters, avoid advancing the intensity controls too high, as the trace may become de-focused. When the highest intensity display is desired, remove the filters and use only the clear faceplate protector (permanently installed behind bezel). Apparent trace intensity can also be improved in such cases by reducing the ambient light or using a viewing hood. Also, be careful that the INTENSITY control is not set too high when changing the time-base unit sweep rate from a fast to a slow sweep rate, or when changing to the X-Y mode of operation. The instrument incorporates protection circuitry which automatically reduces the display intensity to a lower level when the time-base unit is set to a slow sweep rate. This reduces the danger of damaging the CRT phosphor at these slower sweep rates.

Astigmatism Adjustment

If a well-defined display cannot be obtained with the FOCUS control, adjust the ASTIG adjustment as follows:

NOTE

To check for proper setting of the ASTIG adjustment, slowly turn the FOCUS control through the optimum setting. If the ASTIG adjustment is correctly set, the vertical and horizontal portions of the display will come into sharpest focus at the same position of the FOCUS control. This setting of the ASTIG adjustment should be correct for any display. However, it may be necessary to reset the FOCUS control slightly when the intensity of the display is changed.

1. Connect the CAL OUT connector to the vertical unit with a BNC-to-BNC jumper lead.
2. Set the CALIBRATOR switch to 4 V and the RATE switch to 1 kHz. Adjust the vertical deflection factor to produce a two- or three-division display.
3. Set the time-base unit for a sweep rate of 0.2 millisecond/division.
4. Set the INTENSITY control so the display is at normal intensity (about midrange).
5. Turn the FOCUS control fully counterclockwise and set the ASTIG adjustment to midrange.

6. Adjust the FOCUS control so the top and bottom of the displayed square wave are as thin as possible, but not elongated.

7. Set the ASTIG adjustment so the top and bottom of the displayed square wave are as thin as possible.

8. Repeat parts 6 and 7 for best overall focus.

Trace Alignment Adjustment

If a free-running trace is not parallel with the horizontal graticule lines, set the TRACE ROTATION adjustment as follows: Position the trace to the center horizontal line and adjust the TRACE ROTATION adjustment so the trace is parallel with the horizontal graticule lines.

Graticule

The graticule of the 7503 is marked on the inside of the faceplate of the CRT, providing accurate, no-parallax measurements. The graticule is divided into eight vertical and ten horizontal divisions. Each division is one centimeter square. In addition, each major division is divided into five minor divisions at the center vertical and horizontal lines. The vertical gain and horizontal timing of the plug-ins are calibrated to the graticule so accurate measurements can be made from the CRT. The illumination of the graticule lines can be varied with the GRATICULE ILLUM control.

Fig. 2-5 shows the graticule of the 7503 and defines the various measurement lines. The terminology defined here will be used in all discussions involving graticule measurements.

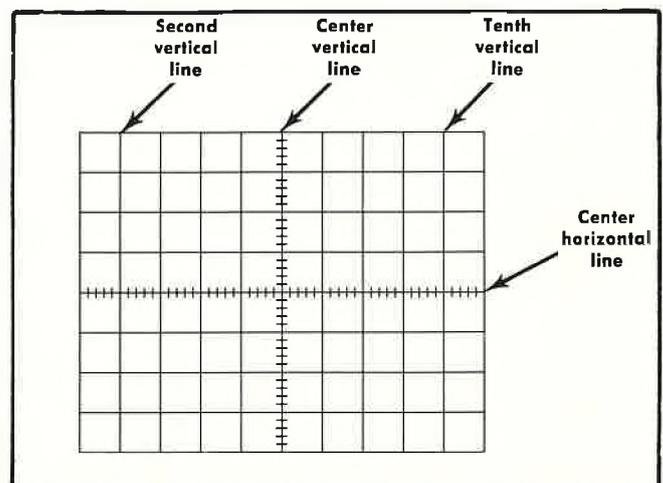


Fig. 2-5. Definition of measurement lines on the 7503 graticule.

Light Filter

The tinted filter provided with the 7503 minimizes light reflections from the face of the CRT to improve contrast when viewing the display under high ambient light conditions. This filter should be removed for waveform photographs or when viewing high-writing-rate displays. To remove the filter, pull outward on the bottom of the plastic CRT mask and remove it from the CRT. Remove the tinted filter (leave the metal light shield in place) and snap the plastic CRT mask back into place. A clear plastic faceplate protector is mounted between the CRT faceplate and the bezel. This faceplate protector should be left in place at all times to protect the CRT faceplate from scratches.

An optional mesh filter is available for use with the 7503. This filter provides shielding against radiated EMI (electro-magnetic interference) from the face of the CRT. It also serves as a light filter to make the trace more visible under high ambient light conditions. The mesh filter fits in place of the plastic CRT mask. The filter can be ordered by Tektronix Part No. 378-0603-00.

Beam Finder

The BEAM FINDER switch provides a means of locating a display which overscans the viewing area either vertically or horizontally. When the BEAM FINDER switch is pressed, the display is compressed within the graticule area. This switch can also be pulled outward to lock it in the beam-finder position. The latter feature is convenient when attempting to locate traces from more than one of the plug-in units in the 7503. Press the BEAM FINDER switch in to release it from the locked position. To locate and re-position an overscanned display, use the following procedure:

1. Press the BEAM FINDER switch in (or if desired, pull it outward to lock position).
2. While the display is compressed, increase the vertical and horizontal deflection factors until the vertical deflection is reduced to about two divisions and the horizontal deflection is reduced to about four divisions (the horizontal deflection needs to be reduced only when in the X-Y mode of operation).
3. Adjust the vertical and horizontal position controls to center the display about the vertical and horizontal center lines of the graticule.
4. Release the BEAM FINDER switch; the display should remain within the viewing area.

Control Illumination

The CONTROL ILLUM switch determines the illumination level of the pushbutton switches on the 7503 and

the associated plug-in units. This switch controls the illumination of only the pushbutton switches on the plug-in units and does not affect the intensity of lights which are used as function indicators (for example, it does not affect the illumination of the ready light on a time-base unit which has the single-sweep feature). In the OFF position, all pushbutton lights on the 7503 and the associated plug-ins are off. In the LOW position, the selected buttons are illuminated at low intensity. This is the recommended position for the CONTROL ILLUM switch, since it provides an adequate indication of switch position and also results in longest bulb life. The HIGH position provides maximum intensity for the pushbuttons and can be used so the selected switch is obvious even under high ambient light conditions.

Readout

NOTE

If the Readout System is not installed in this instrument (Option 1), disregard the following information. Also, the READOUT control has no effect upon instrument operation in this case.

The Readout System of the 7503 allows alpha-numeric display of information on the CRT along with the analog waveform displays. The information displayed by the Readout System is obtained from the plug-in units which are installed in the plug-in compartments. The characters of the readout display are written by the CRT beam on a time-shared basis with the signal waveforms. However, the waveform display is interrupted for only about 20 microseconds for each character that is displayed. Only about 0.1% of total available display time (including retrace and holdoff time of time-base unit) is used to display each character.

The readout information from each plug-in is called a word. Up to six words of readout information can be displayed on the 7503 CRT (two channels from each of the three plug-in compartments). The location at which each readout word is presented is fixed, and is directly related to the plug-in unit and channel from which it originated. Fig. 2-6 shows the area of the graticule where the readout from each plug-in unit and/or channel is displayed. Notice that the readout from channel 1 of each plug-in unit is displayed within the top division of the graticule, and the readout from channel 2 is displayed directly below within the bottom division of the graticule. Only the readout from plug-ins and/or channels which are selected for display by the VERTICAL MODE switch, or by the mode switches of dual-channel plug-ins, appear in the readout display.

An "identify" feature is provided by the Readout System to link the readout word with the originating plug-

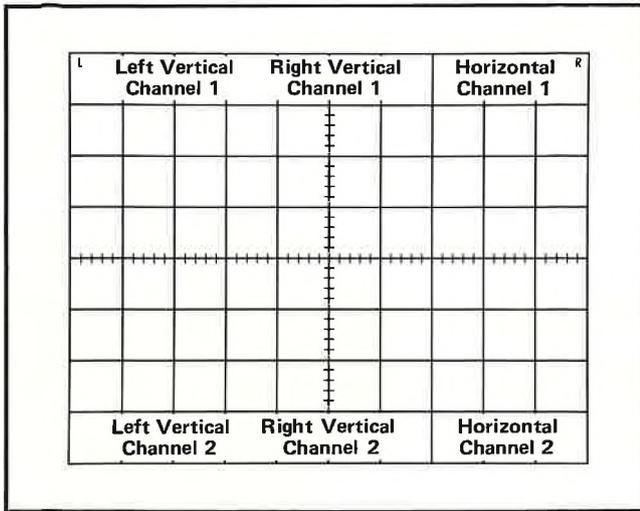


Fig. 2-6. Location of readout words on the CRT identifying the originating plug-in and channel.

in unit and channel (amplifier units only). When the "Identify" button of an amplifier unit is pressed, the word IDENTIFY appears in the readout location allocated to that plug-in and channel. Other readout words in the display remain unchanged. When the "Identify" button is released, the readout display from this plug-in channel is again displayed. Circuitry may be provided in the amplifier unit which produces a noticeable change in the analog waveform display to also identify the associated trace when the "Identify" button is pressed; see the plug-in instruction manual for details.

The READOUT control determines the intensity of the readout portion of the display only, independent of the other traces. The Readout System is inoperative in the fully counterclockwise OFF position. This may be desirable when the top and bottom divisions of the graticule are to be used for waveform display, or when the trace interruptions necessary to display characters do not allow satisfactory waveform display to be obtained.

Vertical Mode

Left and Right Mode. When the LEFT or RIGHT button of the VERTICAL MODE switch is pressed, only the signal from the plug-in unit in the selected compartment is displayed.

Alternate Mode. The ALT position of the VERTICAL MODE switch produces a display which alternates between the plug-in units in the LEFT VERT and RIGHT VERT compartments with each sweep on the CRT. Although the ALT mode can be used at all sweep rates, the CHOP mode provides a more satisfactory display at sweep rates below about 20 milliseconds/division. At these slower sweep rates, alternate-mode switching becomes visually perceptible.

The TRIGGER SOURCE switch allows selection of the triggering for an alternate display. When the switch is set to the VERT MODE position, each sweep is triggered by the signal being displayed on the CRT. This provides a stable display of two unrelated signals, but does not indicate the time relationship between the signals. In either the LEFT VERT or the RIGHT VERT positions, the two signals are displayed showing true time relationship. However, if the signals are not time-related, the display from the plug-in which is not providing a trigger signal will appear unstable on the CRT.

Chopped Mode. The CHOP position of the VERTICAL MODE switch produces a display which is electronically switched between channels at a one-megahertz rate. In general, the CHOP mode provides the best display at sweep rates slower than about 20 milliseconds/division, or whenever dual-trace, single-shot phenomena are to be displayed. At faster sweep rates, the chopped switching becomes apparent and may interfere with the display.

Correct internal triggering for the CHOP mode can be obtained in any of the three positions of the TRIGGER SOURCE switch. When the TRIGGER SOURCE switch is set to VERT MODE, the internal trigger signals from the vertical plug-ins are algebraically added and the time-base unit is triggered from the resultant signal. Use of the LEFT VERT or RIGHT VERT trigger-source positions triggers the time-base unit on the internal trigger signal from the selected vertical unit only. This allows two time-related signals to be displayed showing true time relationship. However, if the signals are not time-related, the display from the channel which is not providing the trigger signal will appear unstable. The CHOP mode can be used to compare two single-shot, transient, or random signals which occur within the time interval determined by the time-base unit (ten times selected sweep rate). To provide correct triggering, the display which provides the trigger signal must precede the second display in time. Since the signals show true time relationship, time-difference measurements can be made from the display.

Algebraic Addition. The ADD position of the VERTICAL MODE switch can be used to display the sum or difference of two signals, for common-mode rejection, to remove an undesired signal, or for DC offset (applying a DC voltage to one channel to offset the DC component of a signal on the other channel). The common-mode rejection ratio between the vertical plug-ins of the 7503 is greater than 20:1 at 75 megahertz. The rejection ratio increases to 100:1 at DC.

The overall deflection on the CRT in the ADD mode is the resultant of the algebraic addition of the signals from the two vertical plug-in units. It is difficult to determine the voltage amplitude of the resultant display, unless the ampli-

tude of the signal applied to one of the plug-ins is known. This is particularly true when the vertical units are set to different deflection factors, since it is not obvious which portion of the display is a result of the signal applied to either plug-in unit. Also, the polarity and repetition rate of the applied signals enters into the calculation.

The following general precautions should be observed to provide the best display when using the ADD mode.

1. Do not exceed the input voltage rating of the plug-in units.
2. Do not apply large signals to the plug-in inputs. A good rule to follow is not to apply a signal which exceeds an equivalent of about eight times the vertical deflection factors. For example, with a vertical deflection factor of 0.5 volt/division, the voltage to that plug-in should not exceed four volts. Larger voltages may result in a distorted display.
3. To ensure the greatest dynamic range in the ADD mode, set the position controls of the plug-in units to a setting which would result in a mid-screen display if viewed in the LEFT or RIGHT positions of the VERTICAL MODE switch.
4. For similar response from each channel, set the plug-in units for the same input coupling.

Trigger Source

The TRIGGER SOURCE switch allows selection of the internal trigger for the time-base unit. For most applications, this switch can be set to the VERT MODE position. This position is the most convenient, since the internal trigger signal is automatically switched as the VERTICAL MODE switch is changed, or as the display is electronically switched between the LEFT VERT and RIGHT VERT plug-ins in the ALT position of the VERTICAL MODE switch. It also provides a usable trigger signal in the ADD or CHOP positions of the VERTICAL MODE switch, since the internal trigger signal in these modes is the algebraic sum of the signals applied to the vertical plug-in units. Therefore, the VERT MODE position ensures that the time-base unit receives a trigger signal regardless of the VERTICAL MODE switch setting, without the need to change the trigger source selection. However, if correct triggering for the desired display is not obtained in the VERT MODE position, the trigger source can be changed to obtain the trigger signal from either the LEFT VERT or RIGHT VERT plug-in. The internal trigger signal is obtained from the selected vertical compartment, whether the plug-in in that compartment is selected for display on the CRT or

not. If the internal trigger signal is obtained from one of the vertical units but the other vertical unit is selected for display, the internal trigger signal must be time-related to the displayed signal in order to obtain a triggered (stable) display.

X-Y Operation

In some applications, it is desirable to display one signal versus another (X-Y) rather than against time (internal sweep). The flexibility of the plug-in units available for use with the 7503 provides a means for applying an external signal to the horizontal deflection system for this type of display. Some of the 7B-series time-base units can be operated as amplifiers in addition to their normal use as time-base generators. This feature allows an external signal to provide the horizontal deflection on the CRT. For most of the time-base units with the amplifier function, the X (horizontal) signal can be connected either to an external input connector on the time-base unit or it can be routed to the time-base unit through the internal triggering system (see time-base instruction manual for details). If the latter method is used, the TRIGGER SOURCE switch must be set so that the X (horizontal) signal is obtained from one of the vertical units and the Y (vertical) signal is obtained from the other vertical unit. It is advantageous to use the internal trigger system to provide the X signal, since the attenuator switch of the amplifier unit providing the horizontal signal determines the horizontal deflection factor, to allow full-range operation; and also, the plug-in units do not have to be moved between compartments when X-Y operation is desired.

Another way to obtain an X-Y display is to install an amplifier plug-in unit in the horizontal plug-in compartment. (Check amplifier unit gain as given in the plug-in instruction manual to obtain calibrated horizontal deflection factors.) This method provides the best X-Y display, particularly if two identical amplifier units are used, since both the X and Y input systems will have the same delay time, gain characteristics, input coupling, etc. For further information on obtaining X-Y displays, see the plug-in unit manuals. Also, the reference books listed under Applications provide information on X-Y measurements and interpreting the resultant lissajous displays.

An X-Y delay compensation network is automatically switched into the horizontal deflection system when an amplifier plug-in unit is installed in the HORIZ compartment, or when a time-base unit is operated in the amplifier mode. This network provides close delay-matching between the vertical and horizontal deflection systems up to two megahertz for use in X-Y applications which require precise phase measurement.

Intensity Modulation

Intensity (Z-axis) modulation can be used to relate a third item of electrical phenomena to the vertical (Y-axis)

and the horizontal (X-axis) coordinates, without affecting the waveshape of the displayed signal. The Z-axis modulating signal applied to the CRT circuit changes the intensity of the displayed waveform to provide this type of display. "Gray scale" intensity modulation can be obtained by applying signals which do not completely blank the display. Large amplitude signals of the correct polarity will completely blank the display; the sharpest display is provided by signals with a fast rise and fall. The voltage amplitude required for visible trace modulation depends on the setting of the INTENSITY control.

Time markers applied to the Z-AXIS INPUTS provide a direct time reference on the display. With uncalibrated horizontal sweep or X-Y mode operation, the time markers provide a means of reading time directly from the display. However, if the markers are not time-related to the displayed waveform, a single-sweep display should be used (for internal sweep only) to provide a stable display.

Two modes of intensity modulation are provided in the 7503. The following discussions list the use and limitations of each mode.

HIGH SENSITIVITY Input. The HIGH SENSITIVITY input (on rear panel) permits intensity modulation of the CRT display through the Z-axis Amplifier circuit. A two-volt peak-to-peak signal will completely blank the display, even at maximum intensity levels. Lower amplitude signals can be used to just change the trace brightness, rather than completely blank the display. Negative-going modulating signals increase the display intensity, and positive-going modulating signals decrease the display intensity. Bandwidth for this mode of intensity modulation is DC to 10 megahertz (input voltage derating necessary above two megahertz). The maximum input voltage in this mode should be limited to 15 volts (DC plus peak AC). Since this input is the most sensitive, it can be used for all applications requiring bandwidth of 10 megahertz or less. When the HIGH SENSITIVITY input is not in use, replace the BNC cap.

HIGH SPEED Input. Intensity modulation signals connected to the HIGH SPEED connector (on rear panel) are connected primarily to the cathode circuit of the CRT. A 60-volt peak-to-peak signal will provide complete blanking of the display, even at maximum intensity settings. Negative-going modulating signals increase the display intensity, and positive-going modulating signals decrease the display intensity. Bandwidth for this mode is DC to 75 megahertz. Maximum input voltage for signals connected to the HIGH SPEED input is 60 volts (DC plus peak AC). Replace the grounding BNC cap when the HIGH SPEED input is not in use.

Raster Displays

A raster-type display can be used to effectively increase the apparent sweep length. For this type of display, the trace is deflected both vertically and horizontally by sawtooth signals. This is accomplished in the 7503 by installing a 7B-series time-base unit in one of the vertical plug-in compartments. Normally, the time-base unit in the vertical compartment should be set to a slower sweep rate than the time-base unit in the horizontal compartment; the number of horizontal traces in the raster depends upon the ratio between the two sweep rates. Information can be displayed on the raster using several different methods. In the ADD position of the VERTICAL MODE switch, the signal from an amplifier unit can be algebraically added to the vertical deflection. With this method, the vertical signal amplitude on the CRT should not exceed the distance between the horizontal lines of the raster. Another method of displaying information on the raster is to use the Z-AXIS INPUTS to provide intensity modulation of the display. Complete information on operation using the Z-axis feature is given under Intensity Modulation. This type of raster display could be used to provide a television-type display.

To provide a stable raster display, both time-base units must be correctly triggered. Internal triggering is not provided for the time-base unit when operated in the vertical compartments; external triggering must be used. Also, blanking is not provided from the time-base unit when operated in a vertical compartment. To blank out the retrace portion from the time-base unit in the vertical compartment, special connections must be made from this time-base unit to the blanking network of the 7503.

Calibrator

General. The internal calibrator of the 7503 provides a convenient signal source for checking basic vertical gain and sweep timing. The calibrator output signal is also very useful for adjusting probe compensation as described in the probe instruction manual. In addition, the calibrator can be used as a convenient signal source for application to external equipment.

Voltage. The calibrator provides accurate output voltages at the CAL OUT connector from four millivolts to 40 volts in decade steps into high impedance loads. In addition, the positions from 4 mV to 4 V provide an output of two millivolts to 0.4 volt into 50 ohms (shown on front panel in brackets). The output voltage is selected by the CALIBRATOR switch. The output voltage is available at the front-panel CAL OUT connector.

Current. The current loop provides a 40-milliampere output current which can be used to check and calibrate current-measuring probe systems. The current signal is obtained by clipping the probe around the current loop. The

arrow above the current loop indicates conventional current flow; i.e., from plus to minus.

Repetition Rate. The calibrator circuit uses frequency-stable components to maintain accurate frequency and constant duty cycle. Thus, the calibrator can be used for checking the basic sweep timing of time-base units (one-kilohertz rate only). The RATE switch selects the repetition rate of the calibrator. Two positions of the RATE switch provide a square-wave output signal either at the CAL OUT connector or through the current loop. In the 1 kHz position, the repetition rate of the calibrator is one kilohertz. The GATE $\div 2$ position of the RATE switch provides a variable calibrator repetition rate. In this position, the repetition rate of the calibrator output signal is one-half the repetition rate of the gate signal produced by the time-base unit in the HORIZ compartment (length of gate is about ten times the setting of the sweep rate switch). This position of the RATE switch allows selection of repetition rate of the calibrator output signal by changing the sweep rate of the time-base unit in the HORIZ compartment. The calibrator circuit maintains a constant 50% duty cycle on the output waveform, regardless of the repetition rate.

In the DC position, positive DC voltage levels are available at the CAL OUT connector; the amplitude of the DC voltage is determined by the setting of the CALIBRATOR switch to one of the voltage ranges. When the CALIBRATOR switch is set to the 40 mA position, a DC current of 40 mA is provided through the current loop.

Wave Shape. The square-wave output signal of the calibrator can be used as a reference wave shape when checking or adjusting the compensation of passive, high-resistance probes. Since the square-wave output from the calibrator has a flat top, any distortion in the displayed waveform is due to the probe compensation.

Signal Outputs

+ **Sawtooth.** The + SAWTOOTH connector provides a positive-going sample of the sawtooth signal from the time-base unit in the horizontal plug-in compartment. Rate of rise of the sawtooth output signal is about 50 millivolts/unit of time into a 50-ohm load or about one volt/unit of time into a one-megohm load. Unit of time is determined by the time-base time/division switch (e.g., if time/division is set to one millisecond/division, a unit of time is one millisecond; at five milliseconds/division, a unit of time is five milliseconds). The peak output voltage is greater than 500 millivolts into a 50-ohm load or greater than 10 volts into a one-megohm load.

+ **Gate.** The + GATE output connector provides a positive-going rectangular output pulse from the time-base

unit in the horizontal plug-in compartment. The Gate switch allows the output signal to be selected from the displayed sweep, or the delayed gate from a delaying-sweep time-base unit, or the AUX GATE from a dual-sweep time-base unit. Duration of the gate output signal is the same as the duration of the sweep or, in the case of the delayed gate, it ends at the end of the delay period. Amplitude of the output signal at the + GATE connector is about 0.5 volt into 50 ohms, or about 10 volts into one megohm.

Vertical Signal. The VERT SIG OUT connector provides a sample of the vertical deflection signal. The source of the output signal at this connector is determined by the TRIGGER SOURCE switch. In the VERT MODE position of the TRIGGER SOURCE switch, the output signal is determined by the setting of the VERTICAL MODE switch. The output signal in the LEFT and RIGHT positions of the VERTICAL MODE switch is obtained only from the selected vertical unit. In the ALT position of the VERTICAL MODE switch, the output signal at the VERT SIG OUT connector switches between vertical units along with the CRT display. However, the vertical output signal in the CHOP position is a composite signal, and is the same as obtained in the ADD position due to the requirements of the triggering system. The LEFT VERT and RIGHT VERT positions of the TRIGGER SOURCE switch provide the vertical output signal only from the selected vertical unit, even when it is not selected for display. The output voltage into a 50-ohm load is about 25 millivolts/division of CRT display and about 0.5 volt/division of display into a one-megohm load. The bandwidth of the output signal is determined by the vertical plug-in unit used (see Systems Specification given in Section 1).

Probe Power Connectors

The two PROBE POWER connectors on the rear panel provide operating power for active probe systems. It is not recommended that these connectors be used as a power source for applications other than the compatible probes or other accessories which are specifically designed for use with this system.

Remote Connector

The nine-terminal connector J1075 on the rear panel of the 7503 provides input for remote operation of the instrument and the associated plug-in unit. Table 2-2 lists the function of each terminal of J1075. The mating connector for J1075 is Tektronix Part No. 134-0049-00 (one mating connector supplied as standard accessory). The methods of obtaining remote single-sweep reset and ready indication are given under Remote Single-Sweep Reset. Notice that there are several blank terminals on J1075. These terminals can be used for special remote applications.

Remote Single-Sweep Reset

Remote single-sweep reset operation can be provided to 7B-series time-base units with compatible features through rear-panel connector J1075. The remote single-sweep reset actuation can be obtained from either an active system (pulse generator, logic circuit, etc.) or a passive system (switch or relay). Input requirements for remote single-sweep reset operation are: Closure to ground (–5 volts to –0.5 volt provides actuation) at 10 milliamperes maximum current; minimum pulse width of 10 microseconds at 50% amplitude points; 15 volts maximum input voltage.

TABLE 2-2
Remote Connections

J1075 Terminal	Function
A	Remote single-sweep reset
B	Chassis ground
C	Remote ready indicator
D	No connection
E	No connection
F	No connection
H	No connection
J	No connection
K	No connection

Fig. 2-7 shows a typical passive system to provide remote single-sweep reset operation. The remote ready light is optional and can be used with an active or passive system whenever it is necessary to provide an indication at the remote location that reset has occurred.

Applications

The 7503 Oscilloscope and its associated plug-in units provide a very flexible measurement system. The capabilities of the overall system depend mainly upon the plug-ins chosen for use with this instrument. Specific applications for the individual plug-in units are described in the plug-in unit manuals. The overall system can also be used for many applications which are not described in detail either in this manual or in the manuals for the individual plug-in units. Contact your local Tektronix Field Office or representative for assistance in making specific measurements with this instrument.

The following books describe oscilloscope measurement techniques which can be adapted for use:

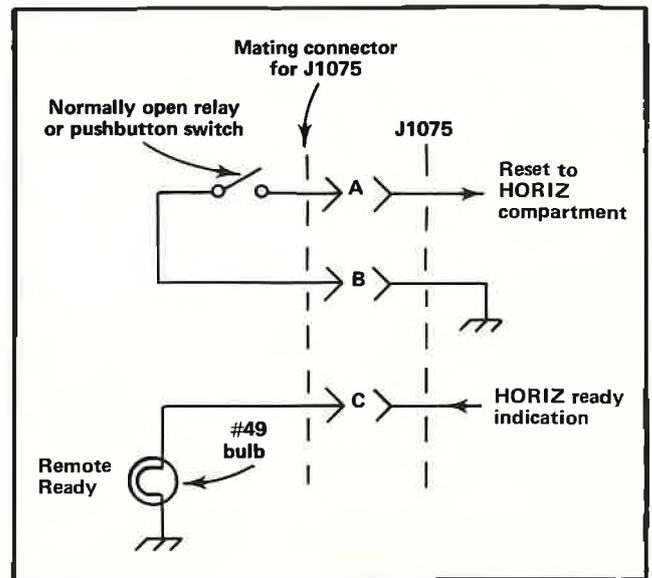


Fig. 2-7. Typical circuit for remote single-sweep reset operation.

Harley Carter, "An Introduction to the Cathode Ray Oscilloscope", Philips Technical Library, Cleaver-Hume Press Ltd., London, 1960.

J. Czech, "Oscilloscope Measuring Techniques", Philips Technical Library, Springer-Verlag, New York, 1965.

Robert G. Middleton and L. Donald Payne, "Using the Oscilloscope in Industrial Electronics", Howard W. Sams & Co. Inc., The Bobbs-Merrill Company Inc., Indianapolis, 1961.

John F. Rider and Seymour D. Uslan, "Encyclopedia of Cathode-Ray Oscilloscopes and Their Uses", John F. Rider Publisher Inc., New York, 1959.

John F. Rider, "Obtaining and Interpreting Test Scope Traces," John F. Rider Publisher Inc., New York, 1959.

Rufus P. Turner, "Practical Oscilloscope Handbook", Volumes 1 and 2, John F. Rider Publisher Inc., New York, 1964.

SECTION 3

CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

This section of the manual contains a description of the circuitry used in the 7503 Oscilloscope. The description begins with a discussion of the instrument using the basic block diagram shown in Fig. 3-1. Then, each circuit is described in detail using detailed block diagrams to show the interconnections between the stages in each major circuit and the relationship of the front-panel controls to the individual stages.

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

BLOCK DIAGRAM

General

The following discussion is provided to aid in understanding the overall concept of the 7503 before the individual circuits are discussed in detail. A basic block diagram of the 7503 is shown in Fig. 3-1. Only the basic interconnections between the individual blocks are shown on this diagram. Each block represents a major circuit within the instrument. The number on each block refers to the complete circuit diagram which is located at the rear of this manual.

Vertical signals to be displayed on the CRT are applied to the Vertical Interface circuit from both vertical plug-in compartments. The vertical Interface circuit determines whether the signal from the left and/or right vertical unit displayed. The vertical signal selected is then amplified by the Vertical Amplifier circuit to bring it to the level necessary to drive the vertical deflection plates of the CRT. This circuit also includes an input to produce the vertical portion of a readout display.

Horizontal signals for display on the CRT are connected to the X-Y Delay Compensation and Horizontal Amplifier circuit from the horizontal plug-in compartment. The X-Y Delay Compensation network provides a delay for the

horizontal (X) portion of an X-Y display to match the delay of the vertical (Y) signal due to the delay line. The horizontal signal is connected to the Horizontal Amplifier circuit, which amplifies it to provide the horizontal deflection for the CRT. This circuit also accepts the X-signal from the Readout System to produce the horizontal portion of a readout display. The Readout System provides alpha-numeric display of information encoded by the plug-in units. This display is presented on the CRT and is written by the CRT beam on a time-shared basis with the analog waveform display.

The internal trigger signals from the vertical plug-in units are connected to the Trigger Selector circuit. This circuit selects the trigger signal which is connected to the horizontal plug-in unit. It also provides the drive signal for the Output Signals circuit to produce an output which is a sample of the vertical signal. The Output Signals circuit also provides a sample of the sawtooth signal and a gate signal from a time-base unit in the horizontal compartment. The Calibrator circuit produces a square-wave output with accurate amplitude which can be used to check the calibration of this instrument and the compensation of probes. The repetition rate of the output signal is selectable; either DC, one kilohertz, or one-half the sweep gate. This signal is available as a voltage at the CAL OUT connector or as a current through the 40 mA current loop.

The Logic Circuit develops control signals for use in other circuits within this instrument and the plug-in units. These output signals automatically determine the correct instrument operation in relation to the plug-ins installed and/or selected, plug-in control settings, and 7503 control settings. The Z-Axis Amplifier circuit provides the drive signal to control the CRT intensity level through the CRT Circuit. The CRT Circuit produces the voltages and contains the controls necessary for operation of the cathode-ray tube.

The Low-Voltage Power Supply circuit provides the power necessary for operation of this instrument. This voltage is connected to all circuits within the instrument. The Mode Switching and Rear Panel Connectors circuit shows the switching logic of the front-panel controls. It also includes the input network for the Z-AXIS INPUTS and the output connectors to supply probe power to active probe systems.

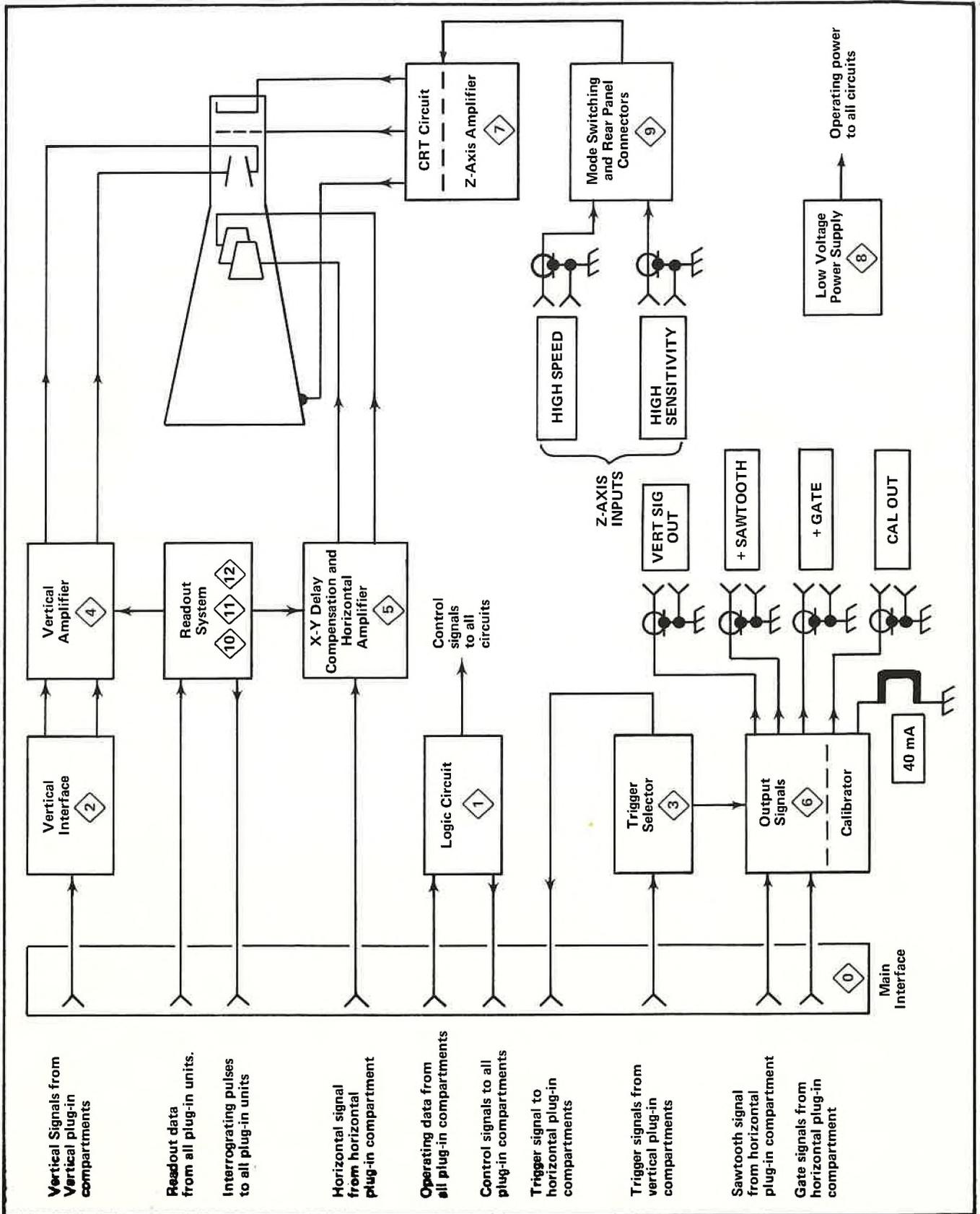


Fig. 3-1. Basic block diagram of the 7503 Oscilloscope.

CIRCUIT OPERATION

General

This section provides a detailed description of the electrical operation and relationship of the circuits in the 7503 Oscilloscope. The theory of operation for circuits unique to this instrument is described in detail in this discussion. Circuits which are commonly used in the electronics industry are not described in detail. If more information is desired on these commonly used circuits, refer to the following textbooks:

Tektronix Circuit Concepts Books (order from your local Tektronix Field Office or representative):

Cathode-Ray Tubes, Tektronix Part No. 062-0852-01.

Oscilloscope Trigger Circuits, Tektronix Part No. 062-1056-00.

Power Supply Circuits, Tektronix Part No. 062-0888-01.

Sweep Generator Circuits, Tektronix Part No. 062-1098-00.

Phillip Cutler, "Semiconductor Circuit Analysis", McGraw-Hill, New York, 1964.

Lloyd P. Hunter (Ed.), "Handbook of Semiconductor Electronics", second edition, McGraw-Hill, New York, 1964.

Jacob Millman and Herbert Taub, "Pulse, Digital, and Switching Waveforms", McGraw-Hill, New York, 1965.

The following circuit analysis is written around the detailed block diagrams which are given for each major circuit. These detailed block diagrams give the names of the individual stages within the major circuits, and show how they are connected together to form the major circuits. The block diagrams also show the inputs and outputs for each circuit and the relationship of the front-panel controls to the individual stages. The circuit diagrams from which the detailed block diagrams are derived are shown in the Diagrams section.

NOTE

All references to direction of current in this manual are in terms of conventional current; i.e., from plus to minus.

LOGIC FUNDAMENTALS

General

Digital logic techniques are used to perform many functions within this instrument. The function and operation of the logic circuits are described using logic symbology and terminology. This portion of the manual is provided to aid in the understanding of these symbols and terms. The following information is a basic introduction to logic concepts, not a comprehensive discussion of the subject. For further information on binary number systems and the associated Boolean Algebra concepts, the derivation of logic functions, a more detailed analysis of digital logic, etc., refer to the following textbooks:

Tektronix Circuit Concepts booklet, "Digital Concepts", Tektronix Part No. 062-1030-00.

Robert C Baron and Albert T. Piccirilli, "Digital Logic and Computer Operations", McGraw-Hill, New York, 1967.

Thomas C. Bartee, "Digital Computer Fundamentals", McGraw-Hill, New York, 1966.

Yaohan Chu, "Digital Computer Design Fundamentals", McGraw-Hill, New York, 1962.

Joseph Millman and Herbert Taub, "Pulse, Digital, and Switching Waveforms", McGraw-Hill, New York, 1965, Chapters 9-11.

Symbols

The operation of circuits within the 7503 which use digital techniques is described using the graphic symbols set forth in military standard MIL-STD-806B. Table 3-1 provides a basic logic reference for the logic devices used within this instrument. Any deviations from the standard symbology, or devices not defined by the standard will be described in the circuit description for the applicable device.

Logic Polarity

All logic functions are described using the positive logic convention. Positive logic is a system of notation where the more positive of two levels (HI) is called the true or 1-state; the more negative level (LO) is called the false or 0-state. The HI-LO method of notation is used in this logic description. The specific voltages which constitute a HI or LO state vary between individual devices.

NOTE

The HI-LO logic notation can be conveniently converted to 1-0 notation by disregarding the first letter of each state. For example:

$$HI = \bar{H}I$$

$$LO = \bar{L}O$$

Wherever possible, the input and output lines are named to indicate the function they perform when at the HI (true) state. For example, the line labeled "Display Right Command" means that the Right Vertical unit will be displayed when this line is HI or true. Likewise, the line labeled "X-Compensation Inhibit" means that the X-Compensation function is inhibited or disabled when this line is HI.

Input/Output Tables

Input/output (truth) tables are used in conjunction with the logic diagrams to show the input combinations which are of importance to a particular function, along with the resultant output conditions. This table may be given either for an individual device or for a complete logic stage. For examples of input/output tables for individual devices, see Table 3-1.

Non-Digital Devices

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

TABLE 3-1
Basic Logic Reference

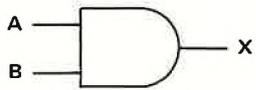
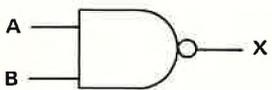
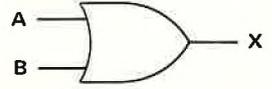
Device	Symbol	Description	Input/Output Table																		
AND gate		A device with two or more inputs and one output. The output of the AND gate is HI if and only if all of the inputs are at the HI state.	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>HI</td> </tr> </tbody> </table>	Input		Output	A	B	X	LO	LO	LO	LO	HI	LO	HI	LO	LO	HI	HI	HI
Input		Output																			
A	B	X																			
LO	LO	LO																			
LO	HI	LO																			
HI	LO	LO																			
HI	HI	HI																			
NAND gate		A device with two or more inputs and one output. The output of the NAND gate is LO if and only if all of the inputs are at the HI state.	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>LO</td> </tr> </tbody> </table>	Input		Output	A	B	X	LO	LO	HI	LO	HI	HI	HI	LO	HI	HI	HI	LO
Input		Output																			
A	B	X																			
LO	LO	HI																			
LO	HI	HI																			
HI	LO	HI																			
HI	HI	LO																			
OR gate		A device with two or more inputs and one output. The output of the OR gate is HI if one or more of the inputs are at the HI state.	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>HI</td> </tr> </tbody> </table>	Input		Output	A	B	X	LO	LO	LO	LO	HI	HI	HI	LO	HI	HI	HI	HI
Input		Output																			
A	B	X																			
LO	LO	LO																			
LO	HI	HI																			
HI	LO	HI																			
HI	HI	HI																			

TABLE 3-1 (cont.)

Basic Logic Reference

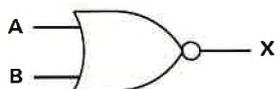
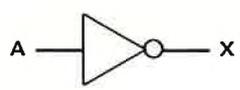
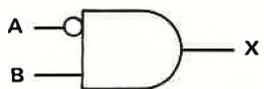
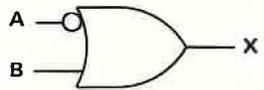
Device	Symbol	Description	Input/Output Table																		
NOR gate		A device with two or more inputs and one output. The output of the NOR gate is LO if one or more of the inputs are at the HI state.	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>LO</td> </tr> </tbody> </table>	Input		Output	A	B	X	LO	LO	HI	LO	HI	LO	HI	LO	LO	HI	HI	LO
Input		Output																			
A	B	X																			
LO	LO	HI																			
LO	HI	LO																			
HI	LO	LO																			
HI	HI	LO																			
Inverter		A device with one input and one output. The output state is always opposite to the input state.	<table border="1"> <thead> <tr> <th>Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> </tr> </tbody> </table>	Input	Output	A	X	LO	HI	HI	LO										
Input	Output																				
A	X																				
LO	HI																				
HI	LO																				
LO-state indicator		A small circle at the input or output of a symbol indicates that the LO state is the significant state. Absence of the circle indicates that the HI state is the significant state. Two examples follow:																			
		<p>AND gate with LO-state indicator at the A input.</p> <p>The output of this gate is HI if and only if the A input is LO and the B input is HI.</p>	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>LO</td> </tr> </tbody> </table>	Input		Output	A	B	X	LO	LO	LO	LO	HI	HI	HI	LO	LO	HI	HI	LO
Input		Output																			
A	B	X																			
LO	LO	LO																			
LO	HI	HI																			
HI	LO	LO																			
HI	HI	LO																			
		<p>OR gate with LO-state indicator at the A input:</p> <p>The output of this gate is HI if either the A input is LO or the B input is HI.</p>	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>HI</td> </tr> </tbody> </table>	Input		Output	A	B	X	LO	LO	HI	LO	HI	HI	HI	LO	LO	HI	HI	HI
Input		Output																			
A	B	X																			
LO	LO	HI																			
LO	HI	HI																			
HI	LO	LO																			
HI	HI	HI																			
Edge symbol		Normally superimposed on an input line to a logic symbol. Indicates that this input (usually the trigger input of a flip-flop) responds to the indicated transition of the applied signal.																			

TABLE 3-1 (cont.)
Basic Logic Reference

Device	Symbol	Description	Input/Output Table																																																																								
Triggered (toggle) Flip-Flop		A bistable device with one input and two outputs which changes output states from one stable state to the other stable state with each trigger (either or both outputs may be used). The outputs are complementary (i.e., when one output is HI the other is LO). The edge symbol on the trigger (T) input may be of either polarity depending on the device.	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th colspan="2">Output</th> </tr> <tr> <th>Condition before trigger pulse</th> <th>Condition after trigger pulse</th> <th>X</th> <th>\bar{X}</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>\bar{X}</td> <td>X</td> <td>\bar{X}</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>HI</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>LO</td> <td>HI</td> </tr> </tbody> </table>	Input		Output		Condition before trigger pulse	Condition after trigger pulse	X	\bar{X}	X	\bar{X}	X	\bar{X}	LO	HI	HI	LO	HI	LO	LO	HI																																																				
Input		Output																																																																									
Condition before trigger pulse	Condition after trigger pulse	X	\bar{X}																																																																								
X	\bar{X}	X	\bar{X}																																																																								
LO	HI	HI	LO																																																																								
HI	LO	LO	HI																																																																								
Set-Clear (J-K) Flip-Flop		A bistable device with two inputs and two outputs which changes output states in response to the states at the inputs (either or both outputs may be used). The outputs are complementary (i.e., when one output is HI the other is LO).	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th colspan="2">Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> <th>\bar{X}</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td colspan="2">No change</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>HI</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>HI</td> <td colspan="2">Changes state</td> </tr> </tbody> </table>	Input		Output		A	B	X	\bar{X}	LO	LO	No change		LO	HI	LO	HI	HI	LO	HI	LO	HI	HI	Changes state																																																	
Input		Output																																																																									
A	B	X	\bar{X}																																																																								
LO	LO	No change																																																																									
LO	HI	LO	HI																																																																								
HI	LO	HI	LO																																																																								
HI	HI	Changes state																																																																									
Triggered Set-Clear (J-K) Flip-Flop	<p>Without direct inputs</p> <p>With direct inputs</p>	<p>A bistable device with three or more inputs and two outputs (either or both inputs may be used). When triggered, the output changes states in response to the states at the inputs prior to the trigger. The outputs are complementary (i.e., when one output is HI the other is LO). The edge symbol on the trigger (T) input may be of either polarity depending on the device.</p> <p>For devices with direct-set (S_D) or direct-clear (C_D) inputs, the indicated state at either of these inputs overrides all other inputs (including trigger) to set the outputs to the states shown in the input/output table.</p>	<table border="1"> <thead> <tr> <th colspan="4">Input</th> <th colspan="2">Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>C^1</th> <th>D^1</th> <th>X</th> <th>\bar{X}</th> </tr> </thead> <tbody> <tr> <td colspan="6">Conditions for triggered operation (output condition after trigger pulse)</td> </tr> <tr> <td>LO</td> <td>LO</td> <td>LO</td> <td>LO</td> <td colspan="2">No change</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>LO</td> <td>LO</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>LO</td> <td>LO</td> <td>HI</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>LO</td> <td>LO</td> <td colspan="2">Changes state</td> </tr> <tr> <td colspan="6">Conditions for direct-set, direct-clear operation</td> </tr> <tr> <td>Φ</td> <td>Φ</td> <td>LO</td> <td>LO</td> <td colspan="2">No change</td> </tr> <tr> <td>Φ</td> <td>Φ</td> <td>LO</td> <td>HI</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>Φ</td> <td>Φ</td> <td>HI</td> <td>LO</td> <td>HI</td> <td>LO</td> </tr> <tr> <td>Φ</td> <td>Φ</td> <td>HI</td> <td>HI</td> <td colspan="2">Undefined</td> </tr> </tbody> </table> <p>Φ = Has no effect in this case</p> <p>¹ Applies only with direct inputs.</p>	Input				Output		A	B	C^1	D^1	X	\bar{X}	Conditions for triggered operation (output condition after trigger pulse)						LO	LO	LO	LO	No change		LO	HI	LO	LO	LO	HI	HI	LO	LO	LO	HI	LO	HI	HI	LO	LO	Changes state		Conditions for direct-set, direct-clear operation						Φ	Φ	LO	LO	No change		Φ	Φ	LO	HI	LO	HI	Φ	Φ	HI	LO	HI	LO	Φ	Φ	HI	HI	Undefined	
Input				Output																																																																							
A	B	C^1	D^1	X	\bar{X}																																																																						
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LO	LO	LO	LO	No change																																																																							
LO	HI	LO	LO	LO	HI																																																																						
HI	LO	LO	LO	HI	LO																																																																						
HI	HI	LO	LO	Changes state																																																																							
Conditions for direct-set, direct-clear operation																																																																											
Φ	Φ	LO	LO	No change																																																																							
Φ	Φ	LO	HI	LO	HI																																																																						
Φ	Φ	HI	LO	HI	LO																																																																						
Φ	Φ	HI	HI	Undefined																																																																							

MAIN INTERFACE

General

Diagram 0 in the rear of the manual shows the plug-in interface and the interconnections between the plug-in compartments, circuit boards, etc. of this instrument.

LOGIC CIRCUIT

General

The Logic Circuit develops control signals for use in other circuits within this instrument. These output signals automatically determine the correct instrument operation in relation to the plug-ins installed and/or selected, plug-in control settings, and the 7503 control settings.

Block Diagram

A block diagram of the Logic Circuit is shown in Fig. 3-2. This diagram shows the source of the input control signals, the output signals produced by this stage, and the basic interconnections between blocks. The interconnections shown are intended only to indicate inter-relation between blocks; and do not indicate a direct connection, or that only a single connection is made between the given blocks. Details of the inter-relation between stages in this circuit are given in the circuit description which follows. A schematic of this circuit is shown on diagram 1 at the rear of this manual.

The operation of each of these stages is discussed relating the input signals and/or levels to the output, with consideration given to the various modes of operation that may affect the stage. A logic diagram is also provided for stages where applicable. These diagrams are not discussed in detail, but are provided to aid in relating the function performed by a given stage to standard logic techniques. It should be noted that these logic diagrams are not an exact representation of the circuit but are only a logic diagram of the function performed by the stage. An input/output table is given, where applicable, for use along with the circuit description and logic diagram. These input/output tables document the combination of input conditions which are of importance to perform the prescribed function of an individual stage.

Vertical Mode Control

The Vertical Mode Control stage is made up of gates CR124-CR125, CR126, and CR130-CR155-CR172 and buffer amplifier Q132-Q137. These components develop the Vertical Mode Command which is connected to the Main Interface circuit (vertical plug-in compartments and trigger selection circuitry) and the Vertical Interface circuit to indicate which vertical unit is to be displayed. When this output level is HI, the Right Vertical unit is displayed and when it is LO, the Left Vertical unit is displayed.

Logic. The VERTICAL MODE switch located on diagram 9 provides control levels to this stage. This switch provides a HI level on only one of four output lines to indicate the selected vertical mode; the remaining lines are LO. The fifth mode, LEFT, is indicated when all four output lines are LO. Operation of this stage in all positions of the VERTICAL MODE switch is as follows:

RIGHT:

When the VERTICAL MODE switch is set to RIGHT, a HI level is connected to the buffer amplifier through R126 and CR126. The other diodes connected to the buffer input (CR125-CR130) are reverse biased, as their anodes are LO. The output of the buffer is not inverted with respect to its input (see discussion of buffer); so the output level is HI, indicating that the Right Vertical unit is to be displayed.

CHOP:

The VERTICAL MODE switch in the CHOP position applies a HI level to the anodes of CR124-CR125 through R125. The Vertical Chop Signal from the Chop Counter stage is connected to the cathode of CR124 through R124, and when it is HI, will reverse bias CR124. The HI level applied to CR125 through R125 will forward bias CR125, putting a HI at the input to the buffer. The buffer couples the HI level input to the output, indicating that the Right Vertical unit is to be displayed. When the Vertical Chop Signal is LO, CR124 is forward biased. This places a LO at the junction of R125-CR125 and reverse biases CR125, putting a LO at the input to the buffer. The buffer output then is LO, indicating that the Left Vertical unit is to be displayed. Since the Vertical Chop Signal from the Chop Counter stage is switching between a HI level and a LO level, the output of the buffer (the Vertical Mode Command signal) will switch at the same rate.

ALT:

In this mode, the VERTICAL MODE switch applies a HI level to the anodes of three diodes through R130. CR130 is connected to the input of the buffer. A switching signal is applied to the cathode of either CR155 or CR172 while the other diode is reverse biased. (The switching signals applied to CR155-CR172 are from the Vertical Binary stage and the Alternate Buffer and Switch stage. The selection of the applied signal is determined by these and other stages in the Logic Circuit and is covered in the discussion of these stages.) When the level of the switching signal is HI, CR155 and CR172 are reverse biased, and the HI level applied to CR130 through R130 forward biases CR130. This applies the HI level to the input of the buffer, which couples it to the output. When the switching signal level to CR155 or CR172 is LO, the selected diode (CR155 or CR172) is forward biased, putting a LO at the junction of R130-CR130. This reverse biases CR130, putting a LO at the input of the buffer. The buffer couples the LO to the output. The output of the buffer, the Vertical Mode

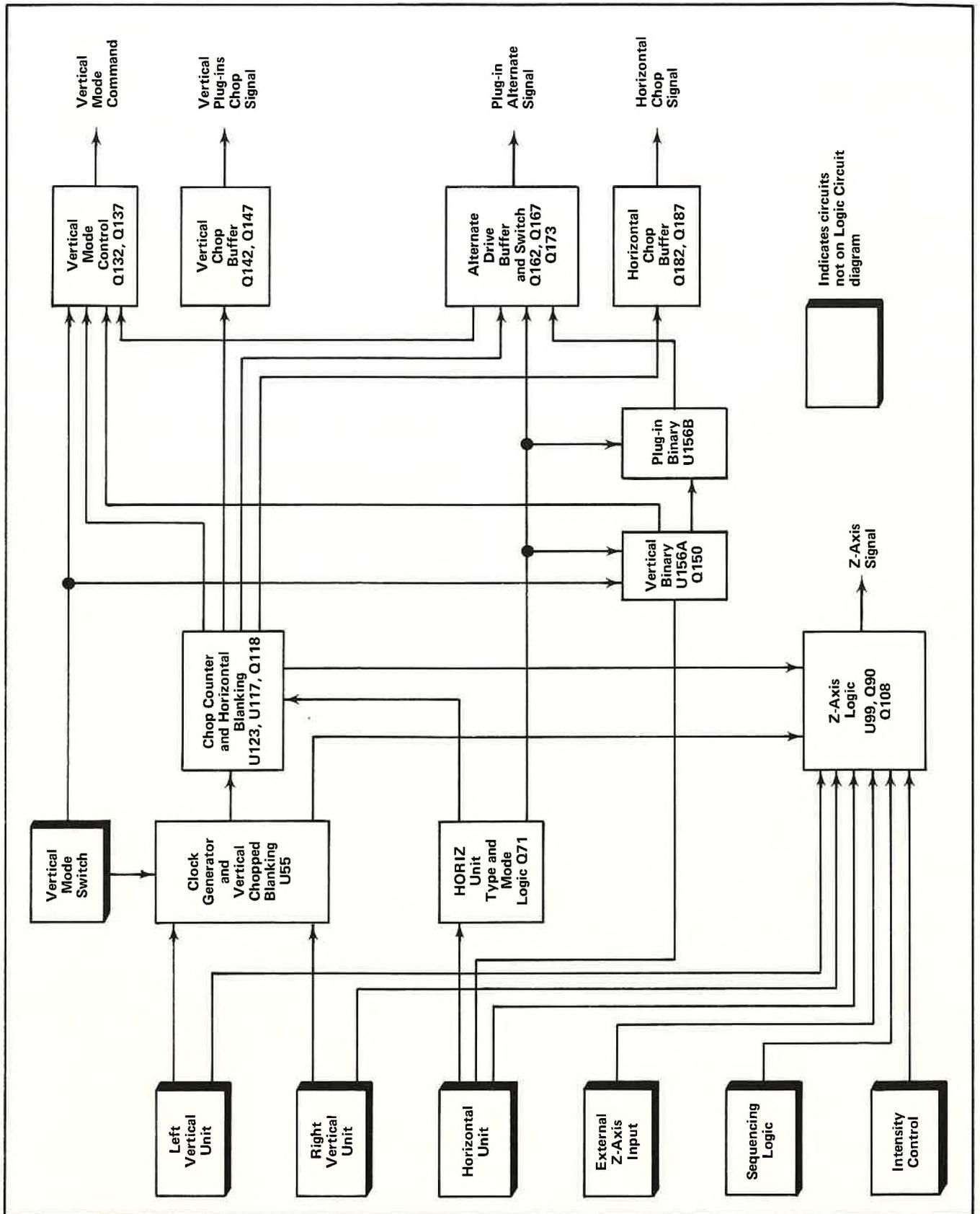


Fig. 3-2. Basic block diagram of the Logic Circuit.

Command signal, now switches between a HI and LO level at a rate determined by either the Vertical Binary stage or the Chop Counter stage.

ADD and LEFT:

The control levels from the VERTICAL MODE switch are not connected to the Vertical Mode Control stage when the VERTICAL MODE switch is set to ADD or LEFT. Since all the inputs to the buffer are LO, the Vertical Mode Command will be LO. This indicates that the Left Vertical unit is to be displayed. For more information on instrument operation in the ADD mode, see the discussion on the Vertical Interface circuit.

A logic diagram of the Vertical Mode Control stage is shown in Fig. 3-3. The discrete components which make up each logic function are identified. The gate connected to the input of the buffer is a phantom-OR gate. A phantom-OR gate performs the OR-logic function merely by interconnection of the two signals.

Buffer

The buffer consists of Q132 and Q137. The input to the buffer is the emitter of common-base connected Q132. This provides a low-impedance load for diode gates. The collector of the input transistor is connected to the output through emitter-follower Q137, providing isolation between the input to the buffer and the circuits driven by this stage. R136, R134, C135, and C136 are used to limit and standardize the risetime of the output signal.

A HI level at the input to this stage will cause current to flow into Q132, raising the collector to a HI. The emitter of Q137 will follow this level, providing a HI level at the output. A LO applied to the input will reverse bias Q132. No current will flow into Q132 and the collector will be LO. This is coupled to the output through Q137, putting a LO level at the output. So the level at the output of the buffer is shown to be in phase with the level applied to the input.

Clock Generator

One half of integrated circuit U55 along with the external components shown in Fig. 3-4A make up the Clock Generator stage. R1, Q1, Q2, and Q3 represent an equivalent circuit contained within U55A. This circuit along with discrete components C59, R56, R57, and R59 comprise a two-megahertz free-running oscillator to provide a timing signal (clock) for main frame vertical and plug-in chopping.

The stage operates as follows: Assume that Q2 is conducting and Q1 is off. The collector current of Q2 produces a voltage drop across R1 which holds Q1 off. This negative level at the collector of Q2 is also connected to pin 14 through Q3 (see waveforms in Fig. 3-4B at time T_0). Since there is no current through Q1, C59 begins to charge towards -15 volts through R56-R57. The emitter of Q1 goes negative as C59 charges, until it reaches a level about 0.6 volt more negative than the level at its base. When the emitter reaches this level, the base-emitter junction becomes forward-biased and Q1 saturates. This causes the emitter to rapidly rise positive (see time T_1 on waveforms).

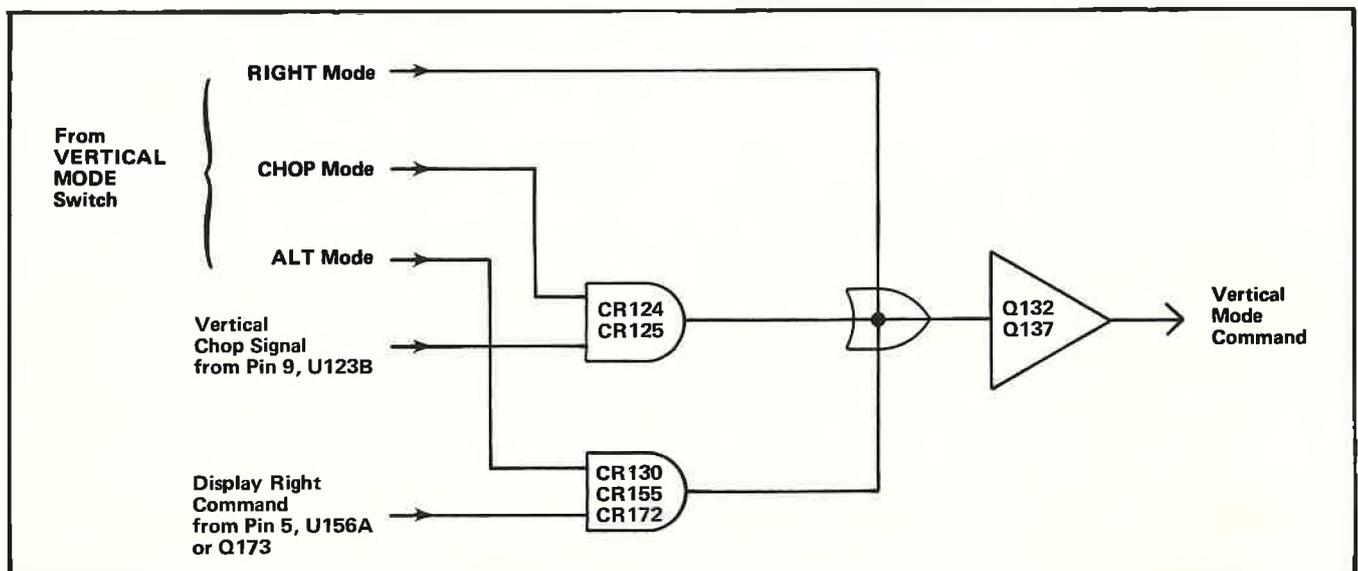


Fig. 3-3. Logic diagram of Vertical Mode Control stage.

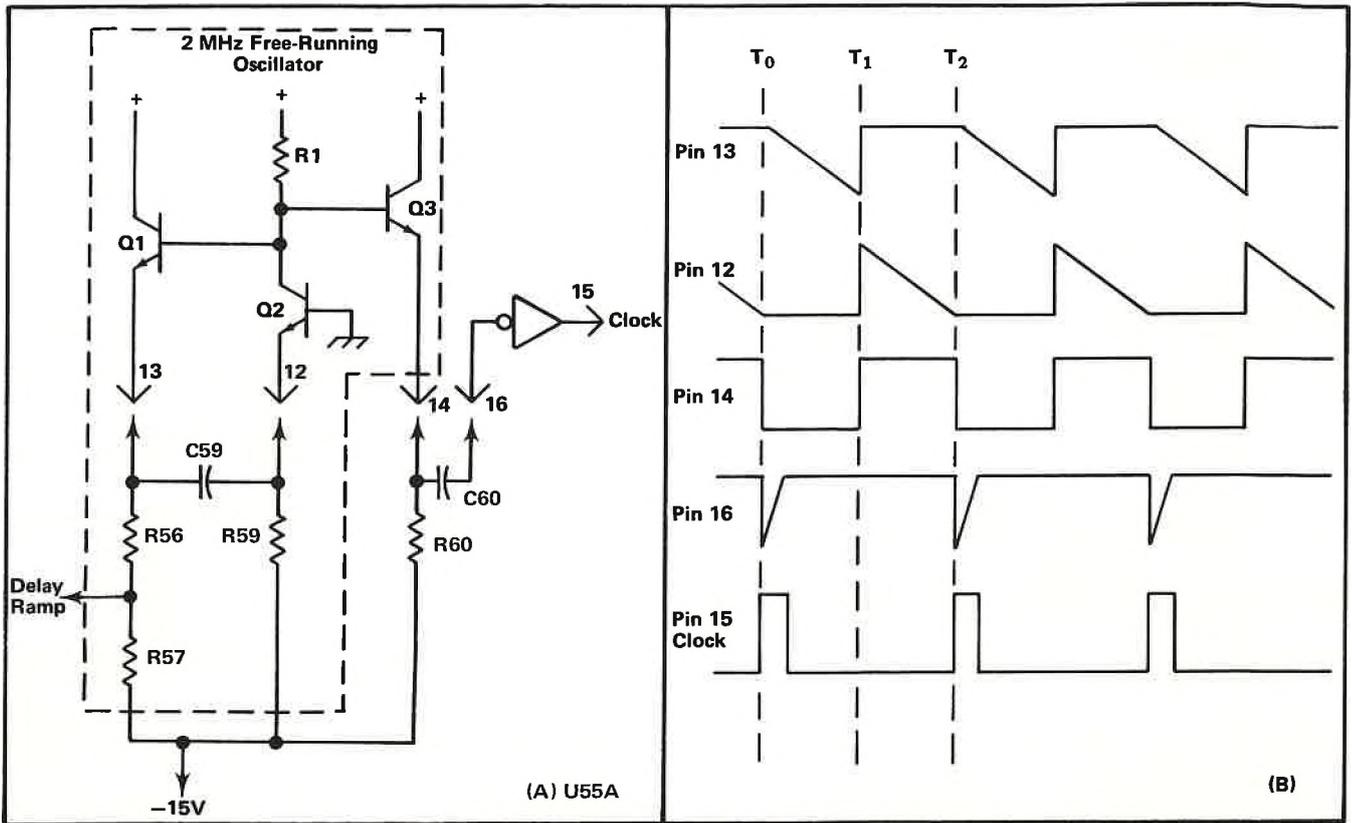


Fig. 3-4. (A) Diagram of Clock Generator stage, (B) Idealized waveforms for Clock Generator stage.

Since C59 cannot change its charge instantaneously, the sudden change in voltage at the emitter of Q1 pulls the emitter of Q2 positive also, to reverse-bias it. With Q2 reverse-biased, its collector rises positive to produce a positive output level at pin 14. This negative-going pulse is connected to pin 15 through an inverter-shaper which is also part of U55A. The output at pin 15 is a positive-going Clock pulse at a repetition rate of about two megahertz.

Now, conditions are reversed. Since Q2 is reverse biased, there is no current through it. Therefore, C59 can begin to discharge through R59. The emitter level of Q2 follows the discharge of C59 until it reaches a level about 0.6 volt more negative than its base. Then Q2 is forward biased and its collector drops negative to reverse-bias Q1. The level at pin 14 drops negative also, to complete the cycle. Once again, C59 begins to charge through R56-R57 to start the second cycle.

Two outputs are provided from this oscillator. The Delay Ramp signal from the junction of R56-R57 is connected to the Vertical Chopped Blanking stage. This signal has the same waveshape, as shown by the waveform at pin 13 with its slope determined by the divider ratio between R56-R57. A square-wave output is provided at pin 14. The frequency

of this square wave is determined by the RC relationship between C59 and R1 ($F \approx \frac{1}{4R1C59}$). The duty cycle is determined by the ratio of R56-R57 to R59.

The square wave at pin 14 is connected to pin 16 through C60. C60, along with the internal resistance of U55A, differentiates the square wave at pin 14 to produce a negative-going pulse coincident with the falling edge of the square wave (positive-going pulse coincident with rising edge has no effect on circuit operation).

Vertical Chopped Blanking

The Vertical Chopped Blanking stage is made up of the remaining half of integrated circuit U55. This stage determines if Vertical Chopped Blanking pulses are required, based upon the operating mode of the vertical system or the plug-in units (dual-trace units only). Vertical Chopped Blanking pulses are produced if: (1.) VERTICAL MODE switch is set to CHOP; (2.) Dual-trace vertical unit is operating in the chopped mode, and that unit is being displayed; (3.) Dual-trace vertical unit is operating in the chopped mode with the VERTICAL MODE switch set to ADD. The repetition rate of the negative-going Vertical Chopped Blanking pulse output at pin 4 is always two megahertz, as determined by the Clock Generator stage.

The Delay Ramp signal from the Clock Generator stage determines the repetition rate and pulse width of the Vertical Chopped Blanking pulses. The Delay Ramp applied to pin 10 starts to go negative from a level of about +1.1 volts, coincident with the leading edge of the Clock pulse (see waveforms in Fig. 3-5B). This results in a HI quiescent condition for the Vertical Chopped Blanking pulse. The slope of the negative-going Delay Ramp is determined by the Clock Generator stage. As it reaches a level slightly negative from ground, the Vertical Chopped Blanking pulse output level changes to the LO state. This signal remains LO until the Delay Ramp goes HI again. Notice the delay between the leading edge of the Clock pulse generated by U55A and the leading edge of the Vertical Chopped Blanking pulses (see Fig. 3-5B). The amount of delay between the leading edges of these pulses is determined by the slope of the Delay Ramp applied to pin 10. This delay is necessary due to the delay line in the vertical deflection system. Otherwise, the trace blanking resulting from the Vertical Chopped Blanking pulse would not coincide with the switching between the displayed traces. The duty cycle of the square wave produced in the Clock Generator stage determines the pulse width of the Vertical Chopped Blanking pulses (see Clock Generator discussion for more information).

Whenever this instrument is turned on, Vertical Chopped Blanking pulses are being produced at a two-megahertz rate. However, these pulses are available as an output at pin 4 only when the remaining inputs to U55B are at the correct levels. The following discussions give the operating conditions which produce Vertical Chopped Blanking pulses to blank the CRT during vertical chopping. Fig. 3-5A identifies the function of the pins of U55B.

1. CHOP VERTICAL MODE

When the VERTICAL MODE switch is set to CHOP, Vertical Chopped Blanking pulses are available at pin 4 at all times. The input conditions necessary are:

Pin 3 HI—VERTICAL MODE switch set to CHOP.

Pin 7 LO—VERTICAL MODE switch set to any position except ADD.

Pin 10 LO—Delay Ramp more negative than about zero volts.

2. LEFT VERTICAL UNIT SET FOR CHOPPED MODE

If the Left Vertical unit is set for chopped operation, the setting of the VERTICAL MODE switch determines whether the Vertical Chopped Blanking pulses are available. If the VERTICAL MODE switch is set to the CHOP position, conditions are as described in #1 previously. Operation in the ADD position of the VERTICAL MODE switch is given later. For the LEFT position of the VERTICAL MODE switch, or when the Left Vertical unit is to be displayed in the ALT mode, Vertical Chopped Blanking pulses are available at all times (two-megahertz rate). The input conditions are:

Pin 3 LO—VERTICAL MODE switch set to any position except CHOP.

Pin 5 LO—Left Vertical unit set to chopped mode.

Pin 6 LO—Left Vertical unit to be displayed (Vertical Mode Command LO).

Pin 7 LO—VERTICAL MODE switch set to any position except ADD.

Pin 10 LO—Delay Ramp more negative than about zero volts.

Notice that the Vertical Mode Command at pin 6 must be LO for output pulses to be available at pin 4. This means that when the VERTICAL MODE switch is set to ALT, Vertical Chopped Blanking pulses will be produced only

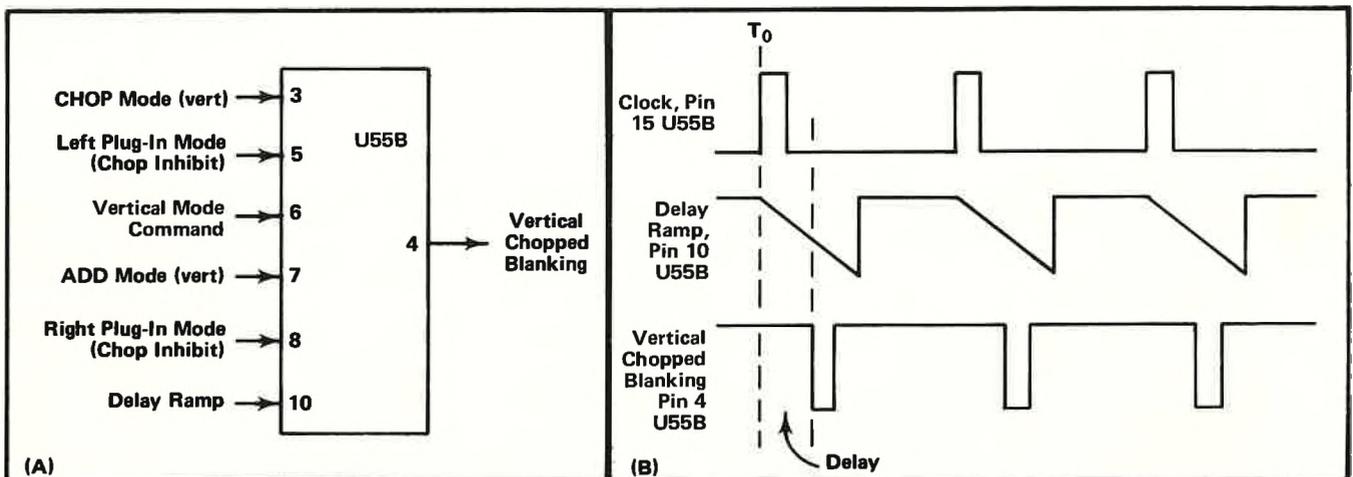


Fig. 3-5. (A) Input and output pins for Vertical Chopped Blanking stage, (B) Idealized waveform for Vertical Chopped Blanking stage.

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during the time that the Left Vertical unit is to be displayed (unless Right Vertical unit is also set for chopped operation).

3. RIGHT VERTICAL UNIT SET FOR CHOPPED OPERATION

If the Right Vertical unit is set for chopped mode, operation is the same as described before for the Left Vertical unit except that Vertical Chopped Blanking pulses are produced when the VERTICAL MODE switch is set to RIGHT or when the Vertical Mode command is HI in the ALT mode. The input conditions are:

Pin 3 LO—VERTICAL MODE switch set to any position except CHOP.

Pin 6 HI—Right Vertical unit to be displayed (Vertical Mode Command HI).

Pin 7 LO—VERTICAL MODE switch set to any position except ADD.

Pin 8 LO—Right Vertical unit set to chopped mode.

Pin 10 LO—Delay Ramp more negative than about zero volts.

4. ADD VERTICAL MODE

When the VERTICAL MODE switch is in the ADD position and either or both of the vertical units are operating in the chopped mode, Vertical Chopped Blanking pulses must be available to block out the transition between the traces of the vertical units. The input conditions are:

Pin 3 LO—VERTICAL MODE switch set to any position except CHOP.

Pin 5 LO—Left Vertical unit set to chopped mode (can be HI if pin 8 is LO).

Pin 7 HI—VERTICAL MODE switch set to ADD.

Pin 8 LO—Right Vertical unit set to chopped mode (can be HI if pin 5 is LO).

Pin 10 LO—Delay Ramp more negative than about zero volts.

Fig. 3-6A shows a logic diagram of the Vertical Chopped Blanking stage. Notice the comparator block on this diagram (one input connected to pin 10). The output of this comparator is determined by the relationship between the levels at its inputs. If pin 10 is more positive (HI) than the grounded input, the output is HI also; if it is more negative (LO), the output is LO. An input/output table for this stage is given in Fig. 3-6B.

HORIZ Unit Type and Mode Logic

This stage of the Logic circuit supplies control levels to indicate the type and operating mode of the plug-in unit installed in the HORIZ compartment. The plug-in provides the inputs to this stage via the Main Interface circuit to pins EA and EF on the Logic board. The inputs are the X-Compensation Inhibit and Plug-In Mode respectively. The outputs are the Sweep Command and Horizontal Chop Blanking Command. A simplified schematic showing input and output points is given in Fig. 3-7A.

The Sweep Command Signal is connected to the Alternate Drive Buffer and Switch, Vertical Binary, and Plug-in Binary stages to indicate if a sweep is being used or not. See the discussion of these individual stages for more information.

The Sweep Command is derived directly from the X-Compensation Inhibit at pin EA. The level here is HI for sweep units and LO for non-sweep units (LO for sweep units operated in an amplifier mode).

The Horizontal Chop Blanking Command from the collector of Q71 is connected to the Chop Counter stage to alter the counting rate (see discussion of Chop Counter stage). The Horizontal Chop Blanking Command is derived from the level of the Plug-in Mode input at pin EF in conjunction with the Sweep Command. An input/output table for Q71 is shown in Fig. 3-7B. The plug-in Mode signal is supplied by dual-trace amplifier units and will be between approximately 0 and +5 volts. The modes and corresponding voltage levels are: CH 1, +5 V; CH 2, +4 V; ADD, +2 V; ALT, +1 V; CHOP, 0 V. A single-channel amplifier unit leaves the line open or treats it as CH 1. A HI level (single-channel) at pin EF will block current through CR67, and Q71 will be turned on. The collector of Q71 will be LO, indicating a single-channel unit. A LO level (below +1 V) at pin EF will turn CR67 on and Q71 off. The collector of Q71 will go HI, generating the Horizontal Chop Blanking Command.

Chop Counter

The Chop Counter stage produces the Vertical Chopping Signal, the Vertical Plug-in Chopping Signal, the Horizontal Plug-in Chopping Signal, and the Horizontal Chopped Blanking Signal. The Clock pulse produced by the Clock Generator stage provides the timing signal for this stage. The function of the input and output connections for the Chop Counter stage are identified in the logic diagram of the Chop Counter stage, Fig. 3-8.

The Chop Counter stage is made up of two integrated circuits U117-U123, and transistor Q118. U117 and U123 each contain two D-type, triggered flip-flops with direct-set,

direct-clear inputs and complementary outputs. A D-type flip-flop, upon application of a positive-going trigger, will transfer to the 1 output the state at the D input prior to triggering. By connecting the D input to the 0 output, the 1 output will change states each time the flip-flop is triggered; thus, the device operates as a triggered flip-flop. U117A, U123A, and U123B are connected in this manner with U123A and U123B using the direct-set input also. U117B is operated as a D-type flip-flop with direct-clear input. Fig. 3-9A shows the input/output table for U117B. Fig. 3-9B shows the input/output table for U123A or U123B. For an input/output table for U117A, see Table 3-1, Basic Logic

Reference. Q118 is used as an AND gate with three inputs inverted i.e., the output is HI when all three inputs are LO.

The repetition rate of the output signals from the Chop Counter stage is determined by the state of the Horizontal Chop Blanking Command input. The following discussions describe the operation of this stage for both states of the Horizontal Chop Blanking Command.

CONDITION 1

Horizontal Chop Blanking Command—LO

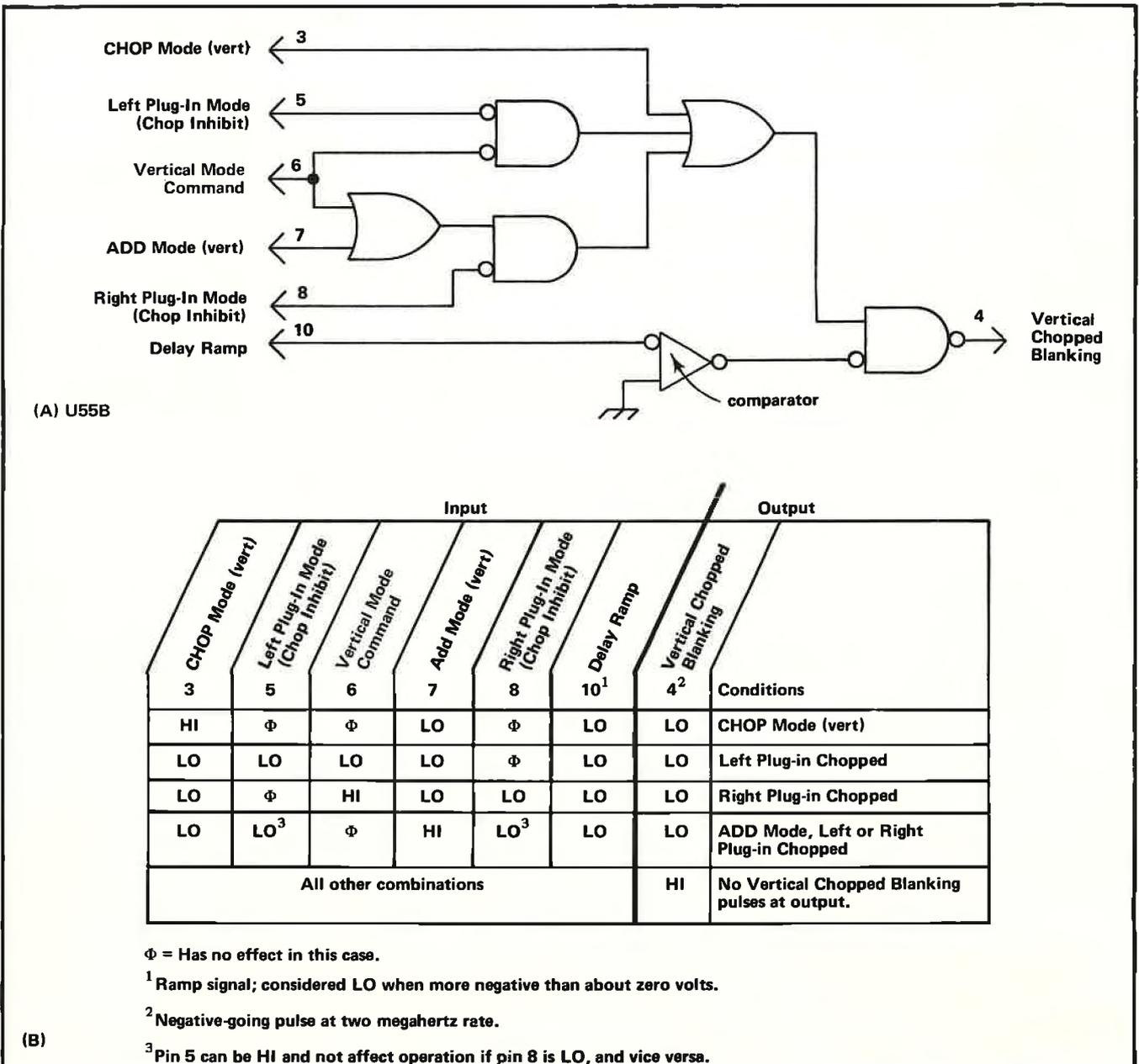


Fig. 3-6. (A) Logic diagram for Vertical Chopped Blanking stage, (B) Table of input/output combinations for Vertical Chopped Blanking stage.

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This is the normal operating level of the Horizontal Chop Blanking Command (for more information, see the discussion on the HORIZ Unit Type and Mode Logic stage).

The direct-clear input of U117B (pin 13) being forced LO by the Horizontal Chop Blanking Command over-rides the other inputs, and sets the level at pin 9 LO and at pin 8 HI (see Fig. 3-9A). The HI level from pin 8, U117B connected to the direct-set inputs of U123B and U123A (pins 10 and 4 respectively) enables them to operate as triggered flip-flops (or divide by two counters). Clock pulses at a 2 MHz rate from the Clock Generator stage are applied to the T input of U123B at pin 11. U123B will

change states with each positive-going Clock pulse, and its output at pin 9 will be a square wave, switching between the HI and LO levels at a 1 MHz rate. This signal is connected to the Vertical Mode Control stage through R124 as the Vertical Chopping Signal. The square wave from pin 9, U123B is also connected to the T input of U123A. U123A will also change states with each positive-going pulse to generate a 500 kHz square wave at pin 5. The output at pin 5 is switching between HI and LO levels and is connected to the T input of U117A through R128 and to the Vertical Plug-in Chop Buffer stage through R140-CR140. U117A will count down from the 500 kHz square wave to generate a 250 kHz square wave at its output at pin 5. This square wave is connected to the Horizontal Plug-in Chop Buffer stage through R180-CR180,

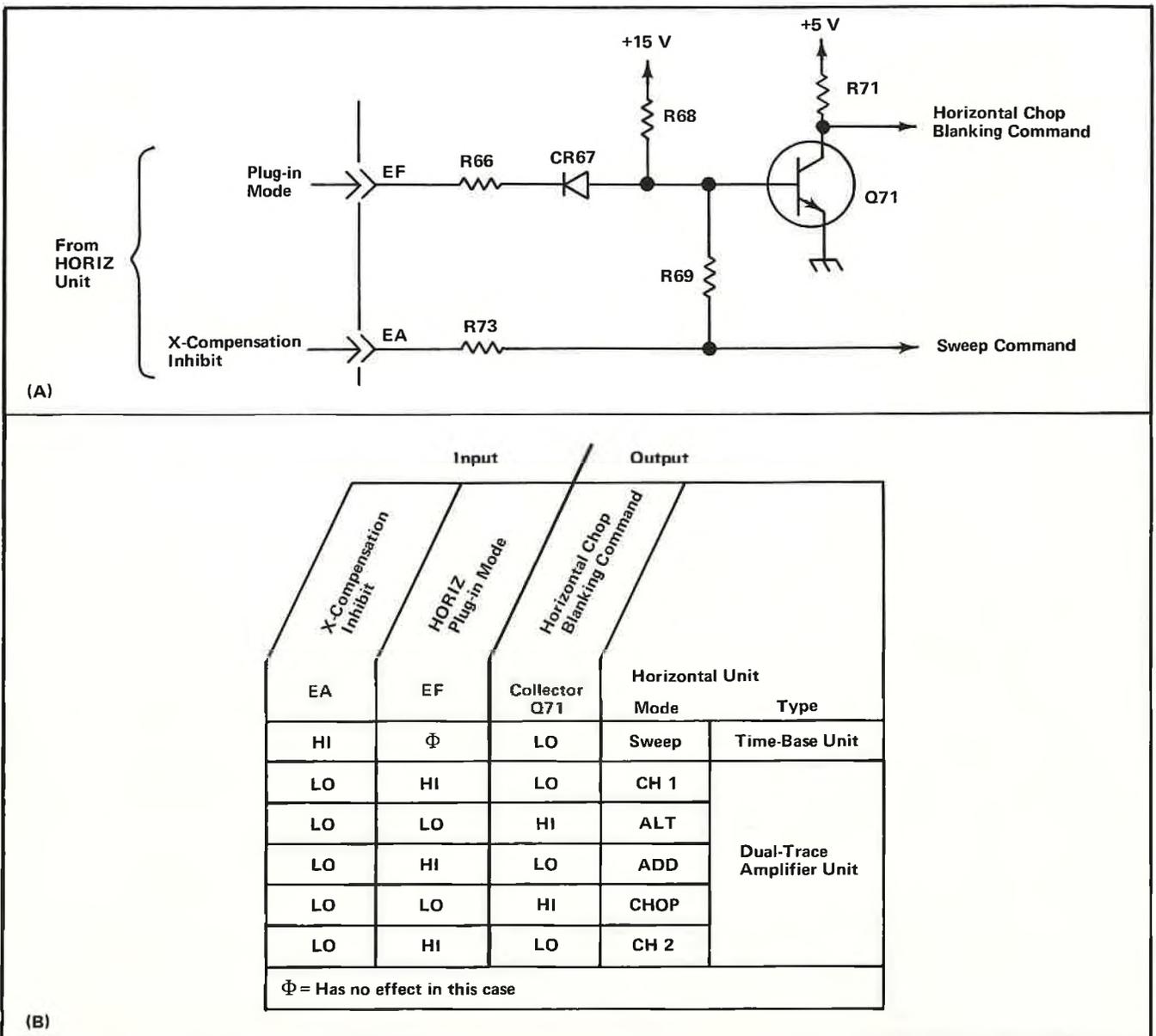


Fig. 3-7. (A) Simplified schematic diagram HORIZ Unit Type and Mode Logic stage, (B) Input/output table for Q71.

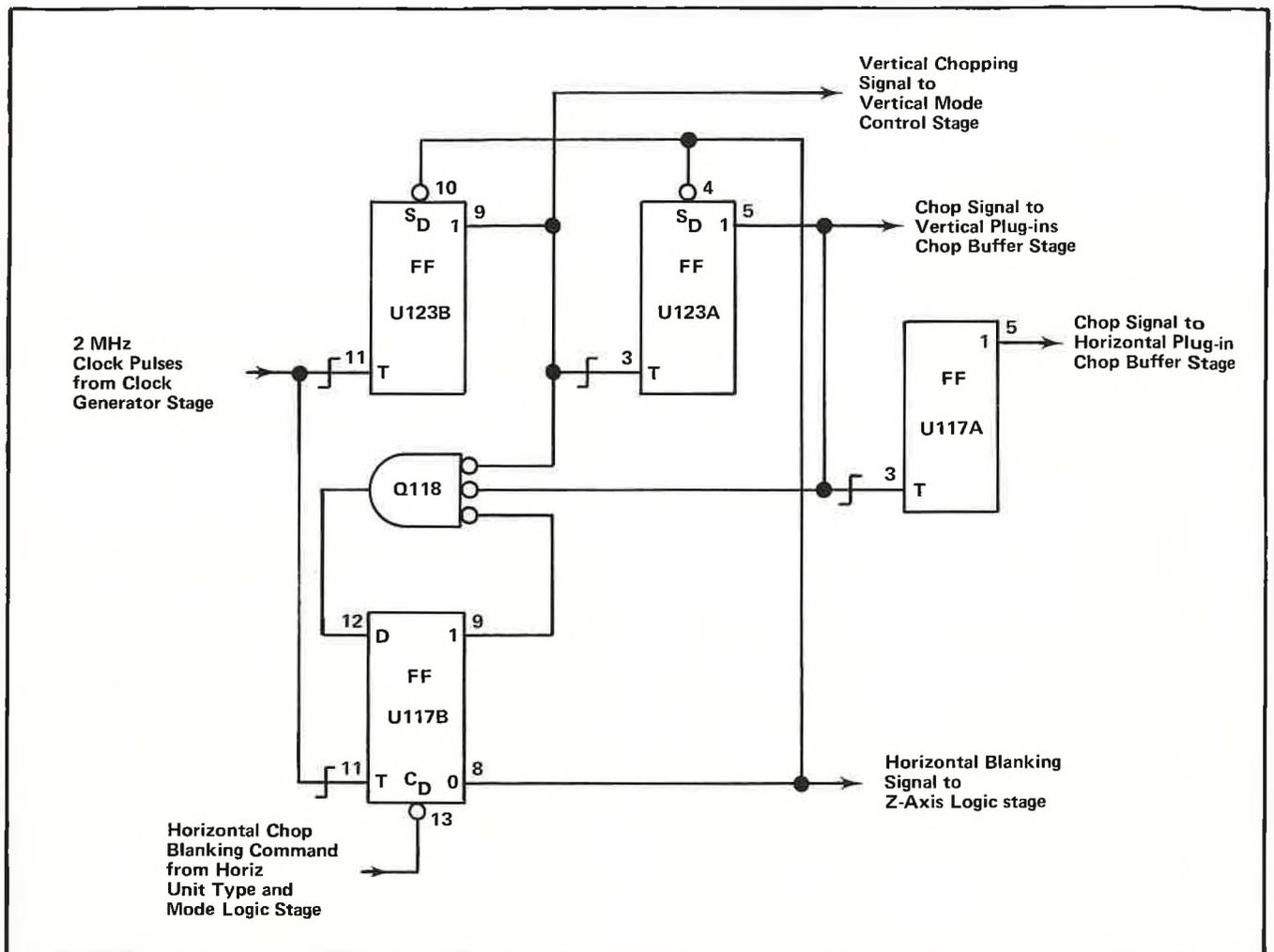


Fig. 3-8. Detailed logic diagram of Chop Counter stage.

and to the Alternate Buffer and Switch stage through R174. Idealized waveforms showing the timing relationship between the input and output signals for this stage when operating in condition 1 are shown in Fig. 3-10.

CONDITION 2

Horizontal Chop Blanking—HI

This is the state the Horizontal Chop Blanking Command will assume when a vertical unit in a dual-trace mode is operated in the HORIZ compartment.

In this condition, the direct-clear input of U117B (pin 13) is HI, which enables it to transfer the level at the D input (pin 12) to the 1 output (pin 9) upon the arrival of each Clock pulse at its T input (pin 11). The D input is connected to the collector of Q118, which is LO until all three inputs (counter outputs) to its base are LO. With the D input of U117B LO, the next Clock pulse will set the 1

output LO and the 0 output HI. This is the condition at time T_0 in Fig. 3-11. At this time, the HI level at the direct-set inputs to U123B and U123A from pin 8-U117B enables them to count down. At time T_1 , the output of each counter is LO and the level at the collector of Q118 goes HI. This HI level is transferred to the 1 output of U117B (pin 9) upon the arrival of the next Clock pulse at time T_2 . At this time, the 0 output of U117B (pin 8) goes LO, setting U123B and U123A 1 outputs to a HI level. The collector of Q118 drops to a LO level, since the inputs went HI. The Clock pulse arriving at time T_3 has no effect on the state of U123B since its direct-set input is LO, but it will trigger U117B to transfer the LO level at its D input to the 1 output. After the Clock pulse at time T_3 has triggered U117B to change states, U123B and U123A are enabled to count and conditions are the same as they were at time T_0 . U117A has changed states on each positive-going change at its T input (pin 3) to produce the waveform shown in Fig. 3-11 for pin 5-U117A. This waveform is connected to the Horiz Unit Chop Buffer stage. The waveform at pin 8-U117B is connected to the Z-Axis Logic stage to blank the CRT during the horizontal unit switching time.

Input				Output	
	13	12	9	8	
Conditions for triggered operation (output condition after trigger pulse)					
	HI	LO	LO	HI	
	HI	HI	HI	LO	
Conditions for direct-clear operation					
	LO	Φ	LO	HI	
Φ Has no effect in this case					

(A)

Input				Output	
	S _D	1	0	1	0
Condition before trigger pulse			Condition after trigger pulse		
	HI	HI	LO	LO	HI
	HI	LO	HI	HI	LO
	LO	HI	LO	HI	LO
over-rides trigger					

(B)

Fig. 3-9. (A) Input/output table for U117B, (B) Input/output table for U123A or U123B.

Vertical Plug-in Chop Buffer

This stage, consisting of Q142 and Q147, provides isolation between the Vertical Plug-in Chopping Signal from pin 5-U123A and the Vertical plug-in units. The Vertical Plug-in Chop Signal is a square wave which is switching between HI and LO levels at a rate determined by the inputs to the Chop Counter stage (see the discussion on the Chop Counter stage for more information). A dual-trace unit operating in the CHOP mode will display CH 2 when this signal level is HI, and CH 1 when the level is LO. The input to the buffer is the emitter of common-base connected Q142, which is connected to the Chop Counter output through R140-CR140. The collector of the input transistor is connected to the output through emitter-follower Q147. R146, R144, C145, and C146 are used to limit and standardize the risetime of the output signal.

When the level of the Vertical Plug-in Chop Signal from pin 5-U123A is HI, CR140 is reverse biased. The level at the emitter of Q142 will be HI through R141. Current will flow through R141 into Q142, raising its collector to a HI level. The emitter of Q147 will follow this level, providing a HI at the output. When the level at pin 5-U123A goes LO, CR140 will be forward biased, pulling the emitter of Q142 LO. No current will flow into Q142 and its collector will be LO. This LO is coupled through Q147 to make the output level LO. So the output of the buffer is shown to follow the level applied to the input.

HORIZ Plug-in Chop Buffer

This stage, consisting of Q182 and Q187, provides isolation between the output of the Chop Counter stage at pin 5-U117A and the HORIZ plug-in unit. The HORIZ Plug-in Chop Signal is a square wave which is switching

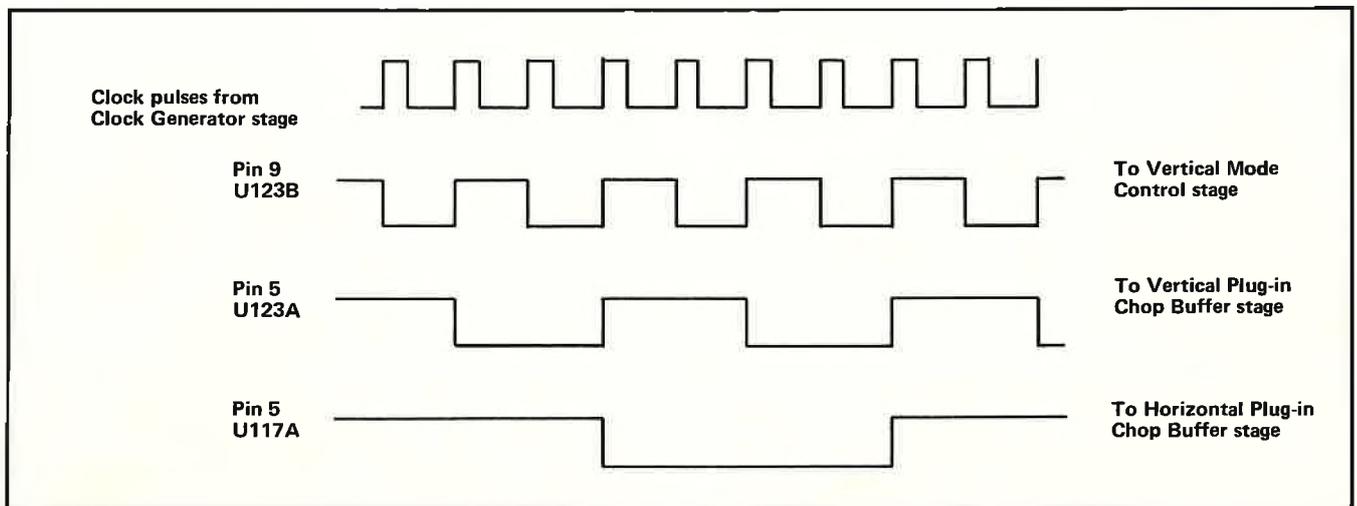


Fig. 3-10. Idealized input and output waveforms of Chop Counter stage when operating in condition 1.

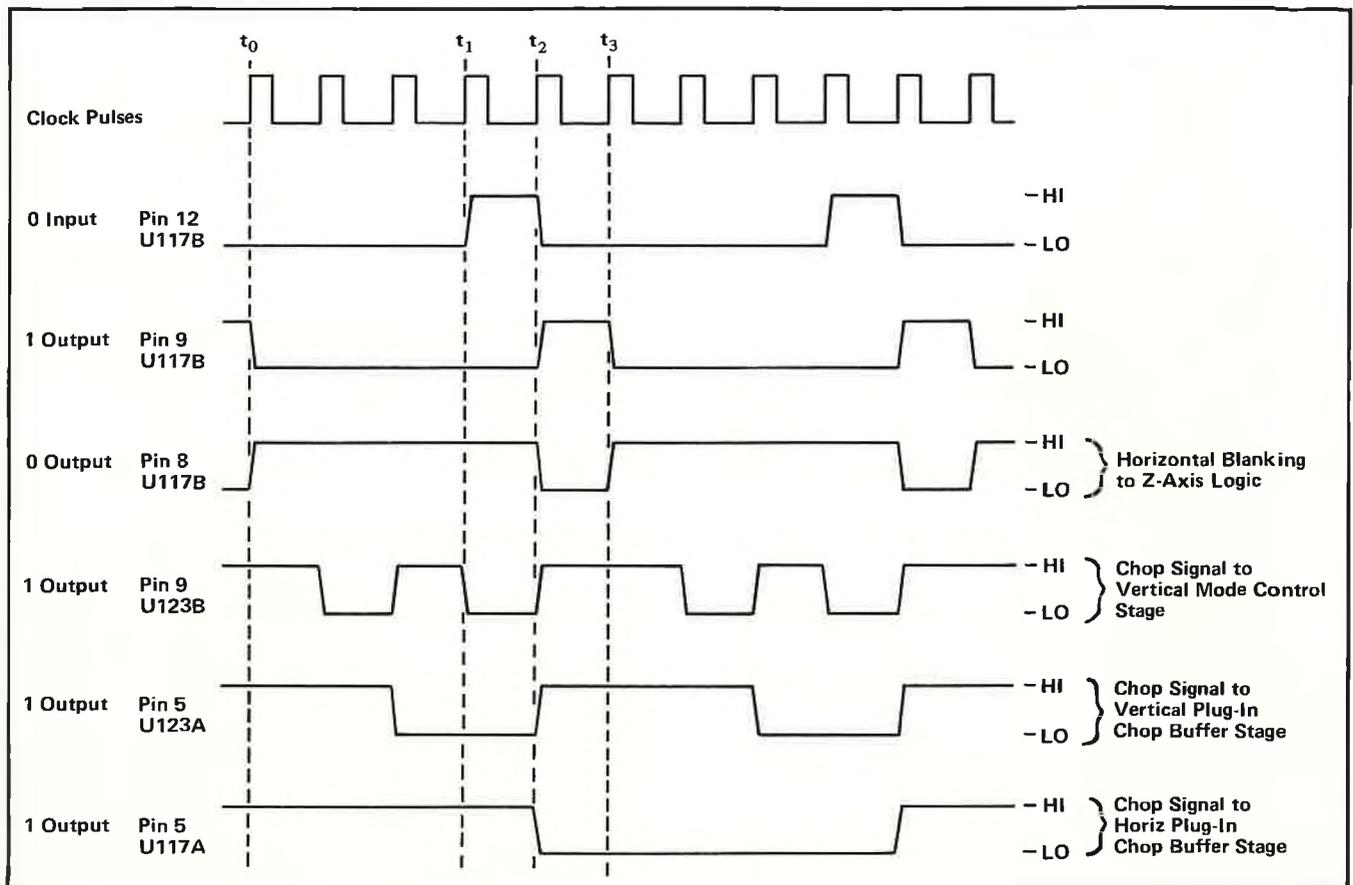


Fig. 3-11. Idealized input and output waveforms of Chop Counter stage when operating in condition 2.

between HI and LO levels at a rate determined by the inputs to the Chop Counter stage (see the discussion on the Chop Counter stage for more information). A dual-trace unit operating in the CHOP mode will display CH 2 when this signal level is HI, and CH 1 when the level is LO. The output of the Chop Counter stage at pin 5-U117A is connected to this stage through R180-CR180 to the emitter of Q182. The circuit and operation of this stage is identical to the Vertical Plug-in Chop Buffer stage. For more information, see the discussion on the Vertical Plug-in Chop Buffer stage.

Vertical Binary, Plug-in Binary, Alternate Drive Buffer and Switch

These three stages are closely related in their function of producing alternate switching signals to drive other circuits in the instrument. The operation of each individual stage is, therefore, more easily understood by first discussing their function and general operation as a unit in relation to the modes of operation that can occur.

CONDITION 1

VERTICAL MODE Switch—ALT.

HORIZ Unit—Time-base unit operating in a sweep mode.

This operating condition requires a signal from the Vertical Binary stage through R155 to the Vertical Mode Control stage, to switch the vertical display between the two vertical units at the completion of each sweep. The Display Right Command signal is a square wave which is switching between HI and LO levels at a rate determined by the sweep rate. To do this, the Vertical Binary stage operates as a divide by two counter triggered by the Holdoff pulse from the time-base unit. The Display Right Command signal is also used to trigger the Plug-in Binary stage which counts down by two to produce a switching waveform at one-fourth the sweep rate. This signal is available to the plug-in units through the Buffer Amplifier and Switch stage for switching between channels at a rate which is one-half the switching rate between vertical units. The Plug-in Alternate Drive signal is also a square wave which is switching between HI and LO levels. A dual-trace unit operated in the alternate mode will display CH 2 when this level is HI, and

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CH 1 when the level is LO. The output waveforms of the Vertical Binary stage and the Plug-in Binary stage for Condition 1 are shown in relation to the sweep sawtooth and Holdoff waveforms in Fig. 3-12.

CONDITION 2

VERTICAL MODE Switch—Set to any position but ALT

HORIZ Unit—Time-base unit operating in a sweep mode

This condition requires a signal from the Plug-in Binary stage to the plug-ins for channel switching at a sweep rate. This is accomplished by the ALT Command from the VERTICAL MODE switch going to a LO level to change the function of the Vertical Binary stage. Now, the output of the Vertical Binary stage is a regeneration of the Holdoff waveform. This output is then divided by two by the Plug-in Binary stage to provide a waveform switching at one-half the sweep rate and available to the plug-ins for channel switching. The output of the Plug-in Binary stage now has the same relation to the sweep as the Vertical Binary stage output had in Condition 1.

CONDITION 3

VERTICAL MODE Switch—Any position

HORIZ Unit—Amplifier unit or a sweep unit operated in a non-sweep mode.

In this condition, there is no holdoff waveform from which to derive alternate switching pulses for either the Vertical Mode Control stage or for the plug-in units. The Sweep Command Signal from the HORIZ Unit Type and Mode Logic stage is LO when the unit installed in the HORIZ compartment is an amplifier unit, or a time-base unit operating in an amplifier mode. This turns on the Switch section of the Alternate Drive Buffer and Switch stage to connect chopping pulses from the Chop Counter stage to the plug-ins via the buffer. These chopping pulses are also connected to the Vertical Mode Control stage through CR172 when the VERTICAL MODE switch is in the ALT position.

Vertical Binary

The Vertical Binary stage consists of integrated circuit U156A and transistor Q150. U156A is a D-type flip-flop connected as a triggered flip-flop with direct-set and direct-clear inputs. An input/output table for U156A is shown in Fig. 3-13. The Sweep Command signal is connected to the direct-set input (pin 4) of U156A through CR157 to inhibit the flip-flop operation when the plug-in in the HORIZ compartment is not a time-base unit, or is a time-base unit operated in an amplifier mode. The ALT Command from the VERTICAL MODE switch is connected to the emitter of Q150 through R152. When the VERTICAL MODE switch is in a position other than ALT, the Vertical Binary stage is changed from a divide by two counter to a Holdoff regenerator. The operation of this stage for each of the

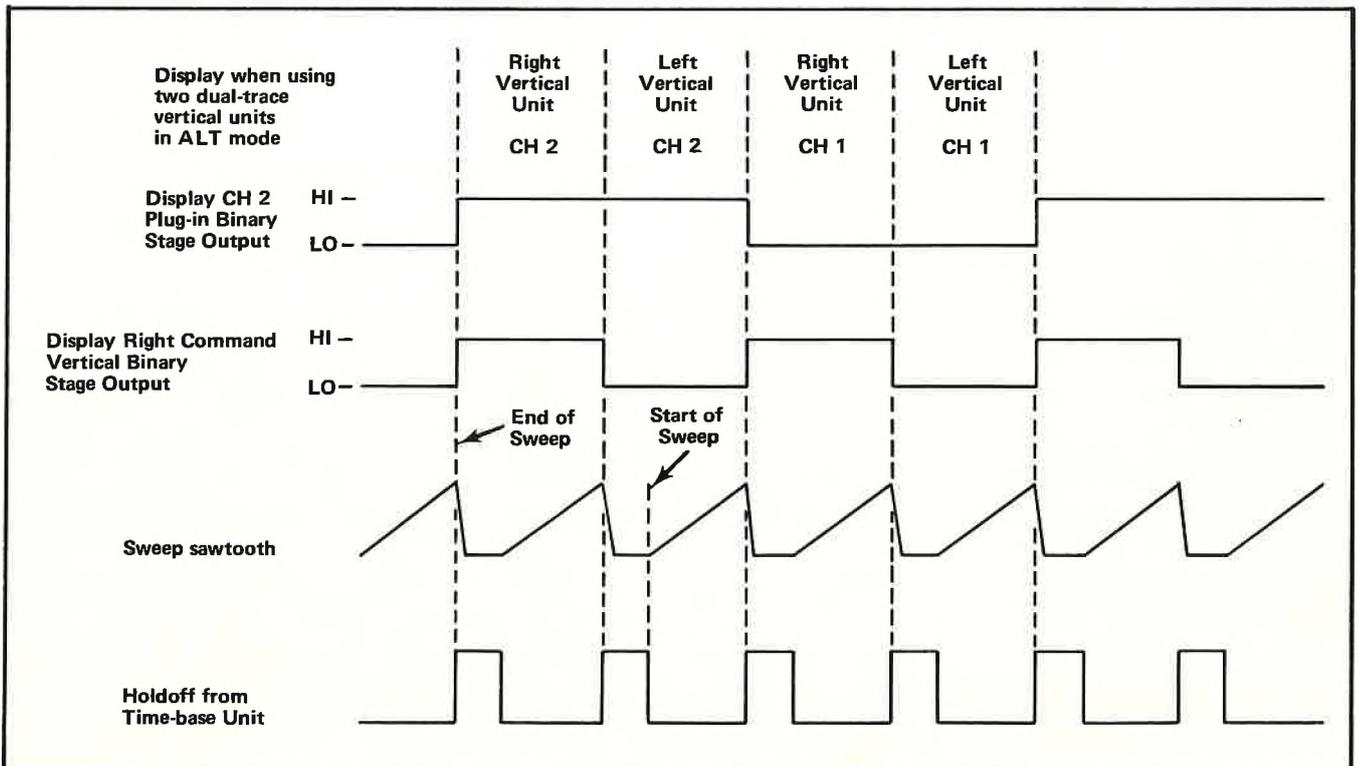


Fig. 3-12. Idealized waveforms showing relationship between sweep sawtooth and output of Vertical Binary and Plug-in Binary stages when operating in condition 1.

Input				Output		
S _D	C _D	1	0	1	0	
Condition before trigger pulse				Condition after trigger pulse		
HI	HI	HI	LO	LO	HI	
HI	HI	LO	HI	HI	LO	
LO	HI	HI	LO	HI	LO	Over-rides trigger
HI	LO	LO	HI	LO	HI	Over-rides trigger
LO	LO	Not allowed				

Fig. 3-13. Input/output table for U156A.

conditions mentioned in the general discussion is as follows:

CONDITION 1

Input levels:

ALT Command—HI
Sweep Command—HI

Holdoff—A pulse which changes from a LO level to a HI level at the end of each sweep.

The HI level from the ALT Command to the emitter of Q150 reverse-biases Q150 to keep its collector at a HI level. This HI level is applied to the direct-clear input of U156A at pin 1. The direct-set input (pin 4) of U156A is also at a HI level as a result of the Sweep Command being applied through CR157. The direct-set and direct-clear inputs being HI enables U156A to operate as a triggered flip-flop. U156A is triggered each time the level of the Holdoff connected to the trigger input (pin 3) through R159 goes HI. Thus, U156A is operating as a divide by two counter, generating a square wave which is switching between a HI and LO level at one-half the rate set by the time-base unit (see Fig. 3-12, which shows the time relationship between the Holdoff pulse and the output of the Vertical Binary stage). The output from pin 5-U156A is connected to CR155 in the Vertical Mode Control stage through R155 and to the plug-in Binary stage at pin 11-U156B.

CONDITION 2

Input levels:

ALT Command—LO
Sweep Command—HI

Holdoff—A pulse which changes from a LO level to a HI level at the completion of each sweep.

The HI level from the Sweep Command reverse-biases CR157, putting a HI level at the direct-set input (pin 4) of U156A. The emitter of Q150 is LO as a result of the ALT Command being LO, so Q150 can conduct whenever its base is HI. The base of Q150 is connected to pin 5 of U156A; and when the 1 output goes HI, Q150 will begin to conduct. In a time determined by the value of R154 and the capacitance between the collector and base of Q150, the collector will drop from its HI level to put a LO at the direct-clear input (pin 1) of U156A. This sets the 1 output (pin 5) to a LO level and turns Q150 off. The collector of Q150 is now HI once again, removing the LO from the direct-clear input of U156A and enabling the flip-flop. Now, upon the arrival of the next positive-going holdoff pulse at the trigger input, pin 5 of U156A will go HI to complete the cycle. The output of the Vertical Binary stage is now a pulse which switches from a LO level to a HI level and back at a rate determined by the time-base unit. This output is connected to the Plug-in Binary stage as a trigger input.

CONDITION 3

Input levels:

ALT Command—Has no effect in this case
Sweep Command—LO
Holdoff—LO

The LO from the Sweep Command forward biases CR157 to put a LO at the direct-set input (pin 4) of U156A. This inhibits the trigger and D inputs and sets the 1 output (pin 5) HI, thus disabling the Vertical Binary stage.

Plug-in Binary

The Plug-in Binary stage consists of U156B, connected as a triggered flip-flop. The output of the Vertical Binary stage is connected to the trigger input (pin 11) of U156B. Each time the level at the trigger input goes positive, the 1 output (pin 9) changes states. Thus, U156B has an output that is switching between HI and LO levels at a rate equal to one-half that of the Vertical Binary stage, or is a divide by two counter. The output of this stage is connected to the Alternate Drive Buffer and Switch stage through R160-CR160. The operation of the Plug-in Binary stage is the same for both Condition 1 and Condition 2. For Condition 3, the LO from the Sweep Command forward biases CR157, putting a LO on the direct-set input (pin 10) of U156B. This inhibits the trigger and D inputs and sets the 1 output (pin 9) to a HI level, thus disabling U156B.

Alternate Drive Buffer and Switch

This stage is made up of buffer Q162-Q167 and transistor Q173, which acts as a switch. The buffer provides isolation between the input signal and the circuits driven by

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its output. The buffer circuitry is identical to the buffer in the Vertical Plug-in Chop Buffer stage. For more information on the operation of the buffer, see the discussion on the Vertical Plug-in Chop Buffer stage. The output of the buffer is connected to all three plug-in compartments via the Main Interface Circuit. The output level of the buffer is either HI or LO depending on the level of the input. The effect of the output level on a dual-trace plug-in is shown in Fig. 3-12.

The switch section of this stage is controlled by the Sweep Command through R170 to the base of Q173. When the Sweep Command level is HI (for conditions 1 and 2 as mentioned previously); Q173, CR173, and CR172 are reverse biased. The input to the buffer is from pin 9-U156B through R160 and CR160. In Condition 3, as previously noted, pin 9-U156B is HI (see Plug-in Binary stage discussion) and the Sweep Command is LO, CR160 is reverse biased by the HI level applied through R160. The base of Q173 is at a LO level from the Sweep Command, so Q173 is forward biased, as is CR173. The level at the emitter of Q173 and the input to the buffer is now determined by the level at the collector of Q173, which is connected to pin 5-U117A through R174. Now the output of the buffer will follow the output at pin 5-U117A, which is the Horizontal Plug-in Chopping Signal. When the VERTICAL MODE switch is set to ALT, CR172 becomes forward biased to pass the Horizontal Plug-in Chopping Signal to the Vertical Mode Control Stage.

Z-Axis Logic

The Z-Axis Logic stage produces an output current which sets the intensity of the display on the CRT. The level of this output current is determined by the setting of

the front-panel INTENSITY control, or by an external signal. The Vertical Chopped Blanking, Horizontal Chopped Blanking, and Readout Blanking are applied to this stage to limit the output current and blank the CRT display for vertical chopping, horizontal chopping, or during a readout display. The Intensity Limit input provides protection for the CRT phosphor at slow sweep rates.

The Z-Axis Logic stage consists of transistor Q108, dual-transistor Q90, and integrated circuit U99, which is a five-transistor array. The individual transistors of U99 are identified in Fig. 3-14. A simplified schematic diagram of the Z-Axis Logic stage is shown in Fig. 3-15.

The output transistor for this stage is common-base connected Q3-U99 whose collector load is the input of the Z-Axis Amplifier in the CRT Circuit. The inputs previously mentioned limit and/or block the current through Q3-U99 by controlling current-limiter Q4 and Q5 of U99. The current limiter also controls the current from the external inputs and the current from the INTENSITY control through CR113. The operation of this stage is as follows: The output current, shown as I_1 in Fig. 3-15, must flow into the collector of Q4-U99 at pin 11. The current into the collector of Q4-U99 through CR113, I_2 , is established by the divider R92-R93 and is quiescently maximum. The maximum amount of I_2 into the collector of Q4-U99 is determined by the current I_1 into R110 from the +15-Volt Supply through network R75-R76-R77, R62-CR62, and R109-R108 which is maximum when the blanking and limiting inputs are HI. The Maximum Intensity adjustment R75 is set to provide optimum writing rate on the CRT when the INTENSITY control is set fully clockwise. When the Sweep Gate input goes HI, the current set by the

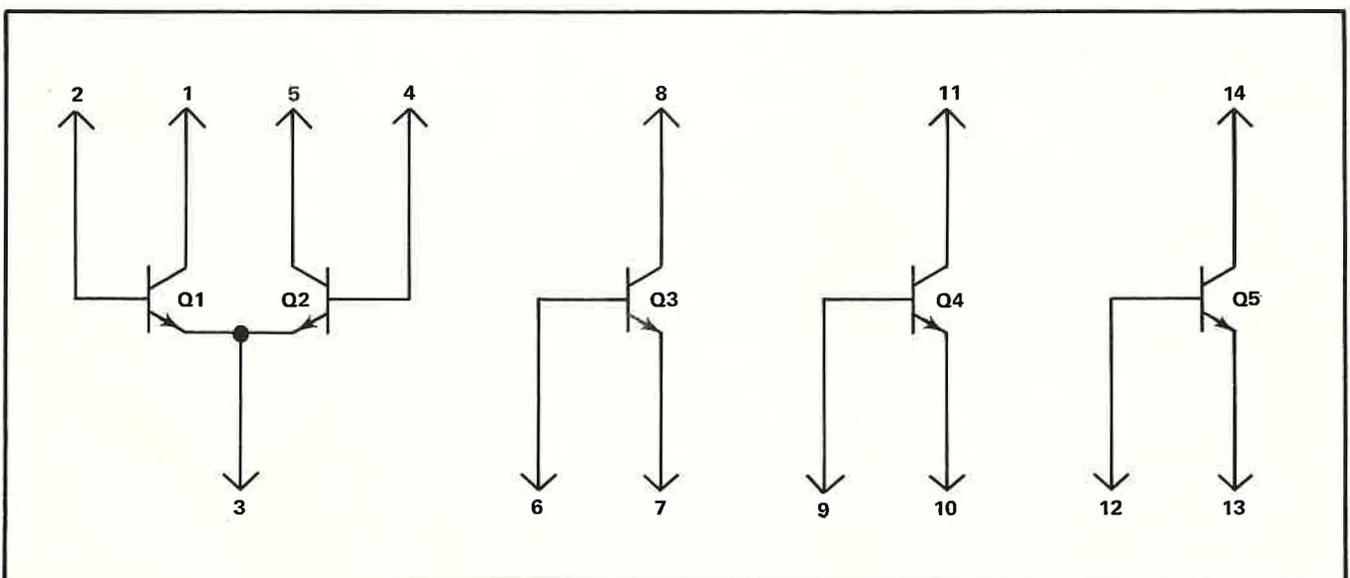


Fig. 3-14. Schematic diagram of five-transistor array identifying pins of individual transistors.

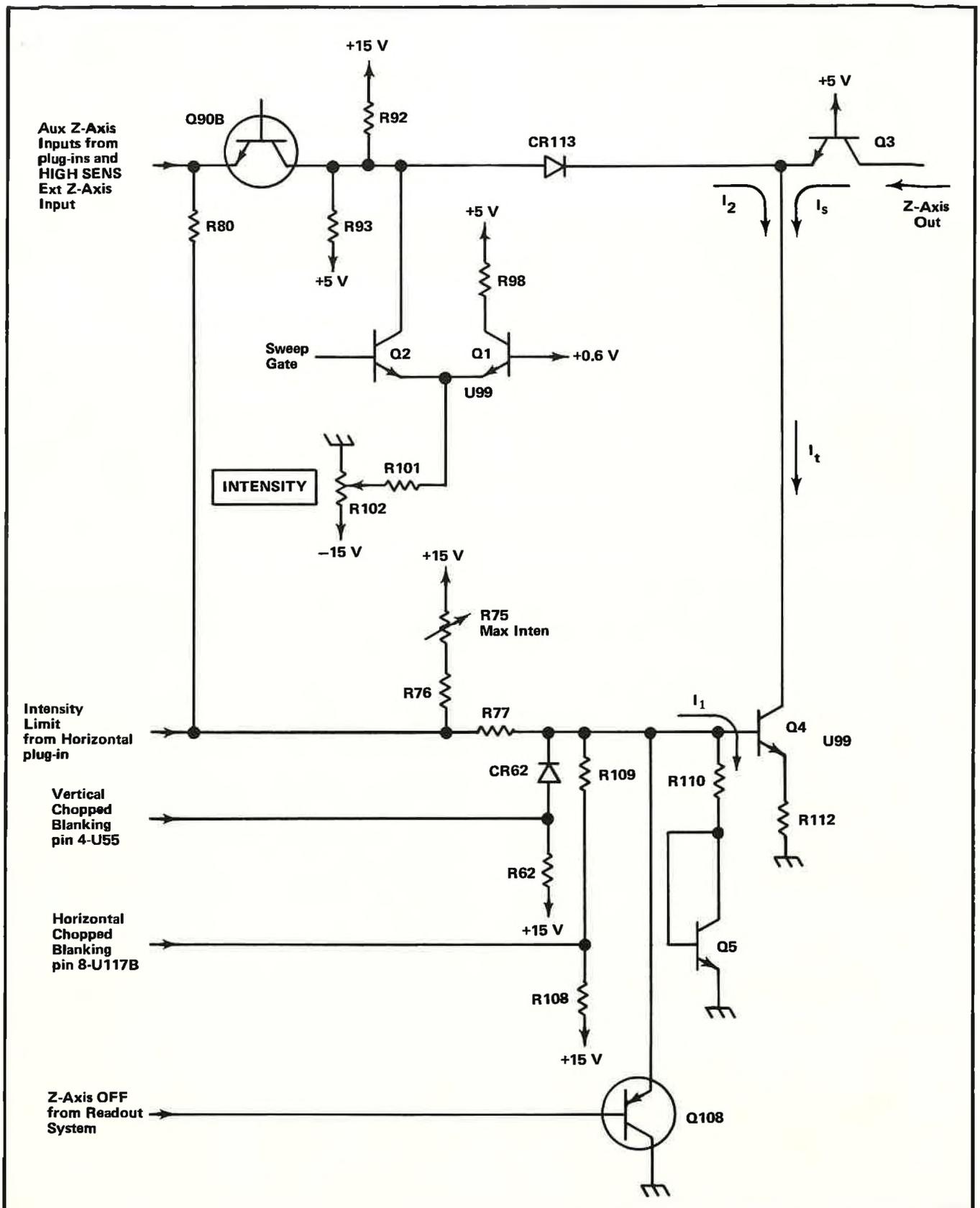


Fig. 3-15. Simplified schematic diagram of Z-Axis Logic stage.

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INTENSITY control flows into the collector of Q2-U99 and is subtracted from the current I_2 . Since I_t into Q4-U99 is set by I_1 into R110, I_s must increase by the same amount as the decrease in I_2 , which results in an increased output current to the Z-Axis Amplifier. The Aux Z-Axis inputs from plug-ins and the HI SENS Ext Z-Axis input are connected to the emitter of Q90B to modulate I_2 .

Since I_s plus I_2 is equal to I_t , if I_t is decreased or dropped to zero, the output I_s must also decrease or fall to zero. During Vertical Chopped Blanking, the level at pin 4-U55 goes LO. The current through R62-CR62 is blocked from flowing into R110 during that time, reducing I_1 (and I_t) by that amount, which is approximately 1.5 mA. During horizontal chopped blanking, the level at pin 8-U117B goes LO and the current through R108 is blocked, reducing I_1 by approximately 4.5 mA. When readout information is to be displayed on the CRT, the Z-Axis Logic OFF Command signal from the Readout System goes LO. This forward biases Q108, and it saturates, shunting I_1 through Q108 to ground. This reduces the output current to zero during the readout time.

The Intensity Limit function limits the output current of this stage, which in turn limits the maximum trace intensity for all CRT displays whenever the time-base unit is set to a sweep rate that requires intensity limiting. For conditions that do not require limiting, approximately 1.5 mA is supplied to I_1 by R75-R76-R77. When the time-base unit is set to a sweep rate which requires intensity limiting, pin EV is connected to ground through the time-base unit. This reduces I_1 by approximately 1.5 mA. However, the emitter of Q90 is also connected to pin EV through R80. When pin EV is grounded, I_2 is also decreased by approximately the same amount as I_1 . So, while I_t was reduced, I_2 was reduced leaving I_s about the same. The intensity limit function then does not change the absolute value of the intensity below the limited value, but limits the maximum setting.

TRIGGER SELECTOR

General

The Trigger Selector circuit determines the trigger signal which is connected to the Time Base unit as controlled by the TRIGGER SOURCE switch. This circuit also provides the drive signal for the Vertical Signal Amplifier circuit. Fig. 3-16 shows a detailed block diagram of the Trigger Selector circuit, along with a simplified diagram of all the circuitry involved in the selection of the trigger source. A schematic of the Trigger Selector circuit is shown on diagram 3 at the rear of this manual. Also see diagrams 0 and 9 for the trigger selection circuitry not shown on diagram 3.

Trigger Mode and ADD Signals

General. The circuitry shown on the left side of the simplified diagram in Fig. 3-16 determines the operation of the Trigger Channel Switch stage. TRIGGER SOURCE switch S1011 controls the Trigger Channel Switch U324 through Q314. When the TRIGGER SOURCE switch is set to the VERT MODE position, the setting of the VERTICAL MODE switch determines the trigger selection. In the LEFT VERT or RIGHT VERT positions, the trigger signal is obtained from the indicated vertical unit. The following discussions give detailed operation in each position of the TRIGGER SOURCE switch.

VERT MODE. In the VERT MODE position of the TRIGGER SOURCE switch, the setting of the VERTICAL MODE switch determines the operation of the Trigger Channel Switch stage. In the LEFT position of the VERTICAL MODE switch, the base of Q314 is connected to ground through the ALT and RIGHT sections of S1021, CR1021 and CR1026 and S1011. This holds Q314 reverse biased to provide a LO level to pin 4 of U324 (see Fig. 3-17).

When the VERTICAL MODE switch is set to ALT, +5 volts is applied to the base of Q314 through CR1021 and S1011. Q314 is forward biased and its emitter level is determined by the Vertical Mode Command signal from the Logic Circuit applied to the collector. This signal switches between the HI level (Right Vertical unit to be displayed) and the LO level (Left Vertical unit to be displayed) at the end of each sweep. When the Vertical Mode Command is HI, it provides a positive collector voltage to Q314. Q314 is saturated due to CR1021, and its emitter level is very near the collector level. This provides a HI output level to the Trigger Channel Switch stage. As the Vertical Mode Command goes LO, the collector supply for Q314 also goes negative. Q314 remains saturated and the output again follows the collector level to supply a LO output level to U324.

For ADD and CHOP vertical mode operation, +5 volts is connected to pin 14 of U324 through CR1023 or CR1024 and S1011. At the same time, the base of Q314 is held LO by the ground connection through the ALT and RIGHT sections of S1021 so the level at pin 4 of U324 is LO also (produces an ADD mode in Trigger Channel Switch; see description of this circuit which follows). In the RIGHT position of the VERTICAL MODE switch, +5 volts is connected to the base of Q314 through CR1026 and S1011 to forward-bias the transistor. The Vertical Mode Command signal connected to the collector of Q314 is also HI in this mode and a HI output level is produced at the emitter of Q314.

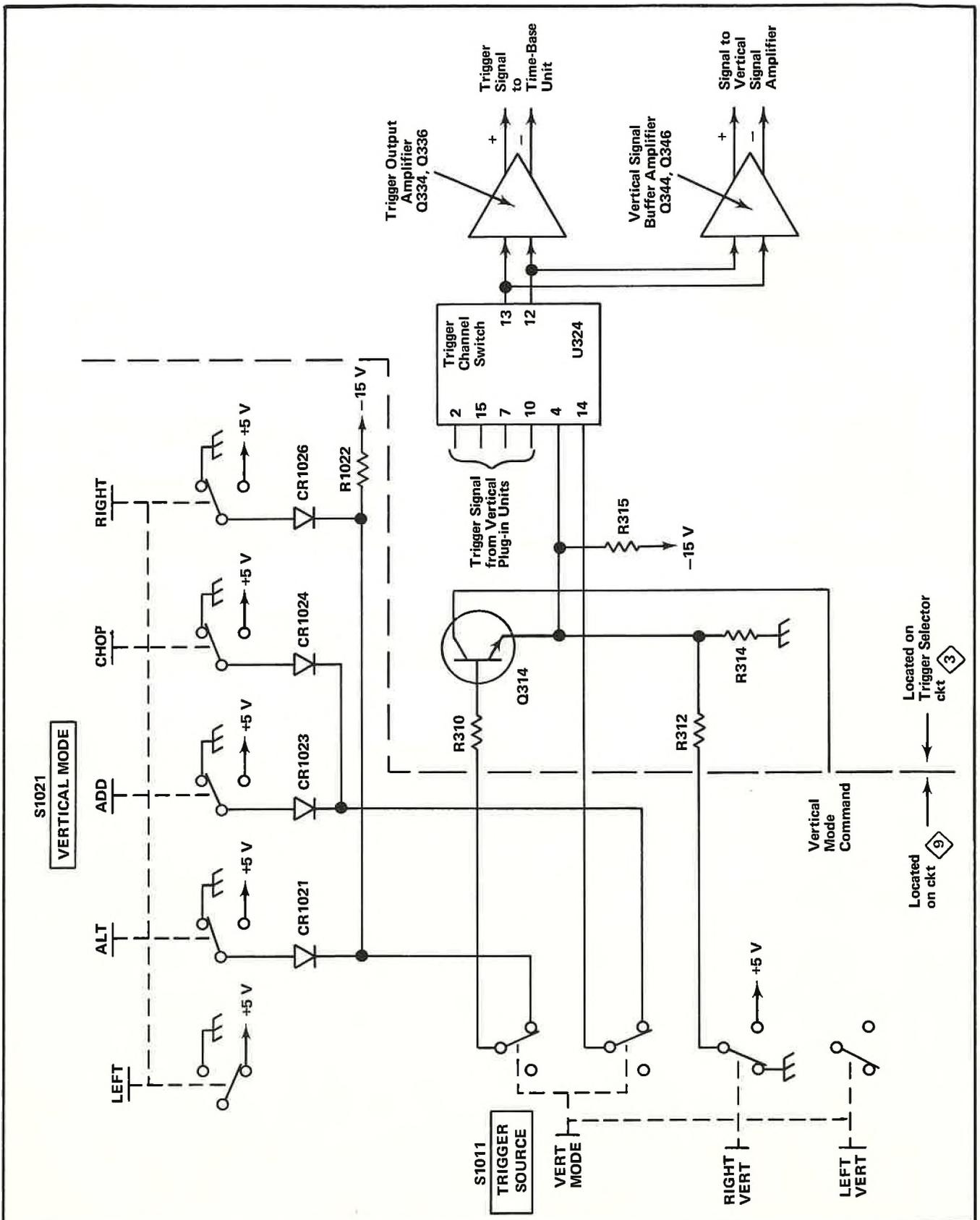


Fig. 3-16. Detailed block diagram of Trigger Selector circuit along with simplified schematic diagram of trigger source selection circuitry.

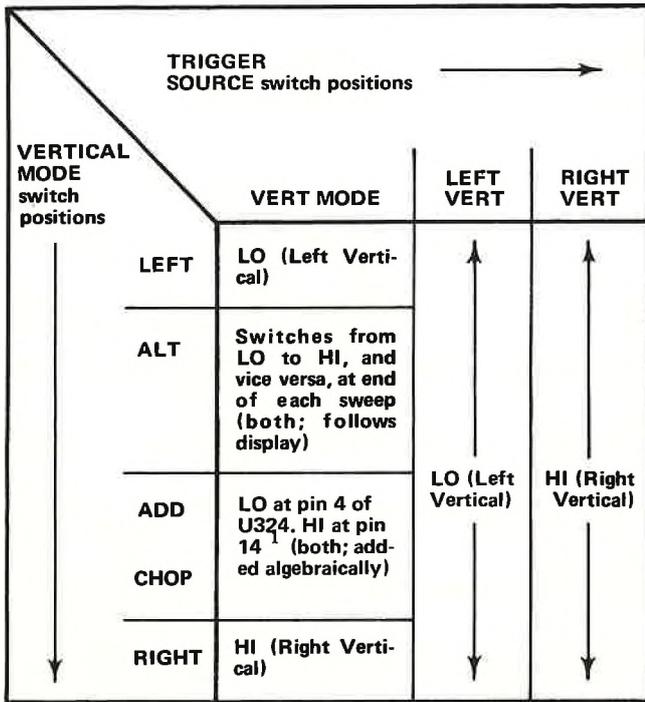


Fig. 3-17. Input levels at pin 4 of U324 (source of triggering signal is shown in parenthesis).

LEFT VERT. When the LEFT VERT trigger source is selected, the VERTICAL MODE switch is disconnected from the trigger selector circuitry. Now, the ground connection through the RIGHT VERT section of S1011 establishes a LO output level at the emitter of Q314.

RIGHT VERT. In the RIGHT VERT position of the TRIGGER SOURCE switch, +5 volts is connected to the emitter of Q314 through S1011 and R312. This produces a HI output level to the Trigger Channel Switch stage.

Trigger Channel Switch

The Trigger Channel Switch stage determines which input signal provides the trigger signal to the time-base unit as controlled by the trigger mode and ADD signals from the trigger selection circuitry.

Resistors R317-R319 establish the input resistance of this stage and provide a load for the trigger output of the Right Vertical plug-in unit (R20-R24 on the Main Interface provide a load for the Left Vertical plug-in unit). R321-R323-R324 and R326-R327-R329 establish the operating level of the Trigger Channel Switch; R321-R323 and R326-R327 set the current gain for each channel. This stage is made up primarily of integrated circuit U324. An input/output table for U324 is shown in Fig. 3-18. U324 provides a high impedance differential input for the trigger signal from the Left Vertical unit at pins 2 and 15 for the

trigger signal from the Right Vertical unit at pins 7 and 10. The output signal at pins 12 and 13 is a differential signal. The sum of the DC current at pins 12 and 13 is always equal to the sum of the DC currents at pins 1, 8, 9 and 16 in all modes. This provides a constant DC bias to the stages which follow as the TRIGGER SOURCE or the VERTICAL MODE switches are changed.

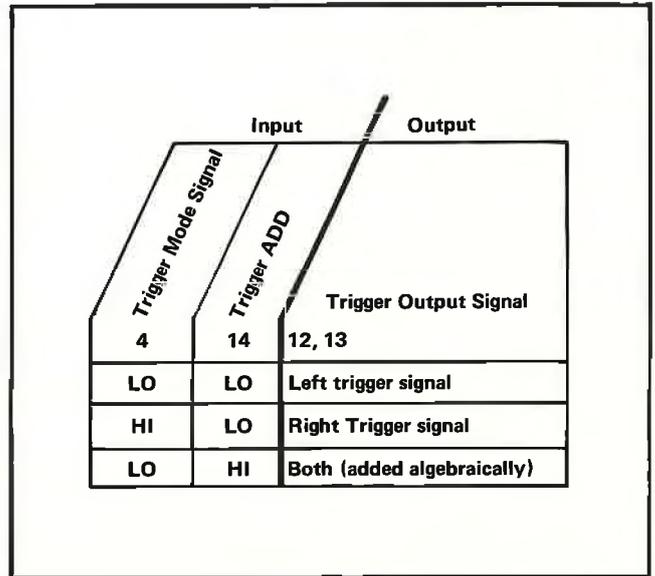


Fig. 3-18. Input/output table for Trigger Channel Switch stage.

When the level at pin 4 is LO (see Trigger Mode and ADD Signals discussion and Fig. 3-18), the trigger signal from the Left Vertical unit passes to the output while the trigger signal from the Right Vertical unit is blocked. A HI level at pin 4 connects the trigger signal from the Right Vertical unit to the output and the trigger signal from the Left Vertical unit is blocked. For VERT MODE operation in the ALT position of the VERTICAL MODE switch, the level at pin 4 switches between the LO and HI level at a rate determined by the Vertical Binary stage (see Logic Circuit description). This action obtains the trigger signal from the Left Vertical unit when the Left Vertical unit is being displayed and from the Right Vertical unit when this unit is being displayed.

When the level at pin 4 is LO and the level at pin 14 is HI, the trigger signal from both the Left and Right Vertical units passes to the output pins. This condition occurs only when the TRIGGER SOURCE switch is set to VERT MODE and the VERTICAL MODE switch is set to either ADD or CHOP. Under this operating mode, the trigger output signal is the algebraic sum of the trigger input signals from the Left and Right Vertical units to prevent triggering on the vertical chopping transition, or only on one signal of an added display.

Trigger Output Amplifier

The trigger output at pins 12 and 13 of U324 is connected to the bases of Q344-Q346 to provide the internal trigger signal for the HORIZ unit (via the Main Interface circuit). This stage provides isolation between the HORIZ unit and the Vertical Signal Buffer stage. The HORIZ unit provides a 50-ohm differential load for this stage. If it is removed from its compartment, the collector load for Q344-Q346 changes and the voltage swing at their collectors increases. The action of this stage prevents this change from affecting the Vertical Signal Buffer stage. CR341-CR349 clamp the collectors of Q344 and Q346 at about +0.6 volt to prevent these transistors from saturating under this no-load condition.

Vertical Signal Buffer

The trigger output signal at pins 12 and 13 of U324 is also connected to the emitters of common-base amplifier Q334-Q336. The output signal at the collectors of Q334 and Q336 is connected to the Vertical Signal Amplifier (see Output Signals and Calibrator description) through R336 and R337. R339 provides a differential output resistance of about 100 ohms.

VERTICAL INTERFACE

General

The Vertical Interface circuit selects the vertical deflection signal from the output of the Left Vertical and/or the Right Vertical plug-in unit. This stage also includes an input from the Readout System to block the vertical signal while readout information is displayed on the CRT. Fig. 3-19 shows a detailed block diagram of the Vertical Interface circuit. A schematic of this circuit is shown on diagram 2 at the rear of this manual.

Vertical Channel Switch

The Vertical Channel Switch determines which input signal provides the vertical signal to the Delay-Line Driver stage as controlled by the Vertical Mode Command from the Logic Circuit. Resistors R200-R202 and R204-R206 establish the input resistance of this stage and provide a load for the Left and Right Vertical units. Resistors R209-R211-R212 and R216-R218-R219 establish the operating levels for this stage. R209-R212 and R216-R219 set the current gain for each channel. C208-R208 and C215-R215 provide frequency compensation.

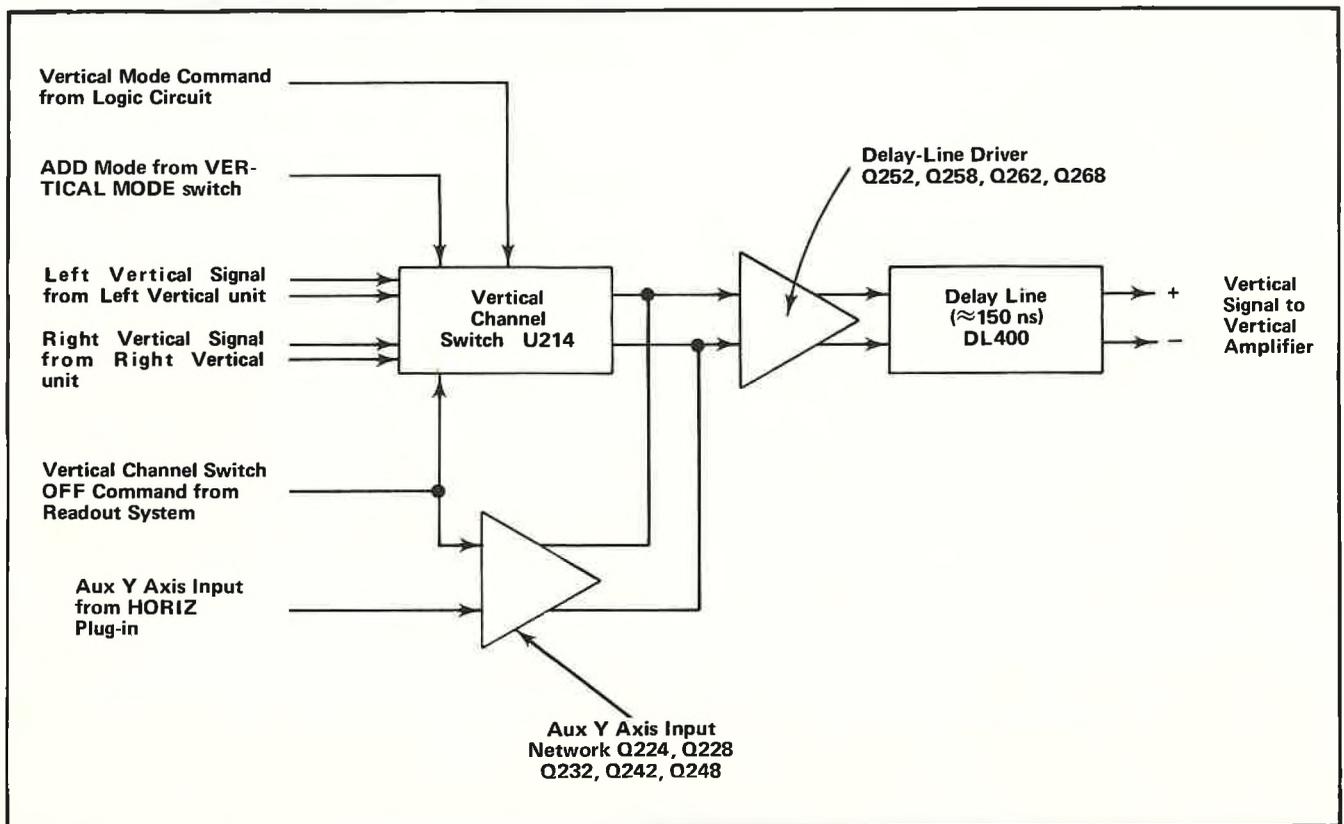


Fig. 3-19. Vertical Interface detailed block diagram.

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This stage is made up primarily of integrated circuit U214, which is the same type as used for the Trigger Channel Switch. An input/output table for U214 is shown in Fig. 3-20. U214 provides a high-impedance differential input for the signal from the Left Vertical unit at pins 2 and 15 and the signal from the Right Vertical unit at pins 7 and 10. The output signal at pins 12 and 13 is a differential signal which is connected to the Delay-Line Driver stage through R221-R222. The sum of the DC current at pins 12 and 13 is always equal to the sum of the DC currents at pins 1, 8, 9 and 16 in all modes. This provides a constant DC bias to the following stage as the VERTICAL MODE switch is changed.

When the VERTICAL MODE switch is set to LEFT, the level at pin 4 is LO. This level allows the signal from the Left Vertical unit to pass to the output while the signal from the Right Vertical unit is blocked. In the RIGHT position of the VERTICAL MODE switch, the level at pin 4 is HI. Now, the signal from the Right Vertical unit is connected to the output while the signal from the Left Vertical unit is blocked.

		Input		Output
Vertical Mode Command	ADD Mode (Vert)	Vertical Channel Switch OFF	Output signal	
4	14	6	12, 13	
LO	LO	LO	Left vertical signal	
HI	LO	LO	Right vertical signal	
LO	HI	LO	Both (added algebraically)	
Φ	Φ	HI	Neither (blocked by Readout System)	

Φ = Has no effect in this case

Fig. 3-20. Input/output table for Vertical Channel Switch.

When the VERTICAL MODE switch is set to either ALT or CHOP, the Vertical Mode Command at pin 4 switches between the LO and HI levels at a rate determined by either the Chop Counter or the Vertical Binary stages (see Logic Circuit description). This action allows the signal from the Left Vertical unit to be displayed when the Vertical Mode Command is LO and the signal from the Right Vertical unit is displayed when the Vertical Mode Command is HI. When ADD vertical mode operation is

selected, a HI level is applied to pin 14 and the level at pin 4 is LO as determined by the Vertical Mode Control stage in the Logic Circuit. This allows both the Right and Left Vertical Signals to pass to the output pins. Now, the signal from both vertical units is algebraically added and the resultant signal determines the vertical deflection.

The Vertical Channel Switch OFF signal from the Readout System which is applied to pin 6 has final control over the output signal from this stage. Quiescently, this signal is LO and the signal from the selected vertical unit can pass to output pins 12 and 13. However, when the Readout System is ready to display readout information, the level at pin 6 goes HI. This level blocks the signal from both vertical units so there is no signal output from this stage under this condition.

Aux Y-Axis Input

The Aux Y-Axis Input from a HORIZ plug-in having this function provides a positioning voltage to offset the display. The Aux Y-Axis signal is connected to a paraphase amplifier consisting of Q224 and Q228. The effective load for the paraphase amplifier is R234 in parallel with R241 on Q224, and R235 in parallel with R238 on Q228. Current from the paraphase amplifier produces a voltage drop across the effective load resistors which causes more current to flow through Q242 and Q248. Q242 and Q248 act as current sources for the Vertical Channel Switch and for Q252-Q258. So, the currents from the Vertical Channel Switch and the Aux Y-Axis Input are summed in the emitters of Q252 and Q258. The Vertical Channel Switch OFF Signal from the Readout System is applied to this stage to block the signal from the Aux Y-Axis Input when readout information is to be displayed on the CRT. Quiescently, this signal is LO and a signal from the Aux Y Axis Input will be added to the signal from the Vertical Channel Switch as described. However, when the Readout System is ready to display readout information, the base of Q232 will go HI. Q232 will conduct and will take over the emitter current in Q224 and Q228. Now, the current that was flowing through these two transistors will flow through Q232. The current through Q232 produces about the same voltage drop across the effective load resistors as was produced by the paraphase amplifier. This limits the common-mode shift that would otherwise occur when the Vertical Channel Switch OFF signal from the Readout System is applied.

Delay-Line Driver

The output of the Vertical Channel Switch stage, along with any current from the Aux Y-Axis Input Network, is connected to the emitters of Q252-Q258. These transistors are connected as common-base amplifiers to provide a low-impedance current-summing point. The signal at the collectors of Q252-Q258 is connected to the bases of Q262-Q268 through R252 and R257. When the trace is at center screen,

diodes CR264-CR266 in the emitter circuits of Q262-Q268 are slightly forward biased by the positive voltage applied to their anodes through R265. As the emitter of either Q262 or Q268 goes positive due to the applied signal at the base, the corresponding diode is reverse biased and its internal resistance increases. This change in resistance produces a decrease in the gain of this stage for large signals, which compensates for the inherent expansion characteristic of the CRT. The output signal from the Delay-Line Driver stage is connected to the Delay Line through T270. This transformer prevents high-frequency common-mode oscillation of Q262-Q268. R271 provides the reverse termination for the Delay Line.

Delay Line

Delay Line L400 provides approximately 150 nano-seconds delay for the vertical signal, to allow the horizontal circuits time to initiate a sweep before the vertical signal reaches the vertical deflection plates of the CRT. This allows the instrument to display the leading edge of the signal originating the trigger pulse when using internal triggering. The delay line used in this instrument has a characteristic impedance of about 50 ohms per side or about 100 ohms differentially. It is of the coaxial type, which does not produce preshoot or phase distortion in the CRT display.

VERTICAL AMPLIFIER

General

The Vertical Amplifier circuit provides the final amplification for the vertical signal before it is applied to the vertical deflection plates of the CRT. This circuit includes an input to produce the vertical portion of a readout display. The BEAM FINDER switch limits the dynamic range of this circuit to compress an over-scanned display within the viewing area of the CRT. Fig. 3-21 shows a detailed block diagram of the Vertical Amplifier circuit. A schematic of this circuit is shown on diagram 4 at the rear of this manual.

Buffer Amplifier

The Buffer Amplifier stage, Q404-Q406, provides a low input impedance for the Vertical Amplifier circuit to permit accurate Delay Line termination. C401-R401, C407-R407 and C400, along with the input resistance of this stage, provide the forward termination for the Delay Line. Collector current for the Delay-Line Driver stage in the Vertical Interface circuit is provided from this stage. The Centering adjustment R405 balances the quiescent DC levels in the Vertical Amplifier circuit so the trace is displayed at the center of the CRT when the inputs to this stage are at the same potential. R406 adjusts the thermal

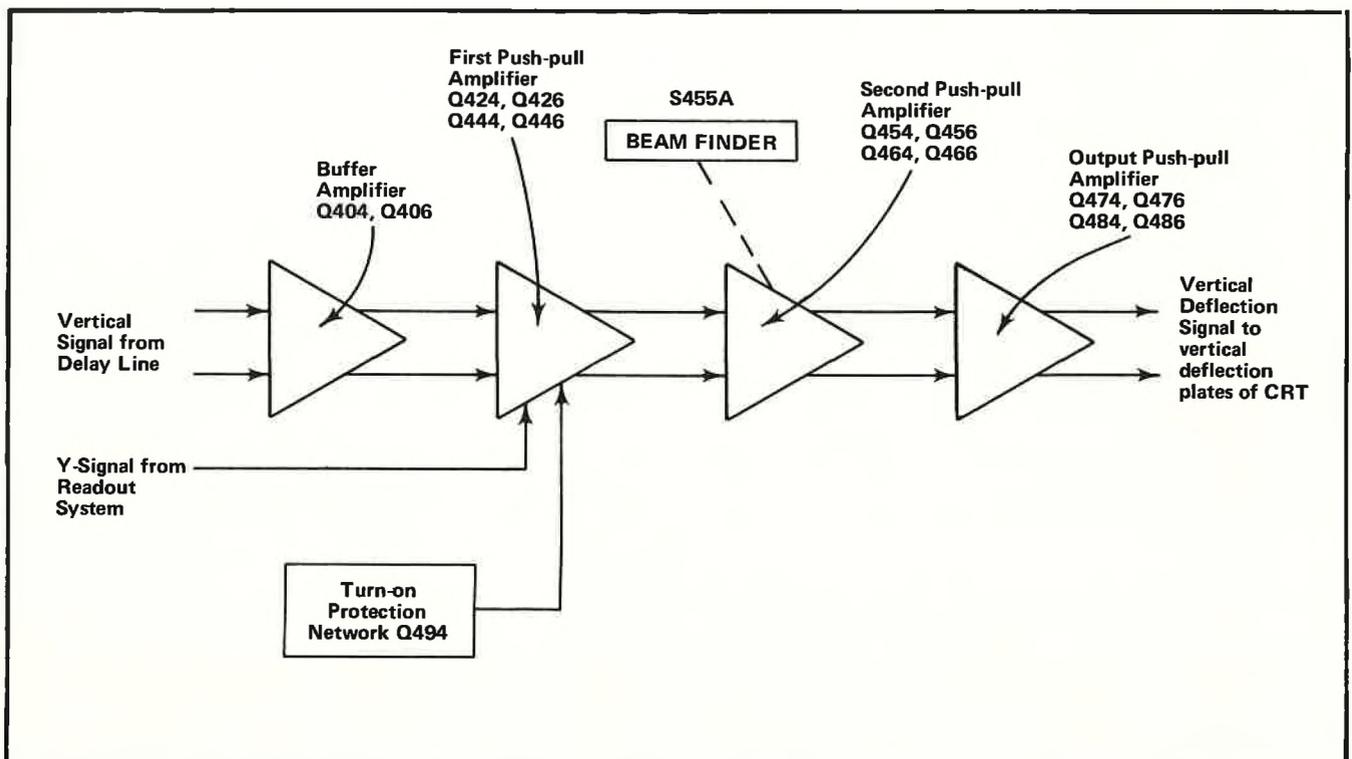


Fig. 3-21. Vertical Amplifier detailed block diagram.

Circuit Description—7503

balance of the Vertical Amplifier circuit by varying the emitter current of Q404-Q406. The output signal from the Buffer Amplifier stage is connected to the First Push-Pull Amplifier stage through C411-R411 and C412-R412.

First Push-Pull Amplifier

Q424-Q444 and Q426-Q446 are connected as a push-pull cascode amplifier stage. The Vertical Gain adjustment R415 sets the resistance between the bases of Q424 and Q426 to control the current gain of Q424-Q444. This adjustment sets the overall gain of the vertical deflection system. Thermistors RT423-RT424 and varactors CR431-CR432 provide high frequency temperature compensation for the Vertical Amplifier circuit. As the internal temperature of the instrument rises, the resistance of RT423-RT424 decreases to reduce the reverse bias on CR431-CR432. This increases the capacitance of varactors CR431-CR432 to change the emitter compensation of Q424-Q426 to maintain high-frequency response at high temperatures. The network C434-C435-C436-C437-C439-R434-R435-R436-R437-R439 provide high frequency compensation. C435-R435 in this network are adjustable to provide high-frequency delay-line compensation. C434-R434 provide high-frequency response adjustment for this stage. The output signals at the collectors of Q424-Q426 are connected to the common-base transistors Q444-Q446 through C428-R428-R441 and C429-R429-R442. The low input resistance of the Q444-Q446 common-base transistors allows this stage to provide maximum high-frequency performance.

Q494 and its associated components provide a positioning voltage to deflect the CRT beam upward, off the display area when the instrument is turned on to protect the CRT phosphor from damage due to a high-intensity spot on the display area. When this instrument is turned off, C491 quickly discharges through CR491. Then, when the instrument is turned back on, C491 begins to charge toward -15 volts through R491 since CR491 is reverse biased. While C491 is charging, Q494 is forward biased, and it conducts current away from Q446 through CR493. This current-shunting deflects the display off the viewing area vertically until the high-voltage circuits reach their full operating capabilities. As C491 continues to charge, the collector level of Q494 rises positive until CR493 is reverse biased, which disconnects the Turn-on Protection Network from the Emitter circuit of Q446.

For readout displays, the Y-signal from the Readout System is connected to the emitter of Q446 through R494. Since the signal from the vertical units is blocked in the Vertical Channel Switch under this condition (see Vertical Interface discussion), the readout signal provides the only vertical deflection. Although this signal is connected to the emitter of Q446 as a single-ended signal, it is converted to a push-pull signal by the cross-coupling networks in the following stages.

Second Push-Pull Amplifier

The Second Push-Pull Amplifier, Q454-Q464 and Q456-Q466 operates in the same manner as the previous stage. The main difference between the stages is the compensation networks and the BEAM FINDER switch located in this circuit. L447-R446 in the base circuit and C450 in the emitter circuit of Q454-Q456 provide high-frequency compensation for the Vertical Amplifier circuit.

Normally, the emitter current for Q454-Q456 is supplied through parallel paths; S455A-L454-C454 and R454. When S455A is pressed in, the current source through L454 is interrupted and the only emitter-current source for Q454-Q456 is through R454. This limits the dynamic range of this stage by limiting its current, so the display is compressed vertically within the graticule area. At the same time, -15 volts is connected to the emitters of Q464-Q466 through R461-R462 to maintain the same DC currents in the following stages as when the Beam Finder switch is in the normal position. The BEAM FINDER switch can also be pulled out to lock it in the "find" position to aid in locating the traces of several plug-in units.

Output Push pull Amplifier

The collector signals from Q464-Q466 are connected to the bases of Q474-Q476 in the Output Push pull Amplifier through L474-L476. These inductors provide series peaking for the very high-frequency components of the vertical signal. Q474-Q484 and Q476-Q486 operate in the same manner as the previous stages. The output signals at the collectors of Q484-Q486 provide the vertical deflection signal for the CRT. RC networks C484-R484 and C486-R486 in the base circuits of Q484-Q486, and LR networks LR486-LR487 prevent oscillation of the output transistors. Diode CR485 provides protection for the output transistors by disconnecting the base circuit of Q484-Q486 from the +15-volt supply if it is shorted to ground or to a negative supply. R475-R477 also provide protection for these transistors by providing a small current source to the emitters of Q484-Q486 to prevent them from turning off completely if no current is supplied from the previous transistors. Additional high-frequency compensation for this stage is provided by variable inductor L485.

X-Y DELAY COMPENSATION and HORIZONTAL AMPLIFIER

General

The Horizontal Amplifier circuit amplifies the push-pull horizontal deflection signal from the HORIZ plug-in via the Delay Compensation Network and connects it to the horizontal deflection plates of the CRT. This circuit also includes a stage with inputs from the Readout System to produce the horizontal portion of a readout display. The X-Y Delay Compensation Network provides a delay for the horizontal (X) portion of an X-Y display to match the

delay of the vertical (Y) signal due to the Delay Line. Fig. 3-22 shows a detailed block diagram of the Horizontal Amplifier circuit. A schematic of this circuit is shown on diagram 5 at the rear of this manual.

Delay Compensation Network

Time-Base Operation. When the plug-in unit installed in the HORIZ compartment is operated as a standard time-base unit to produce a horizontal sweep for deflection of the CRT beam, the Delay Compensation Network is effectively disabled. The X Compensation Inhibit Command is HI and relays K521-K525 are not actuated. Therefore, the relay contacts remain in the normally closed position so the horizontal signal passes directly through this network to the Horizontal Amplifier without delay.

X-Y Operation. If the time-base unit installed in the HORIZ compartment is operated as an amplifier or if a vertical unit is installed in the HORIZ compartment, the X Compensation Inhibit to the Delay Compensation Network drops to the LO level (zero volts). This provides an actu-

ating level to relays K521-K525 to connect the Delay Compensation Network into the circuit. Diode CR525 shunts the voltage produced across the relays when the actuating level is removed. For example, if the X Compensation Inhibit from the HORIZ unit goes LO, K521 and K525 close to route the horizontal signal through the Delay Compensation Network. LR networks L521-R521 and L522-R522 along with capacitors C521 and C522 provide a constant input impedance. The LC network composed of C523-C524-C526-C525-L524-L523-L525-L526 provides a fixed delay from DC to about two megahertz to provide minimum phase shift between the X and Y portions of the CRT display. C521 is adjusted to match the horizontal delay to the vertical delay up to at least two megahertz.

Horizontal Signal Input Amplifier

The horizontal signal from the Delay Compensation Network is connected to the bases of Q530 and Q534. Resistors R529-R533 establish the input resistance of this stage and provide a load for the signal output of the HORIZ plug-in unit. This stage provides adjustments to set the overall gain of the Horizontal Amplifier circuit and to

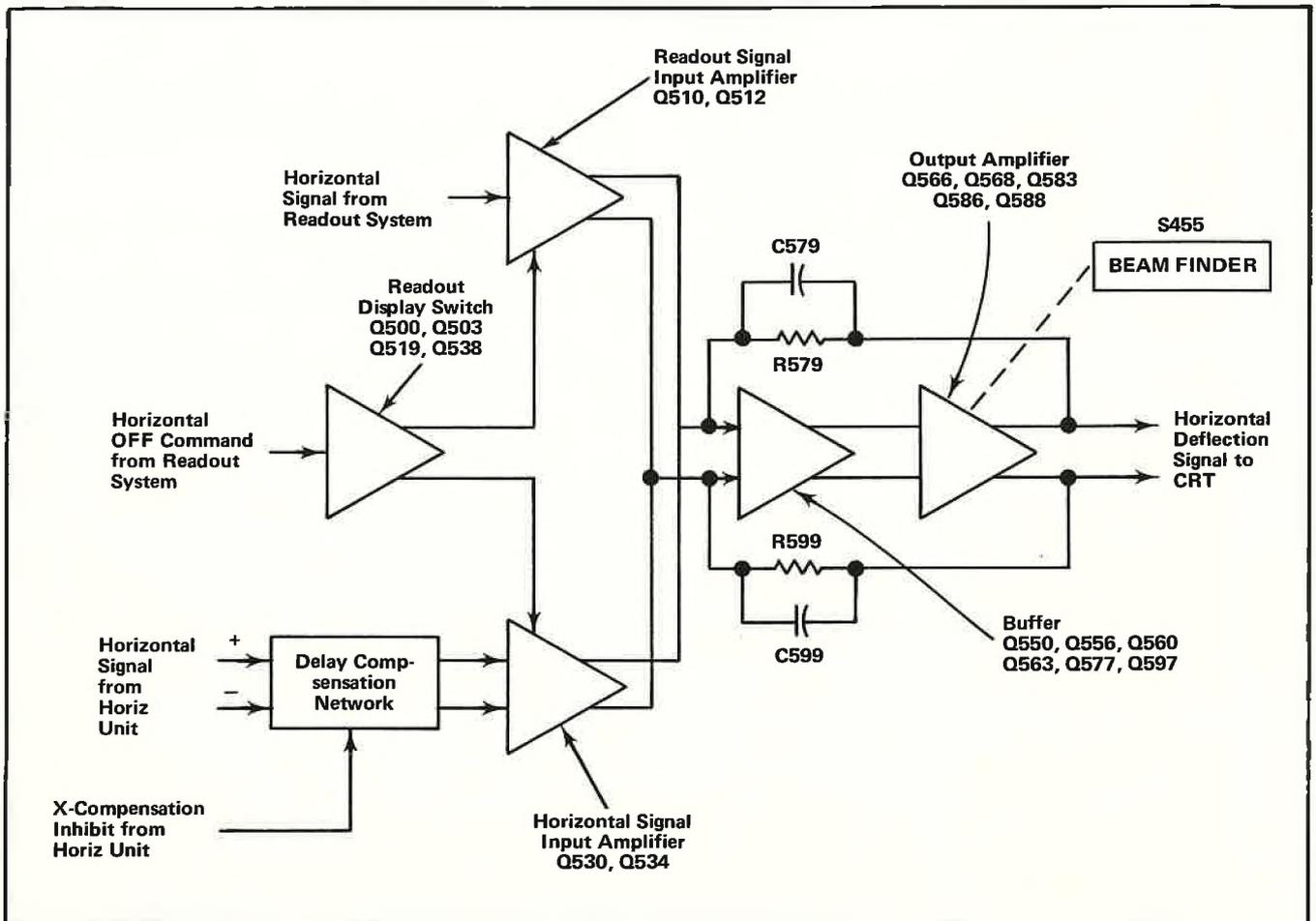


Fig. 3-22. Horizontal Amplifier detailed block diagram.

Circuit Description—7503

balance the collector current of Q530 and Q534. Resistors R532-R533-R535-R537-R530 provide degeneration between the emitters of Q530 and Q534. Horizontal Gain adjustment R530 determines the amount of emitter degeneration to control the signal gain of this stage. DC Center adjustment R536 balances the quiescent current through Q530 and Q534 to produce a centered spot on the CRT with no horizontal deflection signal applied. Emitter current for Q530 and Q534 is supplied through Q538 when Q538 is conducting. Q538 is in the Readout Display Switch stage, and will be conducting current except when readout information is to be displayed on the CRT. For instruments which are not equipped with a Readout System, R538 is added between the collector of Q538 and ground. The signal current output from this stage is connected through R542 and R543 to the input of the Buffer Amplifier stage, where it is summed together with the output of the Horizontal Readout Input stage.

Horizontal Readout Input Amplifier

The X signal from the Readout System is connected to the base of Q510 through R507. Q510 and Q512 operate as a paraphase amplifier to convert the single-ended readout signal to a push-pull signal. Resistors R510-R512-R511-R515-R517 provide degeneration between the emitters of Q510 and Q512. R512 determines the amount of emitter degeneration to control the signal gain of this stage. R516 balances the quiescent current through Q510 and Q512 to center the readout display on the CRT. Q519 supplies emitter current for Q510 and Q512 when it is conducting. Q519 is part of the Readout Display Switch stage and is conducting only when readout information is to be displayed. The collectors of Q510 and Q512 are connected, through R540 and R541, to the input of the Buffer Amplifier stage. Here, the signal current from this stage is summed together with the signal current from the Horizontal Signal Input Amplifier stage.

Readout Display Switch

The Readout Display Switch stage blocks the signal from the HORIZ unit when readout information is to be displayed on the CRT. Conversely, this stage blocks readout signals except when the readout information is to be displayed. The Horizontal OFF Command signal from the Readout System is connected to the base of Q503. Q503 and Q500 are emitter-coupled to form a differential switch. The Horizontal OFF Command signal is quiescently LO, so the emitter-base junction of Q503 is forward biased and Q500 is turned off. The current through R504 will flow through Q503 and R539. The resultant voltage drop across R539 forward biases the emitter-base junction of Q538. Q538 then can supply the emitter current for Q530 and Q534 to pass the signal from the HORIZ plug-in. Because Q500 is not conducting, the base-emitter junction of Q519 is reverse biased. Therefore, there is no source of emitter current for Q510 and Q512 and the X signal from the Readout System is blocked. When readout information is to

be displayed, the Horizontal OFF Command signal goes HI. This turns off Q503 and Q500 is allowed to conduct. Q519 is turned on to supply emitter current for Q510 and Q512 to pass the X-Readout Signal. Q538 is turned off, and the signal from the HORIZ plug-in is blocked.

Buffer Amplifier and Output Amplifier

The Buffer Amplifier consists of Q550-Q556 and Q560-Q563. Q550 and Q556 are common-base connected to provide low-impedance summing points at their emitters. The input signals are connected to the Buffer Amplifier through the limiting network CR542-CR543-CR545-CR547. These diodes protect the Buffer Amplifier stage from being overdriven by excessive current drive from the input stages. The output signals from the input stages are current signals. With normal horizontal deflection signals which produce an on-screen display, CR545 and CR547 remain forward biased and CR542-CR543 are reverse biased. However, when high-amplitude horizontal deflection signals are applied to this circuit as a result of sweep magnification or high-amplitude external horizontal signals, either CR545 or CR547 is reverse biased, depending on the polarity of the overdrive signal. This results in a sufficient voltage change at the anode of either CR542 or CR543 to forward bias it. The shunt diodes provide a current path for the signal current to limit the voltage change during the overdrive condition. Limit Center adjustment R548 balances the quiescent current at the emitters of Q550 and Q556 so limiting does not occur during the displayed portion of the horizontal deflection signal.

The signal at the collectors of Q550-Q556 is connected to the Output Amplifier through emitter followers Q560-Q563. Q560 and Q563 provide a current gain for the horizontal deflection signal. Each half of the Output Amplifier is a current driven stage with a voltage output to drive the horizontal deflection plates of the CRT and feedback to the input of the Buffer Amplifier stage for linearity. The Output Amplifier has a low input impedance and requires very little voltage change at the input to produce the desired output change. Q583 provides a stable voltage source for the bases of Q568-Q588. Diodes CR560-CR563 limit the negative level at the bases of Q566 and Q586 to about 0.6 volt to protect these transistors in case of failure or removal of Q550 or Q556. Negative feedback is provided from the collectors of Q568 and Q588 to the input of the Buffer Amplifier through feedback networks C579-R579-Q577-C570-R571-R570 and C599-R599-Q597-C590-R591-R590. Emitter followers Q577-Q597 in the feedback networks provide isolation between the input of the Buffer Amplifier and the output of the Output Amplifier stage. With this configuration, the input impedance of the Buffer Amplifier appears low, since the feedback network beyond the emitter followers is effectively disconnected as far as the input signal is concerned. However, the total feedback network is active for the feedback signal. Variable capacitors C573 and C593 adjust the transient response of the feedback networks to provide good linearity at fast sweep rates.

The BEAM FINDER switch, S455, reduces horizontal scan by limiting the voltage swing of Q568 and Q588 when actuated. Normally, the collectors of these transistors are returned to +150 volts, and CR455 is reverse biased to disconnect the +75-volt level. However, when the BEAM FINDER switch is actuated, the power from the +150-volt supply is interrupted and the collector voltage for Q568-Q588 is supplied from the +75-volt supply through CR455. This reduced collector voltage limits the output voltage swing at the collectors of Q568-Q588 to limit the trace within the graticule area.

OUTPUT SIGNALS AND CALIBRATOR

General

The Output Signals and Calibrator circuit provides output signals to the connectors located on the front and side panels. These output signals are either generated within this instrument, or they are samples of signals from the associated plug-in units. Fig. 3-23 shows a detailed block diagram of the Output Signals and Calibrator circuit. A schematic of this circuit is shown on diagram 6 at the rear of this manual.

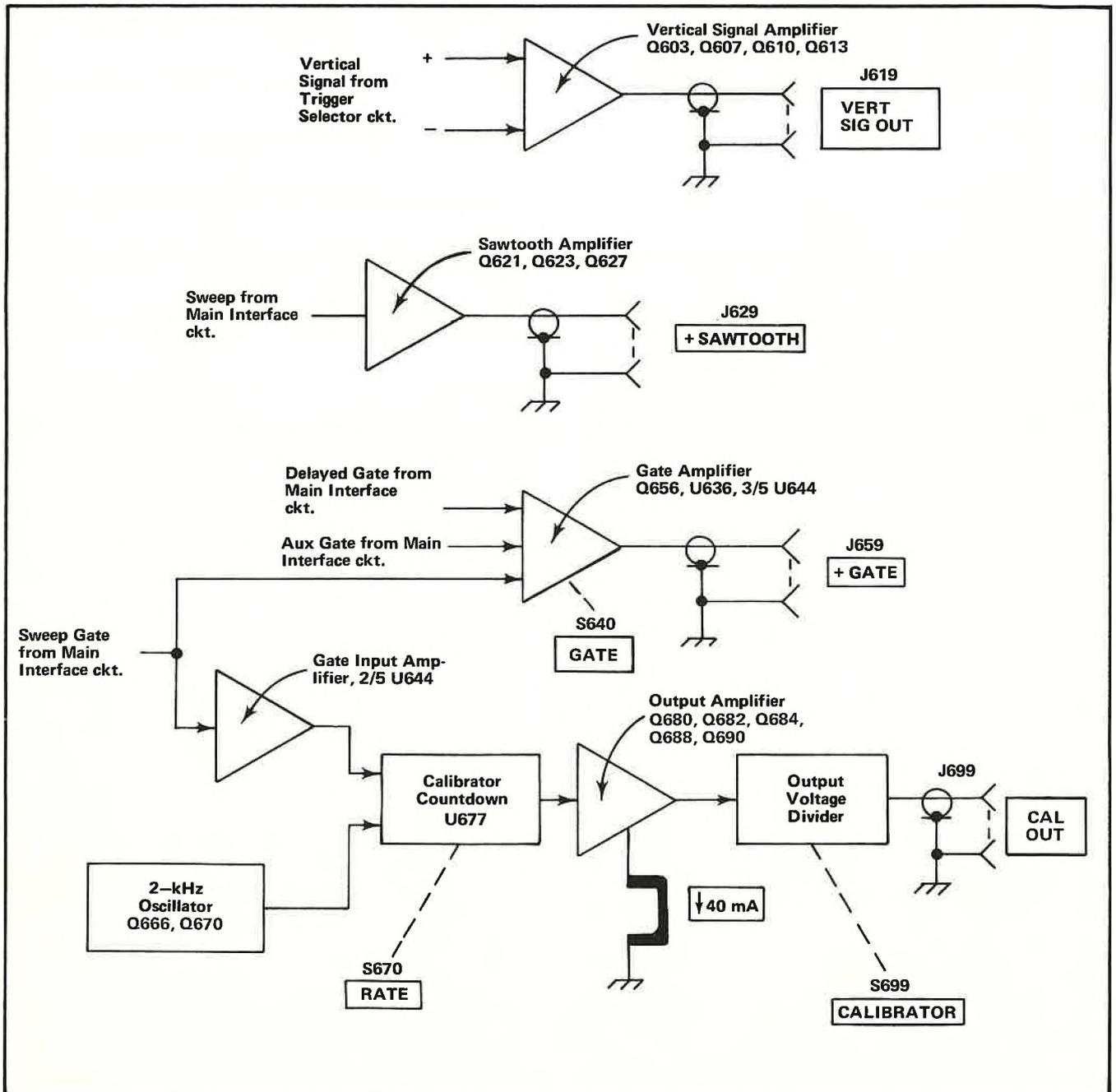


Fig. 3-23. Output Signals and Calibrator detailed block diagram.

Vertical Signal Amplifier

The Vertical signal selected by the Trigger Channel Switch (see Trigger Selector description for more information) is connected to the bases of differential amplifier Q603-Q607. Resistors R600-R601 establish an input resistance of about 50 ohms for this stage. The amplified signal at the collectors of Q603 and Q607 is connected to buffer amplifier Q610-Q613 through RC networks C608-R608 and C609-R609. These networks provide thermal balance for this stage. The single-ended signal at the collector of Q613 is connected to the side-panel VERT SIG OUT connector, J619. The signal at the collector of Q610 is connected to the chassis ground. CR616 and CR617 protect this stage if high-level voltages are accidentally applied to the VERT SIG OUT connector. CR616 provides protection from positive voltages and CR617 provides protection from negative voltages.

Sawtooth Amplifier

The sawtooth signal from the time-base unit is connected to the Sawtooth Amplifier stage through series resistor R40 (on the Main Interface board). Transistors Q621, Q623 and Q627 comprise an inverting feedback amplifier. The gain of this stage is about two, as determined by the ratio of feedback resistor R631 to the input resistance made up of R620 and R40. The signal at the collector of Q627 is connected to the side-panel +SAWTOOTH connector, J629, through R629. RC network C628-R628 provides frequency response stabilization for this stage. Diode CR624 provides protection from high-level positive voltages inadvertently connected to the output connector, by providing a current path to the +15-volt supply through the collector-base junction of Q627. If such a high-level voltage occurs, CR624 is forward biased to clamp the base of Q627

at this level. CR630 provides protection from high-level negative voltages at the +SAWTOOTH connector by clamping the output if it attempts to go more negative than about -15.6 volts.

Gate Amplifier

The output signal at side-panel +GATE connector J659 is selected from three input gate signals by GATE switch S640. The gate signals from the HORIZ plug-in compartment (for gate output signals available, see time-base unit instruction manual) are connected to three comparators, made up from transistors in U644 and U636 transistor arrays (see Fig. 3-24 for schematic diagram of five-transistor array). The GATE switch selects a gate input by supplying a current path to -15 volts for the emitters of the proper comparator. The three comparators share the collector load resistors R646-R647. The input signal selected by S640 is connected to the emitter of Q656 through Q3-U636 and Q3-U644. Diode CR655 provides temperature compensation for common-base connected Q656. The signal at the collector of Q656 is connected to the +GATE connector through CR657 and R659. CR657 protects Q656 if a high-level positive voltage is applied to the +GATE connector, and CR658 clamps the output at about -0.6 volt if a negative voltage is applied to the connector.

Calibrator

General. The Calibrator circuit provides a 40 milli-ampere current output at the front-panel current loop and a voltage output in calibrated steps from four millivolts to 40 volts at the front-panel CAL OUT connector. Mode and repetition rate of the output signal are selected by the calibrator RATE switch, and the output voltage amplitude is selected by the CALIBRATOR switch.

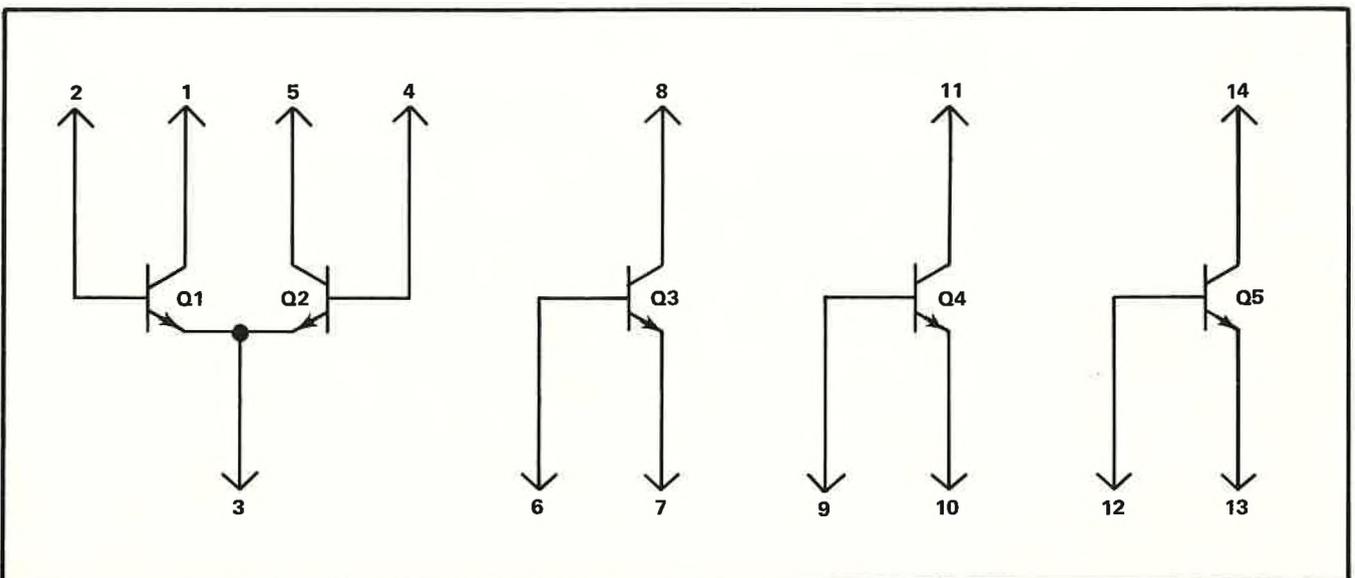


Fig. 3-24. Schematic diagram of five-transistor array identifying individual transistors.

2-kHz Oscillator. Q666 and Q670 are connected as a two-kilohertz square-wave oscillator to provide the drive signal for the Calibrator Countdown stage (one-kilohertz output rate only). Oscillation occurs as follows: Assume that Q666 is conducting and Q670 is off. The collector current of Q666 through R666-R665 produces a voltage level which holds the base of Q670 low. This keeps Q670 turned off, and since there is no current through it, its collector goes positive to produce the positive portion of the square wave. At the same time, C669 begins to charge toward -50 volts through R672. The emitter of Q670 goes negative also as C669 charges, until it reaches a level about 0.6 volt more negative than the level at its base. Then, Q670 is forward biased and its emitter rapidly rises positive. Since C669 cannot change its charge instantaneously, the sudden change in voltage at the emitter of Q670 pulls the emitter of Q666 positive also, to reverse bias it. The current through Q670 produces a voltage drop at its collector to produce the negative portion of the square wave.

Now, conditions are reversed. Since Q666 is reverse biased, there is no current through it. Therefore, C669 can begin to discharge through R668. The emitter level of Q666 follows the discharge of C669 until it reaches about -0.6 volt. Then, Q666 is forward biased and its collector drops negative to reverse bias Q670. This interrupts the current through Q670 and its collector goes positive again to complete the square wave. Once again, C669 begins to charge through R672 to start the second cycle. The signal produced at the collector of Q670 is a two-kilohertz square wave. C673 differentiates this signal to produce positive- and negative-going output pulses, coincident with the rise and fall of the square wave, which provides negative-going trigger pulses for the Calibrator Countdown stage (positive-going pulses have no effect on circuit operation). The 1 kHz adjustment, R665, sets this stage so an accurate one-kilohertz square wave is produced at the output of the Calibrator circuit.

Sweep Gate Buffer. When the RATE switch is in the GATE $\div 2$ position, Q1-Q2 of U644 (5-transistor array) are switched in to invert the Sweep Gate signal to provide negative-going trigger pulses at the sweep rate for the Calibrator Countdown stage.

Calibrator Countdown. Integrated circuit U677 is a triggered set-clear (J-K) flip-flop. An input/output table for this device is shown in Fig. 3-25. The calibrator RATE switch S670 determines the operating mode of U677, and also selects the source of its trigger signal. S670 is a cam-type switch; a contact-closure chart showing its operation is given on diagram 6. The dots on this chart indicate when the associated contact is closed. For the DC position, a LO level is applied to the J input (pin 1) and a HI level is applied to the K input (pin 3). The next negative-going trigger from the 2-kHz Oscillator stage switches the output at pin 7 to its LO level (see input/output table). The output

Input		Output
3	1	Condition at pin 7 after trigger pulse
LO	LO	Output changes state with each trigger pulse
LO	HI	HI
HI	LO	LO
HI	HI	No change

Fig. 3-25. Input/output table for U677.

at pin 7 remains at the LO level as long as the RATE switch remains in this position.

For the 1 kHz position, all contacts except 3 are closed. This places a LO level at both the J and K inputs so that pin 7 changes output levels with each negative-going trigger from the 2-kHz Oscillator stage. This results in a one-kilohertz square wave output signal at pin 7. The J and K inputs are also held LO in the GATE $\div 2$ position of S670 so that U677 changes output levels with each negative-going pulse at its trigger input. However, the signal from the 2-kHz Oscillator is disconnected and the Gate signal provides the trigger to pin 2, resulting in an output square wave with a repetition rate which is one-half the Gate repetition rate.

Output Amplifier

Transistors Q684 and Q688 are connected as a comparator with the reference level at the base of Q688 determined by network R692-R693-R694-R695-Q690. This network establishes a voltage level at the base of Q688 which results in a 40 volt level at its collector when it is on. The 0.4 V adjustment R695 is set in the 0.4 V position of the CALIBRATOR switch, to provide accurate calibrator output voltages at the CAL OUT connector J699. Output Voltage Divider R697 A-H and R696 form a current divider to determine the current through the front-panel 40 mA current loop when S699 is in the 40 mA position. The current loop is a five-turn current transformer, so the effective current applied to a current probe is 40 milliamperes.

The output of the Calibrator Countdown stage is connected to the base of Q680 through R678. Q680 acts as a switch to control the current through Q682, and the output of Q682 controls the conduction of comparator Q684-Q688. When DC operation is selected by the calibrator RATE switch, a LO level is applied to the base of Q680

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to cut it off. Therefore, there is no current through Q682 and the base of Q684 rises positive to cut it off also. Now, the collector current of Q688 produces a voltage drop across the Output Voltage Divider to provide a DC voltage output at the CAL OUT connector.

For the 1 kHz and GATE $\div 2$ positions, the base of Q680 varies between the LO and HI levels at the rate selected by the calibrator RATE switch. When the base of Q680 is LO, Q684 is off and Q688 is conducting. This produces an output voltage at the CAL OUT connector as for DC operation. When the level at the base of Q680 is switched to HI, Q684 conducts and Q688 is reverse biased. Now, the voltage level at the CAL OUT connector drops to zero.

Output Voltage Divider. The collector current of Q688 in the Output Amplifier stage is applied across the voltage divider made up of R697 A-H. This divider is designed to provide a low output resistance in all positions while allowing selection of output voltages between 4 mV and 40 V. The CALIBRATOR switch S699 selects the output from the divider to provide the output voltages listed on the front panel (into high-impedance load). The values shown in brackets indicate the output voltage into a 50-ohm load (notice that 40 V position lists no output into 50 ohms and

should not be used in this manner). S699 is a cam-type switch and the dots on the contact-closure chart (see diagram 6) indicate when the associated contact is closed.

CRT CIRCUIT

General

The CRT Circuit produces the high-voltage potentials and provides the control circuits necessary for the operation of the cathode-ray tube (CRT). This circuit also includes the Z-Axis Amplifier stage to set the intensity of the CRT display. Fig. 3-26 shows a detailed block diagram of the CRT Circuit. A schematic of this circuit is shown on diagram 7 at the rear of this manual.

High-Voltage Oscillator

Unregulated voltage for operation of the high-voltage supply is provided from the +15-Volts Rectifier (see Low-Voltage Power Supply). Diode CR760 disconnects the negative side of this unregulated voltage from the collector of Q760 at the time of turn-on. This allows the starting current for the High-Voltage Oscillator to be supplied from the +15-Volt Supply through R760 and Q760. As the output of the high-voltage supply increases to its required output level, the collector of Q760 goes negative until

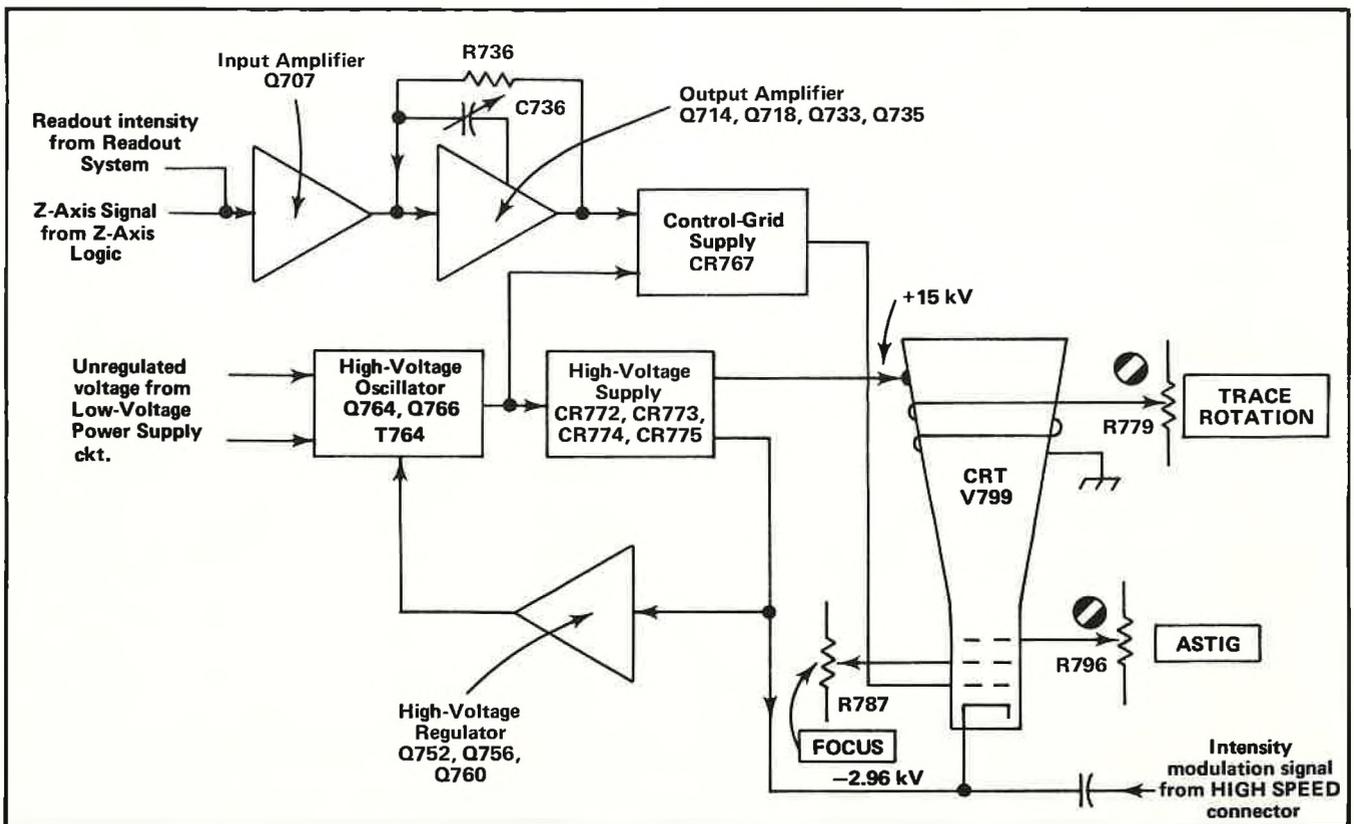


Fig. 3-26. CRT Circuit detailed block diagram.

CR760 is forward biased. Now the collector supply level for Q760 is provided by the negative side of the unregulated voltage. This configuration provides a controlled starting current for the High-Voltage Oscillator at turn-on, and at the same time allows the High-Voltage Regulator stage to control the current for the High-Voltage Oscillator after the stage reaches operating potentials to regulate the output level.

Q764-Q766 and the associated circuitry comprise the high-voltage oscillator to drive the high-voltage transformer T764. When the instrument is turned on, starting current is supplied to the bases of both Q764 and Q766. Both transistors are forward biased, and they both attempt to come into conduction. However, since the transistors will not have identical characteristics (even though they are of the same type), one transistor conducts more heavily than the other. For purposes of the explanation, assume that Q764 conducts more heavily. The collector current of Q764 produces a corresponding current increase in the base-feedback winding of T764 to further increase the bias on Q764. At the same time, the voltage developed across the base-feedback winding connected to Q766 reverse biases it. As long as the collector current of Q764 continues to increase, a voltage is induced into the base-feedback winding of T764 which holds Q764 forward biased. However, when the collector current of Q764 stabilizes, the magnetic field built up in T764 begins to collapse. This induces an opposite current into the base windings which reverse biases Q764, but forward biases Q766. When the induced voltage at the base of Q766 exceeds the bias set by Q760, Q766 is forward biased and the amplified current at its collector adds to the current flowing through T764 due to the collapsing field. Then as the current through T764 stabilizes again, the magnetic field around it once more begins to collapse. This induces a voltage into the base windings which forward biases Q764 and reverse biases Q766 to start another cycle.

The signal produced across the primary of T764 is a sine wave at a frequency of 35 to 45 kilohertz. C765-L765 shapes the signal in the primary of T764 so it maintains essentially a sine-wave characteristic. The amplitude of the oscillations in the primary of T764 is controlled by the High-Voltage Regulator stage to set the total accelerating potential for the CRT. Filter network C762-L762 decouples high peak operating currents from the +15-Volt Supply.

High-Voltage Regulator

A sample of the secondary voltage from T764 is connected to the High-Voltage Regulator stage through divider R740-R744A-R744B-R744C. Q752 and Q756 are connected as an error amplifier to sense any change in the voltage level at the base of Q752. The -15-Volt Supply, connected to the emitter of Q752 through R754, provides

the reference level for this stage. High-Voltage adjustment R746 sets the quiescent level at the base of Q752 to a level which establishes a -2.96 kV operating potential at the CRT cathode. CR740 protects Q752 from excessive reverse emitter-base voltage.

Regulation occurs as follows: If the output voltage at the -2.96 kV test point starts to go positive (less negative), a sample of this positive-going change is connected to the base of Q752. Both Q752 and Q756 are forward biased by this positive change, which in turn increases the conduction of Q760. This results in a more positive level at the emitter of Q760 and a more positive bias level at the bases of Q764 and Q766. Now, the bases of both Q764 and Q766 are biased closer to their conduction level so that the feedback voltage induced into their base-feedback windings produces a larger collector current. This results in a larger induced voltage in the secondary of T764 to produce a more negative level at the -2.96 kV test point to correct the original error. In a similar manner, the circuit compensates for output changes in a negative direction. Since the amplitude of the voltage induced into the secondary of T764 also determines the output level of the positive supply and the Control-Grid Supply, the total high-voltage output is regulated by sampling the output of the negative supply.

High-Voltage Supplies

High-voltage transformer T764 has three output windings. One winding provides filament voltage for the cathode-ray tube. Two high-voltage windings provide the negative and positive accelerating potentials for the CRT and provide the bias voltage for the control grid. All of these outputs are regulated by the High-Voltage Regulator stage to maintain a constant output voltage as previously described.

Positive accelerating potential for the CRT anode is supplied by C772-C773-C774-CR772-CR773-CR774. This rectified voltage is filtered by R776 and the capacitance of the CRT to provide a constant output of about +15 kilovolts. All of these components are included in an encapsulated assembly. The negative accelerating potential for the CRT cathode is also obtained from this same secondary winding. Half-wave rectifier CR775 provides an output voltage of about -2.96 kilovolts which is connected to the CRT filament and cathode through L788 and R789. The cathode and filament are connected together through R789 to prevent cathode-to-filament breakdown due to a large difference in potential between these CRT elements. A sample of the negative accelerating voltage is connected to the High-Voltage Regulator stage to maintain a regulated high-voltage output.

Half-wave rectifier CR767 provides a negative voltage for the control grid of the CRT. Output level of this supply

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is set by CRT Grid Bias adjustment R768. Neon bulbs DS786A-DS786B-DS786C protect the CRT by limiting the voltage difference between the cathode and control grid to a maximum of about 165 volts if either the Control-Grid Supply or negative High-Voltage Supply should fail. The Unblanking Gate from the Z-Axis Amplifier circuit is connected to the positive side of this circuit. As the Unblanking Gate level changes, it shifts the overall supply level to change the bias on the CRT to control the intensity of the display.

Intensity modulating signals from the rear panel HIGH SPEED Z AXIS connector are applied to the CRT cathode through C785 and RC network C783-R783-R784. This signal changes the CRT bias, and thereby the intensity of the display, by changing the level on the cathode.

CRT Control Circuits

Focus of the CRT display is determined by FOCUS control R787. This control is part of divider R788-R787-R744D-VR786 between the negative high-voltage supply and ground. Therefore, the voltage applied to the focus grid is more positive (less negative) than the voltage on either the control grid or cathode. The ASTIG adjustment R796, which is used in conjunction with the FOCUS control to obtain a well-defined display, varies the positive level on the astigmatism grid. Geom adjustment R792 varies the positive level on the horizontal deflection plate shields to control the overall geometry of the display.

Two adjustments control the trace alignment by varying the magnetic field around the CRT. Y Axis Alignment R794 controls the current through L794 which affects the CRT beam after vertical deflection, but before horizontal deflection. Therefore, it affects only the vertical (Y) components of the display. The TRACE ROTATION adjustment R779 controls the current through L779 and affects both the vertical and horizontal rotation of the beam.

Z-Axis Amplifier

General. The Z-Axis Amplifier circuit is a current driven, shunt-feedback amplifier with a voltage output. This output voltage provides the drive signal to control the CRT intensity level through the Control-Grid Supply. Details of operation for the stages in this circuit follow.

Input Amplifier. Transistor Q707 is a common-base amplifier to establish a low input impedance for the Z-Axis Amplifier stage. The output level of this stage is determined by the input current from either of two circuits. For normal operation, the Z-Axis Signal from the Logic Circuit sets the input current as determined by the front-panel INTENSITY control, the chopped blanking logic or an external signal connected to the rear-panel HIGH-SENSITIVITY Z-AXIS INPUT. For readout displays, the Z-Axis Signal is blocked in the Logic Circuit. In this case, the input current is provided from the Readout System as

determined by the READOUT intensity control on the front panel.

Output Amplifier. The output stage is a shunt-feedback operational amplifier with feedback connected from the output to the input through C736-R736. The output voltage is determined by the input current multiplied by the feedback resistor and is expressed by the formula: $E_{out} = I_{in} \times R_{FB}$, where R736 is R_{FB} . The signal current change at the base of Q714 for maximum intensity is about 4 milliamperes. The maximum output voltage change is set for 64 volts (about 4 mA \times 15.4 k Ω). AC feedback is provided by C736, which is adjusted for optimum step response. This provides a fast-rise unblanking gate output signal with minimum overshoot and ringing. Otherwise, the CRT display would vary in intensity level following sudden changes in blanking level.

The signal from the Input Amplifier stage is amplified by Q714-Q718. Variable resistor R712 in the base circuit of Q714 provides transient response adjustment for this stage. The signal at the collector of Q718 is connected to the base of transistor Q733 through C729 and to the base of Q735 through R720-C727-R727. These transistors are connected as a collector-coupled complementary amplifier to provide a linear, fast output signal while consuming minimum quiescent power. Q735 maintains the low-frequency response of the input signal and provides a fast falling edge on the output signal. Only the fast-changing portions of the input signal are coupled to the base of Q733 through C729. Since Q733 is a PNP transistor, it responds faster to negative-going changes at its base than to positive-going changes. This action provides a fast rising edge on the output signal (fast falling edge by Q735, an NPN transistor). The signal at the collectors of Q733-Q735 is connected to the Control-Grid Supply through R738-R739.

Diodes CR731-CR714-CR735 provide protection for the Z-Axis Amplifier. CR731 protects this stage from damage due to high-voltage surges connected back into the circuit from the High-Voltage Supply. CR735 protects Q735 by clamping its base at -0.6 volt if Q718 fails or is removed from its socket. CR714 protects Q714 against excess reverse base-emitter voltage.

LOW-VOLTAGE POWER SUPPLY

General

The Low-Voltage Power Supply circuit provides the operating power for this instrument from seven regulated supplies. Electronic regulation is used to provide stable, low-ripple output voltages. Each regulated supply contains a short-protection circuit to prevent instrument damage if a supply is inadvertently shorted to ground. The Power Input stage includes the Voltage Selector Assembly. This assembly allows selection of the nominal operating voltage and regulating range for the instrument. Fig. 3-27 shows a detailed block diagram of the Low-Voltage Power Supply

circuit. A schematic of this circuit is shown on diagrams 8A, 8B and 8C at the rear of this manual.

Power Input

Power is applied to the primary of transformer T801 through the EMI (electro-magnetic interference) filter FL801, 115-volt line fuse F801, POWER switch S801, thermal cutout S800, Voltage Selector switch S802 and Range Selector switch S803. Voltage Selector switch S802 connects the two halves of the primary of T801 in parallel for 115-volt nominal operation, or in series for 230-volt nominal operation. A second line fuse, F802, is connected into the circuit when the Voltage Selector switch is set to 230 V position to provide the correct protection for 230-volt operation (F802 current rating is less than the rating of F801).

Range Selector switch S803 allows the instrument to regulate correctly on higher or lower than normal line voltages. Each half of the primary of T801 has taps above and below the 115-volt (230) nominal point. As Range Selector switch S803 is switched from LO to M to HI, more turns are effectively added to the primary winding and the turns ratio is decreased. This configuration compensates for higher or lower than normal line voltage to extend the regulating range of the Low-Voltage Power Supply.

Thermal cutout S800 provides thermal protection for this instrument. If the internal temperature of the instrument exceeds a safe operating level, S800 opens to interrupt the applied power. When the temperature returns to a safe level, S800 automatically closes to re-apply the power.

—50-Volt Supply

The following discussion includes the description of the —50-Volt Rectifier, —50-V Series Regulator, —50-V Feedback Amplifier, —50-V Reference and —50-V Current Limiting stages. Since these stages are closely related in the production of the —50-volt regulated output voltage, their operation is most easily understood when discussed as a unit.

The —50-V Rectifier assembly CR821 rectifies the output at the secondary of T801 to provide the unregulated voltage source for this supply. CR821 is connected as a bridge rectifier, and its output voltage is filtered by C822 before it is applied to —50-V Series Regulator Q823. Q825-Q827 and Q1-Q2-Q5 of transistor array U840 (see Fig. 3-28) operate as a feedback-stabilized regulator circuit to maintain a constant —50-volt output level. Q1-Q2 of U840 are connected as a differential amplifier to compare the feedback signal at pin 2 against the reference signal at pin 4. The error output signal at pin 5 reflects the differ-

ence, if any, between the two inputs. The change in level at the error output is always in the same direction as the change at the feedback input (in phase). The error output signal at pin 5 is connected to the —50-V Series Regulator through emitter follower Q827-Q825. Q5 of U840 is diode connected to provide further temperature compensation for the differential amplifier.

Zener diode VR840 sets a reference level of about —9 volts at pin 4 of U840. A sample of the output voltage from this supply is connected to the feedback input (pin 2) through divider R844-R845-R846-R488. R848 in this divider is adjustable to set the output voltage level of the supply. Notice that the feedback voltage to this divider is obtained from a line labeled —50 V Sens. Fig. 3-29 illustrates the reason for this configuration. The inherent resistance of the interconnecting wire between the output of the —50-Volt Supply and the load produces a voltage drop which is equal to the output current multiplied by the resistance of the interconnecting wire. Even though the resistance of the wire is small, it results in a substantial voltage drop due to the high output current of this supply. Therefore, if the feedback voltage were obtained ahead of this drop, the voltage at the load might not maintain close regulation. However, the —50 V Sens configuration overcomes this problem, since it obtains the feedback voltage from a point as close as practical to the load. Since the current in the —50-C Sens line is quite small, the feedback voltage is an accurate sample of the voltage applied to the load.

Regulation occurs as follows: If the output level of this supply decreases (less negative) due to ripple, changes in load, or changes in line voltage, the voltage at pin 2, U840 decreases also. A positive-going change at the feedback input to the differential amplifier results in a positive-going change in the error output signal at pin 5. This allows more base current to flow through Q827 and Q825, resulting in increased conduction of —50-V Series Regulator Q823. This action increases the load current, and the output voltage of this supply increases (more negative). The feedback voltage from the —50 V Sens line increases, and the feedback input to the differential amplifier returns to the same level as the reference input. Similarly, if the output level of this supply increases (more negative), the error output signal to the base of Q827 becomes more negative. Less current can flow through Q827 and Q825, reducing the conduction of Q823 to decrease the output voltage of this supply.

The —50 Volts adjustment R848 determines the divider ratio to pin 2 of U840 and thereby determines the feedback voltage. This adjustment sets the output level of the supply in the following manner: if R848 is adjusted so the voltage at its variable arm goes less negative (closer to ground), this appears as an error signal at pin 2 of U840. In the same manner as described previously, this positive-going change at the feedback input (pin 2) increases the conduction of

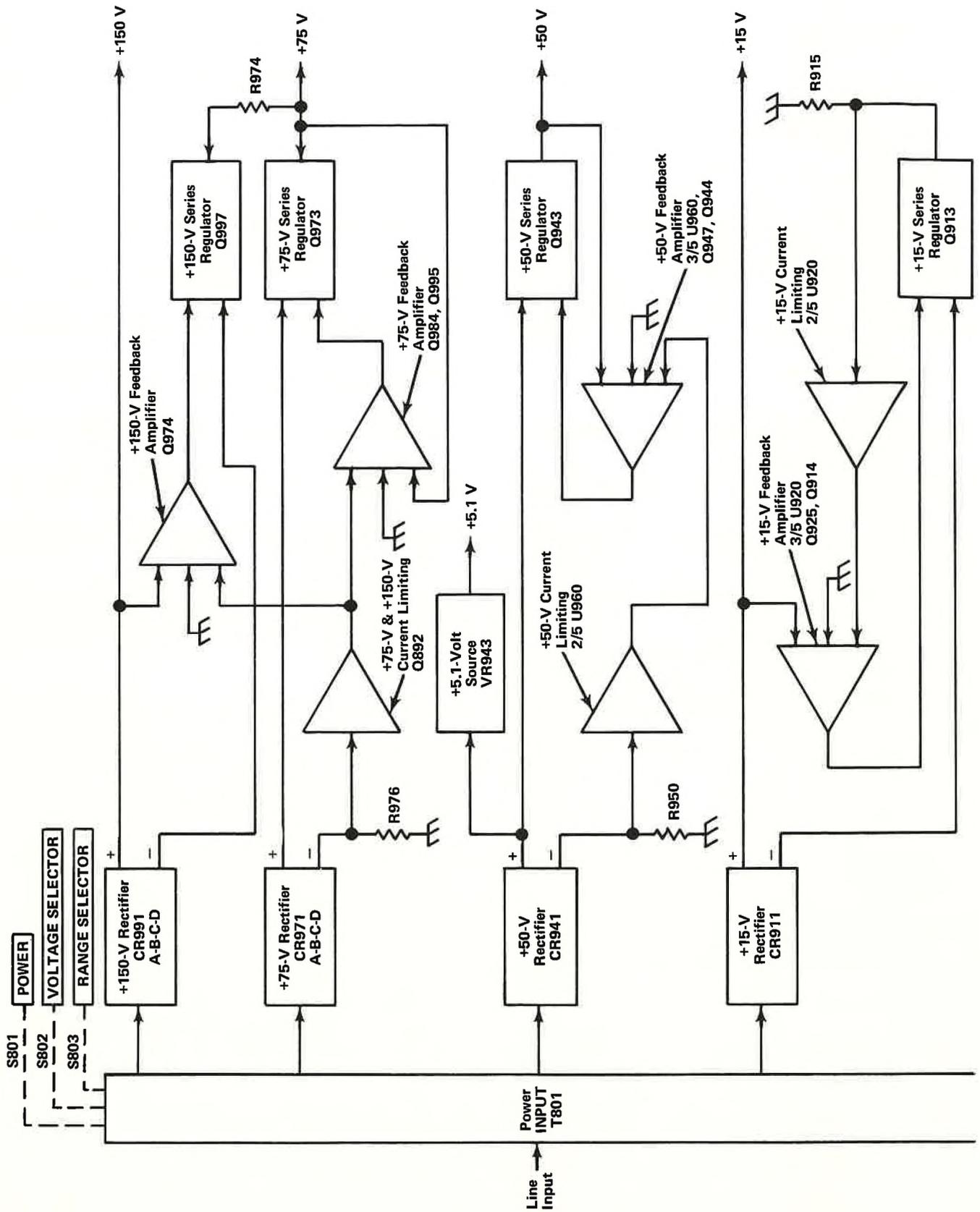


Fig. 3-27. Low-Voltage Power Supply detailed block diagram.

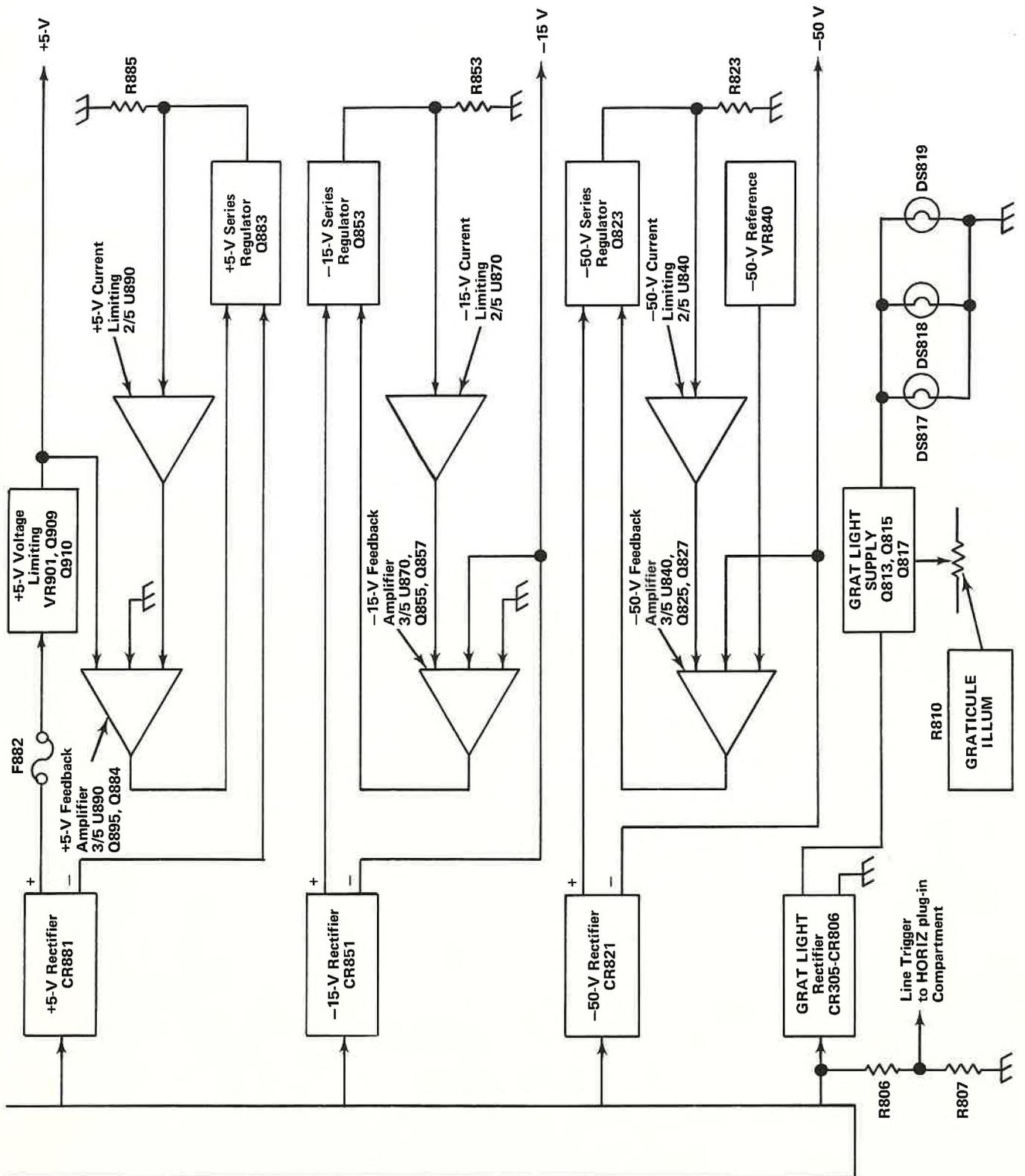


Fig. 3-27. Low-Voltage Power Supply detailed block diagram.

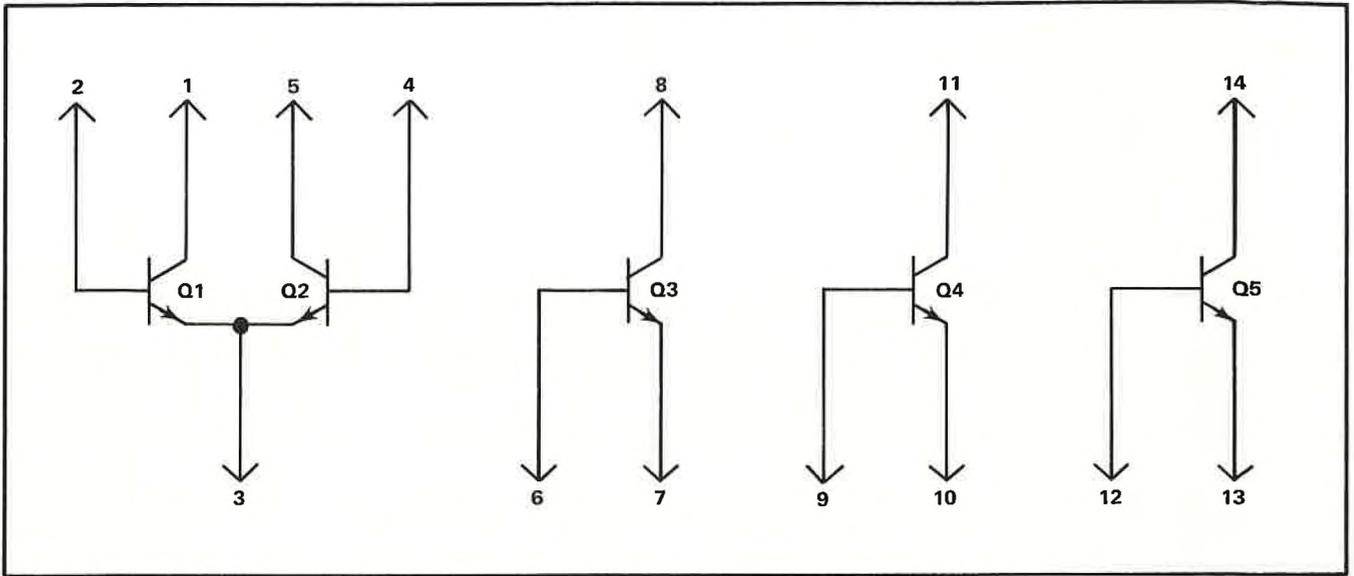


Fig. 3-28. Schematic diagram of five-transistor array identifying individual transistors.

the -50 V Series Regulator to produce more current through the load, and thereby increase the output voltage of this supply. This places more voltage across divider R844-R846-R845-R848, and the divider action returns the feedback input (pin 2) to about -9 volts. Notice that the feedback action of this supply forces a change in the output level which always returns the feedback input (pin 2) to the same level as the reference input (pin 4). In this manner, the output level of the -50-Volt Supply can be set to exactly -50 volts by correct adjustment of R848.

The -50-V Current Limiting stage Q3-Q4 of U840 protects the -50-Volt Supply if excess current is demanded from this supply. Since the ground return for the -50-Volt Supply is through R823, all current from the -50-Volt Supply must flow through R823. The voltage drop across R823 is connected to the base of Q4, U840 through diode-connected Q3, U840 and divider R830-R831. Transistor Q4, U840 senses the voltage drop across R823 and compares it to the voltage at its emitter established by divider R838-R839. When excess current is demanded from the -50-V Series Regulator due to a short circuit or similar malfunction at the output of this supply, the voltage drop across R823 increases until the voltage at pin 9, U840 is sufficient to forward bias Q4, U840. The collector current of Q4, U840 results in a reduction of current through Q827 and Q825 to limit the conduction of Q823. As the output voltage decreases due to the malfunction at the output, the bias established by divider R830-R831 increases. This increases the conduction of Q4, U840 to further limit the current through Q823. The current limiting protects Q823 from damage due to excess power dissipation. CR849 protects the -50-V Supply from damage if its output is shorted to one of the positive supplies. C834-R834 prevent oscillation in the feedback network.

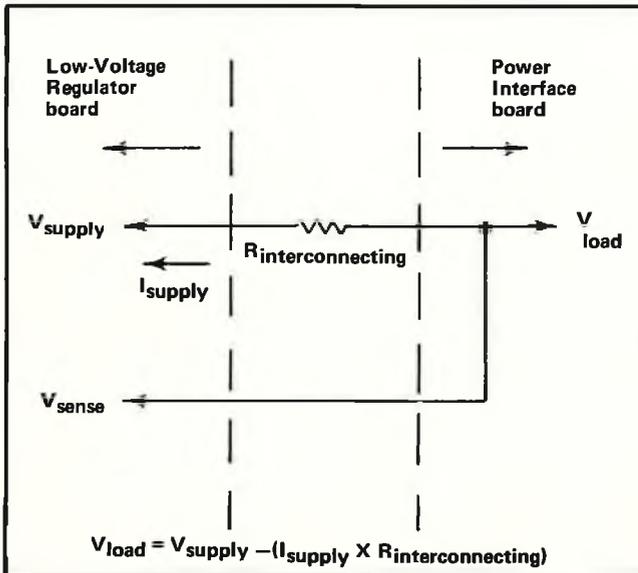


Fig. 3-29. Schematic illustrating voltage drop between power supply output and load due to resistance of interconnecting wire.

-15-Volt Supply

Rectified voltage for operation of the -15-Volt Supply is provided by rectifier assembly CR851. This voltage is filtered by C852 to provide the unregulated voltage source for this supply. Basic operation of all stages in the -15 V Supply is the same as for the -50-Volt Supply. Reference level for this supply is established by divider R870-R871 between the -50-V Sens and ground. The output voltage is regulated in the same manner as described for the -50-Volt Supply.

+5-Volt Supply

Bridge rectifier CR881 A-B-C-D provides the rectified voltage for the +5-Volt Supply. The +5-V Series Regulator Q883 operates the same as the series regulators in the negative supplies, except that it is connected in the negative side of the supply. Reference level for this supply is ground applied to the differential comparator at pin 2, U890. A sample of the output of this supply is connected to the feedback input of the comparator (pin 4) through divider R903-R904. The error output signal at pin 1, U890 is inverted by Q895 and is connected to the +5-V Series Regulator through emitter-follower Q884. The output voltage is regulated in the following manner: if the output level of this supply increases (more positive), the voltage at pin 4, U890 also increases. A positive-going change at the feedback input to the differential comparator results in a positive-going change at pin 1, U890. This positive-going error signal is inverted by Q895 to a negative-going change and is applied to the +5-V Series Regulator through Q884. This action results in decreased conduction of the +5-V Series Regulator, which decreases the load current and thereby decreases the output voltage. The feedback voltage from the +5-V Sens now decreases the level at pin 4, U890 returns to that of the reference input to pin 2, U890 (ground). Similarly, if the output level of this supply decreases, the error output signal to the base of Q883 becomes more positive. This increases the conduction of Q883 to increase the output voltage of the supply.

The ground return for the +5-V Series Regulator is through current-sensing resistor R885. The voltage drop across R885 is sensed by a differential comparator composed of Q3-Q4, U890. The voltage drop across R885 is applied to pin 6, U890 through R886 and divider R887-R888. When the current through R885 is normal, the resulting voltage applied to pin 6, U890 will forward bias that base-emitter junction. As a result, the other transistor in the comparator, Q4-U890, is shut off. When excess current is demanded from this supply, the voltage drop across R885 increases (becomes more negative). The resulting voltage at pin 6, U890 reverse biases that base-emitter and causes Q4-U890 to conduct. The collector current through Q4-U890 removes the emitter current for Q895, thereby removing the drive for Q884 and Q883. As the output voltage decreases due to the malfunction at the output, the bias established by divider R887-R888 decreases to keep Q3-U890 reverse biased.

The +5-V Voltage Limiting stage provides protection for the light bulbs and integrated circuits which are powered from this supply if the output voltage rises above the normal five-volt level. The +5-volt output of this supply is connected across zener diode VR907 through R907. Under normal conditions, there is not enough voltage across VR907 to place it in the zener region. However, if the output of this supply rises positive due to a short to a more positive supply, or similar malfunction, the gate of Q909 (programmable unijunction transistor) is clamped at about

+6.5 volts through R908 by zener diode VR907. As the output voltage increases to about +6 volts, Q909 is forward biased and its cathode current triggers silicon-controlled rectifier Q910 through R910. When Q910 conducts, it effectively shorts the output of the +5-V Supply to ground, demanding high output current. This high current is sensed by the +5-V Current Limiting stage and the output current is reduced as described previously. The output remains limited until the instrument is turned off and the problem is corrected. A momentary voltage surge may also trigger the +5-V Voltage Limiting stage and cause the +5-Volt Supply to shut down. Power can be restored in this case by momentarily turning off the POWER switch and returning it to ON.

Fuse F882 provides further protection for this supply. If the +5-V Current Limiting stage malfunctions (for example, collector of +5-V Series Regulator shorted to ground) and a condition occurs which demands current limiting, F882 opens to interrupt the output of this supply before damage can occur. Due to the high current output of this supply, a separate ground return is used for this supply to prevent its heavy return current from affecting other supplies in the instrument.

+15-Volt Supply

Rectifier assembly CR911 provides the rectified voltage for the +15-Volt Supply. This unregulated voltage is also connected to the High-Voltage Oscillator stage in the CRT circuit through F912. This fuse protects the +15-V Rectifier from damage due to failures in the High-Voltage Oscillator stage. Basic operation of the stages in this circuit are the same as described for the previous supplies.

+50-Volt Supply

Bridge rectifier assembly CR941 provides the rectified voltage for the +50-V Supply. This unregulated voltage is applied across zener diode VR943 through R943 to provide a +5.1-volt source for operation of several circuits within the Low-Voltage Power Supply circuit. Regulation occurs much the same as described for the previous supplies. The Feedback Amplifier is referenced to ground at pin 2, U960. The feedback input is supplied from the +50-V Sens through divider R966-R967. The error output signal from pin 1, U960 is inverted by Q947 and is applied to the +50-V Series Regulator through emitter-follower Q944. When the feedback input goes positive, a negative-going change is applied to the +50-V Series Regulator to decrease the conduction of Q943. A similar but opposite action occurs if the feedback input goes negative. The +50-V Current Limiting stage is made up of Q3-Q4, U960. It senses the voltage drop across R950 to provide protection for this supply if excess current is demanded.

+75-Volt Supply

Unregulated +75-volts is provided by bridge rectifier CR971 A-B-C-D and filtered by C972-R972. Q973 is con-

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nected as a series regulator in the positive side of the supply. Q984 is connected as the +75-V Feedback Amplifier. Q984 applies an inverted error output signal to Q973 through emitter-follower Q995. Notice that the collector supply voltage for Q995 is taken from the +150-V Supply through R995. The current limiting function for the +75-V Supply is shared with the +150-V Supply and is described in the discussion of that supply.

+150-V Supply

Bridge rectifier assembly CR991 A-B-C-D provides the rectified voltage for the +150-Volt Supply. However, this secondary winding of T801 does not supply the full potential necessary to obtain the +150-volt output level. To provide the required output level, the negative side of this supply is connected to the output of the +75-Volt Supply through the +150-V Series Regulator so that the two supplies are effectively connected in series between ground and the +150-volt output. The +150-V Feedback Amplifier Q974 and +150-V Series Regulator Q997 provide basic regulation for the output level in a manner similar to that described for the +75-Volt Supply. Changes in the output level appear as error signals at the base of Q974 (reference established by +75-volts connected to emitter through R974). These changes are reflected to the base of Q997 to provide regulation of the output level. The ground return for both the +75-V Supply and the +150-V Supply is through current-sense resistor R976. The bias established on the base of Q982 by divider R978-R979 will forward bias Q982 under normal conditions. If the current demand on either supply becomes excessive, the resulting voltage at the base of Q982 will reduce the forward bias on the base-emitter of Q982 and the collector will rise. This is connected to the feedback amplifiers of both supplies; to Q984 through R988 and divider R986-R987, and to Q974 through R982 and CR974. This action results in decreased conduction through both series regulators.

Graticule-Light Supply

The graticule lights DS817-DS818-DS819 are powered by the Graticule Light Supply consisting of Q813-Q815-Q817. Rectified voltage for this supply is provided by CR805-CR806 from a center-tapped secondary winding of T801. The setting of the front-panel GRATICULE ILLUM control determines the voltage at the emitter of Q813 and applies it to the graticule lights through emitter-follower Q817 and R818-R819. Current limiting protection for this supply is provided by Q815 should a short or similar malfunction occur on the line to the graticule lights. Circuit operation is as follows: The voltage level at the center arm of the GRATICULE ILLUM control R810 is applied to the base of Q813 through divider R811-R812. The resulting voltage level at the base of Q813 is applied to the graticule lights through emitter-followers Q813-Q817 and R818-R819. A voltage level is applied to the base of Q815 from the emitter of Q813 through divider R814-R815-R816 which is more positive than the voltage

applied to the the graticule lights. If the current through R818-R819 becomes excessive due to a short or similar malfunction, the emitter current through Q815 will increase. This will result in the collector of Q815 dropping, which will cut off the drive to Q813 and Q817, thereby protecting Q817 from damage due to excessive conduction.

Voltage divider R806-R807 provides a sample of the line voltage to the plug-in connectors in the Main Interface circuit for internal triggering at line frequency or for other applications.

MODE SWITCHING AND REAR-PANEL CONNECTORS

General

Diagram 9 shows the mode switches of the 7503 and the interconnections between these switches and the circuit boards, as well as interconnections between the circuit boards within this instrument.

Switch Logic

The VERTICAL MODE switch determines the operating mode of the Vertical Interface circuit. This switch is designed so that it is self-canceling; i.e., only one of the buttons can be pressed at a time. Operation of this switch is discussed in connection with the circuits it controls.

The TRIGGER SOURCE switch controls the operation of the Trigger Selector circuit. This switch is also self-canceling so that only one of the buttons can be pressed at a time. Operation of this switch is discussed in connection with the Trigger Selector circuit.

Indicator Lights

The indicator lights shown in connection with the VERTICAL MODE switch indicate which mode has been selected. When one of the buttons of the switch is pressed, it completes the circuit between the associated bulb and the lamp-common line. Notice that a separate bulb is used for each mode switch position. The selected button of the TRIGGER SOURCE switch is also illuminated to indicate the trigger source. Notice that only one bulb is associated with the TRIGGER SOURCE switch. The source switch is designed so that the button which is pressed receives light from the bulb, but the remaining buttons remain unlighted.

The CONTROL ILLUM switch S1040 determines the illumination level of the pushbutton switches on the 7503 and the associated plug-in units. In the HIGH position of this switch, the lamp power from the Low-Voltage Power Supply circuit is connected directly to the light bulbs. In

the LOW position, the lamp power is connected to the bulbs through diodes CR1041 and CR1042. The forward drop across these diodes reduces the current available to the bulbs so that they operate at a lower intensity level. In the OFF position, the lamp power to all of the pushbutton switches is disconnected.

The Z-Axis Inputs, HIGH SPEED J1055 and HIGH SENSITIVITY J1060, located on the rear panel of the 7503 connect into P1002, to connect into P12 on the Main Interface circuit for routing to the appropriate circuits. The rear-panel PROBE POWER connectors, J1080 and J1085, provide high voltages from the Low-Voltage Power Supply circuit to operate active probes. The 9-Pin Connector J1075 permits external resetting of the single sweep function, and a lamp supply to indicate that the sweep is ready for single sweep operation.

READOUT SYSTEM

Introduction to Readout System

General. The Readout System in the 7503 provides alphanumeric display of information encoded by the plug-in units. This display is presented on the CRT and is written by the CRT beam on a time-shared basis with the analog waveform display. Schematics for the total Readout System are shown on diagrams 10, 11 and 12 at the rear of this manual.

The definitions of several terms must be clearly understood to follow this description of the Readout System. These are:

Character—A character is a single number, letter, or symbol which is displayed on the CRT, either alone or in combination with other characters.

Word—A word is made up of a related group of characters. In the 7503 Readout System, a word can consist of up to ten characters.

Frame—A frame is a display of all words for a given operating mode and plug-in combination. Up to six words can be displayed in one frame. Fig. 3-30 shows one complete frame (simulated readout) and the position at which each of the six words is displayed.

Column—One of the vertical lines in the Character Selection Matrix (see Fig. 3-31). Columns C-0 (column zero) to C-10 (column 10) can be addressed in the 7503 system.

Row—One of the horizontal lines in the Character Selection Matrix (Fig. 3-31). Rows R-1 (row 1) to R-10 (row 10) can be addressed in the 7503 system.

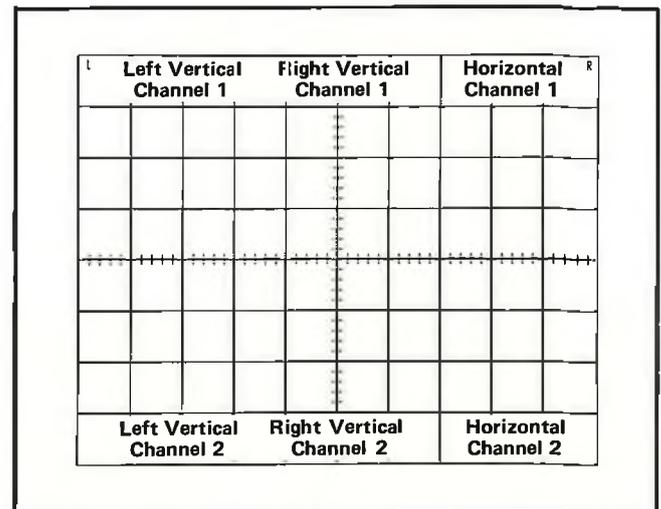


Fig. 3-30. Location of readout words on the CRT identifying the originating plug-in and channel (one complete frame shown, simulated readout).

Time-slot—A location in a pulse train. In the 7503 Readout System, the pulse train consists of 10 negative-going pulses. Each of these time-slots is assigned a number between one and ten. For example, the first time-slot is TS-1.

Time-multiplexing—Transmission of data from two or more sources over a common path by using different time intervals for different signals.

Display Format. Up to six words of readout information can be displayed on the 7503 CRT. The position of each word is fixed and is directly related to the plug-in unit from which it originated. Fig. 3-30 shows the area of the graticule where the readout from each plug-in unit is displayed. Notice that channel 1 of each plug-in unit is displayed within the top division of the CRT and channel 2 is displayed directly below within the bottom division. Fig. 3-32 shows a typical display where only channel 1 of the Right Vertical and both channels of the Horizontal unit are selected for display.

Each word in the readout display can contain up to 10 characters, although the typical display will contain between two and seven characters per word. The characters are selected from the Character Selection Matrix shown in Fig. 3-31. Any one of the 50 separate characters can be addressed and displayed on the CRT. In addition, 12 operational addresses are provided for special instructions to the Readout System. The unused locations in the Matrix (shaded areas) are available for future expansion of the Readout System. The method of addressing the locations in the Character Selection Matrix is described in the following discussion.

Column Number →		C-0	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10
Row Number ↓	Current (Milli-amperes)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	≥1.0
	R-1	0	0	1	2	3	4	5	6	7	8	9
R-2	0.1	/	<	I	/	+	-	+	C	Δ	>	
R-3	0.2	Add* one zero	Add* two zeros	Reduce* prefix	Reduce* prefix and add one zero							IDENTIFY*
R-4	0.3	m	μ	n	p	X	K	M	G	T	R	
R-5	0.4	S	V	A	W	H	d	B	c	Ω	E	
R-6	0.5	U	N	L	Z	Y	P	F	J	Q	D	
R-7	0.6			Decimal* point location #3	Decimal* point location #4	Decimal* point location #5	Decimal* point location #6	Decimal* point location #7				
R-8	0.7											
R-9	0.8											
R-10	0.9	Add Space In Display*										



Unused locations. Available for future expansion of Readout System

Operational address.

Fig. 3-31. Character Selection Matrix for 7503 Readout System.

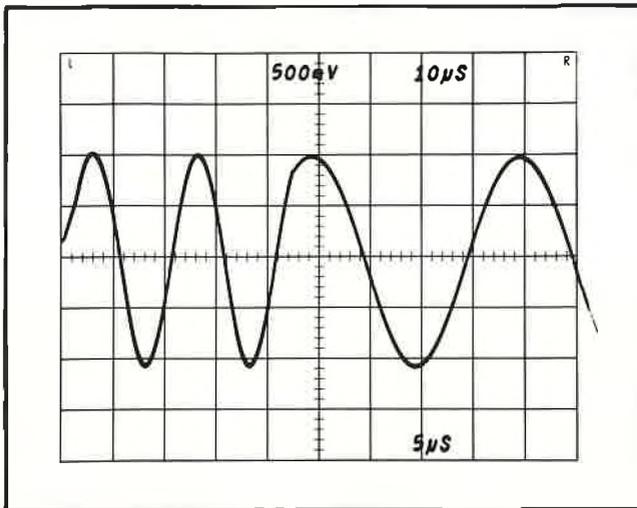


Fig. 3-32. Typical readout display where channel 1 of the Right Vertical unit and both channels of the Horizontal unit are displayed.

Developing the Display. The following basic description of the Readout System uses the block diagram shown in Fig. 3-33. This description is intended to relate the basic function of each stage to the operation of the overall Readout System. Detailed information on circuit operation is given later.

The key block in the Readout System is the Timer stage. This stage produces the basic signals which establish the timing sequences within the Readout System. Period of the timing signal is about 250 microseconds (drops to about 210 microseconds when Display-Skip is received; see detailed description of Timing stage for further information). This stage also produces control signals for other stages within this circuit and interrupt signals to the Vertical Interface and Horizontal Amplifier circuits, CRT Circuit, and Z-Axis Logic stage which allow a readout display to be presented. The Time-Slot Counter stage receives a trapezoidal voltage signal from the Timer stage and directs it to one of ten output lines. These output lines are labeled TS-1 through TS-10 (time-slots one through 10) and are connected to the vertical and horizontal plug-in compartments as well as to various stages within the Readout System. The output lines are energized sequentially so that there is a pulse on any one of the 10 lines during any 250 microsecond timing period. When the Time-Slot Counter stage has completed time-slot 10, it produces an End-of-Word pulse which advances the system to the next channel.

Two output lines, row and column, are connected from each plug-in channel back to the Readout System. Data is typically encoded on these output lines by connecting resistors between them and the time-slot input lines. The resultant output is a sequence of ten analog current levels which range from zero to one milliamper (100 micro-

amperes/step) on the row and column output lines. This row and column correspond to the row and column of the Character Selection Matrix in Fig. 3-31. The standard format in which information is encoded onto the output lines is given in Table 3-2 (special purpose plug-in units may have their own format for readout; these special formats will be defined in the manuals for these units).

TABLE 3-2
Standard Readout Format

Time-Slot Number	Description
TS-1	Determines decimal magnitude (number of zeros displayed or prefix change information) or the IDENTIFY function (no display during this time-slot).
TS-2	Indicates normal or inverted input (no display for normal).
TS-3	Indicates calibrated or uncalibrated condition of plug-in variable control (no display for calibrated condition).
TS-4	1-2-5 scaling.
TS-5 TS-6 TS-7	Not encoded by plug-in unit. Left blank to allow addition of zeros by Readout System.
TS-8	Defines the prefix which modifies the units of measurement.
TS-9 TS-10	Define the units of measurement of the plug-in unit. May be standard units of measurement (V, A, S, etc.) or special units selected from the Character Selection Matrix.

The encoded column and row data from the plug-in units is selected by the Column Data Switch and Row Data Switch stages respectively. These stages take the analog currents from the eight data lines (two data lines from each of the three plug-in compartments and two unused) and produce a single time-multiplexed analog voltage output which contains all of the column or row information from the plug-ins. The Column Data Switch and Row Data Switch are sequenced by the binary Channel Address Code from the Channel Counter.

The time multiplexed output of the Column Data Switch is monitored by the Display-Skip Generator to

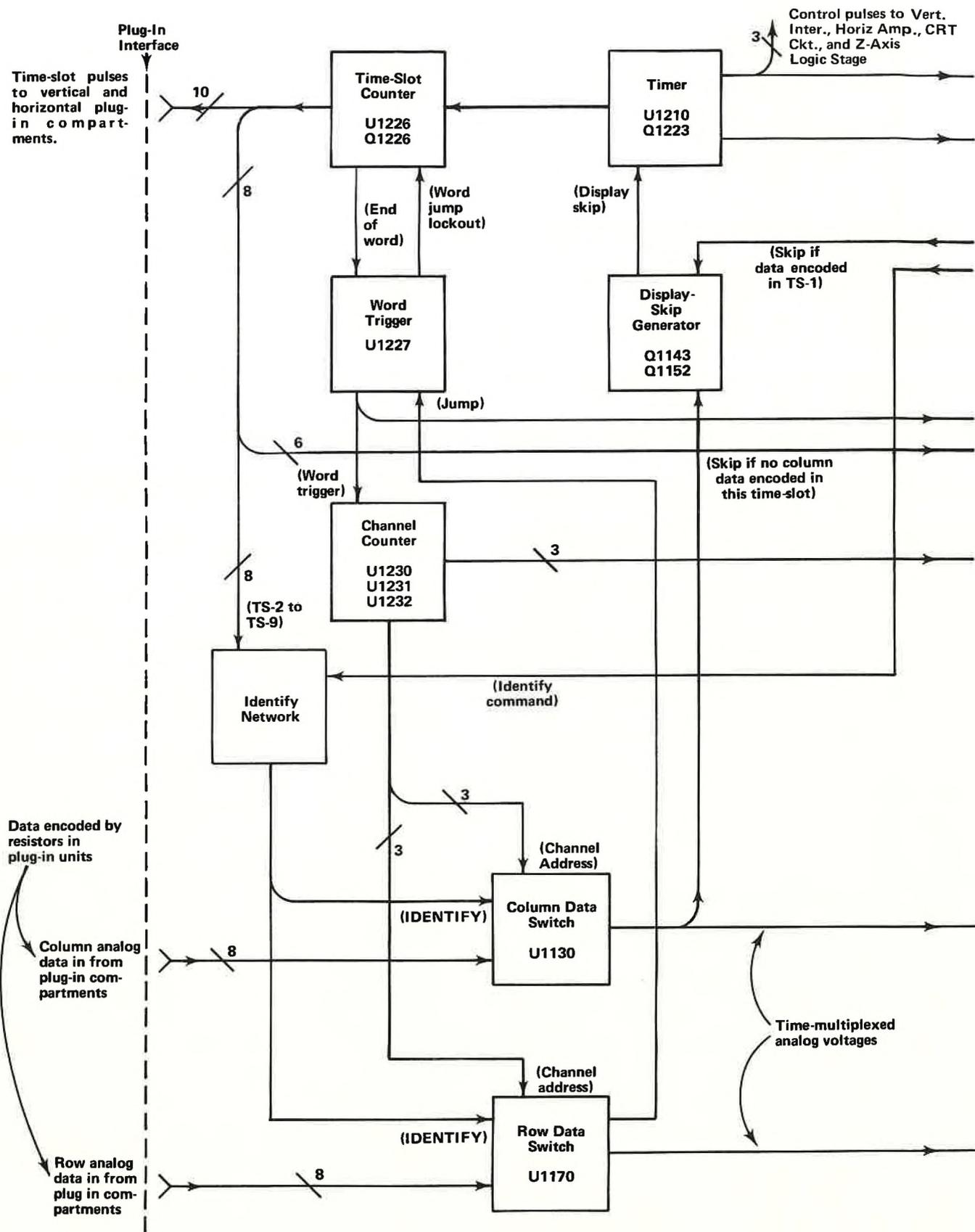


Fig. 3-33. Detailed block diagram of Readout System.

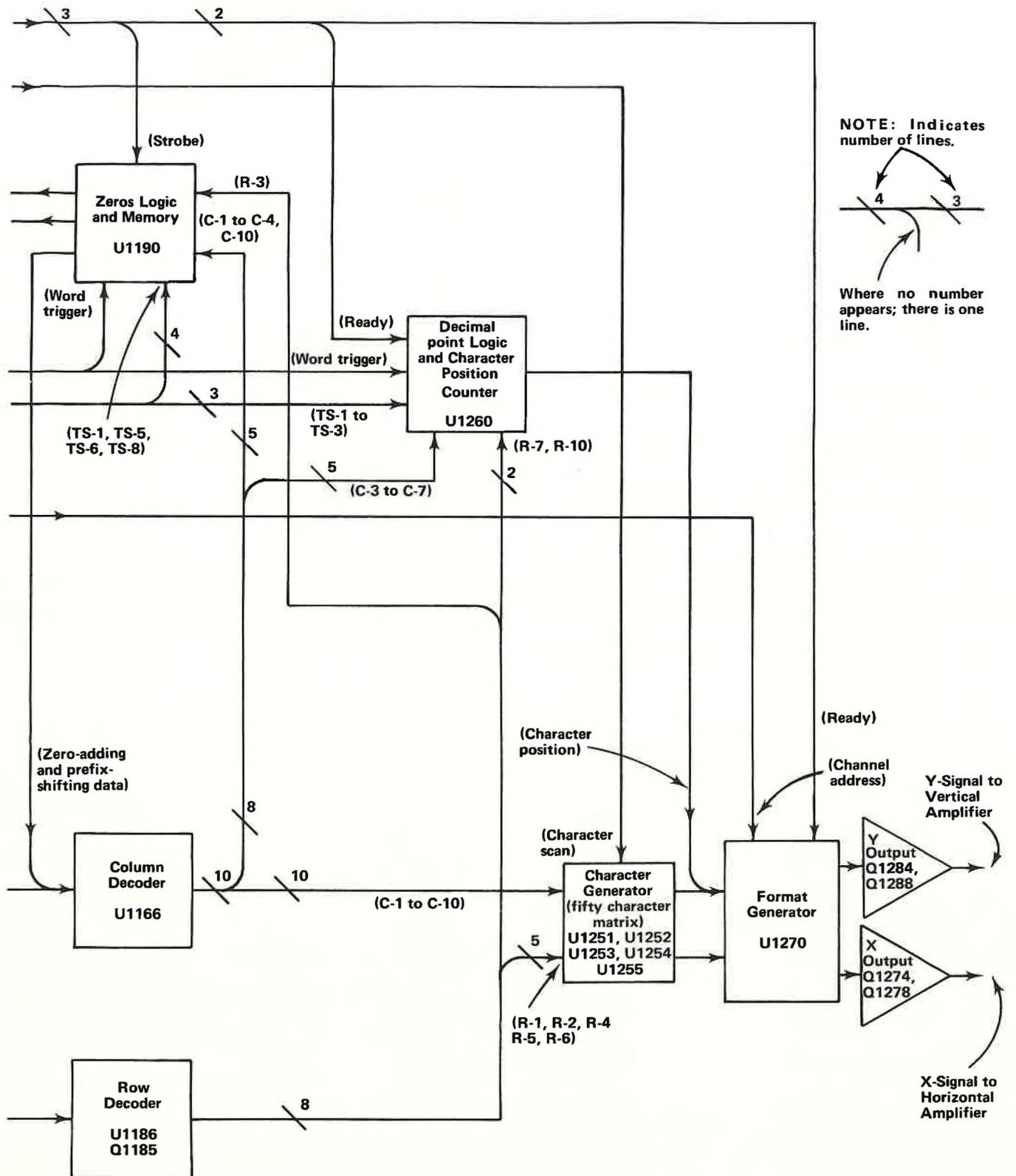


Fig. 3-33. Detailed block diagram of Readout System.

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determine if it represents valid information which should be displayed. Whenever information is not encoded in a time-slot, the Display-Skip Generator produces an output level to prevent the Timer stage from producing the control signals which normally interrupt the CRT display and present a character.

The analog output of the Column Data Switch and Row Data Switch are connected to the Column Decoder and Row Decoder stages respectively. These stages sense the magnitude of the analog voltage input and produce an output current on one of ten lines. The outputs of the Column Decoder stage are identified as C-1 to C-10 (column 1 to 10) which correspond to the column information encoded by the plug-in unit. Likewise, the outputs of the Row Decoder stage are identified as R-1 to R-10 (row 1 to 10) which correspond to the row information encoded by the plug-in unit. The primary function of the row and column outputs is to select a character from the Character Selection Matrix to be produced by the Character Generator stage. However, these outputs are also used at other points within the system to indicate when certain information has been encoded. One such stage is the Zeros Logic and Memory. During time-slot 1 (TS-1), this stage checks if zero-adding or prefix-shifting information has been encoded by the plug-in unit and stores it in memory until time-slots 5, 6 or 8. After storing this information, it triggers the Display-Skip Generator stage so there is no display during this time slot (as defined by Standard Readout Format; see Table 3-2). When time-slots 5, 6 and 8 occur, the memory is addressed and any information stored there during time-slot 1 is transferred out and connected to the input of the Column Decoder stage to modify the analog data during the applicable time-slot.

Another operation of the Zeros Logic and Memory stage is to produce the IDENTIFY function. When time-slot 1 is encoded for IDENTIFY (column 10, row 3), this stage produces an output level which connects the Column Data Switch and Row Data Switch to a coding network within the Readout System. Then, during time-slots 2 through 9, an analog current output is produced from the Column Data Switch and Row Data Switch which addresses the correct points in the Character Selection Matrix to display the word "IDENTIFY" on the CRT. The Zeros Logic and Memory stage is reset after each word by the Word Trigger pulse.

The Character Generator stage produces the characters which are displayed on the CRT. Any of the 50 characters shown on the Character Selection Matrix of Fig. 3-31 can be addressed by proper selection of the column and row current. Only one character is addressable in any one time-slot; a space can be added into the displayed word by the Decimal Point Logic and Character Position Counter stage when encoded by the plug-in. The latter stage counts how many characters have been generated and produces an output current to step the display one character position to

the right for each character. In addition, the character position is advanced once during each of time-slots 1, 2 and 3 whether a character is generated during these time-slots or not. This action fixes the starting point of the standard-format display such that the first digit of the scaling factor always starts at the same point within each word regardless of the encoded information in time-slot 2 (normal/invert) or time-slot 3 (cal/uncal) which precedes this digit. Also, by encoding row 10 and column 0 during any time-slot, a blank space can be added to the display. Decimal points can be added to the display at any time by addressing row 7 and columns 3 through 7 (see Character Selection Matrix for location of these decimal points). The Decimal Point Logic and Character Position Counter stage is reset after each word by the Word Trigger pulse.

The Format Generator stage provides the output signals to the vertical and horizontal deflection systems of the instrument to produce the character display. The binary Channel Address Code from the Channel Counter stage is connected to this stage so that the display from each channel is positioned to the area of the CRT which is associated with the plug-in and channel originating the word (see Fig. 3-30). The positioning current or decimal point location current generated by the Decimal Point Logic and Character Position Counter stage is added to the horizontal (X) signal at the input to the Format Generator stage to provide horizontal positioning of the characters within each word. The X- and Y-output signals are connected to the Horizontal Amplifier and Vertical Amplifier through the Horizontal Output and Vertical Output Stages respectively.

The Word Trigger stage produces a trigger from the End-of-Word pulse generated by the Time-Slot Counter stage after the tenth time-slot. This Word Trigger pulse advances the Channel Counter to display the information from the next channel or plug-in. It also provides a reset pulse to the Zeros Logic and Memory stage and the Decimal Point Logic and Character Position Counter stage. The Word Trigger stage can also be advanced to jump a complete word or a portion of a word when a Jump command is received from the Row Decoder stage.

Circuit Analysis of Readout System

The following analysis of the Readout System discusses the operation of each stage in detail. Complete schematics of the Readout System are shown on diagrams 10, 11 and 12 at the rear of this manual.

Timer

The Timer stage U1210 establishes the timing sequence for all circuits within the Readout System. This stage produces seven time-related output waveforms (see Fig. 3-34). The triangle waveform produced at pin 6 forms the basis for the remaining signals. The basic period of this triangle waveform is about 250 microseconds as controlled

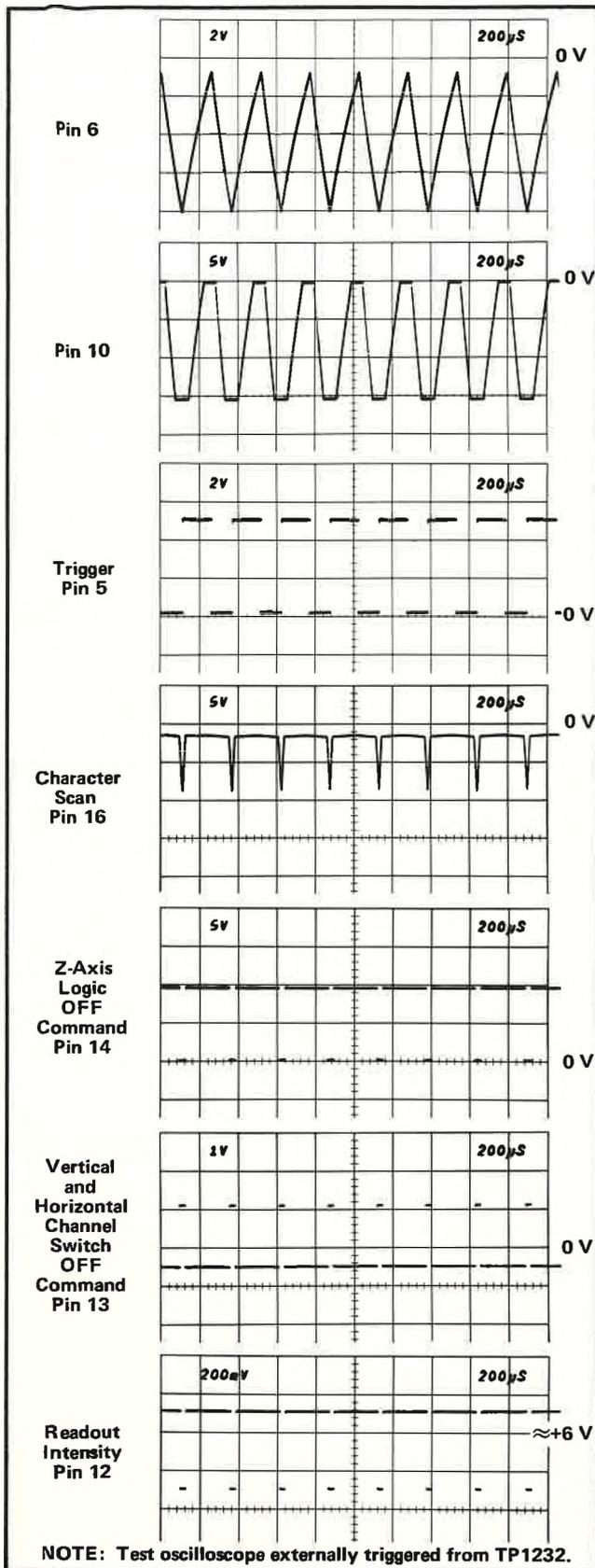


Fig. 3-34. Output waveforms of Timer stage.

by RC network C1214-R1214. The triangle waveform is clipped and amplified by U1210 to form the trapezoidal output signal at pin 10. The amplitude of this output signal is exactly 15 volts as determined by U1210 (exact amplitude necessary to accurately encode data; see Encoding the Data). The Trigger output at pin 5 provides the switching signal for the Time-Slot Counter and Word Trigger stages.

The signals at pins 12, 13, 14 and 16 are produced only when the triangle waveform is on its negative slope and the trapezoidal waveform has reached the lower level. The timing sequence of these waveforms is very important to the correct operation of the Readout System (see expanded waveforms in Fig. 3-35). The Z-Axis Logic OFF Command at pin 14 is produced first. This negative-going signal provides a blanking pulse to the Z-Axis Logic stage (see diagram 1) to blank the CRT before the display is switched to the Readout System. It also produces the Strobe pulse through R1221, Q1223 and CR1224 to signal other stages within the Readout System to begin the sequence necessary to produce a character. The collector level of Q1223 is also connected to Character Generator #2, U1252, through C1222-CR1222. This activates U1252 during the quiescent period of the Strobe pulse (collector of Q1223 negative) and diverts the output current of the Row Decoder stage U1186 to row 2. The purpose of this configuration is to prevent the Zeros Logic and Memory stage U1190 from storing incorrect data during the quiescent period of the Strobe pulse. When the Strobe pulse goes positive, CR1222 is reverse biased to disconnect Q1223 from U1252 and allow the Row Decoder stage to operate in the normal manner.

The next signal to be produced is the Vertical/Horizontal Channel Switch OFF Command at pin 13. This positive-going signal disconnects the plug-in signals in the vertical and horizontal deflection systems so the plug-ins do not control the position of the CRT beam. The Ready signal derived from this output is connected to the Decimal Point Logic and Character Position Counter stage and the Format Generator stage (see diagram 12). The Readout Intensity output at pin 12 is produced next. This current is connected to the Z-Axis Intensity circuit to unblank the CRT to the level determined by the READOUT intensity control R1040. The Character Scan ramp at pin 16 started to go negative before this timing sequence began. However, character-generation does not start until the readout intensity level has been established. The triangular Character Scan ramp runs negatively from about -2 volts to about -8.5 volts and then returns back to the original level. This waveform provides the scanning signal for the Character Generator stages (see diagram 12). The Character Scan adjustment R1219 sets the DC level of the Character Scan ramp to provide complete characters on the display.

The Timer stage operates in one of two modes as controlled by the Display-Skip level at pin 4. The basic

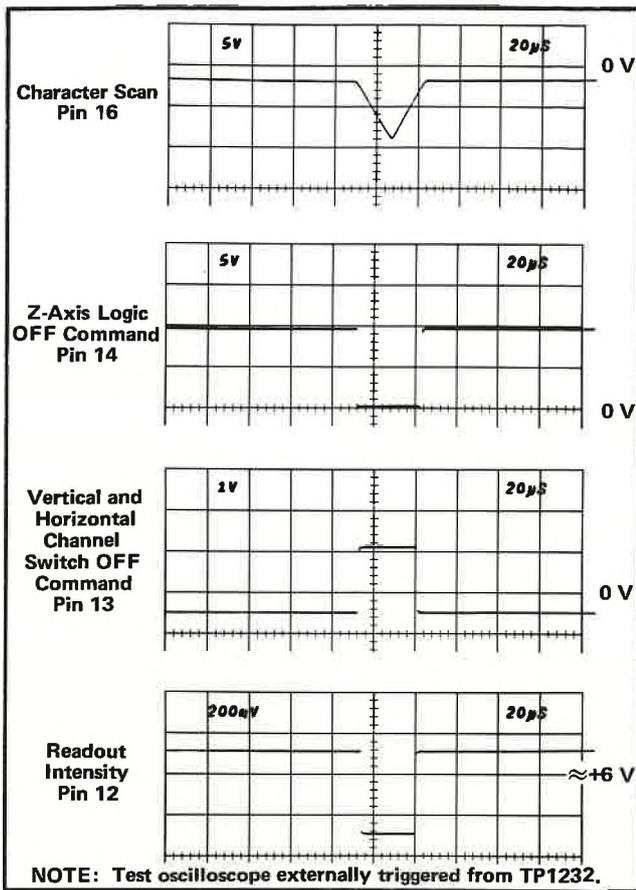


Fig. 3-35. Detail of output at pins 12, 13, 14 and 16 of U1210.

mode just described is a condition which does not occur unless all ten characters of each word (80 characters total) are displayed on the CRT. Under typical conditions only a few characters are displayed in each word. The Display-Skip level at pin 4 determines the period of the Timer output signal. When a character is to be generated, pin 4 is LO and the circuit operates as just described. However, when a character is not to be displayed, a HI level is applied to pin 4 of U1210 through CR1207 from the Display-Skip Generator stage (diagram 11). This signal causes the Timer stage to shorten its period of operation to about 210 microseconds. The waveforms shown in Fig. 3-36 show the operation of the Timer stage when the Display-Skip condition occurs. Notice that there is no output at pin 12, 13, 14 and 16 under this condition. This means that the CRT display is not interrupted to display characters. Also notice that the triangle waveform at pin 6 does not go as far negative and that the negative portion of the trapezoidal waveform at pin 10 is shorter. Complete details on operation of the Display-Skip Generator are given later.

The READOUT intensity control R1040 sets the intensity of the readout display independently of the

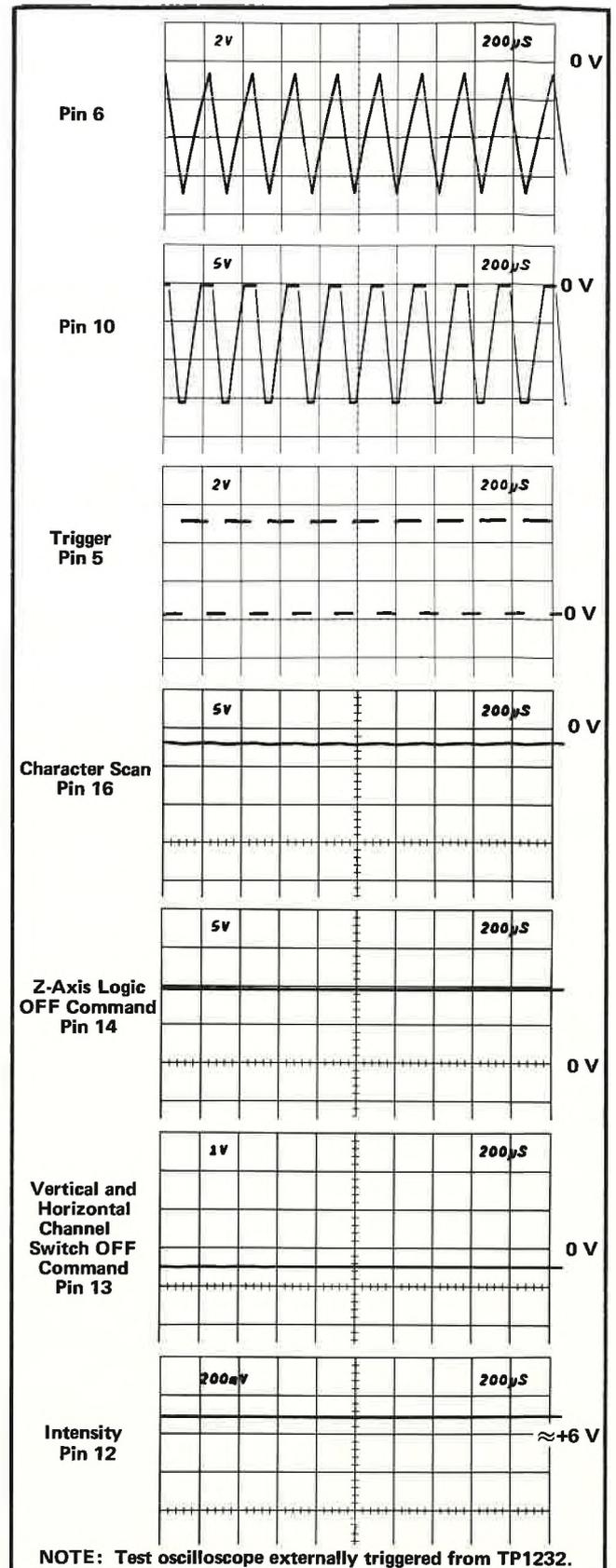


Fig. 3-36. Timer stage operation when Display-Skip condition occurs.

INTENSITY control. The READOUT intensity control also provides a means of turning the Readout System off when a readout display is not desired. When R1040 is turned fully counterclockwise, switch S1040A opens. This interrupts the current to pin 11 of U1210 and at the same time allows a positive voltage to be applied to pin 4 through R1206 and CR1206. This positive voltage switches the stage to the same conditions as were present under the Display-Skip condition. Therefore, the CRT display is not interrupted to present characters. However, time-slot pulses continue to be generated.

Time-Slot Counter

The Time-Slot Counter stage U1226 is a sequential switch which directs the trapezoidal waveform input at pin 8 to one of its ten output lines. These time-slot pulses are used to interrogate the plug-in units to obtain data for the Readout System. The Trigger pulse at pin 15 switches the Time-Slot Counter to the next output line; the output signal is sequenced from time-slot 1 through time-slot 10. Fig. 3-37 shows the time-relationship of the time-slot pulses. Notice that only one of the lines carries a time-slot pulse at any given time. When time-slot 10 is completed, a negative-going End-of-Word pulse is produced at pin 2. The End-of-Word pulse provides a drive pulse for the Word Trigger stage and also provides an enabling level to the Display-Skip Generator during time-slot 1.

Pin 16 is a reset input for the Time-Slot Counter stage. When this pin is held LO, the Time-Slot Counter resets to time-slot 1. The Time-Slot Counter can be reset in this manner only when a Jump signal is received by U1227A (see following discussion).

Word Trigger

The Word Trigger stage is made up of 4 two-input NOR gates in U1227. Quiescently, pin 2 of U1227C is LO as established by the operating conditions of U1227A-U1227B. Therefore, the LO End-of-Word pulse produced by the Time-Slot Counter stage results in a HI level at pin 1 of U1227C. This level is inverted by U1227D to provide a negative-going advance pulse to the Channel Counter stage.

A negative-going advance pulse is also produced by U1227D when a Jump signal is received at pin 8 of U1227A. This condition can occur during any time slot (see Row Decoder for further information on origin of the Jump signal). U1227A and U1227B are connected as a bistable flip-flop. The positive-going Jump signal at pin 8 of U1227A produces a LO level at pin 10. This LO level is inverted by U1227B to produce a HI level at pin 13 which allows pin 9 of U1227A to be pulled HI through R1227. The flip-flop has now been set to its HI state where it remains until reset, even though the Jump signal at pin 8 returns to its LO level. The HI output level at pin 13 turns on Q1226 through R1226 to pull pin 16 of the Time-Slot Counter LO. This resets the Time-Slot Counter to time-slot

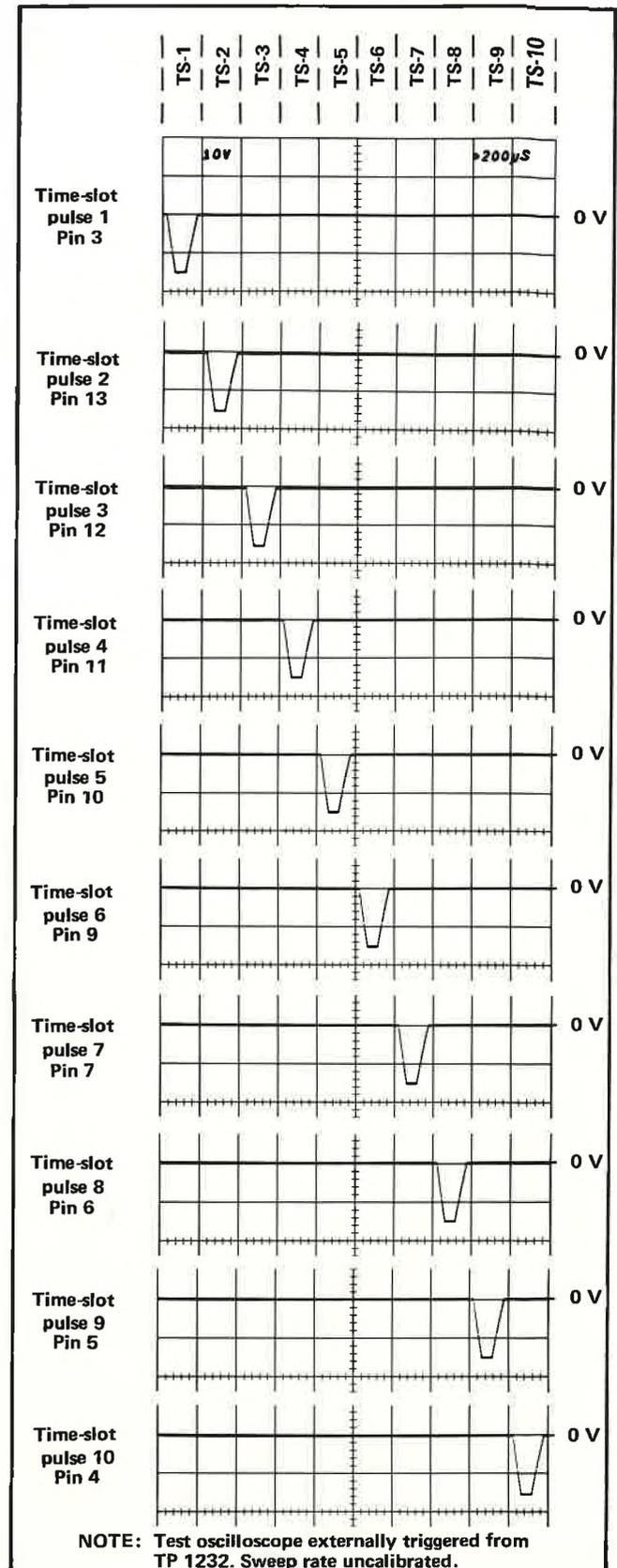


Fig. 3-37. Time relationship of the time-slot (TS) pulses produced by U1226.

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1 and holds it there until U1227 is reset. At the same time, a HI level is applied to pin 4 of the Timer stage through CR1208 and CR1207. This HI level causes the Timer stage to operate in the display-skip mode so that a character is not generated.

The next Trigger pulse is not recognized by the Time-Slot Counter stage, since it is held in Time-Slot 1 by U1227. However, this trigger pulse resets the Word Trigger stage through C1227. This produces a LO level at pin 13 of U1227B which enables the Time-Slot Counter and Timer stages for the next time-slot pulse. At the same time, the negative-going edge produced as U1227B switches output states is connected to pin 2 of U1227C. This results in a negative-going Word Trigger output at pin 4 of U1227D to advance the Channel Counter to the next word. When the next Trigger pulse is received at pin 15, the Time-Slot Counter produces an output on the time-slot 1 line.

Channel Counter

The Channel Counter stage made up of integrated circuits U1230, U1231 and U1232 is a binary counter

which produces the Channel Address Code for the Column and Row Decoder stages (diagram 11) and the Format Generator stage (diagram 12). This code instructs these stages to sequentially select and display the eight channels of data from the plug-ins (two channels unused). The input channel which is displayed with each combination of the Channel Address Code is given in the discussion for the applicable stages.

Encoding the Data

Data is conveyed from the plug-in unit to the Readout System in the form of an analog code having up to 11 current levels (from zero to one milliampere in 100 microampere steps). The characters which can be selected by the encoded data are shown on the Character Selection Matrix (see Fig. 3-31). Each character requires two currents to define it; these currents are identified as the column current and the row current which correspond to the column and row of the matrix. The column and row data is encoded by resistive programming in the plug-in units. Fig. 3-38 shows a typical encoding scheme for a voltage-sensing amplifier plug-in unit. Notice that the 10 time-slot (TS)

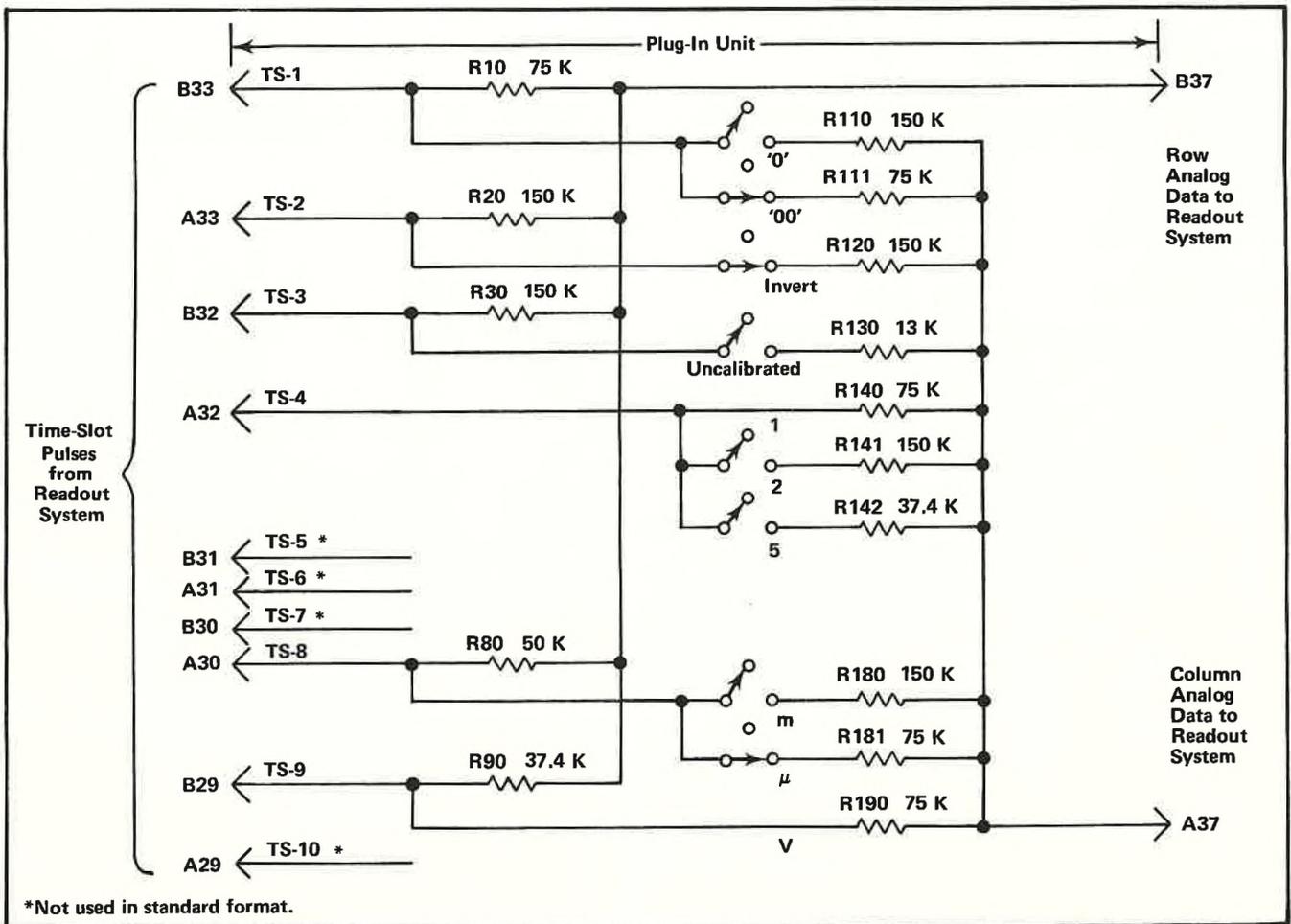


Fig. 3-38. Typical encoding scheme for voltage-sensing plug-in unit. Coding shown for deflection factor of 100 microvolts.

pulses produced by the Time-Slot Counter stage are connected to the plug-in unit. However, time-slots 5, 6, 7 and 10 are not used by the plug-in unit to encode data when using the Standard Readout Format (see Table 3-2 for Standard Readout Format). The amplitude of the time-slot pulses is exactly -15 volts as determined by the Timer stage. Therefore, the resultant output current from the plug-in units can be accurately controlled by the programming resistors in the plug-in units.

For example, in Fig. 3-38, resistors R10 through R90 control the row analog data which is connected back to the Readout System. These resistors are of fixed value and define the format in which the information will be presented by the Readout System. Fig. 3-39A shows an idealized output current waveform of row analog data which results from the 10 time-slot pulses. Each of the steps of current shown in these waveforms corresponds to 100 microamperes of current. The row numbers on the left-hand side of the waveform correspond to the rows in the Character Selection Matrix shown in Fig. 3-31. The row analog data is connected back to the Readout System via terminal B37 of the plug-in interface.

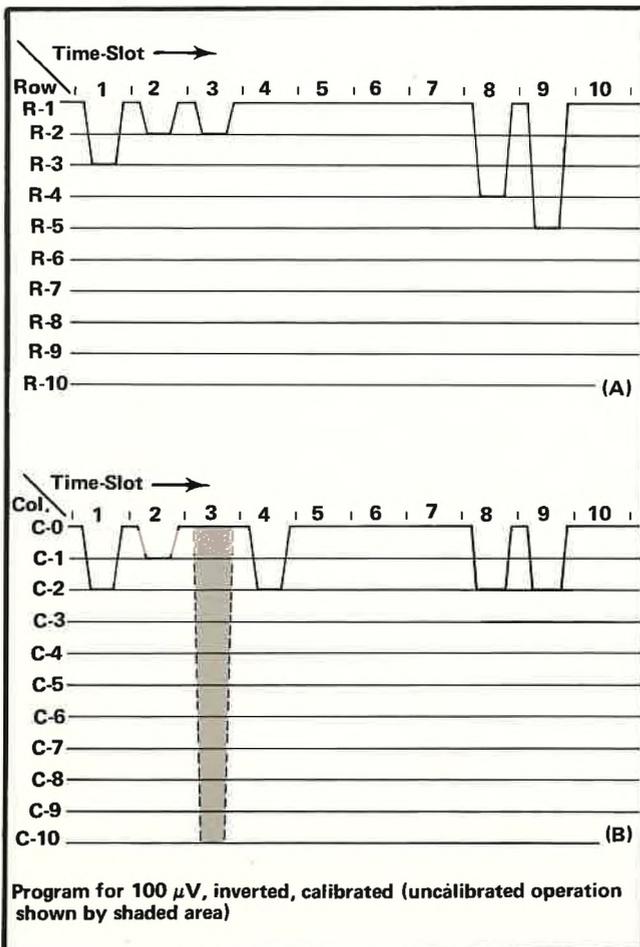


Fig. 3-39. Idealized current waveforms of: (A) Row analog data, (B) Column analog data.

The Column analog data is defined by resistors R110 through R190. The program resistors are connected to the time-slot lines by switch closures to encode the desired data. The data as encoded by the circuit shown in Fig. 3-38 indicates a 100 microvolt sensitivity with the display inverted and calibrated vertical deflection factors. This results in the idealized output current waveforms shown in Fig. 3-39B at the column analog data output, terminal A37 of the plug-in interface. Resistor R111, connected between time-slot 1 and the column analog data output encodes two units of current during time-slot 1. Referring to the Character Selection Matrix, two units of column current along with the two units of row current encoded by R10 (row 3) indicates that two zeros should be added to the display. Resistor R120 adds one unit of column current during time-slot 2 and along with the one unit of current from the row output, the Readout System is instructed to add an invert arrow to the display. R130 is not connected to the time-slot 3 line since the vertical deflection factors are calibrated. Therefore, there is no column current output during this time-slot and there is no display on the CRT (see Display-Skip Generator for further information). During time-slot 4, two units of column current are encoded by R140. There is no row current encoded during this time-slot and this results in the numeral 1 being displayed on the CRT. Neither row nor column analog data is encoded during time-slots 5, 6 and 7 as defined by the Standard Readout Format. During time-slot 8, two units of column current and three units of row current are encoded by resistors R181 and R80 respectively. This addresses the μ prefix in the Character Selection Matrix. The final data output is provided from time-slot 9 by R190 connected to the column output and R90 to the row output. These resistors encode three units of column current and four units of row current to cause a V (volts) to be displayed. Time-slot 10 is not encoded in accordance with the Standard Readout Format. The resultant CRT readout will be $\downarrow 100 \mu$ V.

In the above example, the row analog data was programmed to define which row of the Character Selection Matrix was addressed to obtain information in each time-slot. The column data changes to encode the applicable readout data as the operating conditions change. For example, if the variable control of the plug-in unit was activated, R130 would be connected between time-slot 3 and the column analog data output lines. This encodes 10 units of column current (see shaded area in time-slot 3 of the waveform shown in Fig. 3-39B). Since one unit of row current is also encoded during this time-slot by R30, a $>$ symbol is added to the display. The CRT readout will now say $\downarrow > 100 \mu$ V. In a similar manner, the other switches can change the encoded data for the column output and thereby change the readout display. For information on decoding this information, see the descriptions which follow.

The column analog data encoded by the plug-in can be modified by attenuator probes connected to the input

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connectors of vertical plug-in units. A special coding ring around the input connector of the plug-in unit senses the attenuation ratio of the probe (with readout-coded probes only). The probe contains a resistor which results in additional column current. For example, if a 10X attenuator probe is connected to a plug-in with the coding for 100 microvolts as shown in Fig. 3-38, an additional unit of current is added to the column analog data during time-slot 1. Since two units of current were encoded by R111 (see Fig. 3-38), this additional current results in a total of three units of column analog current during this time-slot. Referring to the Character Selection Matrix, three units of column current along with the two units of row current encoded by R10 indicates that the prefix should be reduced. Since this instruction occurs in the same time-slot which previously indicated that two zeros should be added to the display and only one instruction can be encoded during a time-slot, the zeros do not appear in the display. The CRT readout will now be reduced to 1 mV (readout program produced by plug-in same as for previous example).

Likewise, if a 100X readout-coded probe is connected to the input of the plug-in unit, the column current during time-slot 1 will be increased two units for a total of four units of column current. This addresses an instruction in the Character Selection Matrix which reduces the prefix and adds one zero to the display. The resultant CRT readout with the previous program is 10 mV.

Three other lines of information are connected from the plug-in compartments to the Readout System. The column and row analog data from channel 2 of a dual-channel plug-in are connected to the Readout System through terminals A38 and B38 of the plug-in interface, respectively. Force readout information is encoded on terminal A35; function of this input is described under Column and Row data Switches.

The preceding information gave a typical example of encoding data from an amplifier plug-in unit. Specific encoding data and circuitry is shown in the individual plug-in unit manuals.

Column and Row Data Switches

The readout data from the plug-in units is connected to the Column and Row Data Switch stages in the Readout System. A column-data line and a row-data line convey analog data from each of the eight data sources. The Readout System is designed to display data from four plug-ins; thus eight data sources are possible. Since the 7503 accommodates three plug-ins, only six data sources are connected to the Readout System. The Readout System operates the same as it would in a four plug-in oscilloscope with one plug-in not being operated.

The Column Data Switch U1130 and the Row Data Switch U1170 receive the Channel Address Code from the Channel Counter stage. This binary code directs the Column Data Switch and the Row Data Switch as to which channel should be the source of the readout data. Table 3-3 gives the eight combinations of the Channel-Address-Code and the resultant channel which is selected with each combination. These stages have nine inputs and provide a single time-multiplexed output at pin 7 which includes the information from all of the input channels. Eight of the nine inputs to each stage originate in the plug-in units and the ninth input comes from a special data-encoding network composed of resistors R1131 through R1138 and R1171 through R1178 (see Zeros Logic and Memory description for further information on ninth channel).

TABLE 3-3
Channel Address Code to
Column and Row Decoder Stages

Pin 1 U1190 "Identify" Command	Pin 5 U1232	Pin 5 U1231	Pin 5 U1230	Channel Selected
HI	HI	HI	HI	Channel 1 Left Vertical
HI	HI	HI	LO	Channel 2 Left Vertical
HI	HI	LO	HI	Channel 1 Right Vertical
HI	HI	LO	LO	Channel 2 Right Vertical
HI	LO	HI	HI	Channel 1 Horizontal
HI	LO	HI	LO	Channel 2 Horizontal
HI	LO	LO	HI	Channel 1 Unused
HI	LO	LO	LO	Channel 2 Unused
LO	Φ	Φ	Φ	IDENTIFY

Φ = Has no effect in this case.

In addition to the data inputs from the plug-ins, channel-inhibit inputs are provided from each of the plug-in units. The channel inhibit lines are LO only when the associated plug-in unit has been selected for display. When a plug-in unit is not selected, the respective line is HI which forward biases the associated diode CR1112, CR1113, CR1117, CR1118, CR1122, CR1123, CR1127 or CR1128 to by-pass the encoded data from this plug-in. Notice that the channel inhibit line for the fourth (unused) plug-in is connected to

+5-V to inhibit that channel of information. However, since it may be desired to display information from special-purpose plug-ins even though they do not produce a normal display on the CRT, a feature is provided to over-ride the channel inhibit. This is done by applying a LO level to the associated Force over-ride input. The LO level diverts the HI channel inhibit current and allows the data from this plug-in unit to reach the Column Data switch, even though it has not been selected for display by the mode switches.

Display-Skip Generator

The Display-Skip Generator stage, Q1143-Q1150-Q1152-Q1155, monitors the time-multiplexed column data at the output of the Column Data Switch during each time-slot to determine if the information at this point is valid data which should result in a CRT display. The base of Q1143B is fixed at about +14.25 volts by divider R1146-R1147-R1148. Quiescently, there is about 100 microamperes of current flowing through R1141 from Q1163 and the Zeros Logic and Memory stage (purpose of this quiescent current will be discussed in connection with the Zeros Logic and Memory stage). This current biases Q1143A so its base is at about +14.5 volts in the absence of column data. Therefore, since Q1143A and Q1143B are connected as a comparator, Q1143A will remain on unless its base is pulled more negative than about +14.25 volts. The analog data output from the Column Data Switch produces a 0.5-volt change for each unit of column current that has been encoded by the plug-in. Therefore, whenever any information appears at the output of the Column Data Switch, the base of Q1143A is pulled more negative than the base of Q1143B, resulting in a negative (LO) Display-Skip output to the Timer stage through Q1155. Recall that a LO was necessary at the skip input of the Timer stage so that the Timer stage could perform the complete sequence necessary to display a character.

Q1150-Q1152 also provide display-skip action. The End-of-Word level that is connected to their emitters through R1152 is LO only during time-slot 1. This means that these transistors are only enabled during this time-slot period. These transistors allow the Zeros Logic and Memory stage to generate a display-skip signal when information has been stored in memory which is not to be displayed on the CRT (further information given under Zeros Logic and Memory discussion).

Column and Row Decoder

The Column Decoder stage U1166 and Row Decoder stage U1186 sense the magnitude of the analog voltages at their inputs and produce a binary output on one of ten lines corresponding to the column or row data which was encoded by the plug-in. These outputs provide the Column Digital Data and Row Digital Data which is used by the Character Generator stages to select the desired character for display on the CRT. The column and row data is also

used throughout the Readout System to perform other functions. The input current at pin 9 of the Column Decoder stage is steered to only one of the ten Column Digital Data outputs. The size of the character which will be displayed on the CRT is determined by the value of R1156. When a display-skip signal is present (collector of Q1155 HI), pin 9 is pulled HI through CR1155. This ensures that no current is connected to the Character Generator stage under this condition. Notice the corresponding input on the Row Decoder. This input is connected to ground and causes only one of the ten row outputs to saturate to ground.

The network at the input of the Row Decoder stage made up of Q1185 and its associated components is a Row 13 detector which produces the Jump command. This row current is encoded by special-purpose plug-ins to cause all or part of a word to be jumped. Whenever row 13 (thirteen units of row current; 1.3 milliamperes) is encoded, the base of Q1185 is pulled negative enough so that this transistor is reverse biased to produce a HI Jump output at its collector. This Jump command is connected to the Word Trigger stage (diagram 10) to advance the Channel Counter stage to the next word and to reset the Time-Slot Counter stage to time-slot 1.

Zeros Logic and Memory

The Zeros Logic and Memory stage U1190 stores data encoded by the plug-ins to provide zeros-adding and prefix-shifting logic for the Readout System. The Strobe pulse at pin 15 goes positive when the data has stabilized and can be inspected. This activates the Zeros Logic and Memory stage so it can store the encoded data. A block representation of the memory sequence is shown in Fig. 3-40. Typical output waveforms for the five possible input conditions that can occur are shown in Fig. 3-41. When time-slot 1 occurs, a store command is given to all of the memories. If the plug-in unit encoded data for column 1, 2, 3, 4 and 10 during time-slot 1, the appropriate memory (or memories) is set. Notice that row 3 information from the Row Decoder stage must also be present at pin 16 for data to be stored in the memory of U1190. If data was encoded during time-slot 1, a negative-going output is produced at pin 7 as the memories are being set. This negative-going pulse is connected to the base of Q1152 in the Display-Skip Generator stage to produce a Display-Skip output. Since the information that was encoded during time-slot 1 was only provided to set the memories and was not intended to be displayed on the CRT at this time, the display-skip output prevents a readout display during this time-slot.

During time-slot 5, memory A is interrogated. If information was stored in this memory, a positive-going output is produced at pin 7. This pulse is connected to pin 10 of the Column Decoder stage through Q1163 to add one unit of current at the input of the Column Decoder stage. This produces a zero after the character displayed on the CRT during time-slot 4. During time-slot 6, memory B is interro-

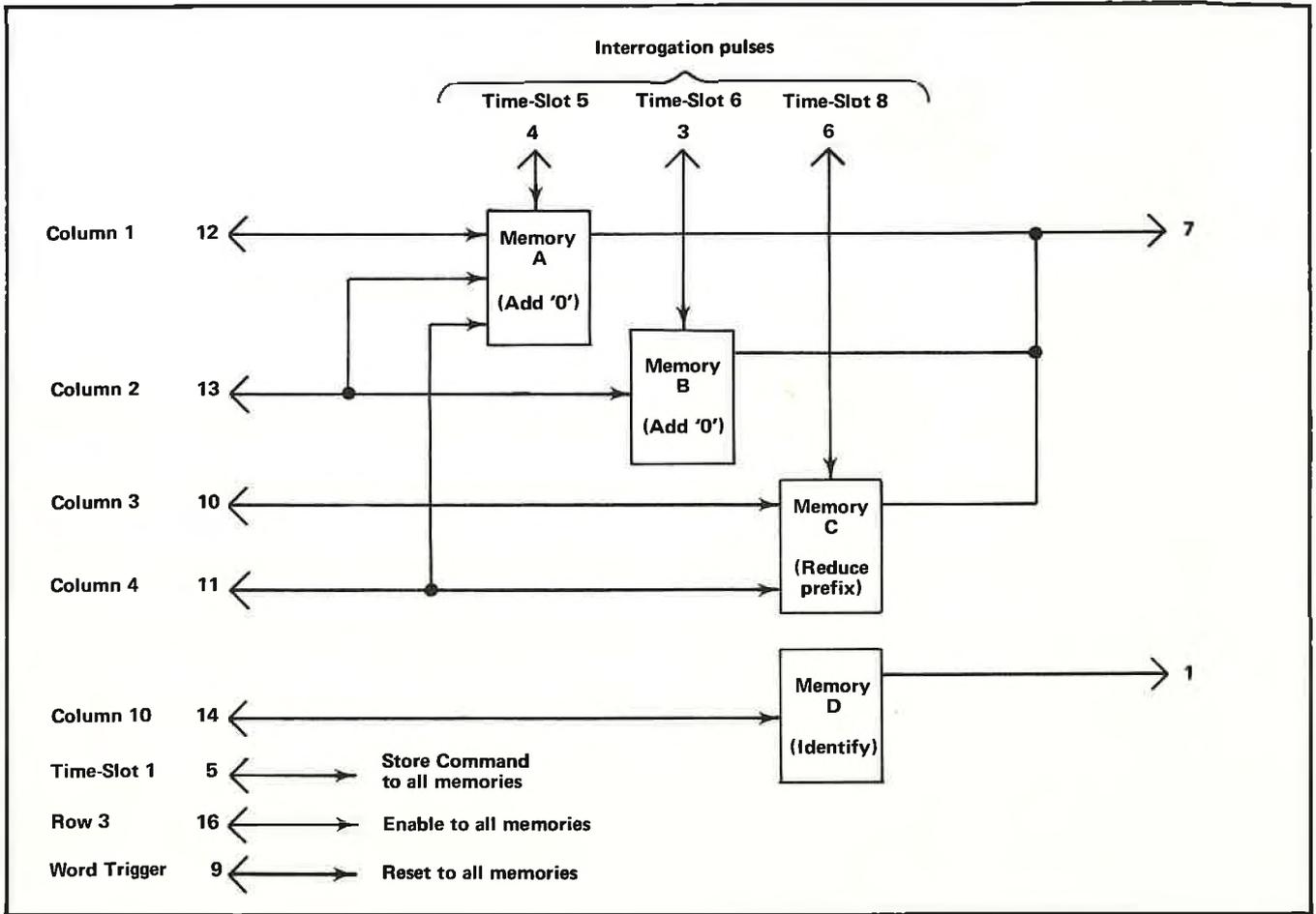


Fig. 3-40. Block representation of memory sequence in U1190.

gated to see if another zero should be added. If another zero is necessary, a second positive output is produced at pin 7 which again results in a column 1 output from the Column Decoder stage and a second zero in the CRT display.

Finally, memory C is interrogated during time-slot 8 to obtain information on whether the prefix should be reduced or left at the value which was encoded. If data has been encoded which calls for a reduction in prefix, a negative-going output level is produced at pin 7. This negative level subtracts one unit of column current from the data at the input to the Column Decoder stage. Notice on the Character Selection Matrix of Fig. 3-31 that a reduction of one column when row 4 is programmed results in a one unit reduction of the prefix. For example, with the 100 μ V program shown in Fig. 3-38, if the data received from the plug-in called for a reduction in prefix the CRT readout would be changed to 1 mV (zeros deleted by program; see Encoding the Data).

The 100 microamperes of quiescent current through R1141 that was provided by Q1163 (see Display-Skip Gen-

erator) allows the prefix to be reduced from m (100 microamperes column current; column 1) to no prefix (zero column current; column zero) so only the unit of measurement encoded during time-slot 9 is displayed. Notice that reducing the prefix program from column 1 to column 0 programs the Readout System to not display a character at this readout location.

A further feature of the Zeros Logic and Memory stage is the Identify function. If 10 units of column current are encoded by the plug-in unit along with row 3 during time-slot 1, the Zeros Logic and Memory stage produces a negative-going output pulse at pin 1 which switches the Column Data Switch and Row Data Switch stages to the ninth channel. Then, time-slot pulses 2 through 9 encode an output current through resistors R1131-R1138 for column data and R1171-R1178 for row data. This provides the currents necessary to display the word IDENTIFY on the CRT in the word position allotted to the channel which originated the Identify command. After completion of this word, the Column Data Switch and Row Data Switch continue with the next word in sequence.

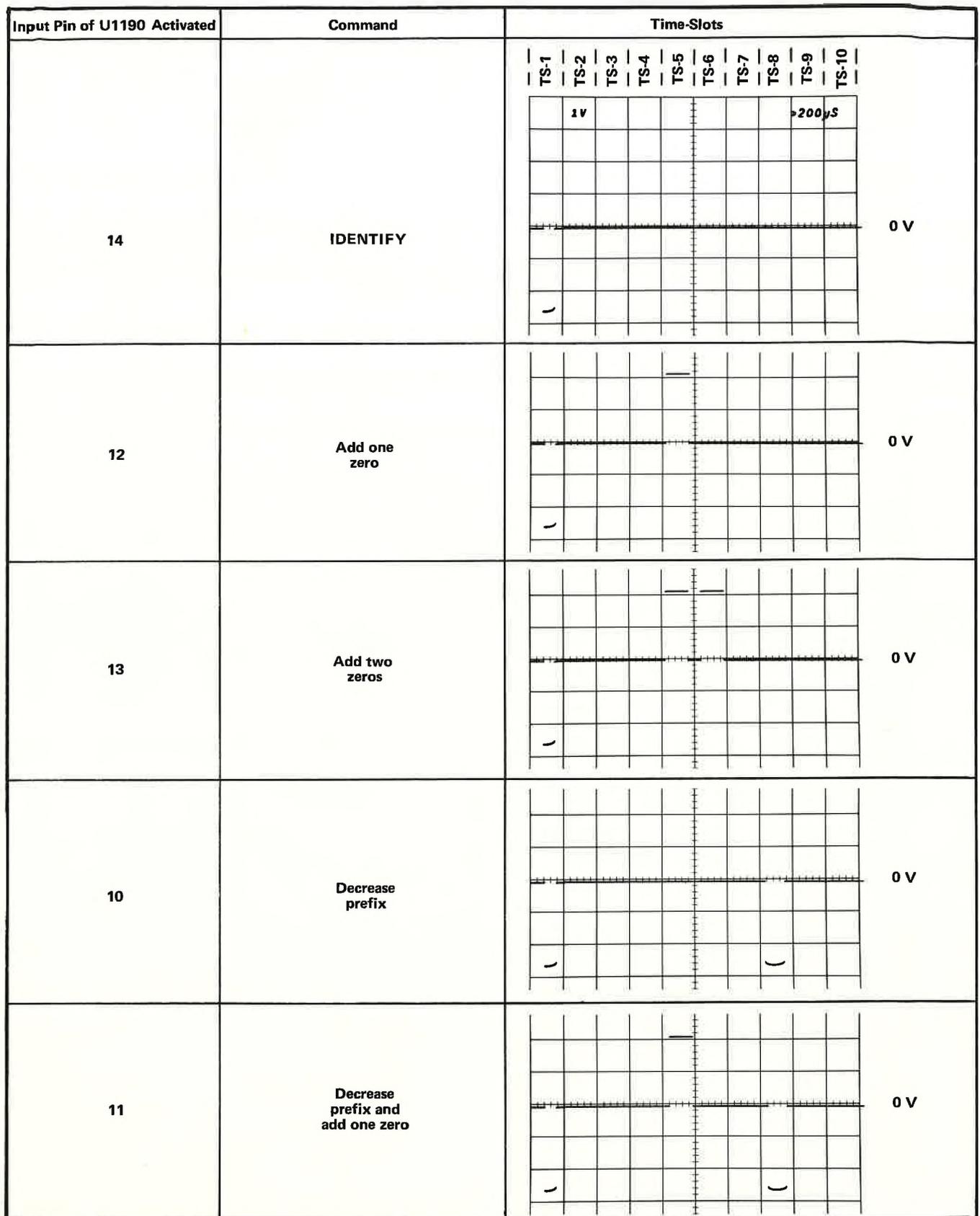


Fig. 3-41. Typical output waveforms for Zeros Logic and Memory stage operation (at pin 7 of U1190).

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The Word Trigger signal from the Word Trigger stage is connected to pin 9 of U1190 through C1190. At the end of each word of readout information, this pulse goes low. This erases the four memories in the Zeros Logic and Memory stage in preparation for the data to be received from the next channel.

Character Generators

The Character Generator stage consists of five similar integrated circuits U1251-U1255 which produce the X (horizontal) and Y (vertical) outputs at pins 16 and 1 respectively to produce the character displayed on the CRT. Each integrated circuit can produce 10 individual characters. U1251, which is designated as the "Numerals" Character Generator, can produce the numerals 0 through 9 shown in row 1 of the Character Selection Matrix (Fig. 3-31). U1252 can produce the symbols shown in row 2 of the Character Selection Matrix and U1253 produces the prefixes and some letters of the alphabet which are used as prefixes in row 4. U1254 and U1255 produce the remaining letters of the alphabet shown in rows 5 and 6 of the Character Selection Matrix. All of these stages receive the column digital data from the Column Decoder stage U1166 in parallel. However, only one of the character generators receives row data at a particular time. Therefore, only the stage which receives both row and column data is enabled. For example, if column 2 is encoded by the plug-in, the five Character Generators are enabled so that either a 1, <, μ , V or an N can be produced. However, if at the same time row 4 has also been encoded by the plug-in, only the Prefix Character Generator U1253 will produce an output to result in a μ displayed on the screen. This integrated circuit provides current outputs to the Format Generator stage which produce the selected character on the CRT. In a similar manner, any of the 50 characters shown in the Character Selection Matrix can be displayed by correct addressing of the row and column.

Decimal Point Logic and Character Position Counter

The Decimal Point Logic and Character Position Counter stage U1260 performs two functions. The first function is to produce a staircase current which is added to the X (horizontal) signal to space the characters horizontally on the CRT. After each character is generated, the negative-going edge of the Ready signal at pin 5 advances the Character Position Counter. This produces a current step output at pin 3 which, when added to the X signal, causes the next character to be produced one character space to the right. This stage can also be advanced when a Space instruction is encoded by the plug-in unit so that a space is left between the displayed characters on the CRT. Row 10 information from the Row Decoder stage is connected to pin 4 of U1260 through R1265. When row 10 and column 0 are encoded, the output of this stage advances one step to move the next character another space to the right. However, under this condition, no display is produced on the CRT during this time-slot.

Time-slot pulses 1, 2 and 3 are also connected to pin 4 of U1260 through VR1261, and VR1262 respectively and R1260, R1265. This configuration adds a space to the displayed word during time-slots 1, 2 and 3 even if information is not encoded for display during these time-slots. With this feature, the information which is displayed during time-slot 4 (1-2-5 data) always starts in the fourth character position whether data has been displayed in the previous time-slots or not. Therefore, the resultant CRT display does not shift position as normal/invert or cal/uncal information is encoded by the plug-in. The Word Trigger pulse connected to pin 8 of U1260 through C1267 returns the Character Position Counter to the first character position at the end of each word.

The Decimal Point Logic portion of this stage allows decimal points to be added to the CRT display as encoded by the plug-in units. When row 7 is encoded in coincidence with columns 3 through 7 (usually encoded during time-slot 1), a decimal point is placed at one of the five locations on the CRT identified in row 7 of the Character Selection Matrix (Fig. 3-31). This instruction refers to the decimal point location in relation to the total number of characters that can be displayed on the CRT (see Fig. 3-42). For example, if column 3 and row 7 are encoded during time-slot 1, the system is instructed to place a decimal point in location #3. As shown in Fig. 3-42, this displays a decimal point before the third character that can be displayed on the CRT (first three time-slots produce a space whether data is encoded or not; see previous paragraph). The simultaneous application of row 7 data to the Y-input of the

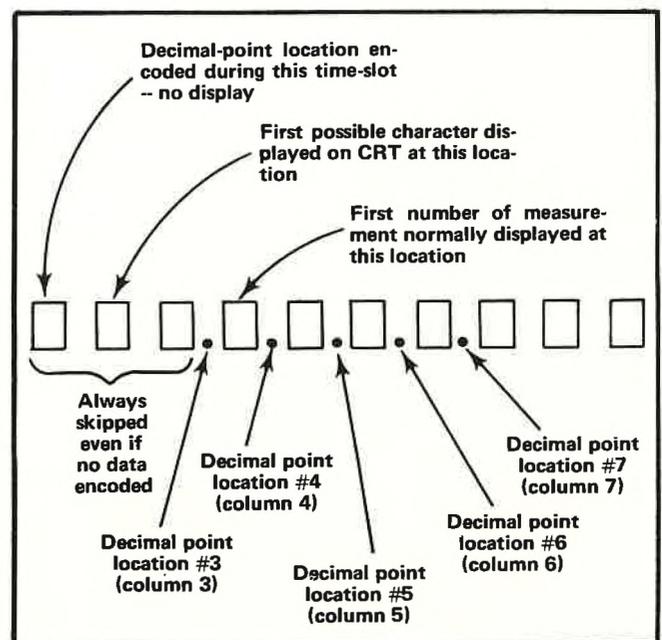


Fig. 3-42. Readout word relating 10 possible character locations to the decimal point instructions that can be encoded, and the resultant CRT display.

Format Generator stage through R1269 raises the decimal point so it appears between the displayed characters.

When decimal-point data is encoded, the CRT is unblanked so a readout display is presented. However, since row 7 does not activate any of the five Character Generators, the CRT beam is not deflected but instead remains in a fixed position to display a decimal point between the characters along the bottom line of the readout word. After the decimal point is produced in the addressed location, the CRT beam returns to the location indicated by the Character Position Counter to produce the remainder of the display.

Format Generator

The X- and Y-deflection signals produced by the Character Generator stage, are connected to pins 2 and 7 respectively of the Format Generator stage U1270. The Channel Address Code from the Channel Counter stage is also connected to pins 1, 8 and 15 of this stage. The Channel Address Code adds current to the X and Y signals to deflect the CRT beam to the area of the CRT which is associated with the plug-in channel that originated the information (see Fig. 3-30). The Channel Address Code and the resultant word positions are shown in Table 3-4. In addition, the character position current from the Decimal Point Logic and Character Position stage is added to the X (horizontal) input signal to space the characters horizontally on the CRT (see previous discussion). The Ready signal at pin 13 (coincident with Vertical/Horizontal OFF Command) activates this stage so it can produce the output from the Readout System.

Y-Output Amplifier

The Y-output signal at pin 6 of U1270 is connected to the Y-Output Amplifier Q1284-Q1288. This stage provides a low impedance load for the Format Generator while providing isolation between the Readout System and the Vertical Amplifier. The Vertical Separation adjustment R1285 changes the gain of this stage to control the vertical separation between the words displayed at the top and bottom of the graticule area.

TABLE 3-4

Channel Address Code to
Format Generator Stage

Pin 7 U1232	Pin 7 U1231	Pin 5 U1230	Channel Displayed
LO	LO	HI	Channel 1 Left Vertical
LO	LO	LO	Channel 2 Left Vertical
LO	HI	HI	Channel 1 Right Vertical
LO	HI	LO	Channel 2 Right Vertical
HI	LO	HI	Channel 1 Horizontal
HI	LO	LO	Channel 2 Horizontal
HI	HI	HI	Channel 1 Unused
HI	HI	LO	Channel 2 Unused

X-Output Amplifier

The X-Output Amplifier Q1274-Q1278 operates similarly to the Y-Output Amplifier to provide the Horizontal deflection from the readout signal available at pin 4 of U1270. The gain of this stage is fixed by the values of the resistors in the circuit.

Display Sequence

Fig. 3-43 shows a flow chart for the Readout System. This chart illustrates the sequence of events which occurs in the Readout System each time a character is generated and displayed on the CRT.

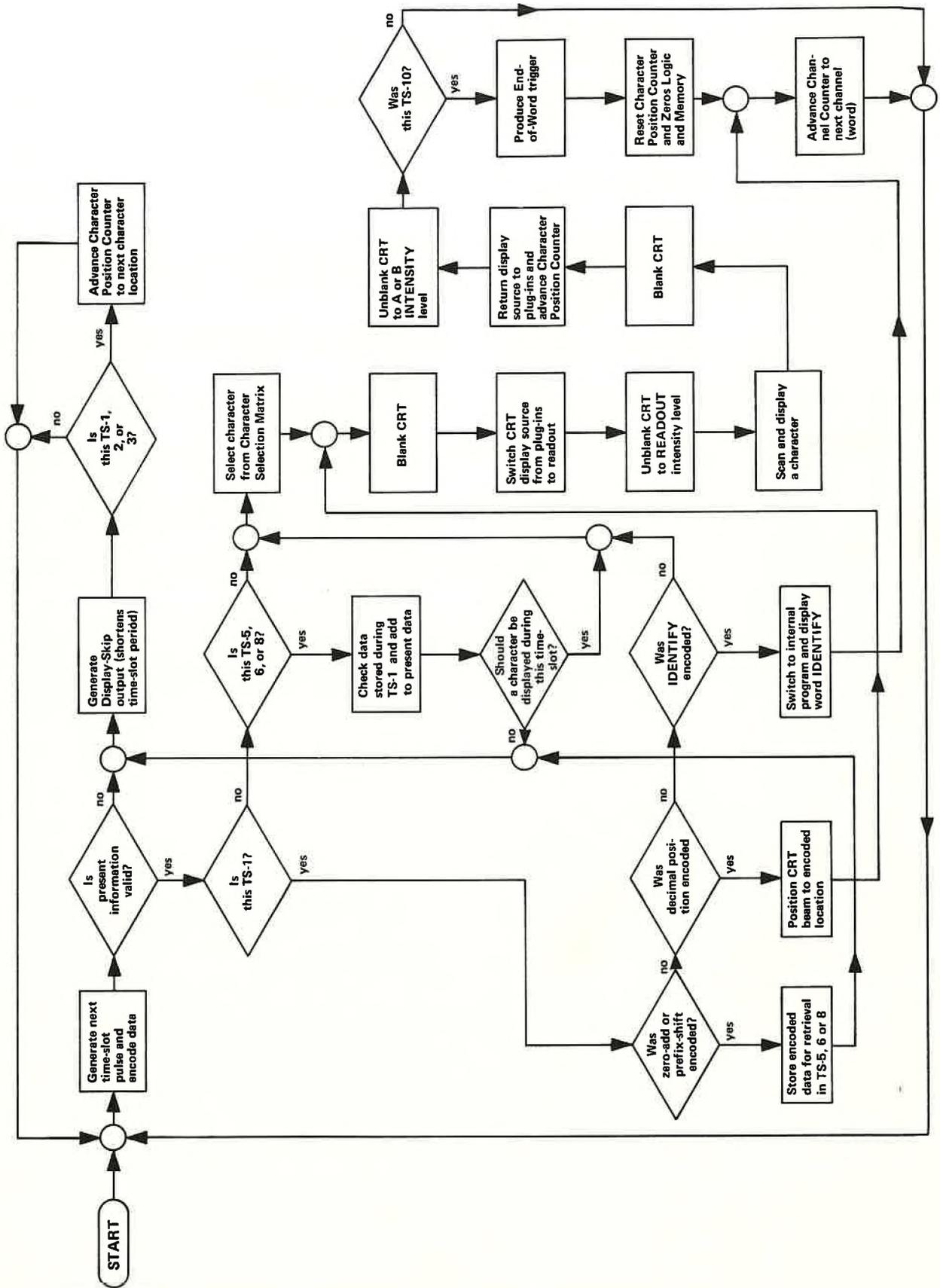


Fig. 3-43. Flow chart for character generation by the Readout System.

SECTION 4 MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance or troubleshooting of the 7503.

Panel Removal

WARNING

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

The side panels of the 7503 are held in place by four slotted fasteners. To remove the panels, turn each fastener counterclockwise a quarter turn with a large screwdriver, coin, or similar device. Then, pull the panel out at the top and lift away from the instrument. The bottom panel is held in place with four slotted fasteners. This panel can be removed to gain access to the bottom areas of the instrument. The panels protect this instrument from dust in the interior, and also provide protection to personnel from the operating potentials present. They also reduce the EMI radiation from the instrument or EMI interference to the display due to other equipment.

Power-Unit Removal

The power unit can be slid out of the rear of the 7503 to gain better access to the Logic, Power Rectifier and Power Regulator circuit boards, CRT socket and for power-unit maintenance. To remove the power unit, rest the instrument on its side or back and remove the two screws (see Fig. 4-1) which hold the power unit to the bottom cross-member. Set the instrument upright and remove the four screws (see Fig. 4-2) which hold the power-unit to the rear frame of the instrument. Slide the power-unit out of the rear of the instrument until it can be set down on the work surface (guide the power cable and interconnecting cables so they do not catch on other parts of the instrument). The power-unit remains connected to the rest of the instrument so that it can be operated in this position for maintenance purposes. Reverse this procedure when replacing the power-unit; be careful not to pinch the cables as the power-unit is

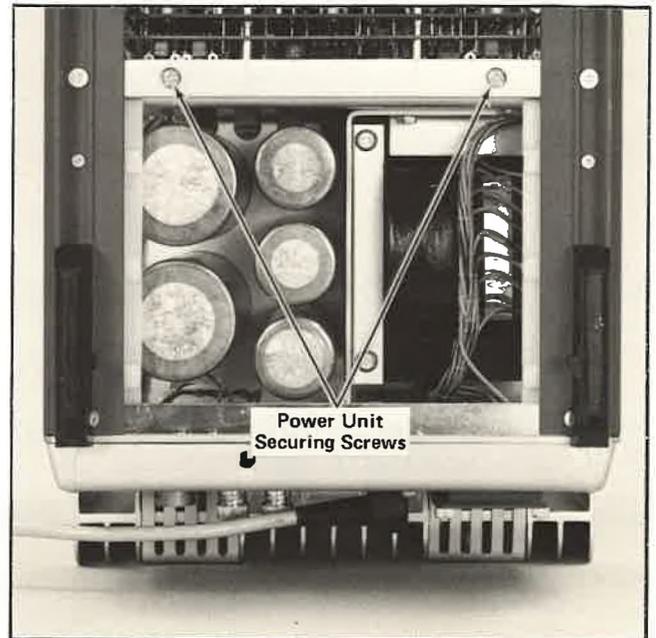


Fig. 4-1. Securing screws for power unit (bottom of instrument).

replaced. Be sure that all the securing screws are tight to hold the power-unit in place properly.

PREVENTIVE MAINTENANCE

General

Preventive maintenance consists of cleaning, visual inspection, lubrication, etc. Preventive maintenance performed on a regular basis may prevent instrument breakdown and will improve the reliability of this instrument. The severity of the environment to which the 7503 is subjected determines the frequency of maintenance. A convenient time to perform preventive maintenance is preceding recalibration of the instrument.

Cleaning

General. The 7503 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides an electrical

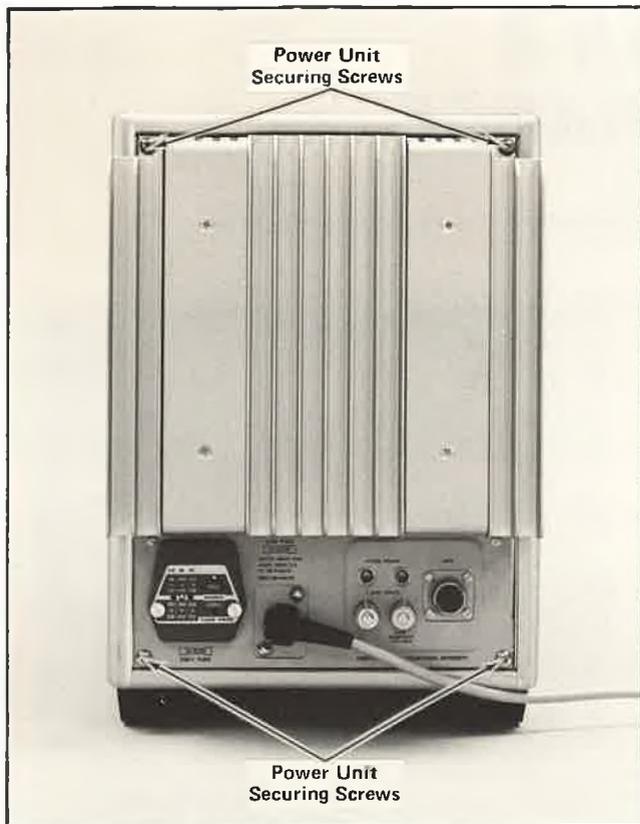


Fig. 4-2. Securing screws for power unit (rear of instrument).

conduction path which may result in instrument failure. The side panels provide protection against dust in the interior of the instrument. Operation without the panels in place necessitates more frequent cleaning.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xylene, acetone or similar solvents.

Exterior. Loose dust accumulated on the outside of the 7503 can be removed with a soft cloth or small paint brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should not be used.

CRT. Clean the plastic light filter, faceplate protector and the CRT face with a soft, lint-free cloth dampened with denatured alcohol.

The CRT mesh filter can be cleaned in the following manner:

1. Hold the mesh filter in a vertical position and brush lightly with a soft #7 water-color brush to remove light coatings of dust or lint.
2. Greasy residues or dried-on dirt can be removed with a solution of warm water and a neutral-pH liquid detergent. Use the brush to lightly scrub the filter.
3. Rinse the filter thoroughly in clean water and allow to air dry.
4. If any lint or dirt remains, use clean low-pressure air to remove it. Do not use tweezers or other hard cleaning tools on the filter, as the special finish may be damaged.
5. When not in use, store the mesh filter in a lint-free, dust-proof container such as a plastic bag.

Interior. Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-pressure air. Remove any dirt which 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 ceramic terminal strips and circuit boards.

The high-voltage circuits, particularly parts located in the high-voltage compartment and the area surrounding the post-deflection anode leads, should receive special attention. Excessive dirt in these areas may cause high-voltage arcing and result in improper instrument operation.

Lubrication

General. The reliability of potentiometers, switches and other moving parts can be maintained if they are kept properly lubricated. However, over lubrication is as detrimental as too little lubrication. A lubrication kit containing the necessary lubricants and instructions is available from Tektronix, Inc. Order Tektronix Part No. 003-0342-01.

Visual Inspection

The 7503 should be inspected occasionally for such defects as broken connections, broken or damaged ceramic strips, improperly seated semiconductors, damaged or improperly installed circuit boards, and heat-damaged parts.

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

Semiconductor Checks

Periodic checks of the semiconductors in the 7503 are not recommended. The best check of semiconductor performance is actual operation in the instrument. More details on checking semiconductor operation are given under troubleshooting.

Recalibration

To assure accurate measurements, check the calibration of this instrument after each 1000 hours of operation or every six months if used infrequently. In addition, replacement of components may necessitate recalibration of the affected circuits. The calibration procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed and/or corrected by recalibration.

An elapsed-time meter is installed on the rear of the Main Interface circuit board (on right side of instrument). This meter provides a full-scale indication of 5,000 hours of operating time and can be used to indicate when recalibration is necessary. Each minor division on this meter indicates 250 hours of operation. When the elapsed-time meter reaches 5,000 hours (full scale), it should be replaced.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting of the 7503. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is very helpful in locating troubles, particularly where integrated circuits are used. See the Circuit Description section for complete information.

Troubleshooting Aids

Diagrams. Complete circuit diagrams are given on fold-out pages in the Diagrams section. The component number and electrical value of each component in this instrument are shown on the diagrams. Each main circuit is assigned a series of component numbers. Table 4-1 lists the main circuits in the 7503 and the series of component numbers assigned to each. Important voltages and waveforms are also shown on the diagrams. The portions of the circuit mounted on circuit boards are enclosed with blue lines.

TABLE 4-1

Component Numbers

Component numbers on diagrams	Diagram numbers	Circuit
1-49	0	Main Interface
50-199	1	Logic Circuit
300-349	3	Trigger Selector
200-299	2	Vertical Interface
400-499	4	Vertical Amplifier
500-599	5	Horizontal Amplifier and X-Y Delay Compensation
600-699	6	Output Signals and Calibrator
700-799	7	Z-Axis Amplifier and CRT Circuit
800-999	8A	Low-Voltage Rectifiers
	8B	Low-Voltage Regulators
	8C	
1000-1099	9	Mode Switching and Rear-Panel Connectors
1200-1249	10	Sequencing Logic
1100-1199	11	Data Collection
1250-1299	12	Character Generators and Output

Cam-Type Switch Contact Identification. The contacts of the cam-type switches shown on the diagrams are coded to indicate the position of the contact in the complete switch assembly counting from the front, or mounting end of the switch, toward the rear. The contact closure chart given on the diagrams indicate when each contact is closed.

Circuit Boards. Figs. 4-7 through 4-20 show the circuit boards used in the 7503. Fig. 4-6 shows the location of each board within the instrument. Each electrical component on the boards is identified by its circuit number. The circuit boards are also outlined on the diagrams with a blue line. These pictures, used along with the diagrams, aid in locating the components mounted on the circuit boards.

Multi-Pin Connector Color-Code. The multi-pin connectors used for interconnection between circuit boards are color-coded to aid in circuit tracing. The color of the connector body matches the resistor color-code for the last digit of the circuit number; e.g., P601 is brown, P603 is orange, etc.

Wiring Color-Code. All insulated wire and cable used in the 7503 is color-coded to facilitate circuit tracing. Table 4-2 gives the wiring color-code used in the 7503.

TABLE 4-2
Wiring Color-Code

Supply or Function	Background Color	Stripe ¹
-50 volt	Violet	Brown
-15 volt	Violet	Black
+5 volt	Red	Black
+15 volt	Red	Brown
+50 volt	Red	Orange
+75 volt	Red	Yellow
+150 volt	Red	Green
Chassis ground	Black ²	Footnote 3
Safety ground	Green	Yellow
AC (internal)	Gray ²	Footnote 4
Bulb filaments	Brown	Footnote 4
Signal leads	White ²	Footnote 4

¹ If more than one stripe appears on lead, extra stripes are for lead identification only (for circuit tracing).

² See WARNING note concerning power-cord color code.

³ White stripe indicates floating (signal) ground.

⁴ All stripes for lead identification only (for circuit tracing).

WARNING

This color code applies to leads within the 7503 only.
Color code of the AC power cord is:

Black Line
White Neutral
Green Safety earth (ground)

Resistor Color-Code. In addition to the brown composition resistors, some metal-film resistors and some wire-wound resistors are used in the 7503. The resistance values of wire-wound resistors are printed on the body of the component. The resistance values of composition resistors and metal-film resistors are color-coded on the components with EIA color-code (some metal-film resistors may have the value printed on the body). The color-code is read starting with the stripe nearest the end of the resistor. Composition resistors have four stripes which consist of two significant figures, a multiplier and a tolerance value (see Fig. 4-3). Metal-film resistors have five stripes consisting of three significant figures, a multiplier and a tolerance value.

Capacitor Marking. The capacitance values of common disc capacitors and small electrolytics are marked in microfarads on the side of the component body. The white ceramic capacitors used in the 7503 are color-coded in picofarads using a modified EIA code (see Fig. 4-3).

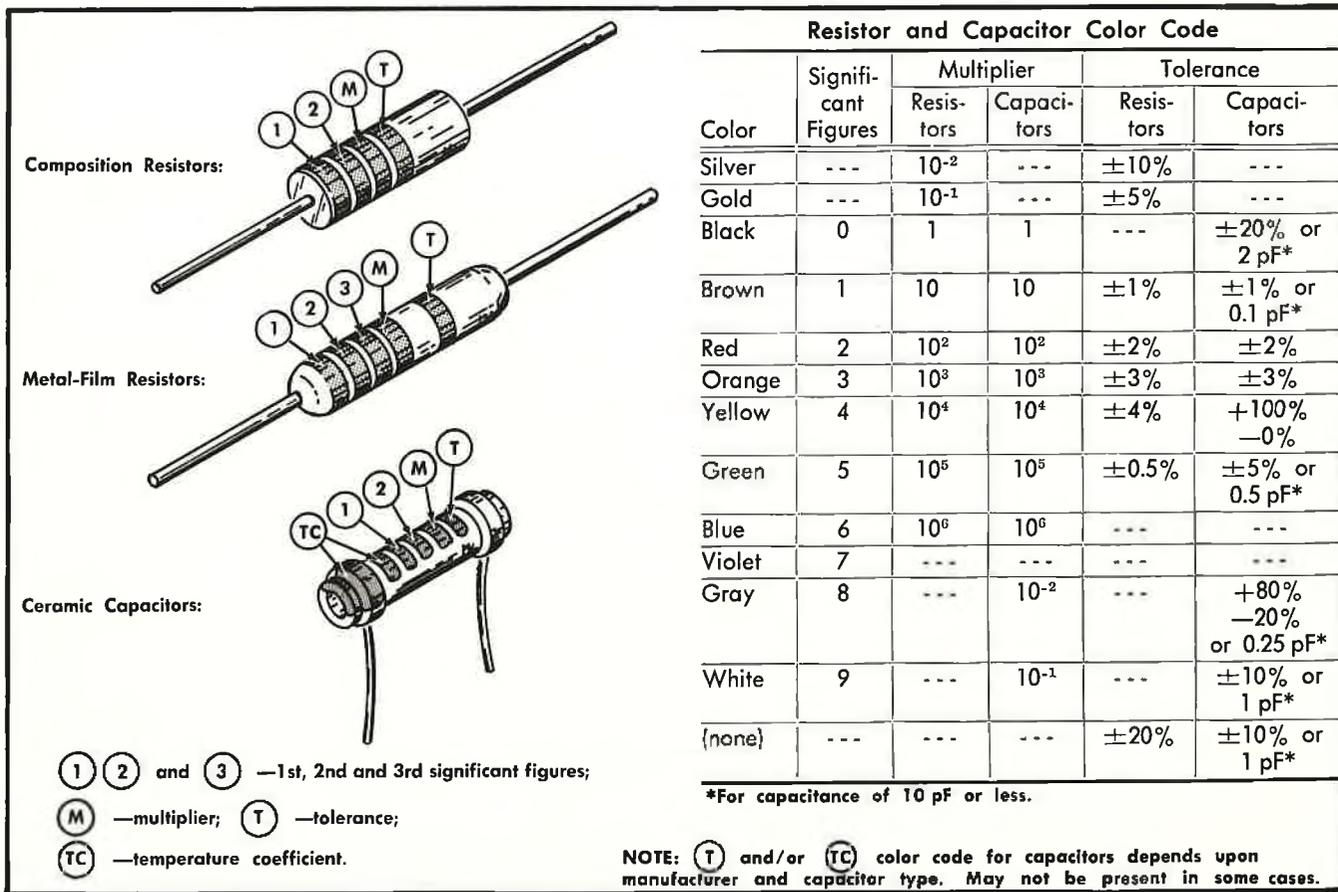


Fig. 4-3. Color-code for resistors and ceramic capacitors.

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

Semiconductor Lead Configuration. Fig. 4-4 shows the lead configuration for the semiconductors used in this instrument. This view is as seen from the bottom of the semiconductors.

Troubleshooting Equipment

The following equipment is useful for troubleshooting the 7503.

1. Transistor Tester

Description: Tektronix Type 576 Transistor-Curve Tracer or equivalent.

Purpose: To test the semiconductors used in this instrument.

2. Multimeter

Description: VTVM, 10 megohm input impedance and 0 to 500 volts range; ohmmeter, 0 to 50 megohms. Accuracy, within 3%. Test probes must be insulated to prevent accidental shorting.

Purpose: To check voltages and for general troubleshooting in this instrument.

NOTE

A 20,000 ohms/volt VOM can be used to check the voltages in this instrument if allowances are made for the circuit loading of the VOM at high-impedance points.

3. Test Oscilloscope

Description: DC to 50 megahertz frequency response; 50 volts/division deflection factor. A 10X probe should be used to reduce circuit loading.

Purpose: To check operating waveforms in this instrument.

Troubleshooting Techniques

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

1. Check Control Settings. Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, see the Operating Instructions section.

2. Check Associated Equipment. Before proceeding with troubleshooting of the 7503, check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source. The associated plug-in units can be checked for proper operation by substituting other units which are known to be operating properly (preferably of the same types). If the trouble persists after substitution, the 7503 is probably at fault.

3. Visual Check. Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visual indications such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.

4. Check Instrument Calibration. Check the calibration of this instrument, or the affected circuit if the trouble appears in one circuit. The apparent trouble may only be a result of misadjustment or may be corrected by calibration. Complete calibration instructions are given in the Calibration section.

5. Isolate Trouble to a Circuit. To isolate trouble to a particular circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. For example, poor focus indicates that the CRT circuit (includes high voltage supplies) is probably at fault. When trouble symptoms appear in more than one circuit, check affected circuits by taking voltage and waveform readings. Also check for the correct output signals at the front-panel output connectors with a test oscilloscope. If the signal is correct, the circuit is working correctly up to that point. For example, correct sawtooth output indicates that the time-base is operating correctly.

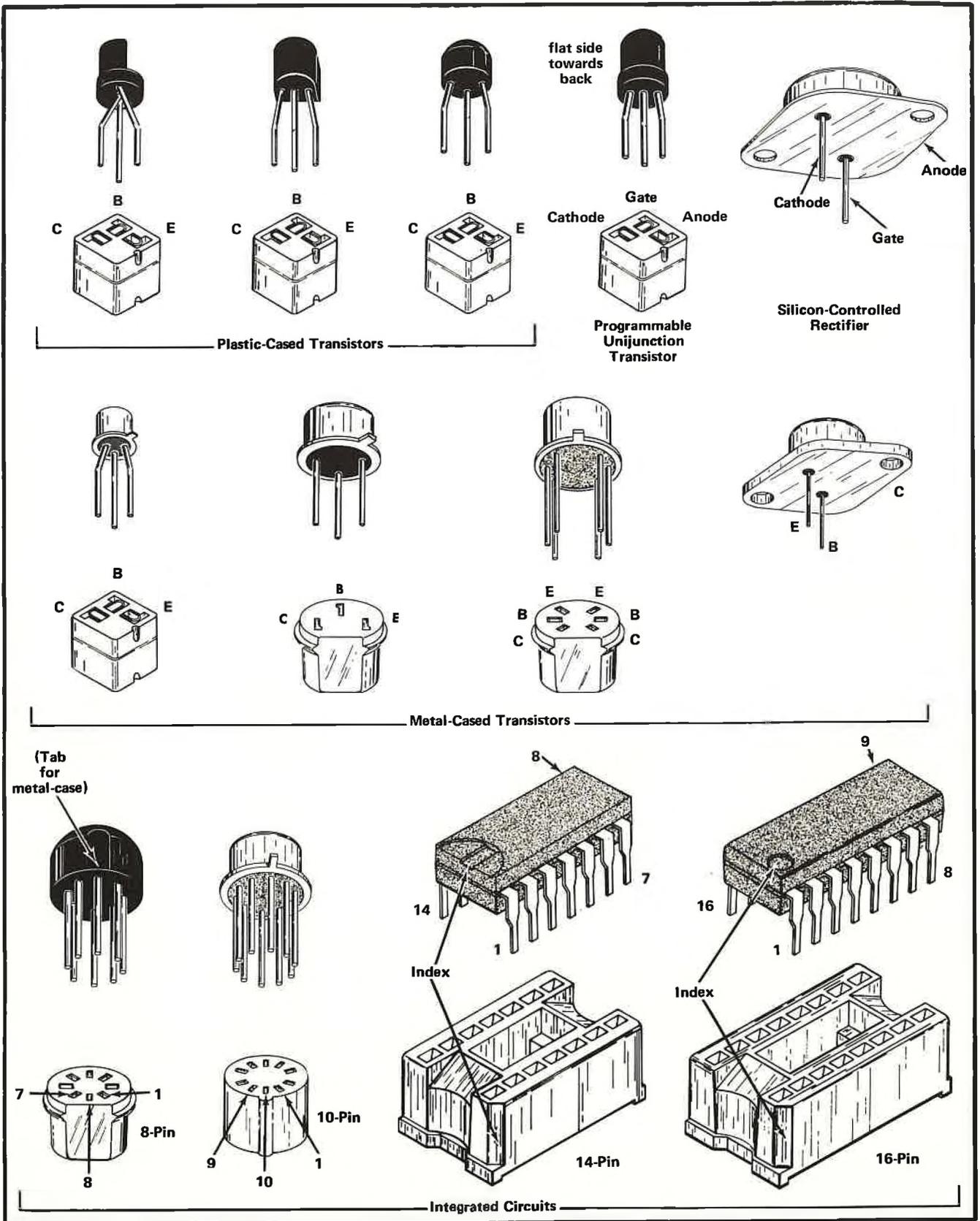


Fig. 4-4. Electrode configuration for semiconductors in this instrument.

Incorrect operation of all circuits often indicates trouble in the power supply. Check first for correct voltage of the individual supplies. However, a defective component elsewhere in the instrument can appear as a power-supply trouble and may also affect the operation of other circuits. Table 4-3 lists the tolerances of the power supplies in this instrument. These voltages are measured between the power-supply test points (see Section 5 for test point location) and ground. If a power-supply voltage is within the listed tolerance, the supply can be assumed to be working correctly. If outside the tolerance, the supply may be misadjusted or operating incorrectly. Use the procedure given in the Calibration section to adjust the power supplies.

TABLE 4-3
Power Supply Tolerance and Ripple
(Referenced to TP GND)

Power Supply	Tolerance	Maximum ripple (peak-to-peak)
-50 volt	± 0.10 volts	Five millivolts
-15 volt	± 0.75 volts	Two millivolts
+5 volt	± 0.15 volts	Two millivolts
+15 volt	± 0.30 volts	Two millivolts
+50 volt	± 0.60 volts	Five millivolts
+75 volt	± 2.25 volts	200 millivolts
+150 volt	± 6.0 volts	300 millivolts

Fig. 4-5 provides a guide for locating a defective circuit. This chart does not include checks for all possible defects; use step 6 and 7 or the Special Troubleshooting Information in such cases. Start from the top of the chart and perform the given checks on the left side of the page until a step is found which does not produce the indicated results. Further checks and/or the circuit in which the trouble is probably located are listed to the right of this step.

After the defective circuit has been located, proceed with steps 6 and 7 to locate the defective component(s).

6. Check Voltages and Waveforms. Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages and waveforms are given on the diagrams.

NOTE

Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the first diagram page.

7. Check Individual Components. The following procedures describe methods of checking individual components in the 7503. Components which are soldered in place are best checked by first disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

A. SEMICONDUCTORS.

CAUTION

Power switch must be turned off before removing or replacing semiconductors.

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

Integrated circuits can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of the circuit description is essential to troubleshooting circuits using integrated circuits. In addition, operating waveforms, logic levels and other operating information for the integrated circuits are given in the Circuit Description section. Use care when checking voltages and waveforms around the integrated circuits so that adjacent leads are not shorted together. A convenient means of clipping a test probe to the 14- and 16-pin integrated circuits is with an integrated-circuit test clip. This device also doubles as an integrated-circuit extraction tool.

B. DIODES.

A diode can be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of between 800 millivolts and 3 volts, the resistance should be very high in one direction and very low when the meter leads are reversed.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High currents may damage the diode.

C. RESISTORS.

Check the resistors with an ohmmeter. See the Electrical Parts List for the tolerance of the resistors used in this

CIRCUIT ISOLATION TROUBLESHOOTING CHART

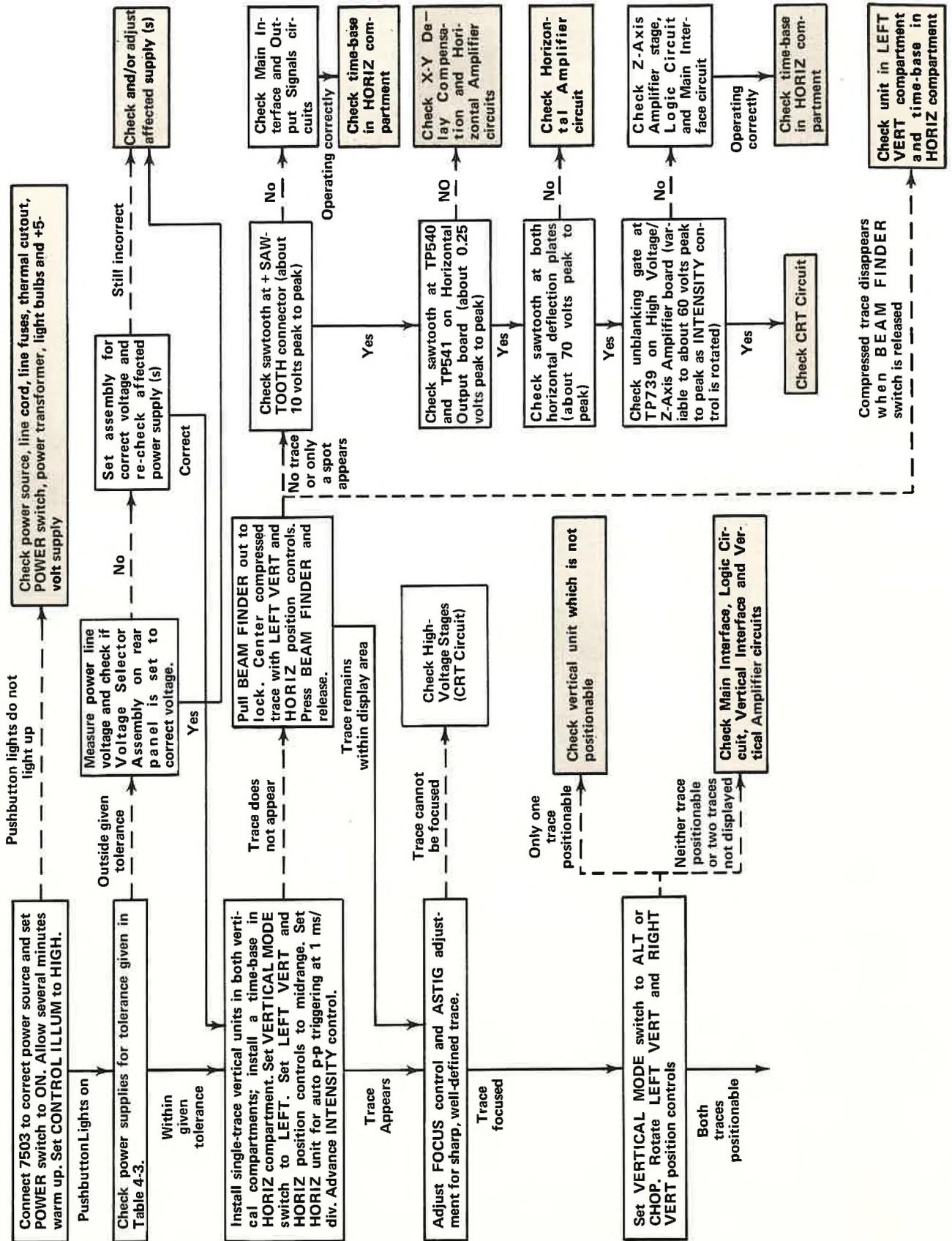


Fig. 4-5.

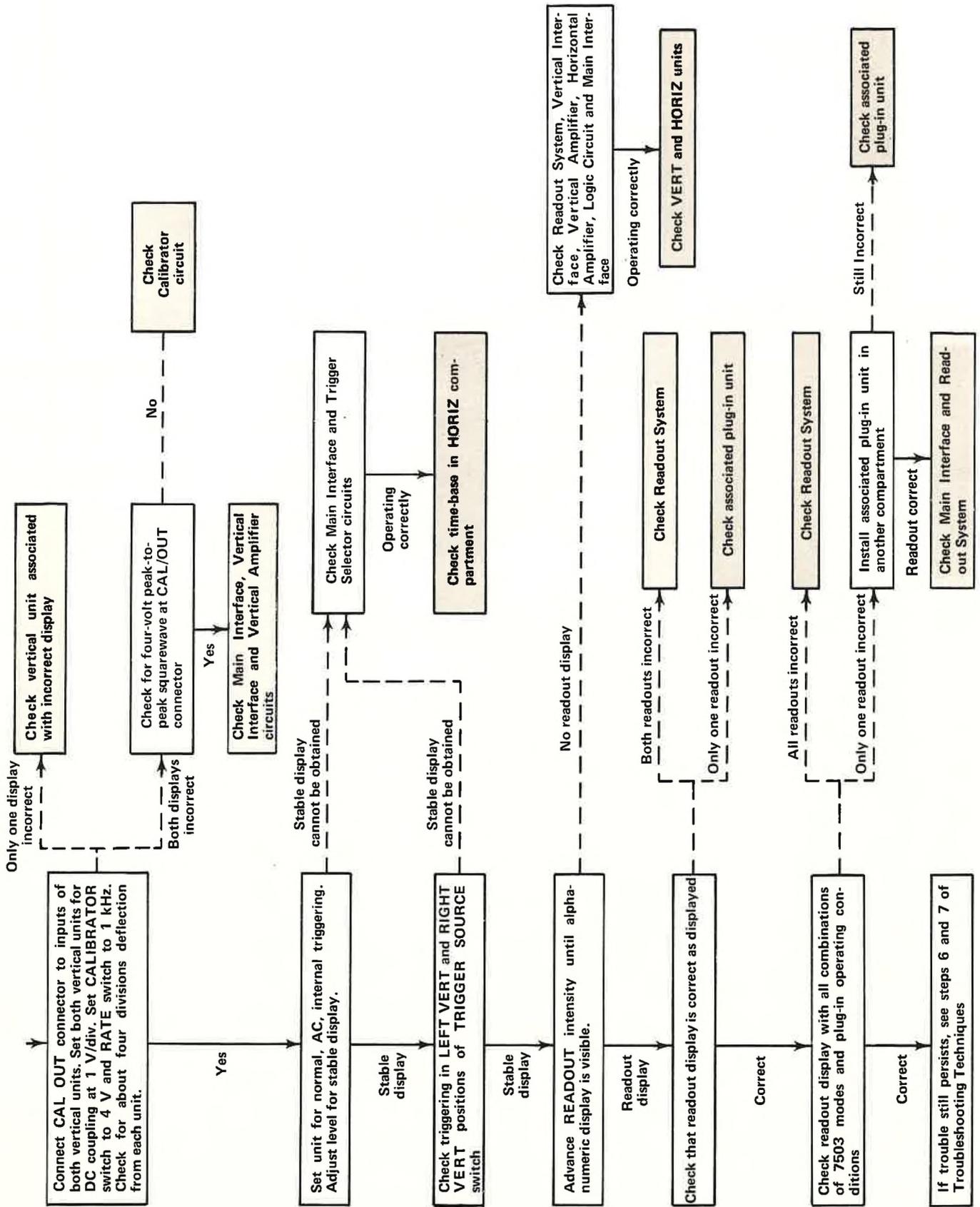


Fig. 4-5. (cont)

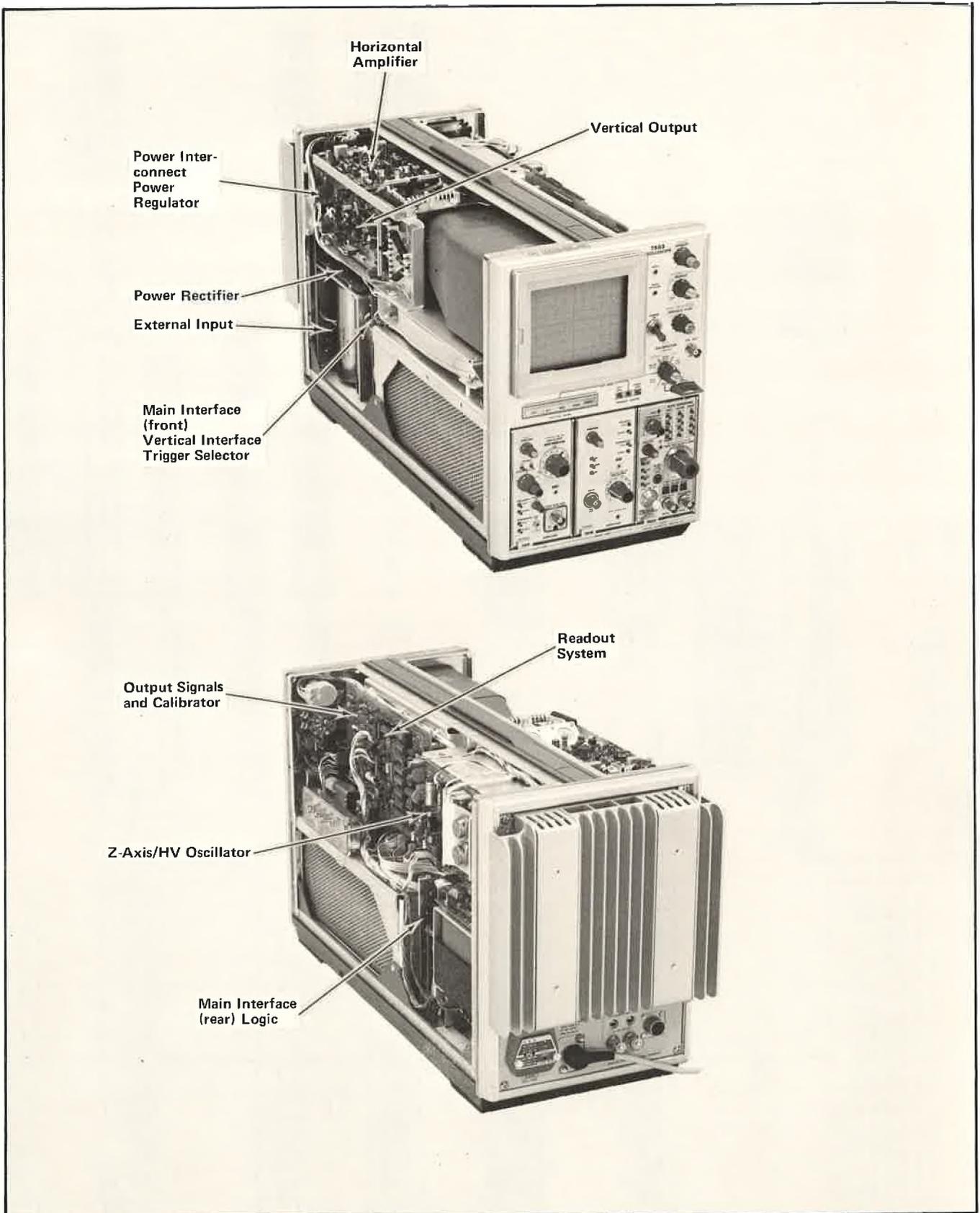


Fig. 4-6. Location of circuit boards in the 7503.

instrument. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

D. INDUCTORS.

Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit. Partial shorting often reduces high-frequency response (roll-off).

E. CAPACITORS.

A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter or by checking if the capacitor passes AC signals.

8. Repair and Readjust the Circuit. If any defective parts are located, follow the replacement procedures given in this section. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced.

Troubleshooting the Readout System. The following procedure provides a guide to troubleshooting the Readout System of the 7503.

NOTE

In the following procedure, the integrated circuits can be checked by interchanging with similar types on the Readout System board or with other instruments of the same type. Also, the voltages and waveforms as described in the Circuit Description and given on the diagrams can be used to check the operation of the integrated circuits where replacement devices are not available.

1. Isolating the Trouble

1.1 Remove the Readout System board from the instrument and check for damaged components, damaged circuit board, or improperly installed transistors or integrated circuits. Check that the index of all integrated circuits on the Readout System board matches the index of the socket. If no defects are found, re-install the board on the instrument.

1.2 Set the 7503 POWER switch to ON and note which of the following problems exist. Then refer to the step listed.

1.2.1 No readout in any word location. Go to step 2.1.

1.2.2 All readout words incorrect. Go to step 3.1.

1.2.3 Some readout words correct, some incorrect. Go to step 4.1.

2. No Readout

2.1 Remove all plug-in units from the instrument.

2.2 Remove dual transistor Q1143 from the Readout System board.

2.3 Set the 7503 POWER switch to ON and allow a warmup period.

NOTE

Observe the readout display and refer to one of the following steps.

2.4 At least 60 zeros in display (30 within top division of graticule, 30 within bottom division).

2.4.1 If correct display of 60 zeros is obtained, interchange U1130 and U1170. Then return to step 1.2. If the present readout display is in any way different than the original problem, the trouble is located in the U1130 or U1170 circuits.

2.4.2 If step 2.4.1 does not correct the readout display, interchange U1166 and U1186 and return to step 1.2. If the present readout display is in any way different from the original problem, the trouble is located in the U1166 or U1186 circuits.

2.4.3 If less than 60 zeros are displayed, check output of U1226 (see Fig. 3-44). If incorrect, the trouble is located in the U1226 or U1210 circuits. If correct, check U1130, U1170, U1166, and U1186 circuits as given in steps 2.4.1 and 2.4.2.

2.5 At least 60 dots in display

2.5.1 Exchange character generator U1251 with one of the other character generators U1252 — U1255. If display is still only dots, check U1166 by interchanging it with U1186.

2.5.2 If at least 60 characters are displayed (exact character will depend on which character generator was substituted), re-install the char-

acter generators in the correct sockets and replace U1251 with a new integrated circuit.

2.6 Pattern other than 60 zeros or dots

2.6.1 Check Channel Address Code (see Table 3-4). If incorrect, check U1230-U1231-U1232.

2.6.2 Check Q1274, Q1278, Q1284, and Q1288 with the transistor tester (see recommended troubleshooting equipment). If correct, check U1260 and U1270 circuits.

2.7 No display

2.7.1 Turn front-panel READOUT control fully clockwise and check voltage at interconnecting pin XM.

2.7.1.1 If less than about -13 volts, check R1040 and S1040. Also check interconnecting leads.

2.7.1.2 If greater than -13 volts, check voltage at TP1255: If zero volts or more negative, check the U1210 circuit; if +1 volt or greater, check Q1150-Q1152-Q1155-Q1163. Finally, check U1190.

2.7.2 Check waveforms at TP1215, TP1217, and pin 5 of U1210. If correct, check the level at pin 16 of U1226.

2.8 Re-install Q1143 in its socket. Check readout display.

3. All Readout Words Incorrect

3.1 If only one character is wrong in all displayed readouts, check the character generator which produces this character.

3.2 Install a time-base unit in any compartment and turn the time/division switch throughout its range. Note which portions of the readout display are missing or incorrect in each decade of the time/division switch.

3.3 Install the time-base unit in another compartment and repeat step 3.2. If the results are the same, continue with this step. If the readout is now correct, go to step 4.1.

3.4 Remove the time-base unit and substitute a different unit and repeat step 3.2. If the results are the same, continue with this step. If the readout is now correct, check the original plug-in units.

3.5 Interchange U1130 and U1170 and repeat step 3.2. If the readout is still incorrect but different portions of the readout display are wrong, the trouble is in either the U1130 or U1170 circuit. If the readout is correct, the error may have been corrected; check readout in all plug-in compartments for original error. If no change is noted, proceed to next step.

3.6 Repeat step 3.5, only this time interchange U1166 and U1186.

3.7 If the zeros adding or prefix shifting portion of the readout display is incorrect, check following steps:

3.7.1 Check waveform at TP1130 to see if information is being encoded during time-slot 1. If not, check U1130 by substitution with U1170. Also check the encoding network in the plug-in unit.

3.7.2 Check for a Word Trigger pulse at pin 9 of U1190 (one pulse for each 10 time-slot pulses). If not present, check U1227 and U1226 circuits.

3.7.3 Check for presence of row 3 information at pin 16 and column 1, 3, 3, 4 information at pins 12, 13, 10 and 11 respectively of U1190 (current signals). If no signal is present, check U1166 and U1186.

3.7.4 Check waveform at TP1190 (see Fig. 3-41). If not present, check U1190 circuit.

4. Some Readout Words Correct, Some Incorrect.

4.1 Install different plug-in units in the compartment(s) producing the incorrect readout. Check resulting display.

4.1.1 Readout correct. Check original plug-in unit.

4.1.2 Readout still incorrect.

4.1.2.1 Interchange U1130 and U1170 and check the resulting display. If the readout is still incorrect but different portions of the readout display are wrong, the trouble is in either U1130 or U1170. If the readout is correct, the error may have been corrected; check readout in all plug-in compartments. If no change is noted, proceed to the next step.

4.1.2.2 Repeat step 4.1.2.1, only this time interchange U1166 and U1186.

4.1.2.3 Check all time-slot pulses connected to the plug-in unit at the plug-in

interface connector. Pulses must be exactly -15 volts in amplitude. If not, check U1210 and U1226 circuits, and the interconnecting wires.

- 4.2 This completes the troubleshooting procedure for the Readout System.

CORRECTIVE MAINTENANCE

General

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

Obtaining Replacement Parts

Standard Parts. All electrical and mechanical part replacements for the 7503 can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts lists 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, particularly at high frequencies. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Special Parts. In addition to the standard electronic components, some special components are used in the 7503. These components are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. These special components are indicated in the Electrical Parts List by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts. When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument type.
2. Instrument serial number.

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

4. Tektronix Part Number.

Soldering Techniques

WARNING

Disconnect the instrument from the power source before soldering.

Circuit Boards. Use ordinary 60/40 solder and a 35- to 40-watt pencil type soldering iron on the circuit boards. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the wiring from the base material.

The following technique should be used to replace a component on a circuit board. Use the procedures given under Component Replacement to remove the boards from the instrument before soldering.

1. Grip the component lead with long-nose pliers. Touch the soldering iron to the lead at the solder connection. Do not lay the iron directly on the board as it may damage the board.

2. When the solder begins to melt, pull the lead out gently. This should leave a clean hole in the board. If not, the hole can be cleaned by reheating the solder and placing a sharp object such as a toothpick into the hole to clean it out. A vacuum-type desoldering tool can also be used for this purpose.

3. Bend the leads of the new component to fit the holes in the boards. Insert the leads into the holes in the board so the component is firmly seated against the board, or as positioned originally. If it does not seat properly, heat the solder and gently press the component into place.

4. Touch the iron to the connection and apply a small amount of solder to make a firm solder joint; do not apply too much solder. To protect heat-sensitive components, hold the lead between the component body and the solder joint with a pair of long-nose pliers or other heat sink.

5. Clip the excess lead that protrudes through the board.

6. Clean the area around the solder connection with a flux-remover solvent. Be careful not to remove information printed on the board.

Maintenance—7503

Metal Terminals. When soldering metal terminals (e.g., switch terminals, potentiometers, etc.), ordinary 60/40 solder can be used. Use a soldering iron with a 40- to 75-watt rating and a 1/8-inch wide wedge-shaped tip.

Observe the following precautions when soldering metal terminals:

1. Apply only enough heat to make the solder flow freely. Use a heat sink to protect heat-sensitive components.
2. Apply only enough solder to form a solid connection. Excess solder may impair the function of the part.
3. If a wire extends beyond the solder joint, clip off the excess.
4. Clean the flux from the solder joint with a flux-remover solvent.

Component Replacement

WARNING

Disconnect the instrument from the power source before replacing components.

General. The exploded-view drawings associated with the Mechanical Parts List (Figs. 1 through 5 located on back of diagram pullout pages) may be helpful in the removal or disassembly of individual components or sub-assemblies.

Circuit Board Replacement. If a circuit board is damaged beyond repair, either the entire assembly including all soldered on components, or the board only, can be replaced. Part numbers are given in the Mechanical Parts List for either the completely wired (670- ---- - ---) or the unwired board (388- ---- - ---). Most of the main circuit boards in this instrument plug onto the chassis or onto other circuit boards (exceptions; Main Interface, Calibrator, Power Rectifier and Power Interconnect boards). Use the following procedure to remove the plug-on circuit boards (removal instructions for the exceptions will be given later).

A. PLUG-ON BOARDS.

1. Disconnect any pin connectors located on the front of the board.

2. Loosen all of the securing screws on the board.

3. Pull out on the edges of the board until the board clears the chassis terminals. Attempt to lift the board away from the chassis in such a way that it remains parallel to the chassis at all times so as not to bend the interconnecting terminals.

4. To replace a plug-on circuit board, position it so the securing-screw holders mate with the guide posts on the chassis.

5. Gently press the circuit board against the chassis. Be sure that all of the interconnecting pins and sockets mate properly.

6. Uniformly tighten the securing screws. Recommended torque, four to six inch-pounds.

B. MAIN INTERFACE CIRCUIT BOARD REPLACEMENT.

Use the following procedure to replace the Main Interface circuit board:

1. Slide out the power-unit as described previously.

2. Remove all of the plug-on circuit boards from the Main Interface circuit board (remove plug-in units to gain access to plug-on boards on front of Main Interface board).

3. Disconnect the multi-pin connectors from the front and rear of the Main Interface board. Note the order of these connectors so they can be correctly replaced.

4. Remove the three screws from inside each plug-in compartment which hold the plug-in interface connectors to the chassis of this instrument (total of 9 screws). Also remove the two screws which hold the ground straps to the chassis.

5. Slide the Main Interface board assembly to the rear and disconnect all of the pin connectors. Now, the Main Interface board assembly can be removed from the instrument.

6. To replace the Main Interface board, reverse the order of removal. Match the arrows on the multi-pin connectors to the arrows on the board. Correct location of the pin connectors is shown in Fig. 4-7.

C. PWR RECTIFIER BOARD REMOVAL.

To remove the Power Rectifier board, proceed as follows:

1. Slide out the power unit as described previously.
2. Disconnect all of the multi-pin connectors from the Power Rectifier board.
3. Remove the nuts which hold the Power Rectifier board to the transformer bolts.
4. Remove the screws which mount the Power Rectifier board to the filter capacitors.
5. To replace the Power Rectifier board, reverse the order of removal. Match the arrows on the multi-pin connectors to the arrows on the board.

D. PWR INTERCONNECT BOARD REMOVAL.

To remove the Power Interconnect board, proceed as follows:

1. Remove the four Phillips-head screws which secure the protective aluminum strips to the heat radiator.
2. Remove the four screws which hold the heat radiator to the rear of the power unit.
3. Remove the heat radiator, taking care to disconnect the three multi-pin connectors from the Power Interconnect board before removing completely.
4. Remove the Power Regulator board from the Power Interconnect board—note the Phillips-head screw securing the center of the board.
5. The components on the Power Interconnect board are now accessible. If further disassembly is necessary, remove the six screws securing the Power Interconnect board and the two Power Transistor boards from the rear of the heat radiator.
6. To replace the Power Interconnect circuit board, reverse the order of removal. Match the arrows on the multi-pin connectors to the arrows on the board.

E. CALIBRATOR—SIGNALS OUT BOARD REMOVAL.

To remove the Calibrator—Signals Out circuit board, use the following procedure:

1. Rotate the CALIBRATOR and RATE switches fully counterclockwise.
2. Remove the knobs from the CALIBRATOR and RATE switches with a 1/16-inch hex-key wrench (CALIBRATOR knob has two set screws).
3. Remove the securing nut which holds the switch/board assembly to the front panel with a #14 nut driver.
4. Remove the Readout System circuit board.
5. Disconnect the multi-pin connectors from the front-center and top-center of the Calibrator—Signals Out board.
6. Remove the six screws securing the circuit board.
7. Slide the Calibrator—Signals Out board assembly out of the front panel and then disconnect the remaining multi-pin connectors.
8. To replace the Calibrator—Signals Out switch/board assembly, reverse the removal procedure. Match the arrows on the multi-pin connectors to the arrows on the board. Be sure the front-panel knobs are installed so they indicate the correct switch positions.

Plug-In Interface Connectors. The individual contacts of the plug-in interface connectors can be replaced. However, it is recommended that the entire Main Interface board be replaced if a large number of the contacts are damaged. An alternative solution is to refer the maintenance of the damaged Main Interface board to your local Tektronix Field Office or representative. Use the following procedure to replace an individual contact of the plug-in interface connector.

1. Remove the Main Interface circuit board from the instrument as described previously.
2. Snap the connector cover (white plastic) off the side of the plug-in interface connector which needs repair.
3. Unsolder and remove the damaged contact.

4. Install the replacement contact. Carefully form it to the required shape to fit against the connector body.
5. Snap the connector cover back onto the plug-in interface connector. Check that the contact which was replaced is aligned with the other contacts.
6. Replace the Main Interface board.

Semiconductor Replacement. Semiconductors should not be replaced unless actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of semiconductors may affect the calibration of this instrument. When semiconductors are replaced, check the operation of the part of the instrument which may be affected.



POWER switch must be turned off before removing or replacing semiconductors.

Replacement semiconductors should be of the original type or a direct replacement. Fig. 4-4 shows the lead configuration of the semiconductors used in this instrument. Some plastic case transistors have lead configurations which do not agree with those shown here. If a replacement transistor is made by a different manufacturer than the original, check the manufacturer's basing diagram for correct basing. All transistor sockets in this instrument are wired for the standard basing as used for metal-case transistors. Transistors which have heat radiators or are mounted on the chassis use silicone grease to increase heat transfer. Replace the silicone grease when replacing these transistors.



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

An extracting tool should be used to remove the 14- and 16-pin integrated circuits to prevent damage to the pins. This tool is available from Tektronix, Inc. Order Tektronix Part No. 003-0619-00. If an extracting tool is not available when removing one of these integrated circuits, pull slowly and evenly on both ends of the device. Try to avoid having one end of the integrated circuit disengage from the socket before the other, as the pins may be damaged.

Access to Power Transistors. The power transistors associated with the Low-Voltage Power Supply are

mounted on the heat radiator at the rear of this instrument. To gain access to these transistors, remove the Phillips-head screws which secure the protective aluminum strips to the heat radiator. The transistors are mounted in sockets so they can be removed from the rear by taking out the two screws in the mounting tabs (cases elevated above chassis). To replace the sockets or wiring, refer to the procedure for removal of the Power Interconnect circuit board.

NOTE

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

Interconnecting Pin Replacement. Interconnecting pins are used in the 7503 to interconnect the circuit boards and/or wire leads. When the interconnection is between circuit boards, the pin is soldered into the board. Two types of mating connectors are used for these interconnecting pins. If the mating connector is mounted on a plug-on circuit board, a special socket is soldered into the board. If the mating connector is on the end of a lead, an end-lead pin connector is used which mates with the interconnecting pin. The following information provides the replacement procedure for the various types of interconnecting methods.

A. CIRCUIT-BOARD PINS.

NOTE

A pin replacement kit including necessary tools, instructions and replacement pins is available from Tektronix, Inc. Order Tektronix Part No. 040-0542-00.

To replace a pin which is mounted on a circuit board, first disconnect any pin connectors. Then, unsolder the damaged pin and pull it out of the circuit board with a pair of pliers. Be careful not to damage the wiring on the board with too much heat. Ream out the hole in the circuit board with a 0.031-inch drill. Remove the ferrule from the new interconnecting pin and press the new pin into the hole in the circuit board. Position the pin in the same manner as the old pin. Then, solder the pin on both sides of the circuit board. If the old pin was bent at an angle to mate with a connector, bend the new pin to match the associated pins.

B. CIRCUIT-BOARD PIN SOCKETS.

The pin sockets on the circuit boards are soldered to the rear of the board. To replace one of these sockets, first unsolder the pin (use a vacuum-type desoldering tool to remove excess solder). Then straighten the tabs on the socket and remove it from the hole in the circuit board. Place

the new socket in the circuit board hole and press the tabs down against the board. Solder the tabs of the socket to the circuit board; be careful not to get solder into the socket.

NOTE

The spring tension of the pin sockets ensures a good connection between the circuit board and the pin. This spring tension can be destroyed by using the pin sockets as a connecting point for spring-loaded probe tips, alligator clips, etc.

C. END-LEAD PIN CONNECTORS.

The pin connectors used to connect the wires to the interconnecting pins are clamped to the ends of the associated leads. To replace damaged end-lead pin connectors, remove the old pin connector from the end of the lead and clamp the replacement connector to the lead.

Some of the pin connectors are grouped together and mounted in a plastic holder; the overall result is that these connectors are removed and installed as a multi-pin connector. To provide correct orientation of this multi-pin connector when it is replaced, an arrow is stamped on the circuit board and a matching arrow is molded into the plastic housing of the multi-pin connector. Be sure these arrows are aligned as the multi-pin connector is replaced. If the individual end-lead pin connectors are removed from the plastic holder, note the color of the individual wires for replacement.

Cathode-Ray Tube Replacement. To replace the cathode-ray tube, proceed as follows:

WARNING

Use care when handling a CRT. Protective clothing and safety glasses should be worn. Avoid striking it on any object which might cause it to crack or implode. When storing a CRT, place it in a protective carton or set it face down in a protected location on a smooth surface with a soft mat under the faceplate to protect it from scratches.

A. REMOVAL:

1. Slide out the power-unit as described previously.
2. Remove the plastic CRT mask, light filter and metal light shield.
3. Remove the four screws securing the CRT bezel to the front panel. Disconnect the multi-pin connector from the left rear of the CRT bezel.

4. Press inward on the white tabs of the graticule-light assembly and pull the assembly out of the CRT bezel (leave wires connected).

5. Disconnect the CRT anode plug from the jack located on the right side of the main bulkhead. Ground this lead to the chassis to dissipate any stored charge.

6. Disconnect the deflection plate connectors. Be careful not to bend these pins.

7. Remove the CRT base socket from the rear of the CRT.

8. Loosen the two 3/32-inch hex-socket screws located on each side of the CRT socket until the tension of the springs on these screws is released. Then, press in on the screws to be sure that the CRT clamp is loose.

9. Hold one hand on the CRT faceplate and push forward on the CRT base with the other. As the CRT starts out of the shield, grasp it firmly. Guide the anode lead through the cutout in the CRT shield as the CRT is removed.

B. REPLACEMENT:

1. Insert the CRT into the shield. Guide the anode lead through the hole in the CRT shield. Seat the CRT firmly against the cushions mounted on each corner of the faceplate.

2. Place the black-plastic CRT mask over the CRT faceplate.

3. Reconnect the multi-pin connector to the CRT bezel (align arrow on connector with arrow on bezel). Hold the clear faceplate protector in position and re-install the CRT bezel. Firmly tighten the four screws.

4. Push forward on the CRT base to be certain that the CRT is as far forward as possible. Then tighten the two hex-socket screws beside the CRT base socket until the springs on the screws are fully compressed.

5. Replace the CRT base socket.

6. Reconnect the CRT anode plug.

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7. Carefully reconnect the deflection-plate connectors. Correct location is shown on the CRT shield. After each connector is installed, lightly pull on its lead to be sure that it will remain in its socket.

8. Replace the graticule-light assembly.

9. Clean the CRT faceplate, plastic faceplate protector, and the light filter with denatured alcohol.

10. Replace the metal light shield and the tinted filter. Then snap the plastic CRT mask into the CRT bezel.

11. Re-install the power-unit.

12. Check the calibration of the complete instrument. Calibration procedure is given in Section 5.

Switch Replacement. Several different types of switches are used in the 7503. The toggle, micro, slide and rotary switches should be replaced as a unit if damaged. Observe the soldering precautions given earlier in this section when replacing these switches. The following special maintenance information is provided for the cam-type switches and the pushbutton switches.



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

A. CAM-TYPE SWITCHES.

NOTE

A cam-type switch repair kit including necessary tools, instructions, and replacement contacts is available from Tektronix, Inc. Order Tektronix Part No. 040-0541-00.

The cam-type switches consist of a rotating cam, which is turned by the front-panel knobs, and a set of contacts mounted on an adjacent circuit board. These switch contacts are actuated by lobes on the cam. The CALIBRATOR and RATE cam-type switches can be disassembled for inspection, cleaning, repair, or replacement as follows:

1. Remove the Calibrator board/switch assembly as described previously.

2. Remove the two screws which hold the metal covers on the switches. The front switch section on the Calibrator board is the CALIBRATOR switch and the rear switch section is the RATE switch. The switches are now open for inspection or cleaning.

3. To completely remove either of the switches from the board, loosen the two hex-socket screws in the shaft at the front of the rear switch section with a 0.050-inch hex-key wrench. Pull the long shaft out of the switch assembly.

4. Remove the four screws which hold the cam switch to the circuit board (from rear side of board).

5. To remove the cam from the front support block, remove the retaining ring from the shaft on the front of the switch and slide the cam out of the support block. Be careful not to lose the small detent roller.

6. To replace defective switch contacts, unsolder the damaged contact and clean the solder from the hole in the circuit board. Then, position the new contact in the hole so it is properly aligned in relation to the other switch contacts and the mating area on the circuit board (alignment tool provided in switch repair kit). Solder the new contact into place; be sure that the spring end of the contact has adequate clearance from the circuit board.

7. To re-install the switch assembly, reverse the above procedure.

B. PUSHBUTTON SWITCHES.

The pushbutton switches are not repairable and should be replaced as a unit if defective. Components which are mounted on the circuit board associated with the pushbutton switch can be replaced using the normal replacement procedures. See the information under Light-Bulb Replacement for instructions on replacing the light bulbs. Use the following procedure to replace the VERTICAL MODE pushbutton switch:

1. Disconnect the multi-pin connectors from the rear of the switch.

2. Remove the two Phillips-head screws holding each upper plug-in guide bar to the top of the vertical plug-in compartments.

3. Remove the switch from the instrument. It will be necessary to carefully guide the switch around the cabling and structural members of the instrument as it is removed.

4. To replace the switch, reverse the above procedure. Be sure the EMI gasket is in place between the switch and the front panel when the switch is replaced. Match the arrows on the multi-pin connectors to the arrows on the switch assembly.

To replace the TRIGGER SOURCE pushbutton switch, proceed as follows:

1. Disconnect the multi-pin connector from the switch.
2. Press the center of the release bar of the switch holder, then press on the front-panel pushbuttons to remove the switch from the holder.
3. To replace the switch, reverse the above procedure. The switch locks into the holder as it is pressed into place. Match the arrow on the multi-pin connector to the arrow on the switch assembly.

Light-Bulb Replacement. The following procedures describe replacement of the light bulbs in this instrument.

A. VERTICAL MODE SWITCH.

To replace light bulbs in the VERTICAL MODE switch, proceed as follows:

1. Remove the switch as given previously.
2. Unsolder the leads of the bulbs and the plastic holder from the circuit board; remove these items from the switch assembly as a unit.
3. Remove the defective bulb from the plastic holder.
4. Install the new bulb in the plastic holder; install this unit in the switch assembly.
5. Solder the bulb and holder to the circuit board.
6. Replace the switch as described previously.

B. TRIGGER SOURCE SWITCH.

To replace the light bulb in the TRIGGER SOURCE switch, proceed as follows:

1. Remove the trigger source switch, using the procedure described previously.
2. Remove the screw which holds the metal cover on the back of the switch to expose the light bulb.
3. Note the position of the bulb on the switch. Then unsolder the defective bulb from the circuit board.
4. Install the new bulb so it is positioned in the same manner as the original bulb.
5. Solder the bulb to the circuit board. If possible, use a heat sink to protect the bulb during soldering.
6. Replace the metal cover on the switch.
7. Re-install the switch using the procedure described previously.

C. GRATICULE BULB REPLACEMENT.

To replace the graticule bulbs, first remove the plastic CRT mask, light filter and metal light shield. Pull on the white tabs to remove the graticule lamp assembly. Now, slide the lamp retaining strips to the side, off the bulb base. Pull the bulb out of the circuit board. Reverse the order of removal for replacement.

Relay Replacement. The relays in the X-Y Delay Compensation network on the Horizontal Amplifier board are mounted in sockets. The basing (as well as the internal connections) of these relays is symmetrical so that these relays may be plugged into the sockets facing in either direction.

Power Transformer Replacement. The power transformer in this instrument is warranted for the life of the instrument. If the power transformer becomes defective, contact your local Tektronix Field Office or representative for a warranty replacement (see the Warranty note in the front of this manual). Be sure to replace only with a direct replacement Tektronix transformer.

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When removing the transformer, tag the leads with the corresponding terminal numbers to aid in connecting the new transformer. After the transformer has been replaced, check the performance of the complete instrument using the procedure given in the calibration section.

High-Voltage Compartment. The components located in the high-voltage compartment can be reached for maintenance or replacement by using the following procedure. Fig. 4-21 shows the location of the components in the high-voltage compartment and color-coding of the wires.

NOTE

All solder joints in the high-voltage compartment should have smooth surfaces. Any protrusions may cause high-voltage arcing at high altitudes.

1. Slide out the power-unit as described previously.
2. Disconnect the CRT base socket.
3. Disconnect the CRT anode plug and discharge it to the chassis. Using an insulated probe or wire, discharge the jack portion of the CRT anode connector to chassis ground.
4. Disconnect the multi-pin connectors on the High-Voltage/Z Axis Amplifier board.
5. Remove the screw on the rear of the high voltage compartment and the two screws located at the front by the CRT anode connector.
6. Guide the high-voltage compartment away from the instrument chassis. Be careful not to damage any of the components or the pin connectors on the High Voltage/Z-Axis Amplifier circuit board. Lay the high-voltage compartment down.
7. Remove the three screws which hold the plastic cover onto the high-voltage box.
8. Using an insulated shorting strap, discharge the exposed connections to chassis ground.
9. Unsolder the three leads between the encapsulated voltage-multiplier assembly and the high-voltage transformer. Now, all of the circuitry in the high-voltage box can be reached for maintenance or replacement except those in the encapsulated assembly.

10. To replace the encapsulated assembly or the plastic high-voltage box, remove the four screws located beneath the High Voltage/Z-Axis Amplifier circuit board (remove board to reach screws).

11. To replace the high-voltage compartment, reverse the above procedure. Be careful not to pinch any of the interconnecting wires when replacing the cover to the high-voltage box or when re-attaching the high-voltage compartment to the chassis.

Fuse Replacement. Table 4-4 gives the rating, location and function of the fuses used in this instrument.

TABLE 4-4
Fuse Ratings

Circuit Number	Rating	Location	Function
F801	4 A Slow	Voltage Selector Assembly	115-volt line
F802	3 A Slow	Voltage Selector Assembly	230-volt line
F882	6 A Fast	Rectifier	+5 volts
F912	2 A Fast	Rectifier	High Voltage

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 low-voltage supply affects all circuits, calibration of the entire instrument should be checked if work has been done in the low-voltage supply or if the power transformer has been replaced. The Performance Check procedure provides a quick and convenient means of checking instrument operation.

Instrument Repackaging

If the 7503 is to be shipped for long distances by commercial means of transportation, it is recommended that the instrument be repackaged in the original manner for maximum protection. The original shipping carton can be saved and used for this purpose. Fig. 8 in the Mechanical Parts Illustrations shows repackaging instructions and part numbers for the packaging components. New shipping cartons can be obtained from Tektronix, Inc.

NOTE

The packaging material is not designed to protect the plug-ins if shipped installed in the plug-in compartments. The plug-ins should be shipped in their own shipping cartons.

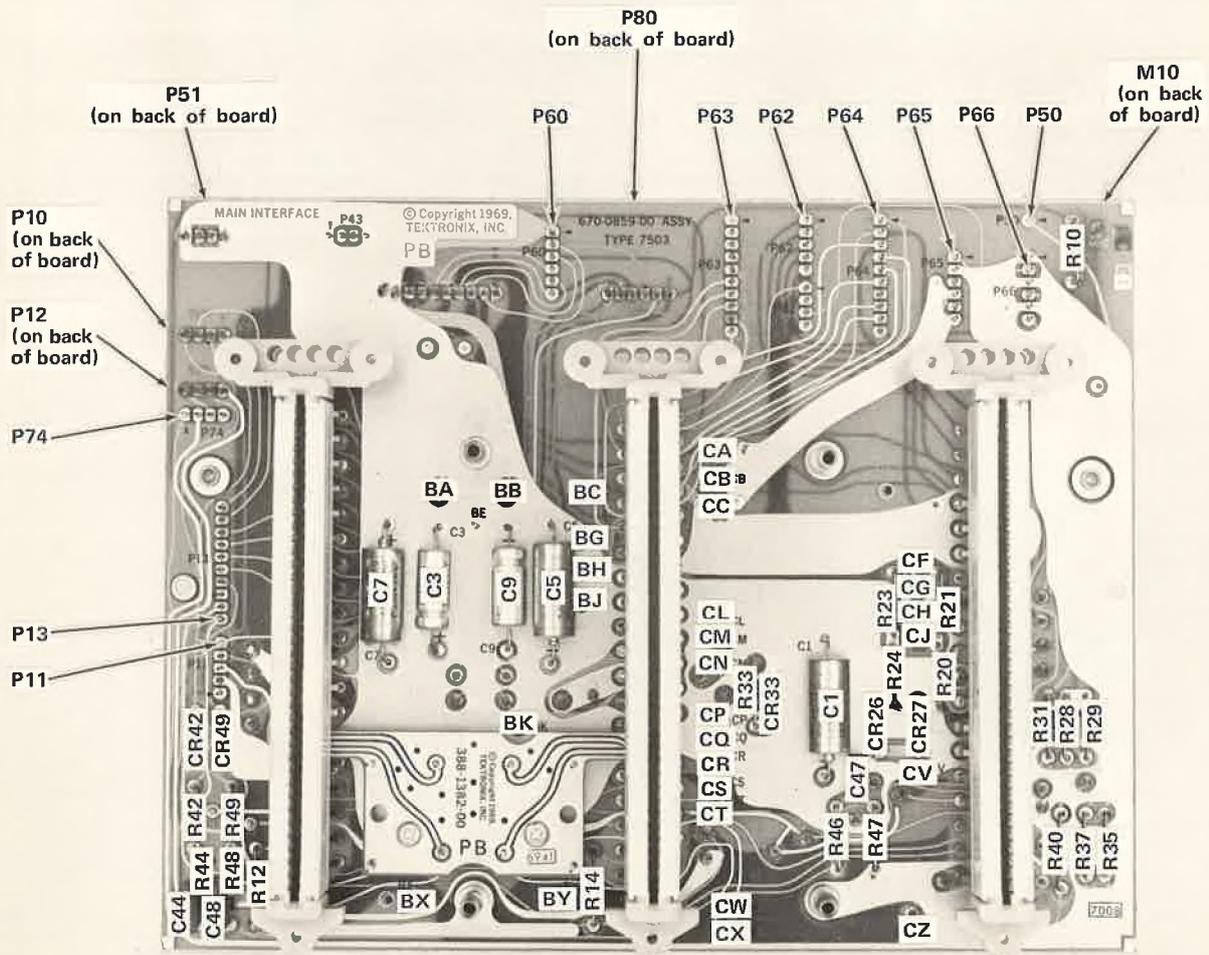


Fig. 4-7. Main Interface circuit board.

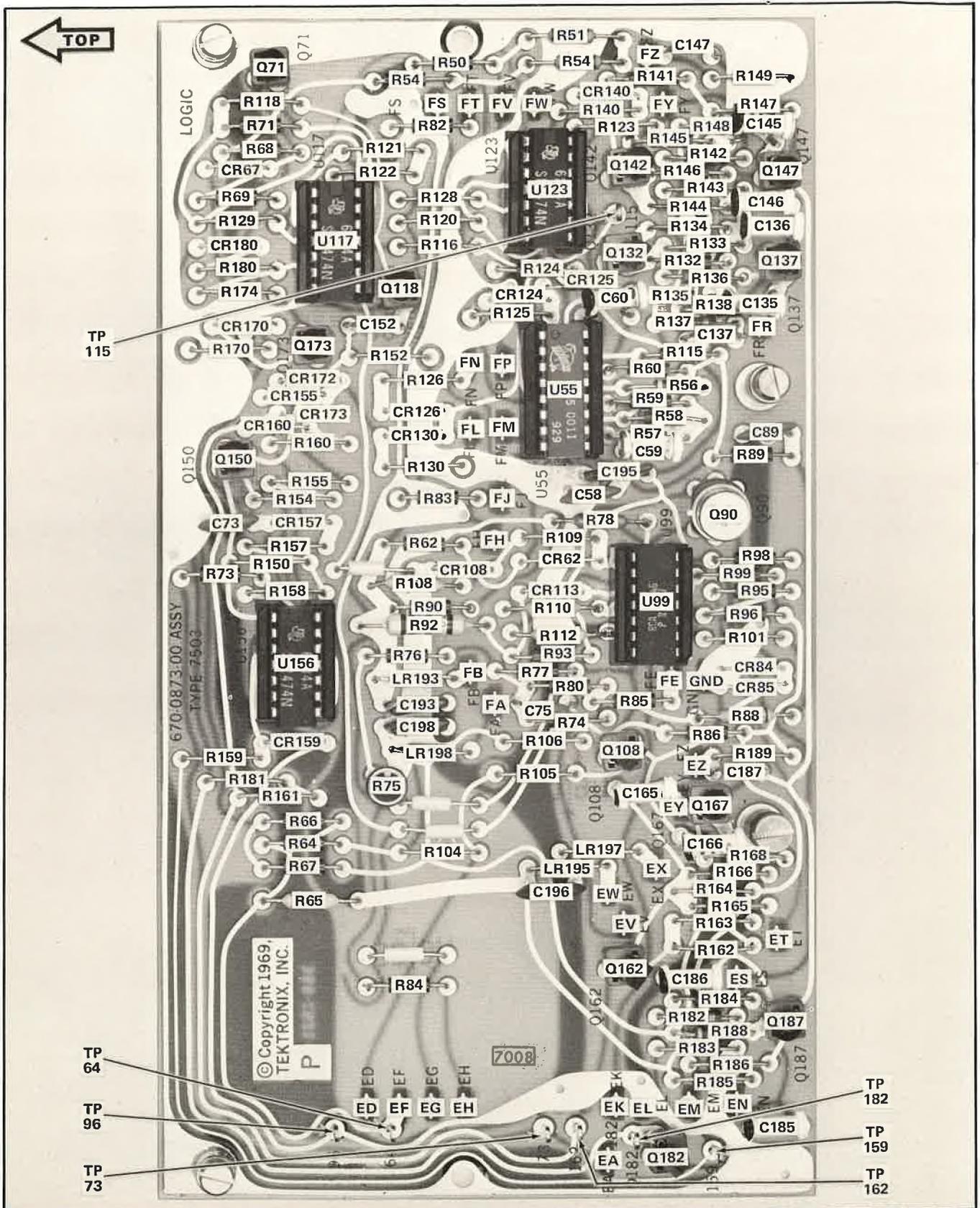


Fig. 4-8. Logic circuit board.

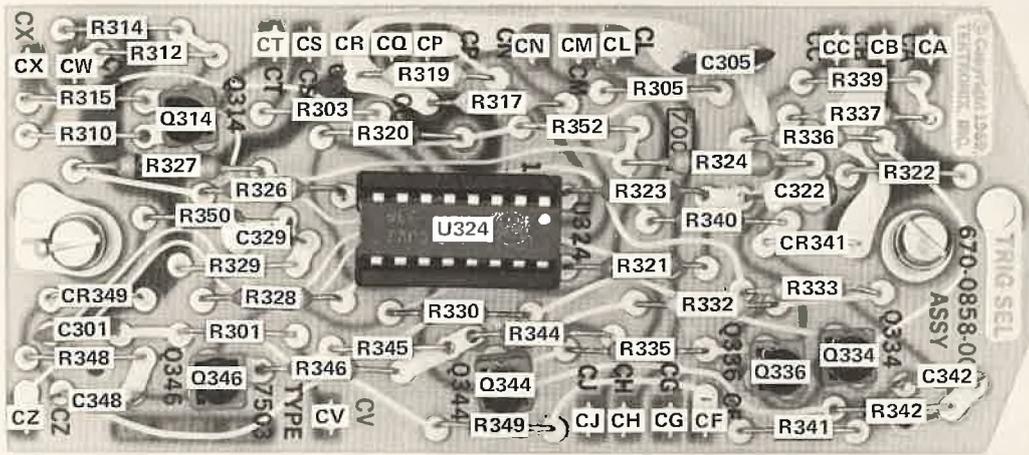


Fig. 4-9. Trigger Selector circuit board.

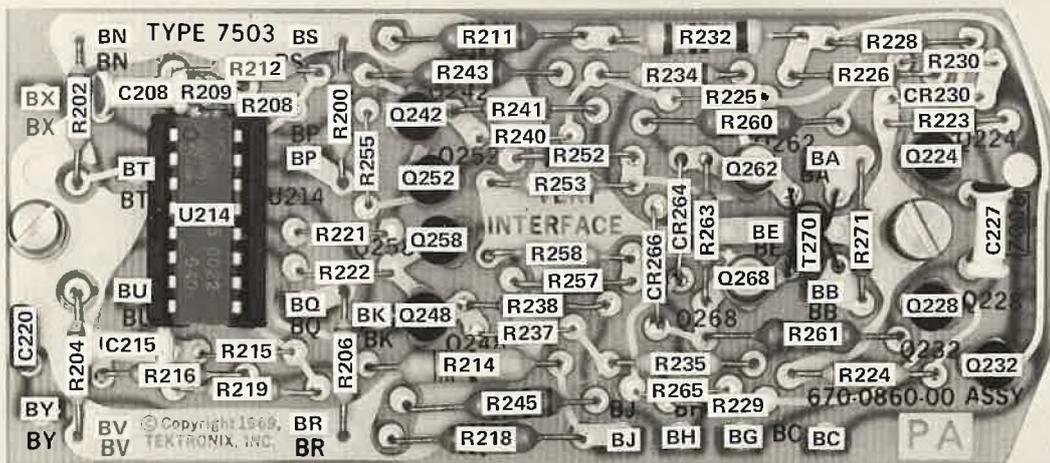


Fig. 4-10. Vertical Interface circuit board.

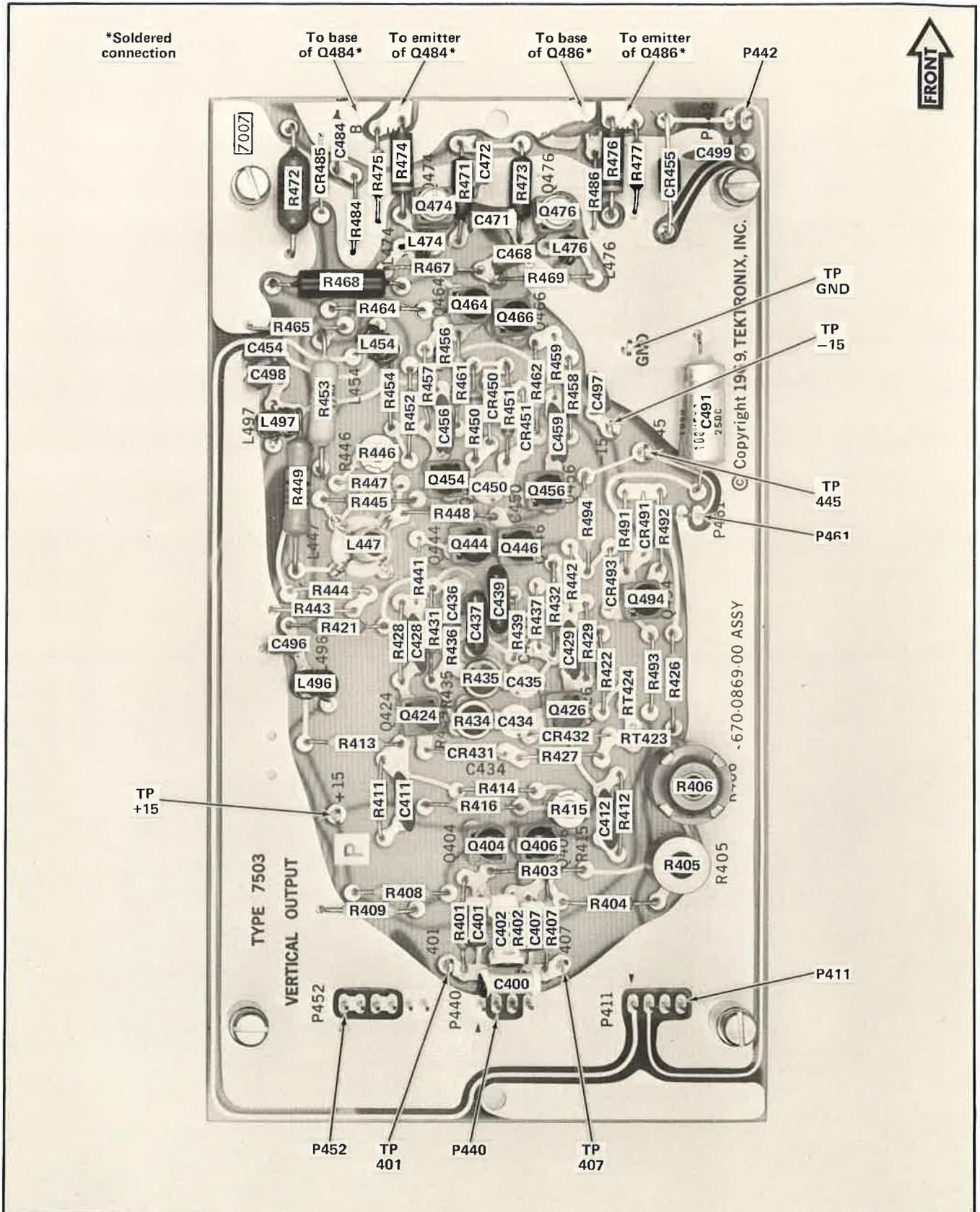


Fig. 4-11. Vertical Output circuit board.

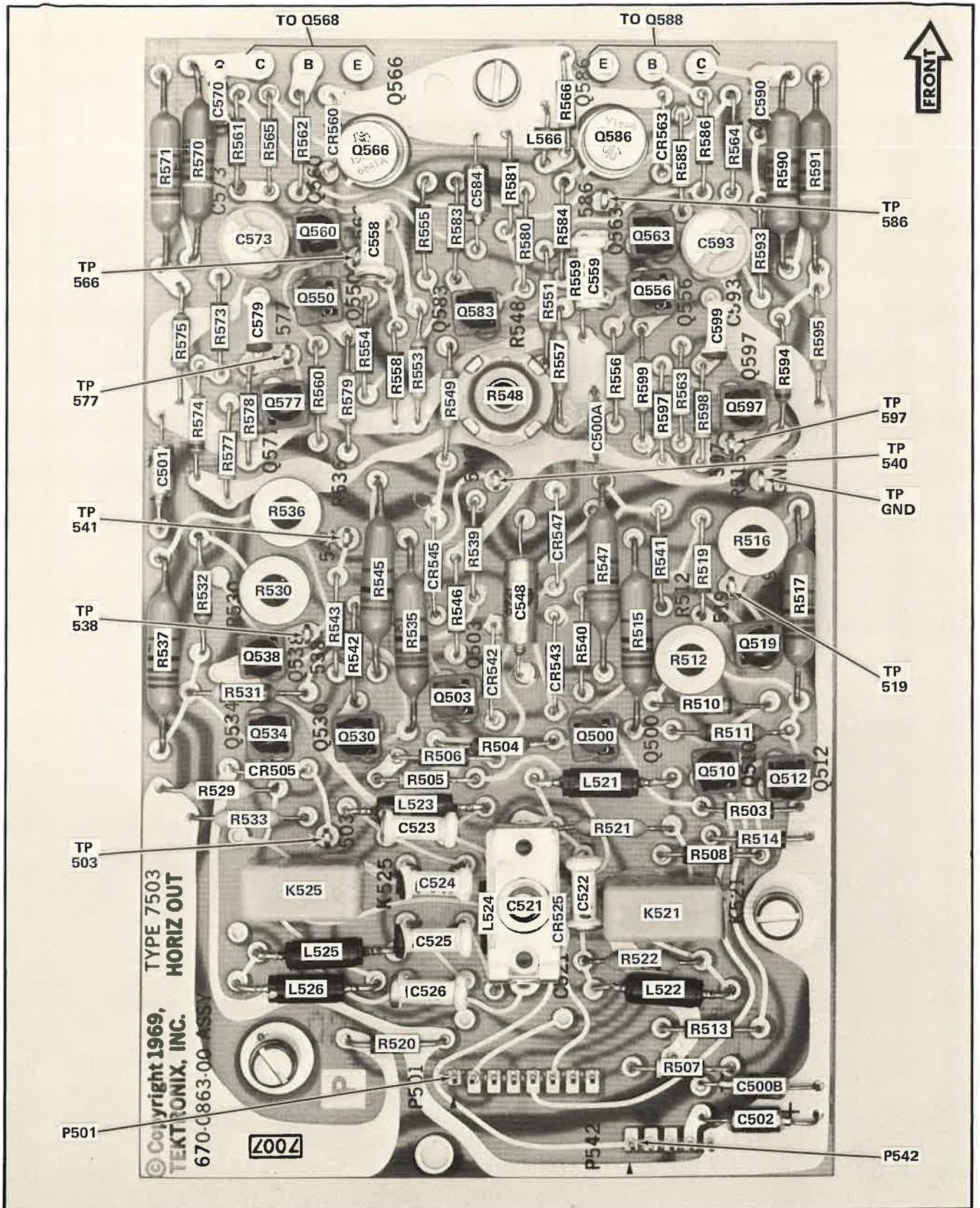


Fig. 4-12. Horizontal Output circuit board.

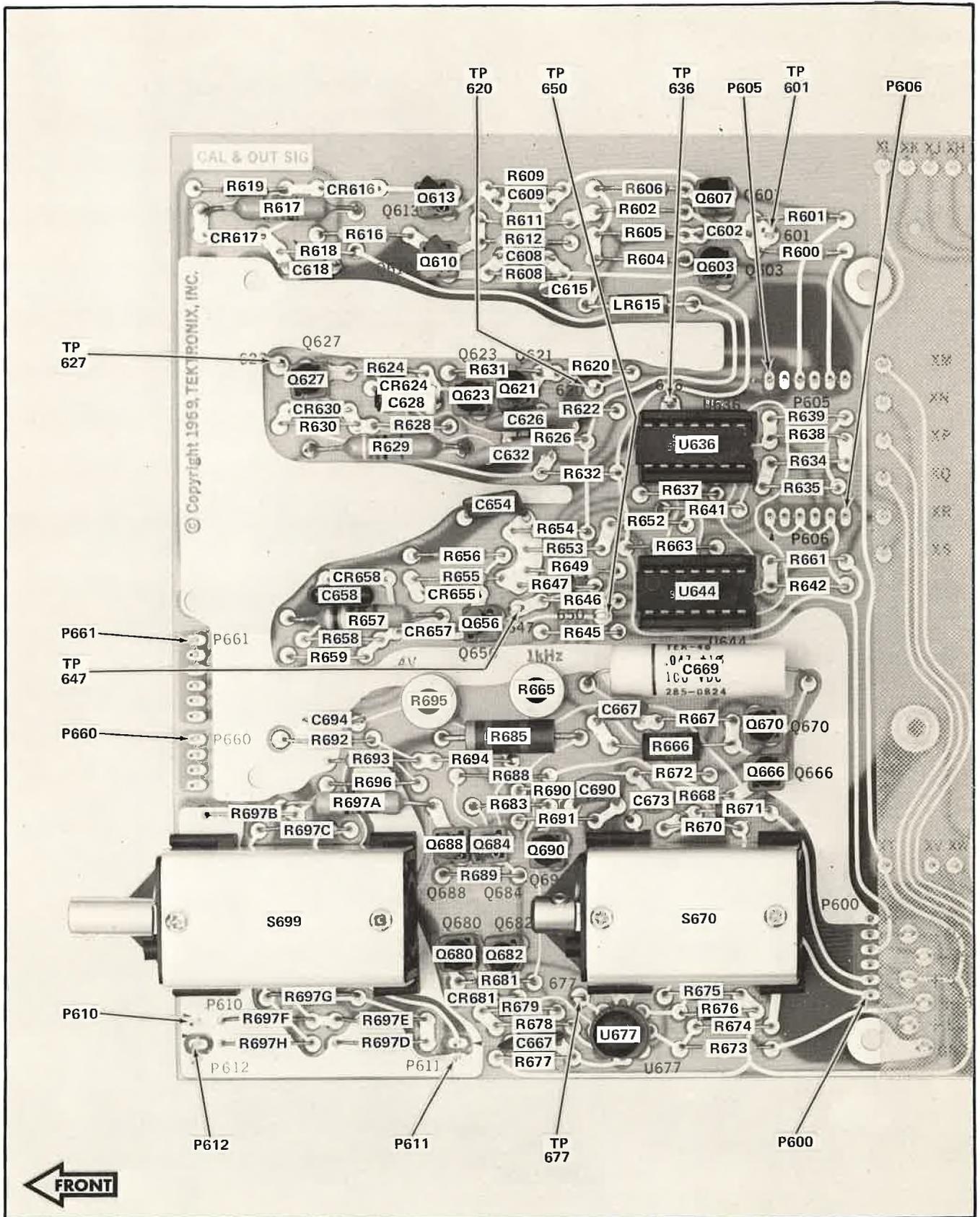


Fig. 4-13. Partial Output Signals and Calibrator circuit board/switch assembly.

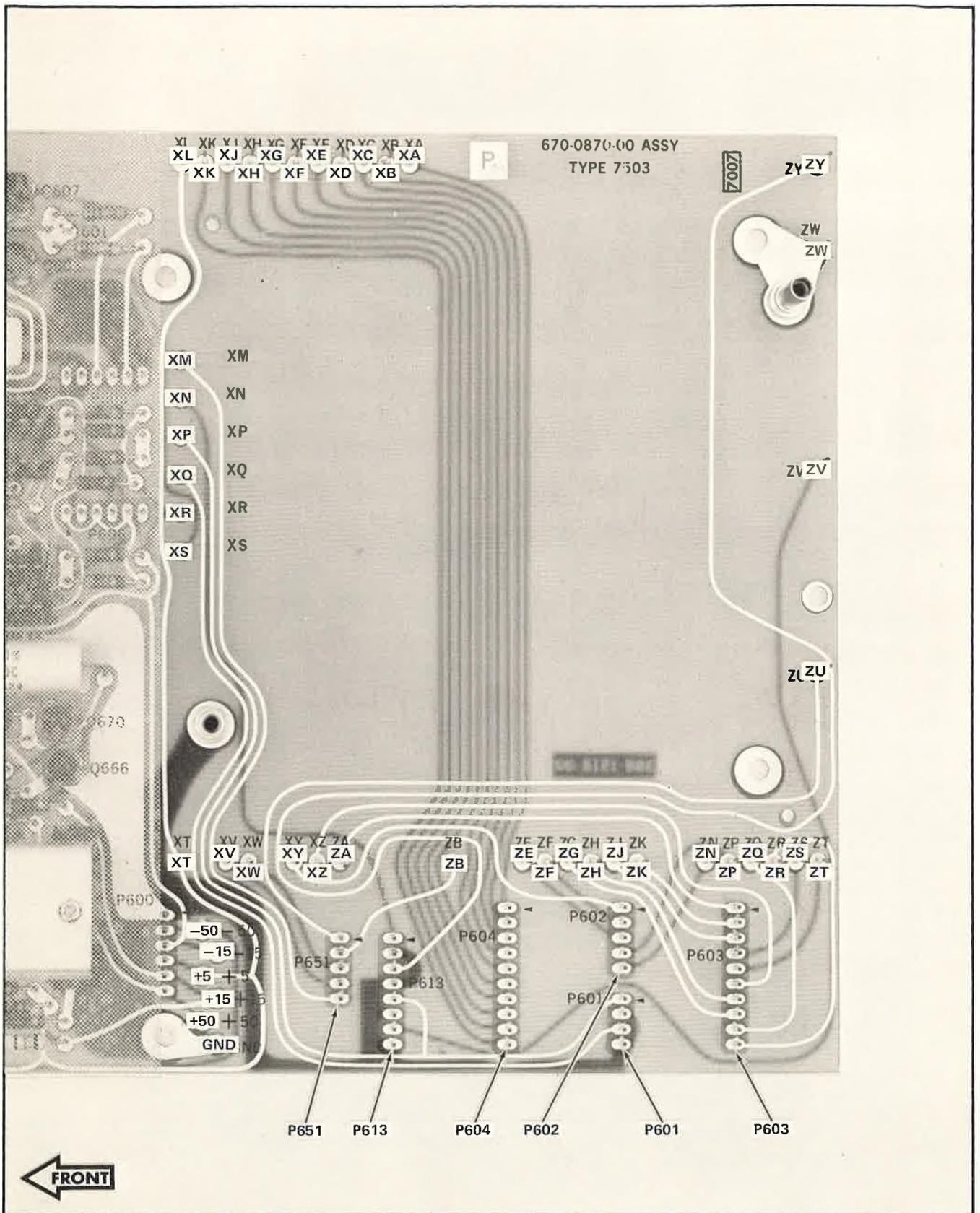


Fig. 4-14. Partial Output Signals and Calibrator circuit board/switch assembly.

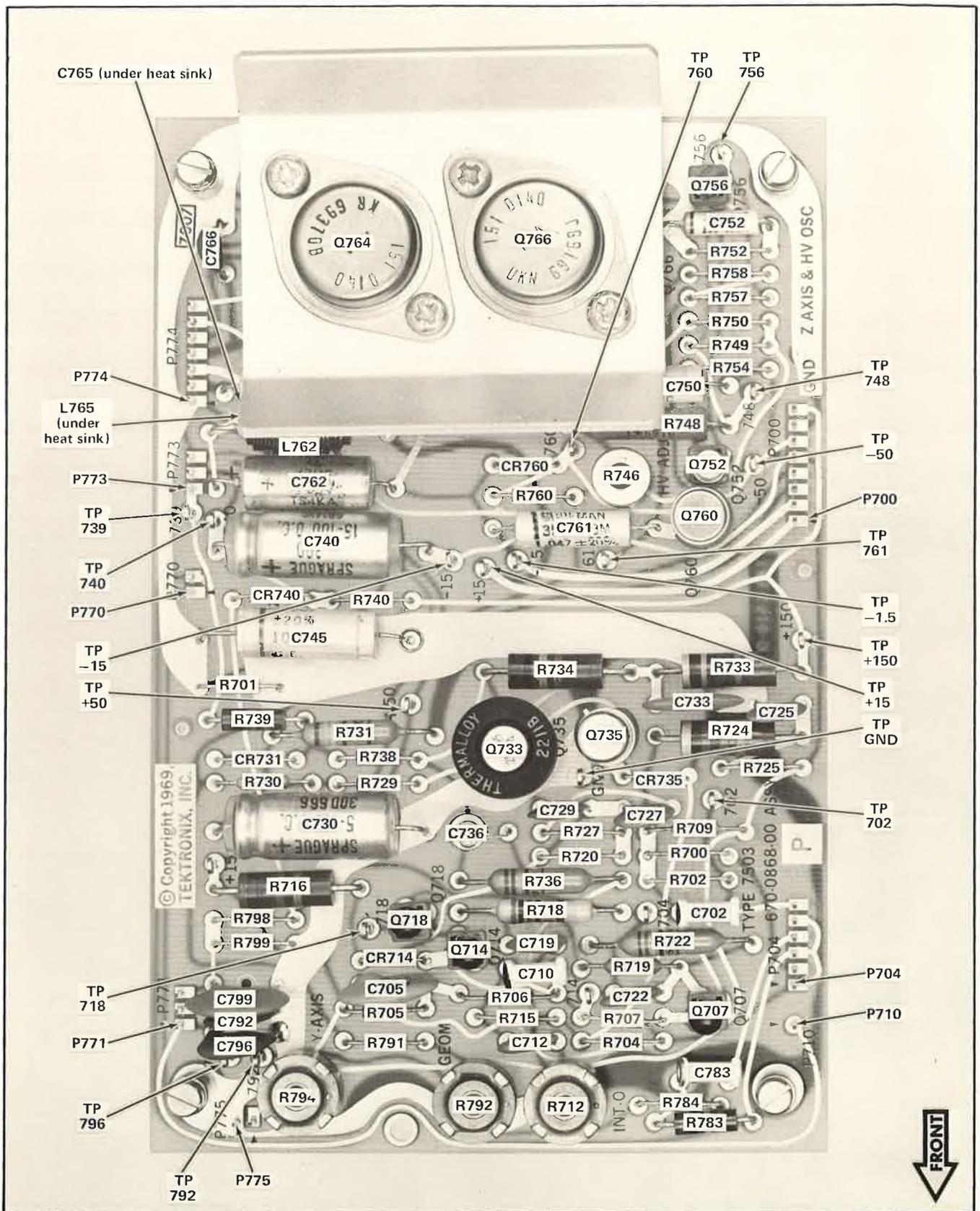


Fig. 4-15. Z-Axis and High Voltage Oscillator circuit board.

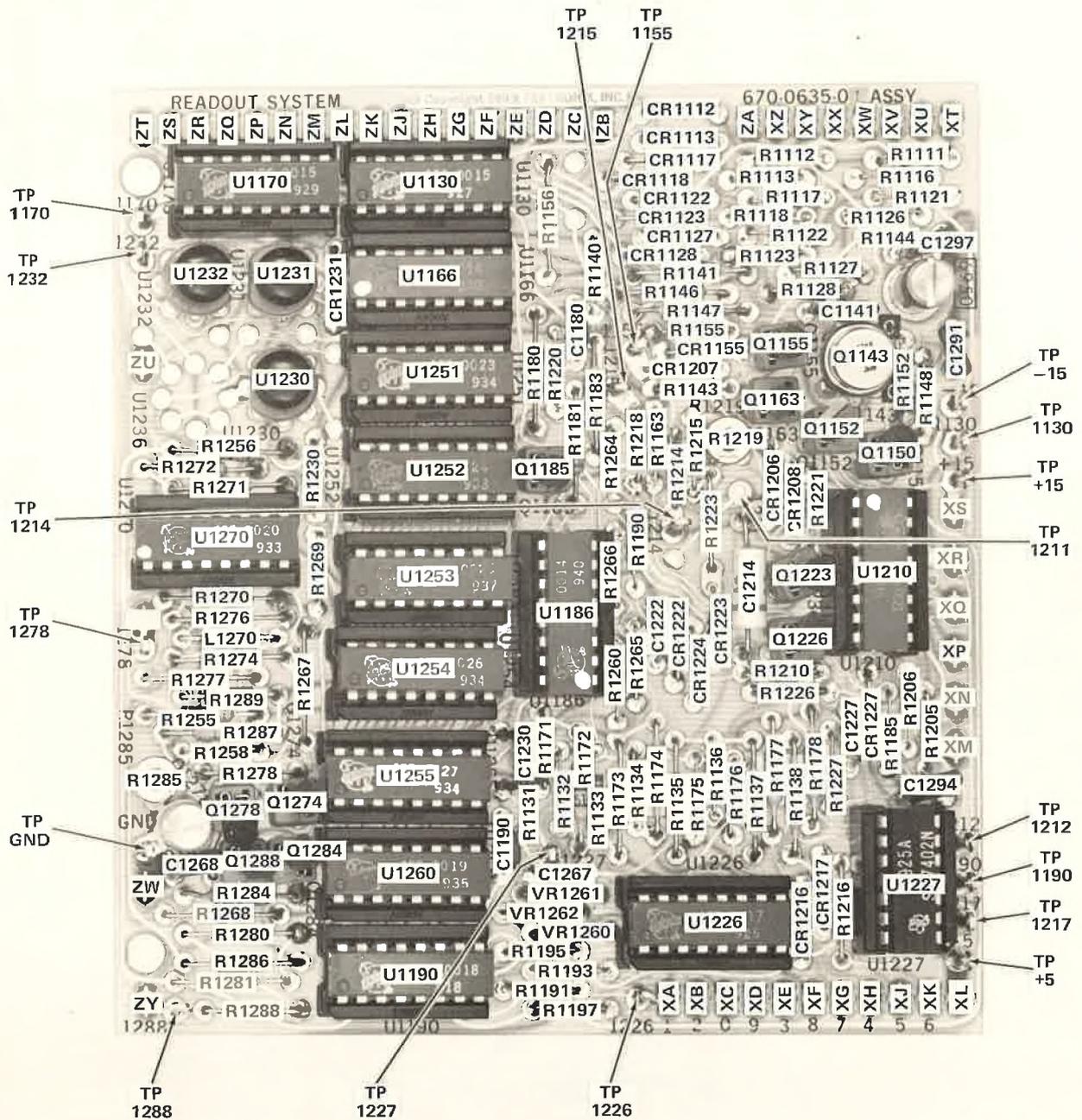


Fig. 4-16. Readout System circuit board.

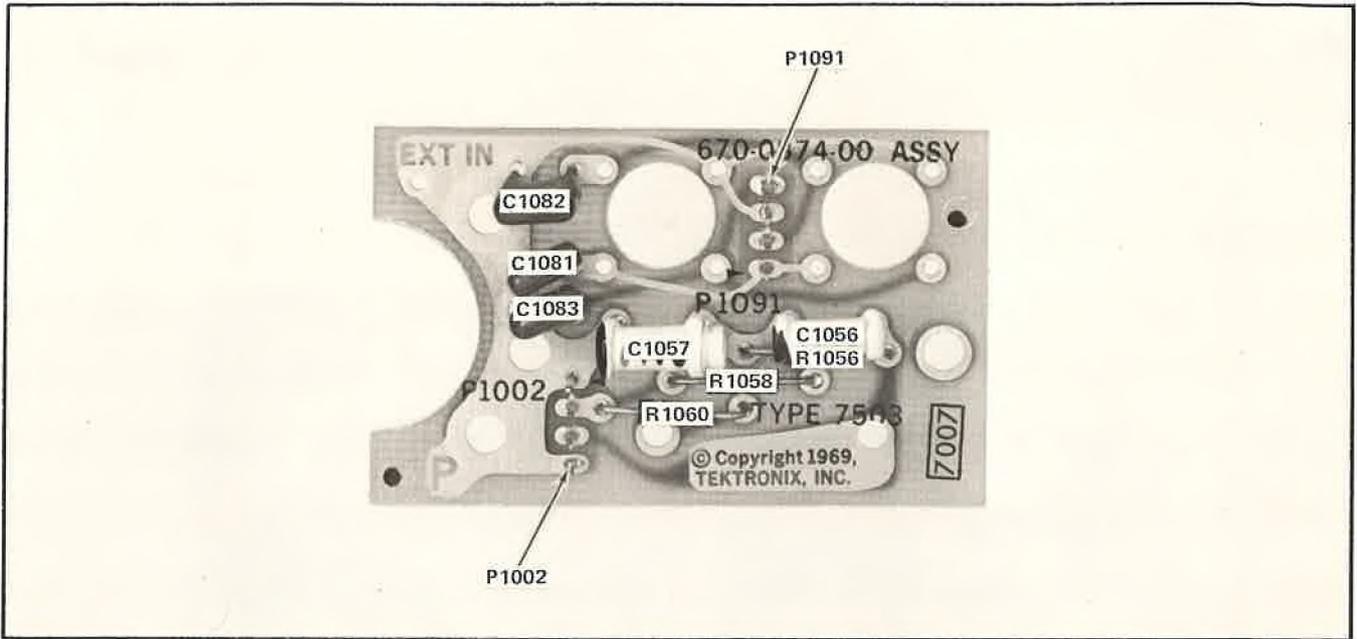


Fig. 4-17. External Inputs circuit board.

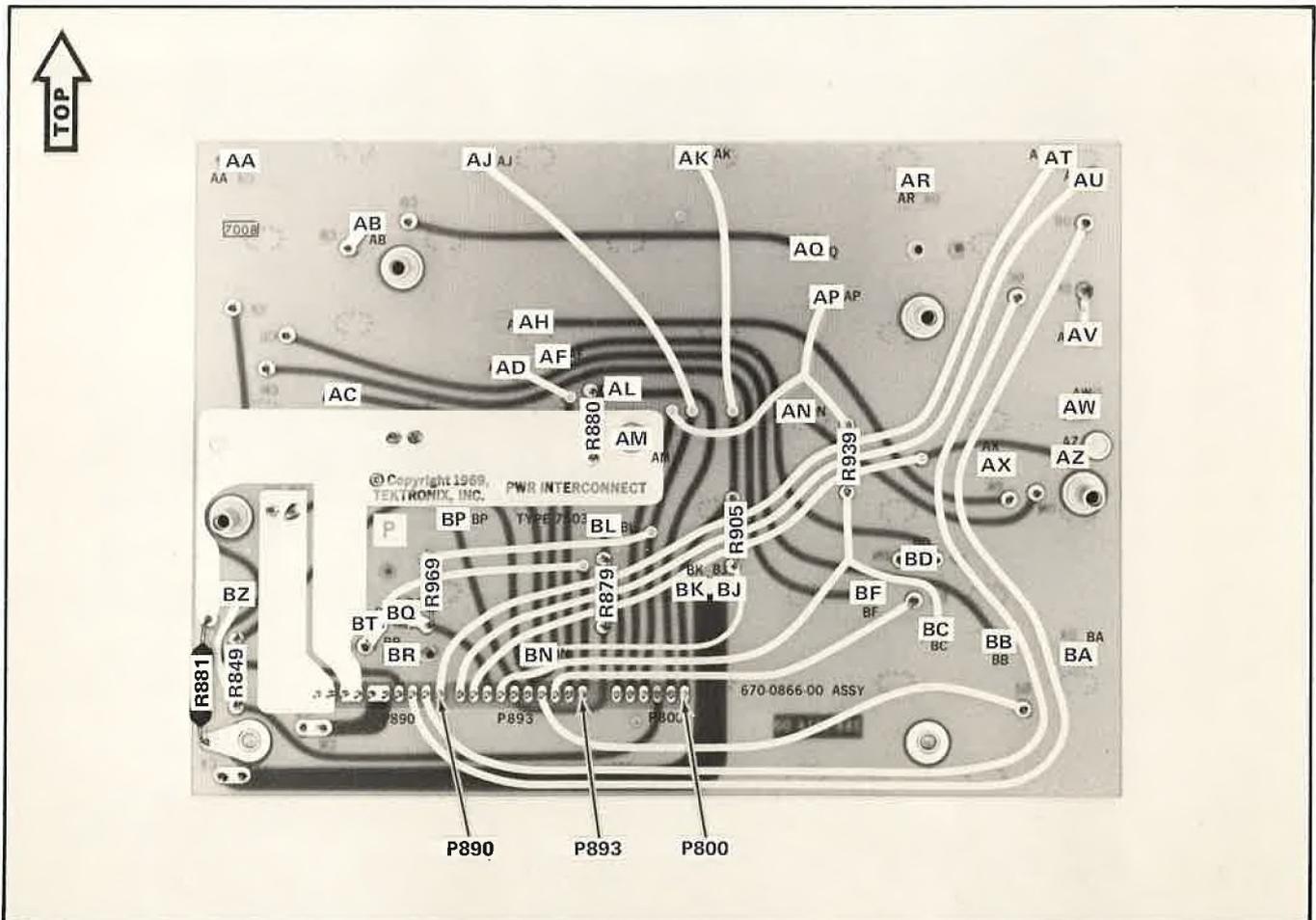


Fig. 4-18. Power Interconnect circuit board.

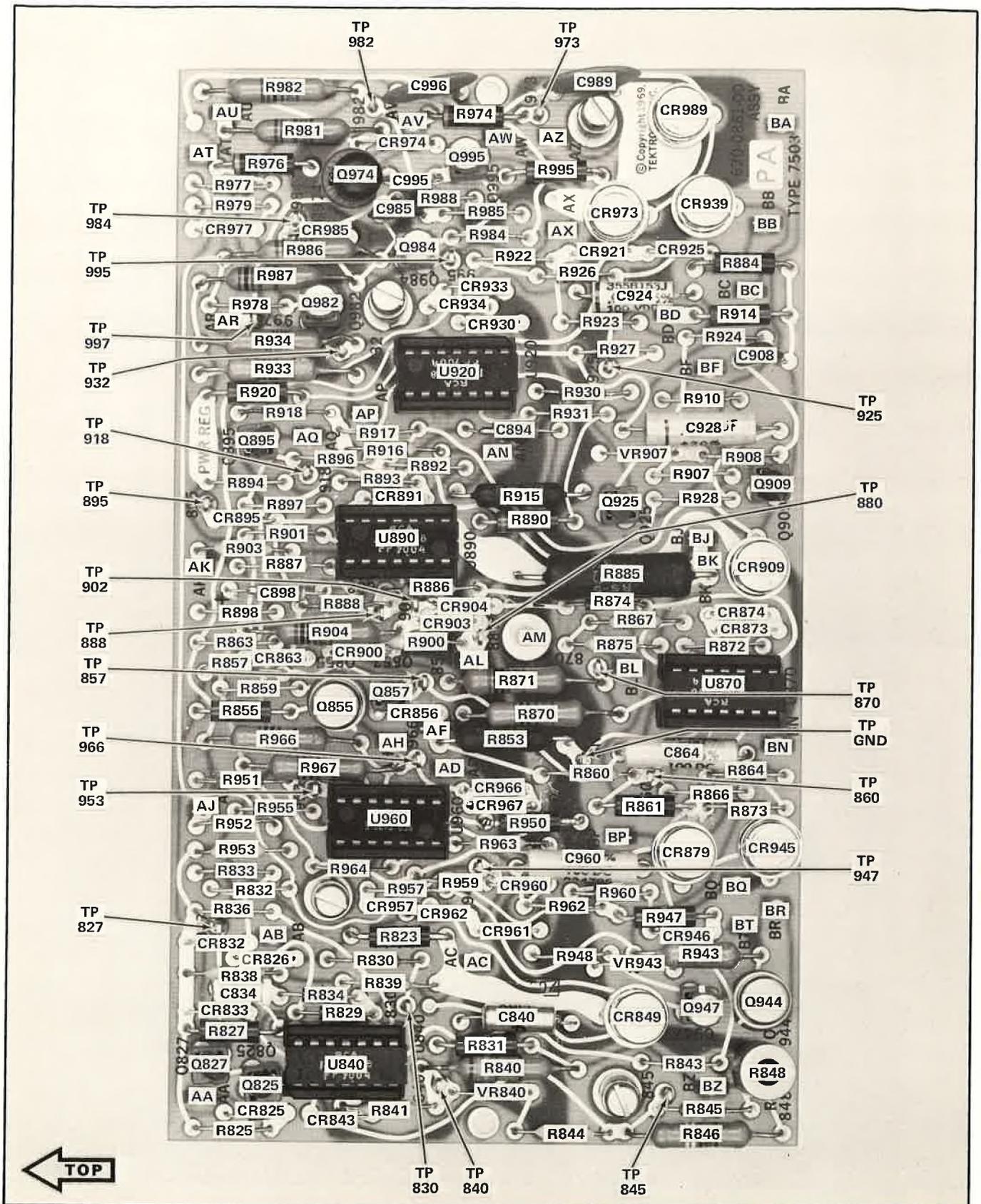


Fig. 4-19. Power Regulator circuit board.

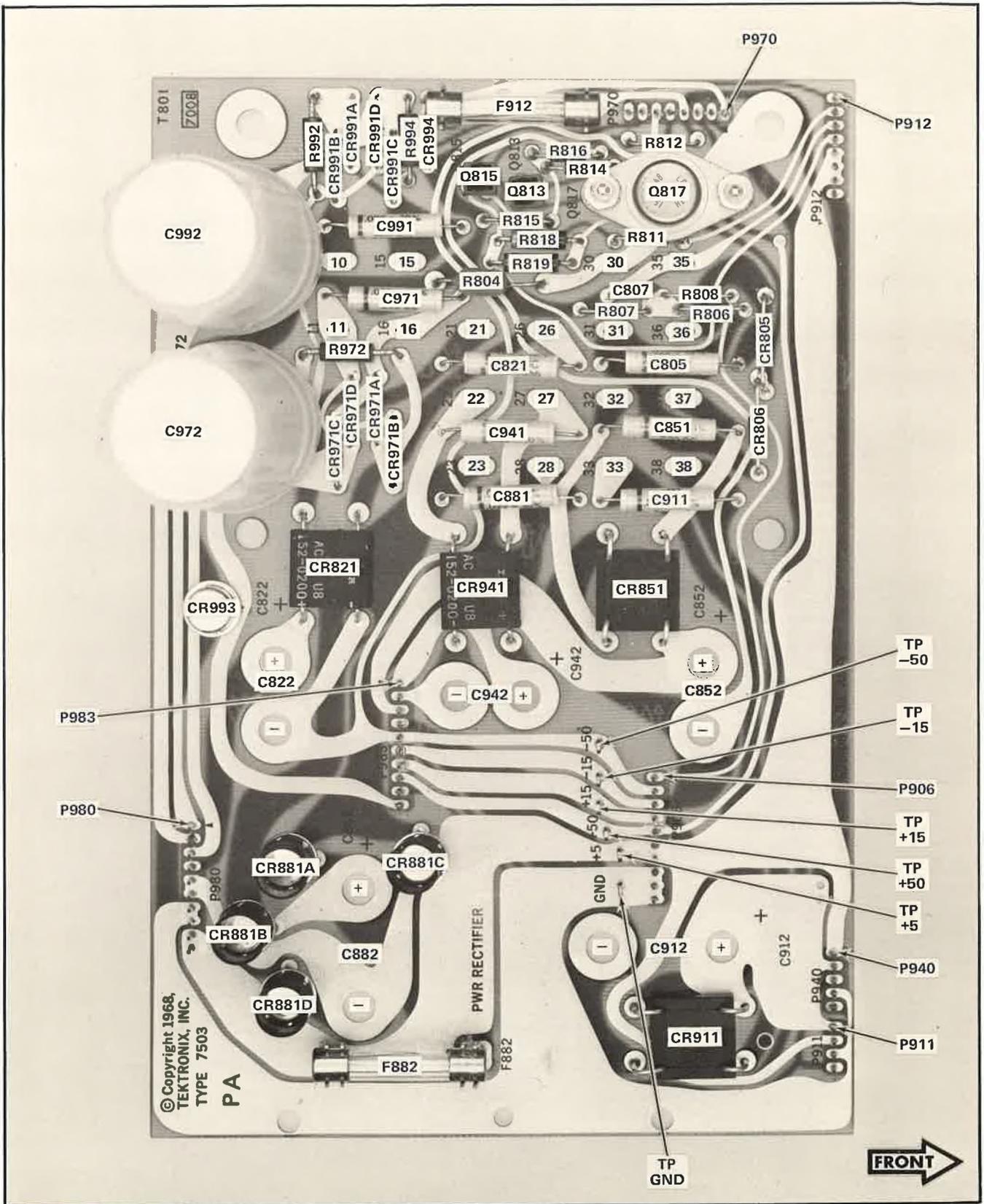


Fig. 4-20. Power Rectifier circuit board.

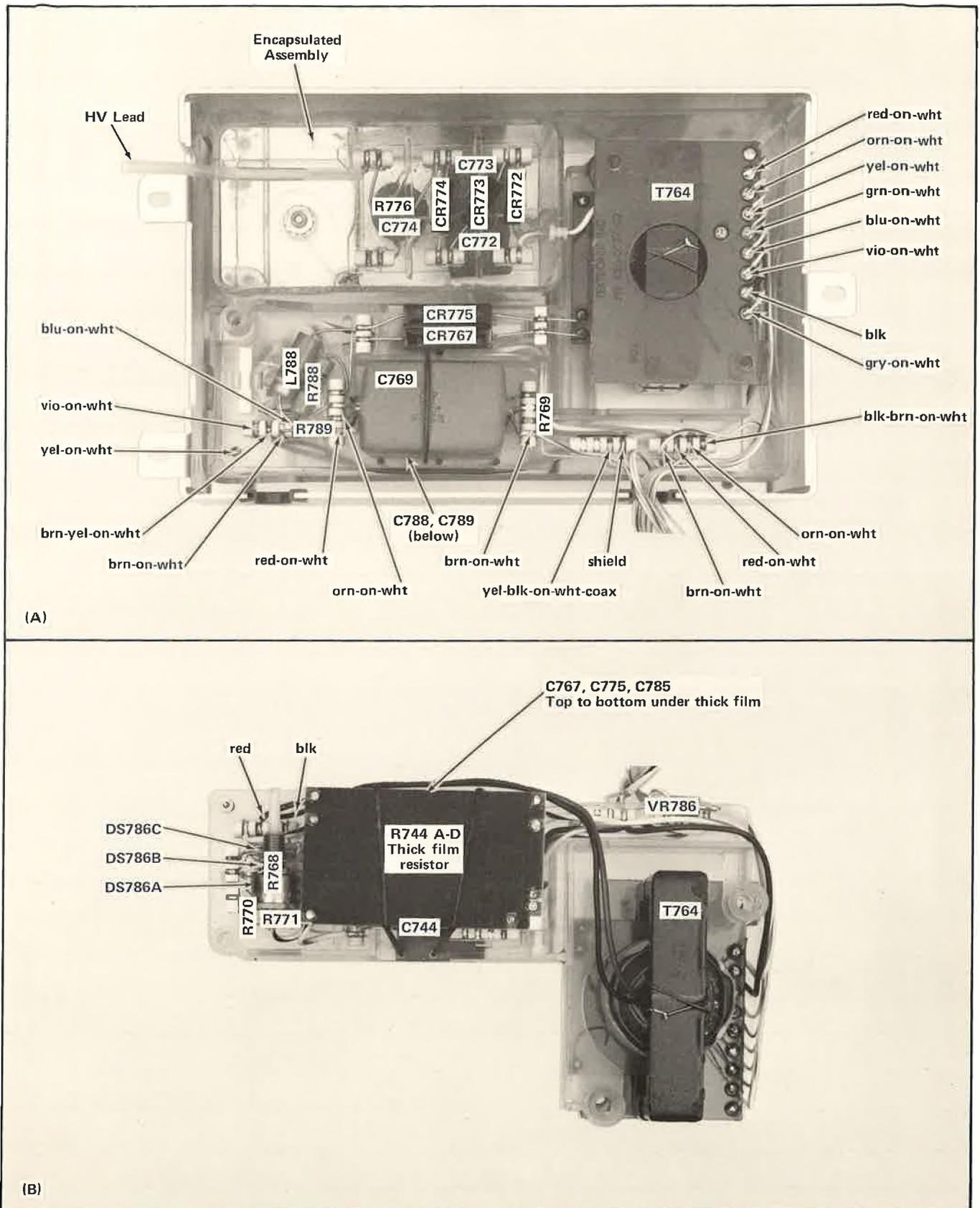


Fig. 4-21. (A) High Voltage assembly, (B) Rear-view of High Voltage assembly.

SECTION 5

PERFORMANCE CHECK/CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

To assure instrument accuracy, check the calibration of the 7503 every 1000 hours of operation, or every six months if used infrequently. Before complete calibration, thoroughly clean and inspect this instrument as outlined in the Maintenance section.

As an aid to the calibration of the instrument, a Short-Form Procedure is given prior to the complete procedure. To facilitate instrument calibration for the experienced calibrator, the Short-Form Procedure lists the calibration adjustments necessary for each step and the applicable tolerances. This procedure also includes the step number and title as listed in the complete Performance Check/Calibration Procedure and the page number on which each step begins. Therefore, the Short-Form Procedure can be used as an index to locate a step in the complete procedure. Another feature of the Short-Form Procedure is the spaces provided to record performance data or to check off steps as they are completed. This procedure can be reproduced and used as a permanent record of instrument calibration.

The complete Performance Check/Calibration Procedure can be used to check instrument performance without removing the cover or making internal adjustments by performing all portions except the "ADJUST—" part of a step. Screwdriver adjustments which are accessible without removing the covers are adjusted as part of the performance check procedure.

Completion of each step in the complete Performance Check/Calibration Procedure insures that this instrument meets the electrical specifications given in Section 1. Where possible, instrument performance is checked before an adjustment is made. For best overall instrument performance when performing a complete calibration procedure, make each adjustment to the exact setting even if the "CHECK—" is within the allowable tolerance.

NOTE

All waveforms shown in this procedure were taken with a Tektronix Oscilloscope Camera System. Limits, tolerances and waveforms in this procedure are given as calibration guides and should not be interpreted as instrument specifications except as specified in Section 1.

A partial calibration is often desirable after replacing components, or to touch up the adjustment of a portion of the instrument between major recalibrations. To check or adjust only part of the instrument, set the controls as given in the first step following the nearest applicable equipment-required picture. To prevent unnecessary recalibration of other parts of the instrument, readjust only if the tolerance given in the "CHECK—" part of the step is not met. If readjustment is necessary, also check the calibration of any steps listed in the "INTERACTION—" part of the step.

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories, or an equivalent, is required for complete calibration of the 7503. Specifications given are the minimum necessary for accurate calibration. Therefore, some of the recommended equipment may have specifications which exceed those given. All test equipment is assumed to be correctly calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

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

Test Equipment

1. Variable autotransformer. Must be capable of supplying about 250 volt-amperes over a range of 95 to 136 volts (190 to 272 volts for 230-volt nominal line). (If autotransformer does not have an AC voltmeter to indicate output voltage, monitor the output with an AC voltmeter with a range of at least 136 to 272 volts, RMS.) For example, General Radio W10MT3A Metered Variac Autotransformer. (Use General Radio W20HMT3A for 230-volt nominal operation.)

2. Precision DC voltmeter. Accuracy, within 0.1%; resolution, 50 microvolts; range zero to 500 volts. For example, Fluke Model 825A Differential DC Voltmeter.

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3. DC voltmeter (VOM). Range, zero to 6000 volts; accuracy, checked to within 1% at -2960 volts. For example, Triplet Model 630-NA.

4. Time-mark generator. Marker outputs, 5 nanoseconds to 0.5 second; marker accuracy, within 0.1%. Tektronix 2901 recommended.

5. Constant-amplitude sine-wave generator. Frequency, 350 kilohertz to 100 megahertz; reference frequency, 50 kilohertz; output amplitude, variable from five millivolts to five volts peak to peak into 50 ohms; amplitude accuracy, output amplitude constant within 3% at 50 kilohertz and 350 kilohertz to 100 megahertz. Tektronix Type 191 Constant-Amplitude Signal Generator recommended.

6. High-frequency constant-amplitude signal generator. Frequency, 65 megahertz to above 190 megahertz; reference frequency, 3 megahertz; output amplitude, variable from 0.5 volt to five volts; amplitude accuracy, within 1% at three megahertz and from 65 megahertz to above 190 megahertz. Tektronix calibration fixture 067-0532-00 recommended.

7. Dual-trace test oscilloscope with two 10X probes. Bandwidth DC to 15 MHz; Vertical deflection factor range, 10 mV/division to 20 V/division. Tektronix Type 422 with two P6012 10X probes (Tektronix Part No. 010-0203-00) recommended.

8. Vertical plug-in unit, Tektronix 7A16. Two required.

9. Dual Time Base plug-in unit, Tektronix 7B52.

10. Tektronix Calibration Fixture, 067-0587-00.

11. Tektronix Plug-In Extender, 067-0589-00.

12. Probe. 10X attenuation, 500 megahertz bandwidth. Tektronix P6053.

13. Probe. 1X attenuation, 30 MHz bandwidth. Tektronix P6052.

14. Dual-Input Coupler. Matched signal transfer to each input. Tektronix Calibration Fixture 067-0525-00.

Accessories

15. BNC T connector. Tektronix Part No. 103-0030-00.

16. In-line termination. Impedance, 50 ohms; Accuracy, $\pm 2\%$; connectors, BNC. Tektronix Part No. 011-0049-01.

17. In-line termination. Impedance, 50 ohms; wattage rating, two watts; accuracy, $\pm 2\%$; connectors GR874 input with BNC male output. Tektronix Part No. 017-0083-00.

18. Cable. Impedance, 50 ohms; type RG58U; length, 18 inches; connectors, BNC; Tektronix Part No. 012-0076-00.

19. Cable. Impedance, 50 ohms; type RG58U; length, 42 inches; connectors, BNC; Tektronix Part No. 012-0057-01.

20. Cable. Impedance, 50 ohms; type RG58C/U; length, 5 ns; connectors, GR. Tektronix Part No. 017-0512-00.

21. Adapter. Adapts GR874 connector to BNC male connector. Tektronix Part No. 017-0064-00.

22. Adapter. Adapts BNC female connector to clip leads. Tektronix Part No. 013-0076-00.

23. Adapter. Probe tip to BNC connector, Tektronix Part No. 013-0084-01.

Adjustment Tools

24. Screwdriver. Three-inch shaft. Tektronix Part No. 003-0192-00.

25. Low-capacitance screwdriver. 1 1/2-inch shaft. Tektronix Part No. 003-0000-00.

26. Tuning tool. Handle and insert for 5/64-inch (ID) hex cores. Tektronix Part No. 003-0307-00 and 003-0310-00.

SHORT FORM PROCEDURE AND INDEX

7503, Serial No. _____
 Calibration Data _____
 Elapsed-Time Reading _____
 Calibrated By _____

1. Check Control and Graticule Illumination Page 5-6

REQUIREMENT: Rotation of the CONTROL ILLUM switch from OFF, to LOW then to HIGH; the depressed pushbuttons must illuminate first dimly, then brightly. Each pushbutton should light as it is actuated.

PERFORMANCE: Correct _____; Incorrect _____.

2. Adjust -50 Volt Power Supply (R848) Page 5-7

REQUIREMENT: -50 volts, $\pm 0.2\%$ (0.1 volt).

PERFORMANCE: -50 volts \pm _____ volt.

3. Check Output of Remaining Supplies Page 5-8

	REQUIREMENT: Voltage tolerance	PERFORMANCE: Output voltage
-50 volt supply	Set in step 2	
+5 volt supply	± 0.15 volt	_____ volts
+15 volt supply	± 0.3 volt	_____ volts
+50 volt supply	± 0.6 volt	_____ volts
-15 volt supply	± 0.3 volt	_____ volts
+75 volt supply	± 2.25 volts	_____ volts
+150 volt supply	± 6.0 volts	_____ volts

4. Check Power Supply Ripple Page 5-8

SUPPLY	REQUIREMENT: Maximum ripple	PERFORMANCE: Maximum ripple
-50 volt supply	5 millivolts	_____ millivolts
+5 volt supply	2 millivolts	_____ millivolts
+15 volt supply	2 millivolts	_____ millivolts
+50 volt supply	5 millivolts	_____ millivolts
-15 volt supply	2 millivolts	_____ millivolts
+75 volt supply	200 millivolts	_____ millivolts
+150 volt supply	300 millivolts	_____ millivolts

5. Adjust High Voltage Power Supply (R746) Page 5-9

REQUIREMENT: -2960 volts, ± 59.2 volts.

PERFORMANCE: _____ volts.

6. Adjust CRT Bias (R768) Page 5-9

REQUIREMENT: See complete procedure.

PERFORMANCE: Correct _____; Incorrect _____.

7. Check/Adjust Maximum Intensity (R75) and Intensity Limit. Page 5-9

REQUIREMENT: +69 volts at test point 739 for maximum intensity level.

PERFORMANCE: +_____ volts at TP739.

REQUIREMENT: Varies between 40-44 volts at test point 739 for Intensity Limit.

PERFORMANCE: +_____ volts.

8. Check/Adjust ASTIG control Page 5-10

REQUIREMENT: Optimum focus of CRT display.

PERFORMANCE: Correct _____; Incorrect _____.

9. Check/Adjust TRACE ROTATION Page 5-10

REQUIREMENT: Trace alignment horizontally within ± 0.1 division.

PERFORMANCE: Trace alignment horizontally \pm _____ division.

10. Check/Adjust Y Axis Alignment (R794) Page 5-11

REQUIREMENT: Trace alignment vertically within ± 0.1 division.

PERFORMANCE: Trace alignment vertically \pm _____ division.

11. Check/Adjust CRT Geometry (R792) Page 5-11

REQUIREMENT: Bowing of markers at the left and right edges of graticule within 0.1 division.

PERFORMANCE: Left and right edges within _____ division.

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12. Check/Adjust Horizontal Amplifier Gain (R530) Page 5-12

REQUIREMENT: Eight divisions deflection, $\pm 1\%$ (0.08 division).

PERFORMANCE: _____ divisions.

13. Adjust DC Limit Center (R548) Page 5-12

REQUIREMENT: Both baselines should have the same level and be approximately ten volts above ground reference.

PERFORMANCE: Correct _____; Incorrect _____.

14. Check/Adjust DC Centering (R536) Page 5-13

REQUIREMENT: Trace at the center vertical graticule line, ± 0.2 division.

PERFORMANCE: Within _____ division.

15. Check/Adjust Normal Timing and Linearity Page 5-13

REQUIREMENT: Correct timing within 0.05 division over center eight divisions of display and correct timing in any one division within 0.05 division.

PERFORMANCE: Correct _____; Incorrect _____

16. Check/Adjust High Frequency Timing (C573, C593) Page 5-14

REQUIREMENT: See complete procedure.

PERFORMANCE: Correct _____; Incorrect _____.

17. Check/Adjust Vertical Gain (R415) and Low-Frequency Linearity Page 5-15

REQUIREMENT: Six divisions deflection, ± 0.06 division.

PERFORMANCE: _____ divisions deflection.

REQUIREMENT: Right Vertical channel gain must match Left Vertical channel within 1% (± 0.06 div).

PERFORMANCE: Within _____ division.

REQUIREMENT: 0.1 division or less compression or expansion of 2 division signal positioned over 8 divisions.

PERFORMANCE: Compression or expansion of _____ division.

18. Check/Adjust Thermal Compensation (R406) with Readout System. Page 5-17

REQUIREMENT: Readout display does not move more than 0.03 division when the trace is positioned.

PERFORMANCE: Correct _____; Incorrect _____.

19. Check/Adjust Thermal Compensation (R406) Without Readout System. Page 5-17

REQUIREMENT: Trace does not shift when the other trace is positioned.

PERFORMANCE: Correct _____; Incorrect _____.

20. Check/Adjust Vertical Amplifier Centering (R405) Page 5-17

REQUIREMENT: Trace(s) at the center horizontal graticule line within ± 0.3 division.

PERFORMANCE: Within _____ division.

21. Check/Adjust Vertical High Frequency Compensation (R435-C435, R434-C434, L447-R446, L485-C450) Page 5-17

REQUIREMENT: Optimum square-wave response, less than 3.5 nanosecond risetime.

PERFORMANCE: Correct _____; Incorrect _____.

22. Check Upper Vertical Bandwidth Limit Page 5-18

REQUIREMENT: Not more than -3 dB at 100 megahertz.

PERFORMANCE: Bandwidth, _____ megahertz.

23. Check CHOP Mode Repetition Rate Page 5-19

REQUIREMENT: CHOP mode repetition rate 1 MHz within 20%.

PERFORMANCE: _____ MHz.

24. Check External Z-Axis Inputs Page 5-20

REQUIREMENT: See step 24 for complete procedure.

PERFORMANCE: Correct _____; Incorrect _____.

25. Check/Adjust Z-Axis Amplifier Compensation (C736-R712). Page 5-20

REQUIREMENT: Risetime or falltime not to exceed 30 nanoseconds.

PERFORMANCE: Correct _____; Incorrect _____.

26. Check/Adjust Calibrator Amplitude (R695) Page 5-21

REQUIREMENT: 0.4 volt, ± 0.004 volt (unterminated)
0.2 volt, ± 0.002 volt (terminated)

PERFORMANCE: 0.4 volt, _____ volt.

27. Check/Adjust Calibrator Repetition Rate (R665) Page 5-21

REQUIREMENT: 1 kHz, $\pm 0.25\%$.

PERFORMANCE: Correct _____; Incorrect _____.

28. Check Calibrator Risetime Page 5-22

REQUIREMENT: 4 mV through 4 V waveform risetime and falltime 0.25 microsecond or less. 40 V waveform, 2 microseconds or less.

PERFORMANCE: Correct _____; Incorrect _____.

29. Check/Adjust X-Y Phasing (C521) Page 5-23

REQUIREMENT: 0.28 division or less (2° or less) at 2 megahertz.

PERFORMANCE: _____ division.

30. Check Horizontal Bandwidth Page 5-23

REQUIREMENT: Not more than -3 dB at 2 megahertz.

PERFORMANCE: Correct _____; Incorrect _____.

31. Check + Sawtooth Output Page 5-24

REQUIREMENT: 10 volts p-p, $\pm 10\%$.

PERFORMANCE: Correct _____; Incorrect _____.

32. Check + Gate Output; Main, Delayed, or Aux Page 5-24

REQUIREMENT: 10 volts, within ± 1 volt (10%).

PERFORMANCE: _____ volts unterminated.

33. Check VERT SIG OUT Page 5-24

REQUIREMENT: Vertical deflection of 4 divisions, within $\pm 10\%$.

PERFORMANCE: _____ divisions, unterminated.

34. Check/Adjust Readout Character Separation and Operation (R1285, R512, R516) Page 5-24

REQUIREMENT: See complete procedure.

PERFORMANCE: Correct _____; Incorrect _____.

NOTES

PERFORMANCE CHECK/CALIBRATION PROCEDURE

General

The following procedure is arranged so the 7503 Oscilloscope can be calibrated with the least interaction of adjustments and reconnection of equipment. A picture of the test equipment setup for each group of steps is given to aid in identification of the necessary equipment. The control settings and test equipment setup throughout this procedure continue from the preceding step(s) unless noted otherwise. Check control settings at any "test equipment setup" picture by setting the controls as given at the start of the procedure, under the heading Preliminary Control Settings. Then make any changes listed in the first step following the test equipment setup picture.

NOTE

Control titles which are printed on the front panel of the 7503 are capitalized in this procedure (e.g., INTENSITY). Internal adjustments are initially capitalized only (e.g., Ch 1 Gain).

The following procedure uses the equipment listed under Test Equipment Required. If other equipment is substituted, control settings or calibration setup may need to be altered to meet the requirements of the equipment used. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the instruction manual for the test equipment if more information is needed.

NOTE

This instrument should be calibrated at an ambient temperature of $+25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for best overall accuracy. The performance of this instrument can be checked at any temperature within the 0°C to $+50^{\circ}\text{C}$ range. Refer to Section 1 for exceptions in this temperature range.

Preliminary Procedure for Performance Check Only

1. Connect the 7503 to a power source which meets the voltage and frequency requirements of this instrument.
2. Set the controls as given under Preliminary Control Settings. Allow at least 20 minutes warmup before proceeding.
3. Begin performance check with step 1.

PRELIMINARY PROCEDURE FOR COMPLETE CALIBRATION

1. Connect the autotransformer and test equipment to a suitable power source.
2. Turn on the autotransformer.
3. Set the autotransformer output for the nominal line voltage to be used (115 volts or 230 volts).
4. Remove the side and bottom panels from the 7503.
5. Check that the voltage selector and range selector switch bars in the LINE VOLTAGE SELECTOR assembly on the rear of the 7503 are set to correspond to the autotransformer output voltage.
6. Connect the 7503 to the autotransformer output.

Preliminary Control Settings

7. Install the 067-0589-00 Plug-in Extender in the Left Vertical compartment of the 7503.

Set the 7503 controls as follows:

POWER	ON
INTENSITY	Counterclockwise
READOUT	Counterclockwise
CONTROL ILLUM	OFF
GRATICULE ILLUM	Counterclockwise
TRIGGER SOURCE	VERT MODE
VERTICAL MODE	LEFT
Other Controls	As set

The test equipment is now setup as shown in Fig. 5-1.

Turn on all equipment and allow at least 20 minutes warm-up time at approximately $+25^{\circ}\text{C}$ before making any checks or adjustments.

1. Check Control and Graticule Illumination

- a. Turn the GRATICULE ILLUM control fully clockwise.
- b. CHECK—The graticule must become smoothly illuminated to full brilliance as the control is rotated.

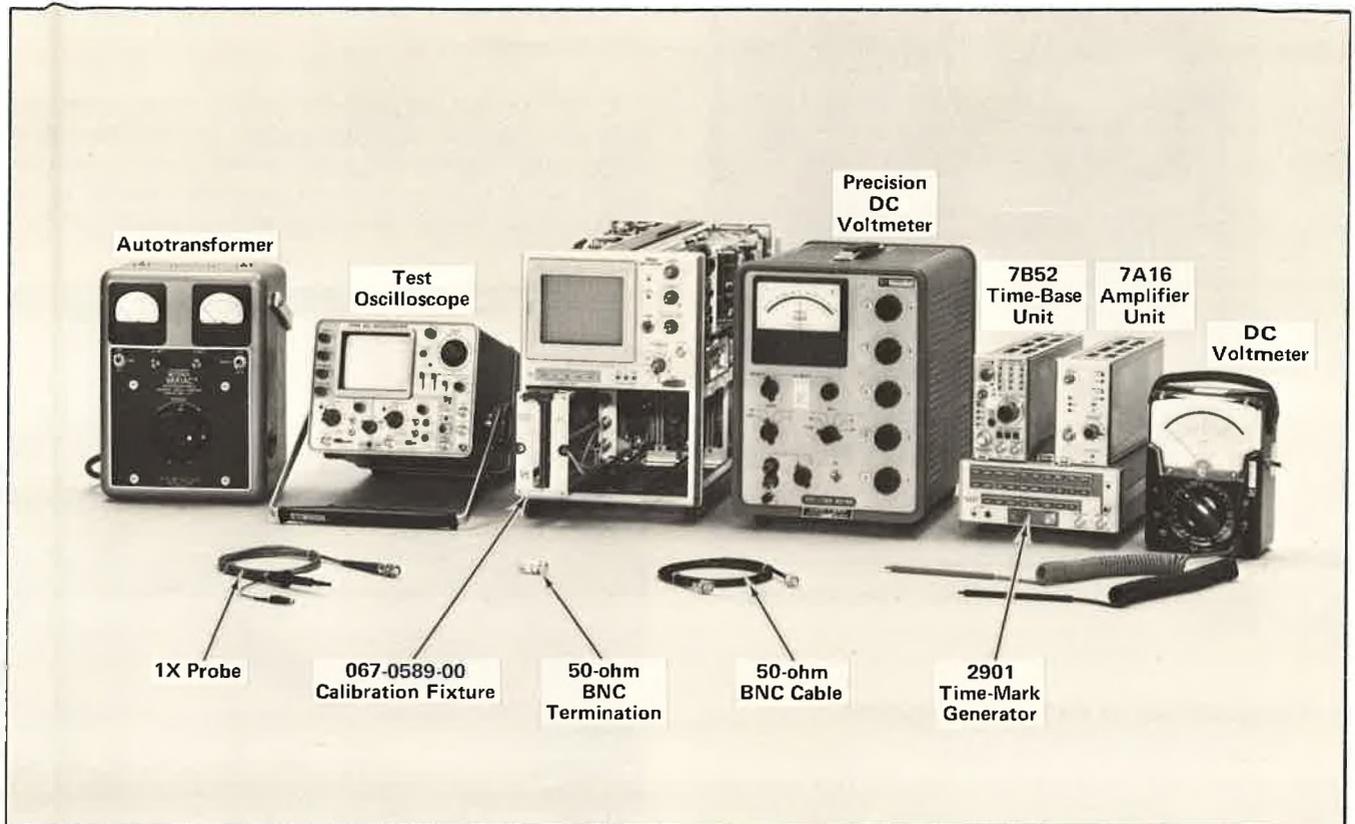


Fig. 5-1. Test equipment setup for steps 1 through 11.

c. Return the GRATICULE ILLUM control fully counterclockwise.

d. Rotate the CONTROL ILLUM switch clockwise from OFF to LOW and then to HIGH. The depressed push-buttons must illuminate dimly with CONTROL ILLUM at LOW, then brightly with CONTROL ILLUM at HIGH.

e. Press each of the TRIGGER SOURCE and VERTICAL MODE pushbuttons in turn.

f. CHECK—Each pushbutton should light as it is actuated.

g. Return the CONTROL ILLUM control to OFF.

NOTE

Steps 2, 3, 4, 5, 6 and 7 are internal checks which are performed only during calibration. They are not part of the Performance Check.

2. Adjust -50 Volt Power Supply

a. Connect the precision DC voltmeter between the -50 volt test point on the Plug-in Extender circuit board and ground.

b. CHECK—Meter reading; -50 volts, ± 0.1 volt.

c. ADJUST— -50 Volts adjustment, R848 (see Fig. 5-2) on the Power Regulator board, for a meter reading of exactly -50 volts. Removal of the power unit from the 7503 is necessary to make this adjustment. See Section 4 for power unit removal procedure.

d. INTERACTION—May affect the operation of all other circuits in the 7503. Check step 5.

e. Remove the meter lead from the -50 volt test point.

f. If the power unit was removed from the instrument, replace it following the instructions given in Section 4.

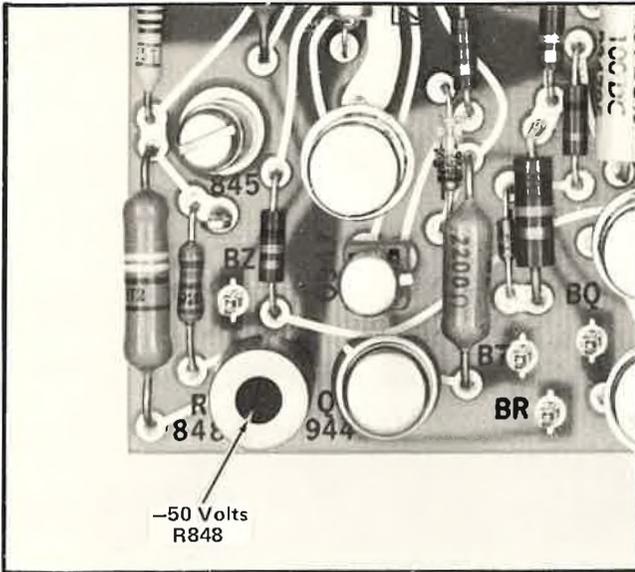


Fig. 5-2. Location of -50 Volts adjustment, R848, on the Power Regulator board.

3. Check Output of Remaining Supplies

a. Table 5-1 lists the power supplies in the instrument. Check each supply with the precision DC voltmeter for output voltage within the given tolerance. Test points for the +5 V, +15 V, +50 V, -15 V and -50 V supplies are on the circuit board of the Plug-in Extender. The test point for the +75 V Supply is the junction of R481 and the red-brown on white wire. The location of this test point is on a ceramic strip mounted near the CRT vertical deflection plates, and is shown in Fig. 5-3. The test point for the +150 V Supply is on the Z-Axis/HV OSC board; see Fig. 5-4.

TABLE 5-1

Power Supply Tolerance and Ripple

Power supply	Output voltage tolerance	Maximum ripple (peak to peak)
+5 volt	± 0.15 volt	2 mV
± 15 volt	± 0.3 volt	2 mV
+50 volt	± 0.6 volt	5 mV
-15 volt	± 0.3 volt	2 mV
-50 volt	± 0.1 volt	5 mV
+75 volt	± 2.25 volts	200 mV
+150 volt	± 6.0 volts	300 mV

b. Remove the precision DC voltmeter from the 7503.

4. Check Power Supply Ripple

a. Install a 7A16 plug-in unit in the Right Vertical compartment and a 7B52 unit in the Horizontal compartment.

b. Connect the 1X probe to the test oscilloscope vertical input connector.

c. Set the test oscilloscope for a vertical deflection factor of 5 mV/Div, input AC coupled, at a sweep rate of 5 ms/Div with internal triggering. (If the 7503 is operated from a power source with a frequency other than 60 hertz, set the test oscilloscope sweep rate to an applicable setting.)

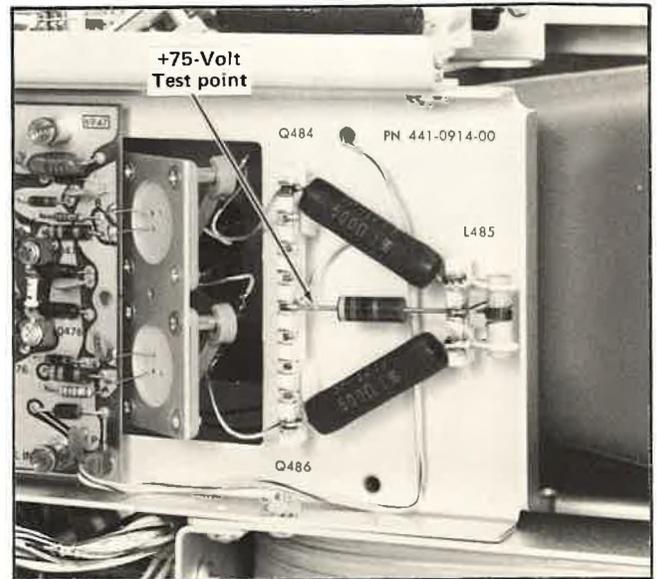


Fig. 5-3. Location of +75-Volt test point.

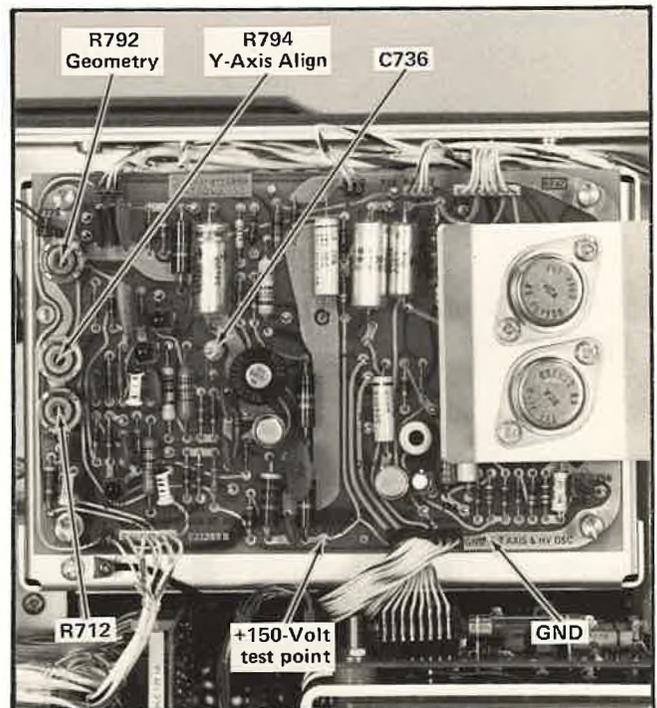


Fig. 5-4. Location of +150-Volt and GND test points and adjustments on Z-Axis/High Voltage Oscillator board.

d. CHECK—Refer to step 3 for the appropriate test points and check each supply for proper regulation at 90 VAC, 115 VAC, and 136 VAC line voltages. Ripple limits are given in Table 5-1.

e. Disconnect the 1X probe.

f. Disconnect the 7503 from the autotransformer and connect it to an appropriate power source.

g. Remove the Plug-in Extender.

5. Adjust High Voltage Power Supply (R746) ①

a. Turn off the power to the 7503.

b. Connect the DC voltmeter (VOM) between the HV Test Point (see Fig. 5-5) and ground.¹



Fig. 5-5. Location of high voltage test point and grid-bias adjustment.

c. Turn on the power to the 7503.

d. CHECK—Meter reading of -2960 volts, ± 59 volts.

e. ADJUST—HV ADJ, R746, on the Z-Axis/HV OSC board (see Fig. 5-4) for a meter reading of -2960 volts.

f. ADJUST—HV ADJ, R746, on the Z-Axis/HV OSC board (see Fig. 5-4) for a meter reading of -2960 volts.

¹If a precision high voltage divider is available, this measurement should be made using the precision divider in conjunction with the precision DC voltmeter.

f. Turn off the power and remove the meter leads.

g. Turn on the power to the 7503.

6. Adjust CRT Bias ①

a. Set the 7A16 controls as follows:

Position	Centered
Polarity	Up
Bandwidth	Full
Input	Gnd
Volts/Div	.2 V
Variable	Cal (in)

b. Set the 7B52 controls as follows:

Main Triggering	
Mode	Auto
Coupling	AC
Source	Int
X10 Mag	Off (in)
Display Mode	Main Sweep
Time/Div	Ampl
Variable	Cal (in)
Position	Centered
Remaining controls	As set

c. Connect the DC voltmeter (VOM) between test point 739 and Ground on the Z Axis/HV Osc circuit board (see Fig. 5-4).

d. CHECK—Meter reading of approximately $+8$ volts (check to insure that the INTENSITY control is fully counterclockwise for this measurement).

e. Rotate the INTENSITY control clockwise until the reading on the DC voltmeter is 4 volts higher than the reading obtained in part d.

f. ADJUST—CRT Grid Bias adjustment, R768 (see Fig. 5-5), so the displayed spot is just extinguished. At this point, the CRT is properly biased.

7. Check/Adjust Maximum Intensity and Intensity Limit ①

a. Press the VERTICAL MODE switch RIGHT push-button.

b. Set the 7B52 Time/Div switch to 1 ms.

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- c. Obtain a trace on the CRT by rotating the INTENSITY control and position controls as necessary.
- d. Completely defocus the displayed trace by turning the FOCUS control fully counterclockwise.
- e. Position the defocused trace completely off the graticule area by turning the 7A16 Position control fully clockwise.
- f. Turn the INTENSITY control fully clockwise.
- g. CHECK—DC voltmeter for a reading of +69 volts.
- h. ADJUST—Maximum Intensity adjustment, R75 (see Fig. 5-6), on the Logic board for a DC voltmeter reading of +69 volts. Removal of the power unit from the 7503 is necessary to make this adjustment. See Section 4 for power unit removal procedure.

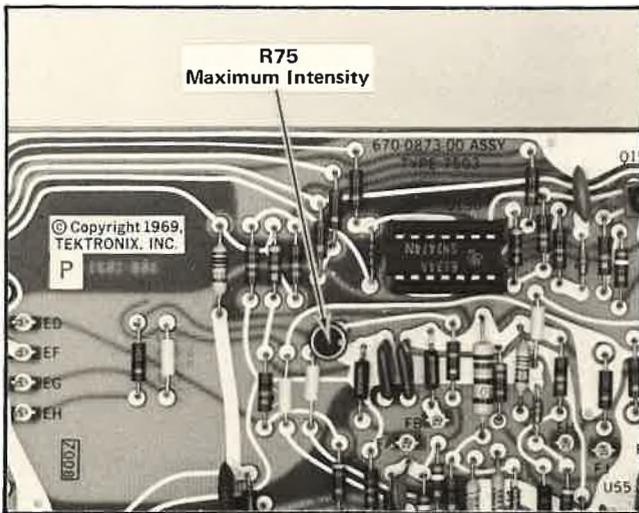


Fig. 5-6. Location of R75 Maximum Intensity adjustment on Logic circuit board.

NOTE

Readjustment of R75 is usually necessary only if the CRT has been replaced.

- i. Change the 7B52 Time/Div switch to .1 s.
- j. CHECK—DC voltmeter reading varying between +40 and +44 volts.

NOTE

This tolerance is intended as a guide to correct instrument operation, and is not an instrument specification.

- k. Turn the INTENSITY control counterclockwise to a normal viewing level.
- l. Position the trace to the normal viewing area with the 7A16 Position control.

8. Check/Adjust ASTIG Control

- a. Set the 7B52 Time/Div switch to .5 ms.
- b. Connect a 50-ohm BNC cable between the CAL OUT connector and the 7A16 Input connector.
- c. Set the CALIBRATOR switch to 0.4 V and the RATE switch to 1 kHz.
- d. Change the 7A16 Input switch to DC.
- e. Adjust the 7B52 Level/Slope control to obtain a stable display.
- f. CHECK—Optimum focused CRT display can be obtained by adjusting the FOCUS control.
- g. ADJUST—FOCUS and ASTIG adjustments to obtain optimum focused display.
- h. Disconnect the 50-ohm BNC cable.

9. Check/Adjust TRACE ROTATION control

- a. Position the trace to the center horizontal graticule line using the 7A16 Position control.
- b. CHECK—Trace should be parallel to the center horizontal graticule line within 0.1 division over the sweep length of 10 divisions.
- c. ADJUST—TRACE ROTATION front-panel adjustment R779 so the trace is parallel to the center horizontal graticule line.

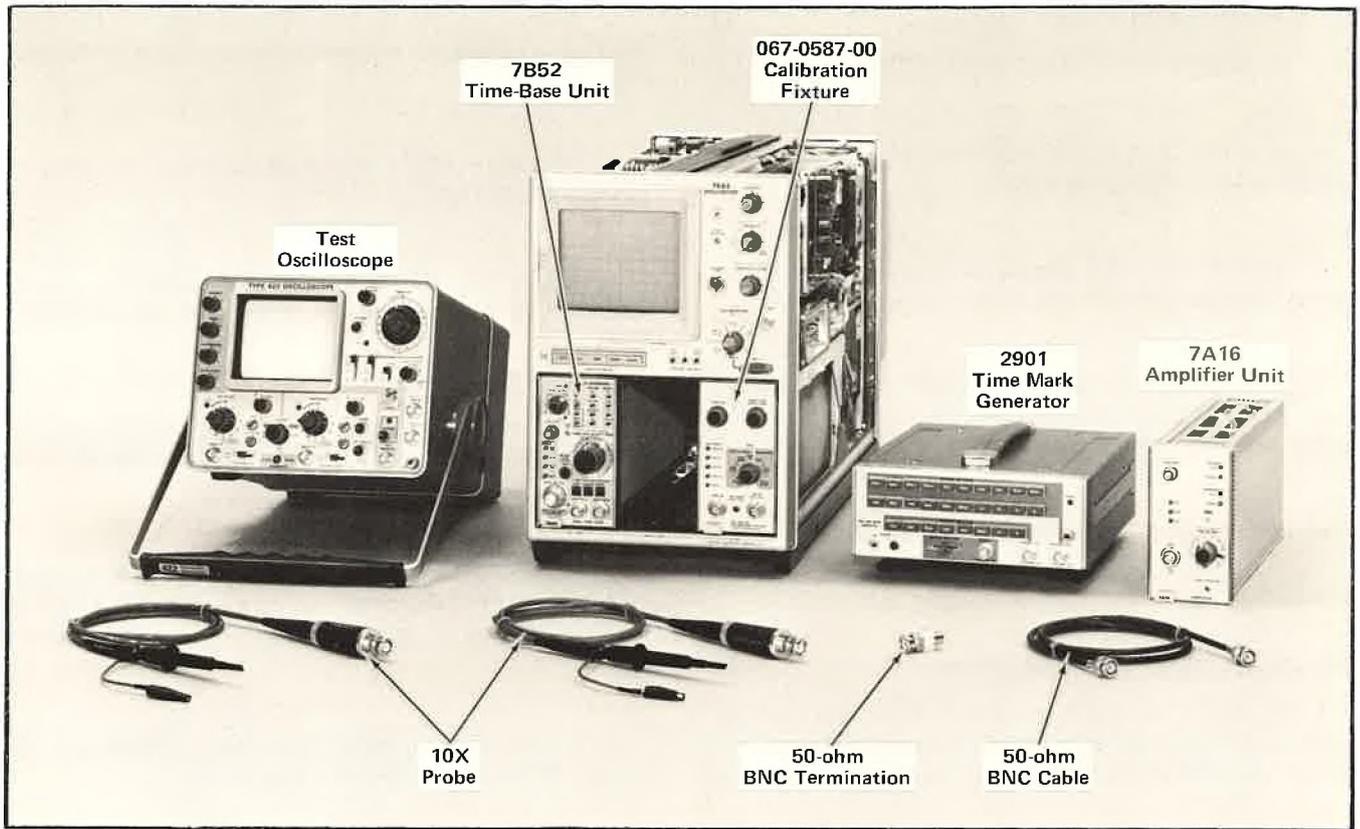


Fig. 5-7. Test equipment setup for steps 12 through 16.

12. Check/Adjust Horizontal Amplifier Gain

a. Set the 7503 controls as follows:

VERTICAL MODE	LEFT
TRIGGER SOURCE	VERT MODE
Remaining controls	As set

b. Install the 7B52 Time Base in the Left Vertical compartment and set the 7B52 controls as follows:

Main Triggering	
Mode	Auto
Coupling	AC
Source	Int
X 10 Mag	Off (in)
Display Mode	Main Sweep
Time/Div	1 ms
Variable	Cal (in)
Remaining controls	As set

c. Install the 067-0587-00 Calibration Fixture in the Horizontal compartment and set the controls as follows:

Rep Rate	250 kHz
Test	Vert or Horiz Gain
Remaining controls	As set

The test equipment is now setup as shown in Fig. 5-7.

d. Free-run the sweep with the 7B52 Level/Slope control to display nine vertical traces.

e. Position the display for centering of the middle trace on the center vertical graticule line.

f. CHECK—That total separation of the traces corresponding to the center eight divisions of the graticule is eight divisions, ± 0.08 division.

g. ADJUST—Horizontal Gain control, R530 (see Fig. 5-8) for exactly eight divisions total spacing between the traces, corresponding to the center eight divisions on the graticule. Use the calibration fixture Position control as necessary to center the display.

h. Remove both plug-ins from the 7503.

13. Adjust DC Limit Center

a. Install the 7B52 Time Base in the Horizontal compartment of the 7503.

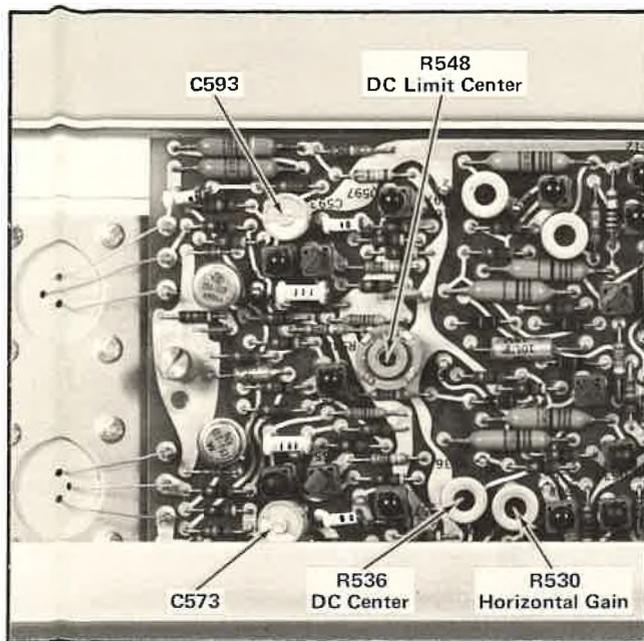


Fig. 5-8. Horizontal Amplifier Adjustments.

b. Set the 7B52 Time/Div switch to 1 ms, X10 Mag on (button out) and free run the sweep with the Level/Slope control.

c. Connect one 10X probe to each vertical input connector of the test oscilloscope.

d. Connect one 10X probe tip to the RIGHT GREEN horizontal deflection plate lead on the 7503 (at the top of the CRT shield) and the other 10X probe tip to the RED LEFT horizontal deflection plate lead.

e. Set up the test oscilloscope for alternate display vertical deflection factor of 0.5 volt/division (5 volts/division at 10X probe tip) at a sweep rate of one millisecond/division. Set the test oscilloscope input coupling switches to the ground position.

f. Position both test oscilloscope traces to the bottom horizontal line of the graticule to establish a zero reference level, then set the test oscilloscope input coupling switches to DC.

g. Trigger the test oscilloscope for a stable display.

h. CHECK—Both displayed baselines should have the same level, approximately 10 volts (2.0 div) above ground reference.

i. ADJUST—Limit Center control R548 (see Fig. 5-8) for identical DC base line levels.

j. Remove both probe tips from the horizontal deflection plate leads.

14. Check/Adjust DC Centering ①

a. Remove the 7B52 Time Base from the Horizontal compartment and install it in the Left Vertical compartment.

b. Push the 7B52 X10 Mag button in (off).

c. Install the 067-0587-00 Calibration Fixture in the Horizontal compartment.

d. Set the Calibration Fixture Test switch to Triggering Gain.

e. CHECK—Free-running trace should be centered at the center vertical graticule line within 0.2 division.

f. ADJUST—DC Centering control R536 (see Fig. 5-8) to precisely align the free-running trace on the center vertical graticule line.

g. Remove both plug-ins from the 7503.

15. Check/Adjust Normal Timing and Linearity ①

a. Install the 7B52 Time Base in the Horizontal compartment.

b. Set the 7B52 Time/Div switch to 1 ms, X10 Mag off.

c. Install the 7A16 Amplifier in the Left Vertical compartment.

d. Connect 1 ms time marks from the 2901 Time-Mark Generator to the 7A16 input connector, using a 50-ohm coaxial cable and a 50-ohm termination.

e. Set the 7A16 controls to obtain a display 2 to 3 divisions in amplitude.

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f. Adjust the 7B52 Level/Slope control for a stable display.

g. With the 7B52 Position control, position the first time mark to the first (farthest left) vertical graticule line.

h. CHECK—CRT display. The center eight time intervals must coincide with the center eight graticule divisions, ± 0.05 div. (See Fig. 5-9.)

i. ADJUST—The 7B52 front-panel Swp Cal for one marker each division. The center eight time intervals must coincide with their respective graticule lines within 0.05 division.

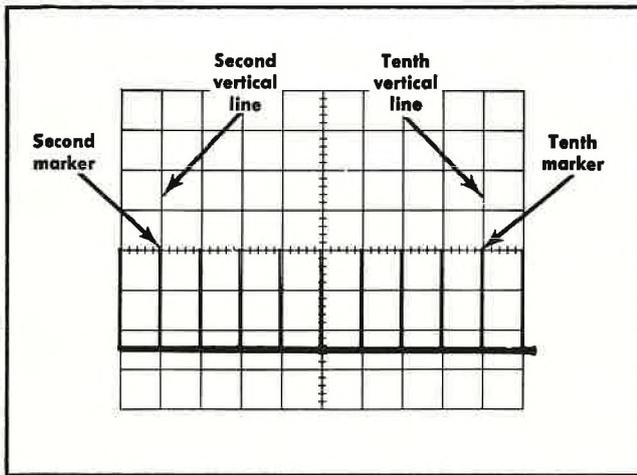


Fig. 5-9. Typical CRT display showing correct sweep calibration.

16. Check/Adjust High Frequency Timing

a. Set the 2901 Time Mark Generator for 10 ns markers.

b. Change the 7B52 Time/Div switch to $.05 \mu\text{s}$.

c. Center the display on the graticule area.

d. Actuate the 7B52 X10 Mag pushbutton and adjust the Level/Slope control for a stable display.

e. CHECK—CRT display for one marker every two divisions between the second and tenth vertical lines of the graticule.

f. ADJUST—C573 and C593 (see Fig. 5-8) for one marker every two divisions (use a low-capacitance screwdriver). Adjust these capacitors a little at a time, trying to maintain equal capacitances.

g. Position the fourth marker of the display to the second vertical graticule line with the 7B52 Position control.

h. CHECK—CRT display for one marker every two divisions over the center eight divisions.

i. Position the next-to-last marker to the tenth vertical line.

j. CHECK—CRT display for one marker every two divisions over the center eight divisions.

k. ADJUST—C573 and C593 (see Fig. 5-8) for one marker every two divisions while maintaining the best linearity. Position the display back and forth and check linearity over the entire sweep while making these adjustments.

l. CHECK—Linearity at the $.1$ and $.2 \mu\text{s}$ positions of the 7B52 Time/Div switch, using appropriate time markers.

m. Return the X10 Magnifier to the Off position.

n. Disconnect the 2901 Time Mark Generator, 50-ohm BNC cable and 50-ohm termination.

NOTES

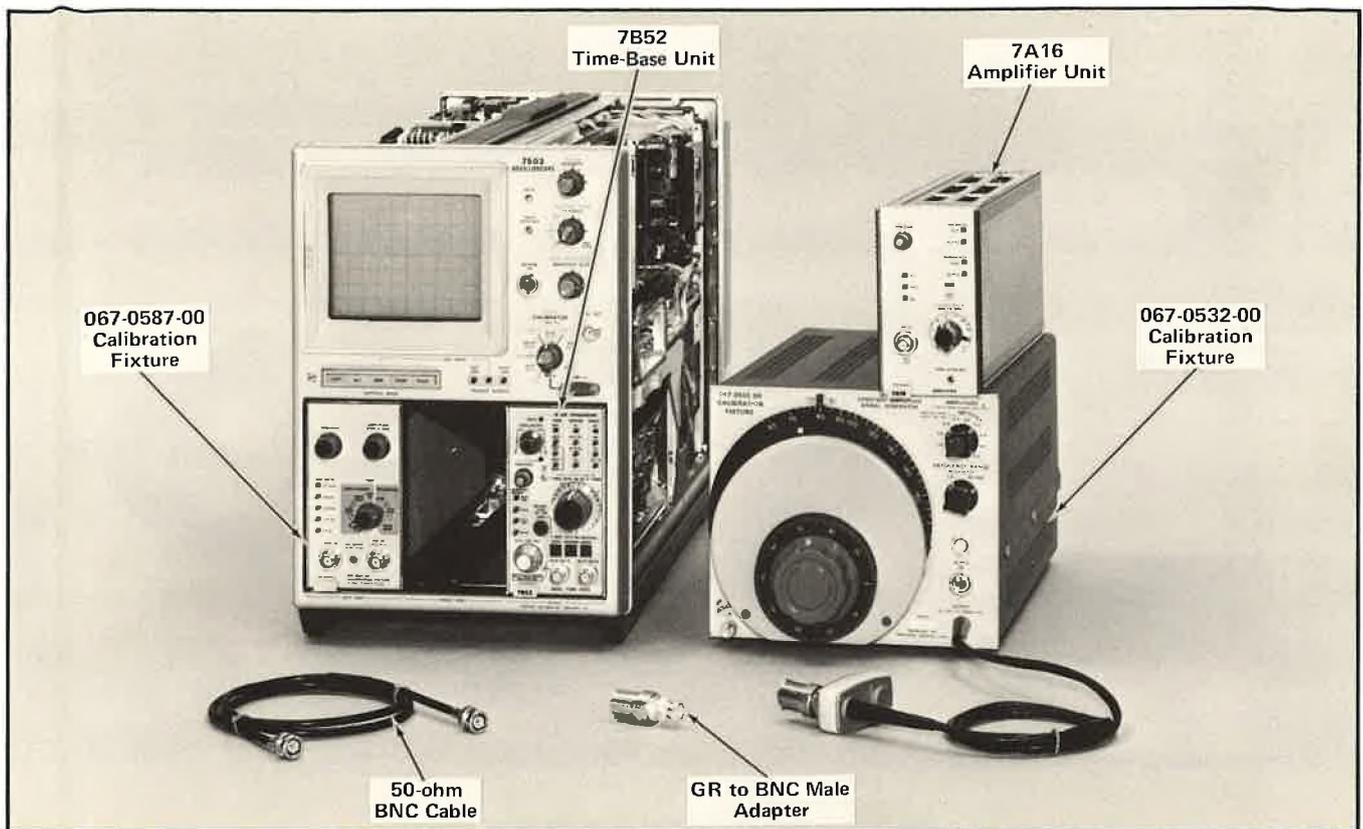


Fig. 5-10. Test equipment setup for steps 17 through 22.

17. Check/Adjust Vertical Gain

- a. Set the 7503 controls as follows:

VERTICAL MODE	LEFT
TRIGGER SOURCE	VERT MODE
CALIBRATOR	0.4 V
RATE	1 kHz
Remaining controls	As set

- b. Install the 7B52 Time Base in the Horizontal compartment and set the controls as follows:

Main Triggering	
Mode	Auto
Coupling	AC
Source	Int
X10 Mag	Off (in)
Display Mode	Main Sweep
Time/Div	1 ms
Variable	Cal (in)
Remaining controls	As set

- c. Install the 067-0587-00 Calibration Fixture in the Left Vertical compartment and set the controls as follows:



Rep Rate
Test
Remaining controls

250 kHz
Vert or Horiz Gain
As set

The test equipment is now set up as shown in Fig. 5-10.

- d. Adjust the 7B52 Level/Slope control to display seven horizontal traces.

- e. Position the display to center the middle trace on the center horizontal graticule line.

- f. CHECK—That total separation of the traces corresponding to the center vertical 6 division area of the graticule is 6 divisions, ± 0.06 division.

- g. ADJUST—Vertical Gain adjustment, R415 (see Fig. 5-11) for exactly six divisions between the second and sixth traces (corresponding to the center 6 divisions) on the graticule. Use the Calibration Fixture Position control as necessary to center the display.

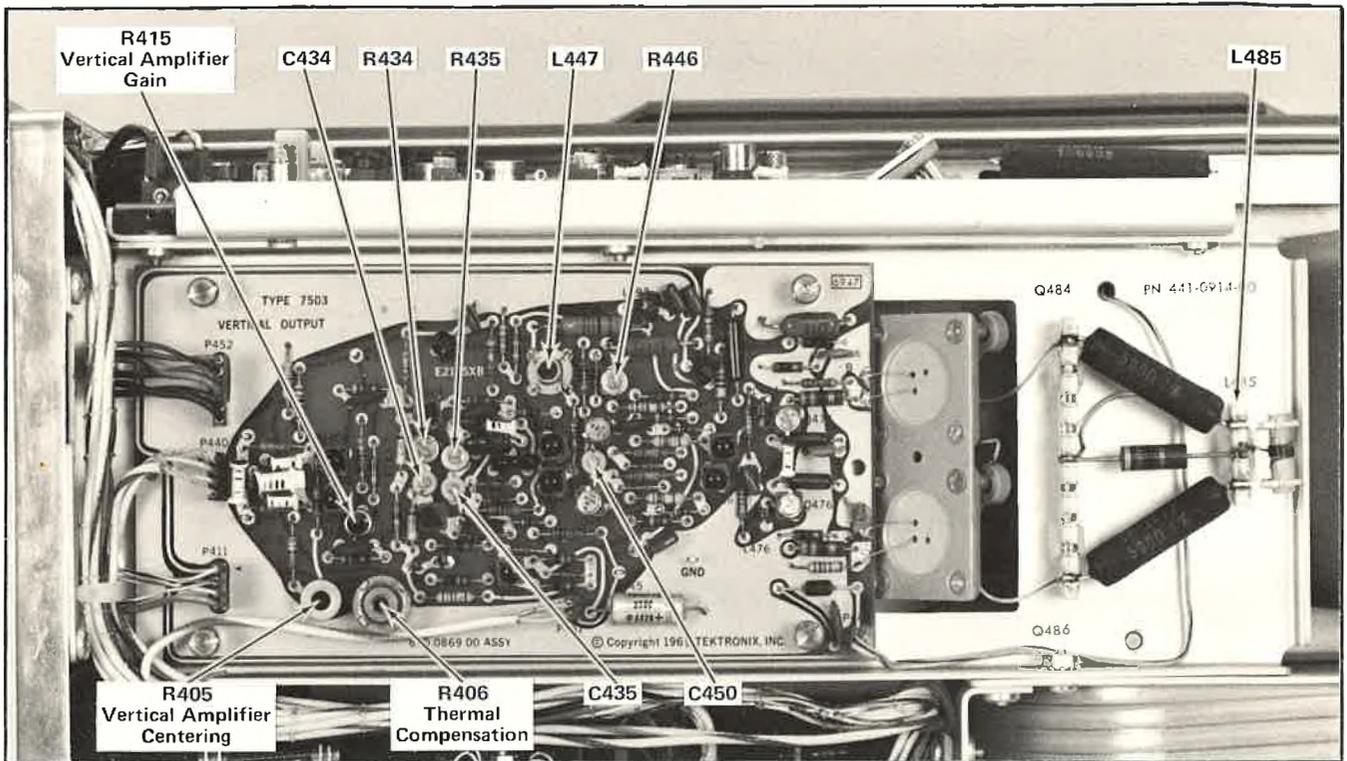


Fig. 5-11. Location of Vertical Amplifier adjustments.

h. Remove the calibration fixture from the Left Vertical compartment and place it in the Right Vertical compartment.

i. Press the VERTICAL MODE RIGHT switch.

j. Repeat part f of this step. The reading obtained must be the same as that obtained in part f within 0.06 division.

k. Repeat part g of this step.

l. Remove the calibration fixture from the 7503.

m. Install the 7A16 Amplifier unit in the Right Vertical compartment.

n. Set the 7A16 Volts/Div switch to .2 V and the Input switch to DC.

o. Connect a 50-ohm BNC cable between the CAL OUT connector and the 7A16 Input connector.

p. Adjust the 7B52 Level/Slope control for a free-running sweep.

q. Position the display to the center of the graticule area with the 7A16 Position control.

r. Adjust the 7A16 Volts/Div and Variable controls, if necessary, to obtain exactly 2 divisions of vertical deflection.

s. CHECK—CRT display for 0.1 division or less of compression or expansion while positioning the display to the top and bottom of the graticule (8 divisions).

t. Disconnect the 50-ohm BNC cable.

u. Remove the 7A16 Amplifier unit from the 7503.

NOTE

For a 7503 with Readout, omit step 19. For a 7503 without Readout, omit step 18.

18. Check/Adjust Thermal Compensation with Readout System ①

a. Install the 067-0587-00 Calibration Fixture in the Left Vertical compartment and set the Test mode switch to Vert or Horiz Step Resp +. Set Amplitude Step or Aux control fully counterclockwise.

b. Actuate the LEFT pushbutton on the VERTICAL MODE switch.

c. Adjust READOUT front-panel control for a display of the time-base display factor.

d. CHECK—That the readout display does not move more than about 0.03 division vertically as the Calibration Fixture Position control is used to move the trace off screen above and below the graticule.

e. ADJUST—R406 (see Fig. 5-11) for minimum vertical readout shift as the Calibration Fixture Position control is used to move the trace off screen above and below the graticule.

f. Turn the READOUT control fully counterclockwise.

19. Check/Adjust Thermal Compensation without Readout System ①

a. Install the 067-0587-00 Calibration Fixture in the Left Vertical compartment and set the Test mode switch to Vert or Horiz Step Resp +. Set Amplitude Step or Aux fully counterclockwise.

b. Actuate the CHOP pushbutton on the VERTICAL MODE switch.

c. CHECK—That the stationary trace does not shift position vertically when the Calibration Fixture Position control is used to position the other trace off screen at the top and bottom of the graticule.

d. ADJUST—R406 (see Fig. 5-11) for minimum change in the stationary trace as the Calibration Fixture Position control is used to position the other trace off screen above and below the graticule.

20. Check/Adjust Vertical Amplifier Centering ①

a. Remove the 067-0587-00 Calibration Fixture from the 7503.

b. Set the VERTICAL MODE switch to LEFT.

c. Set the 7B52 Level/Slope control for a free-running sweep.

d. CHECK—That the displayed trace is centered on the center horizontal graticule line within 0.3 divisions.

e. ADJUST—Vertical Centering adjustment, R405 (see Fig. 5-11), for exact centering of the displayed trace on the center horizontal graticule line.

f. Set the VERTICAL MODE switch to RIGHT.

g. Repeat parts d and e of this step. It may be necessary to readjust R405 for the best centering between the RIGHT and LEFT positions of the VERTICAL MODE switch. The trace(s) must be within 0.3 division of center in all settings of the VERTICAL MODE switch.

21. Check/Adjust Vertical High-Frequency Compensation ①

a. Install the 067-0587-00 Calibration Fixture in the Left Vertical compartment.

b. Actuate the LEFT pushbutton of the VERTICAL MODE switch.

c. Set the Calibration Fixture Rep Rate to 250 kHz.

d. Set the Test switch to Vert or Horiz Step Resp +.

e. Adjust the Calibration Fixture Amplitude Step or Aux control for a displayed waveform 6 divisions in amplitude. Center the display vertically.

f. Set the 7B52 Time/Div switch to .05 μ s and the X10 Mag On (button out).

g. Set the 7B52 Level/Slope control for a stable display.

h. CHECK—CRT display for optimum pulse, square leading corner and flat top with aberrations not exceeding 0.1 division, peak to peak.

i. ADJUST—R435-C435 (major effect 20-50 ns after corner), R434-C434 (for best corner without ringing), L447

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(major effect 5 ns after corner), R446 (major effect 8 ns after corner), L485 (major effect 5 ns after corner), and C450 (fast leading edge) for optimum square-wave response (use low-capacitance screwdriver for the capacitors, and tuning tool for the inductors). Fig. 5-11 shows the location of these adjustments. Since these adjustments interact, readjust until optimum square-wave response is obtained, with rise time of less than 3.5 nanoseconds. Use the 7B52 X10 Mag On or Off as required to best view the effect of each adjustment.

j. Install the Calibration Fixture in the Right Vertical compartment.

k. Actuate the RIGHT pushbutton on the VERTICAL MODE switch.

l. CHECK—CRT display for optimum square-wave response similar to the Left Vertical channel in part h, with rise time less than 3.5 nanoseconds.

m. ADJUST—If necessary, compromise the adjustments as given in part i of this step for best square-wave display in parts h and l of this step.

22. Check Upper Vertical Bandwidth Limit

a. Set the 7B52 Time/Div switch to 1 ms and the X10 Mag Off (in).

b. Set the 067-0587-00 Calibration Fixture Test mode switch to Vert or Horiz Freq Resp.

c. Connect the High-Frequency Constant-Amplitude Signal Generator (Tektronix Part No. 067-0532-00) to the

CW In connector of the Calibration Fixture, using a GR to BNC male adapter.

d. Set the constant-amplitude generator for an eight-division display on the CRT, centered on the graticule, at the reference frequency (3 MHz).

e. Without changing the output amplitude, increase the output frequency of the constant-amplitude generator until the display is reduced to 5.6 divisions (−3 dB point).

f. CHECK—Output frequency of the generator to be 100 megahertz or higher.

g. Install the Calibration Fixture in the Right Vertical compartment.

h. Actuate the RIGHT pushbutton on the VERTICAL MODE switch.

i. Repeat parts d and e of this step.

j. CHECK—Output frequency of generator to be 100 megahertz or higher.

k. Disconnect the 067-0532-00 Signal Generator and GR to BNC adapter.

l. Remove all plug-ins from the 7503.

NOTES

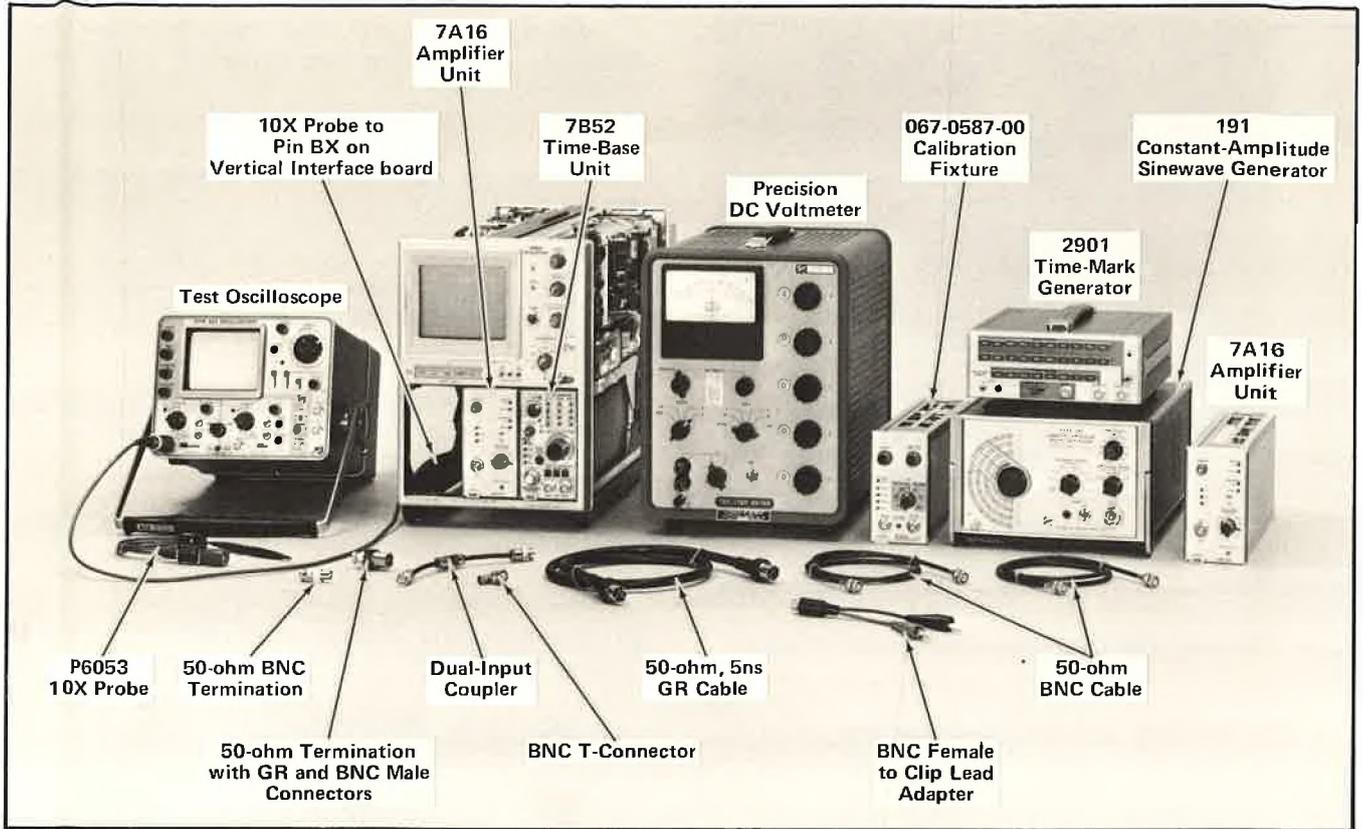


Fig. 5-12. Test equipment setup for steps 23 through 34.

23. Check CHOP Operation and Repetition Rate

Test equipment setup, with connections made at completion of step 23C, is shown in Fig. 5-12.

a. Set the 7503 controls as follows:

VERTICAL MODE	CHOP
TRIGGER SOURCE	VERT MODE
CALIBRATOR	0.4 V
RATE	DC
Remaining controls	As desired

b. Install the 7B52 Time Base in the Horizontal compartment and set the controls as follows:

Main Triggering	
Mode	Auto
Coupling	AC
Source	Int
Time/Div	20 μ s
Variable	Cal (in)
Remaining controls	As desired

c. Install the 7A16 Amplifier in the Right Vertical compartment and set the controls as follows:

Position	Centered
Polarity	Up
Bandwidth	Full
Input	DC
Volts/Div	1 V
Variable	Cal (in)

d. Connect a 10X probe to the test oscilloscope vertical input connector.

e. Connect the 10X probe tip to pin BX on the Vertical Interface circuit board (see Fig. 5-13).

f. Set the test oscilloscope for a vertical deflection of 50 mV/Div (0.5 V/Div at the 10X probe tip), input AC coupled at a sweep rate of 0.2 μ s/Div (2 μ s/Div with X10 Mag).

g. CHECK—Test oscilloscope display; should be square-wave display with a repetition rate of 1 microsecond \pm 20% (5 divisions at 0.2 μ s/Div).

h. Adjust the 7A16 Position control to obtain two traces on the 7503 CRT.

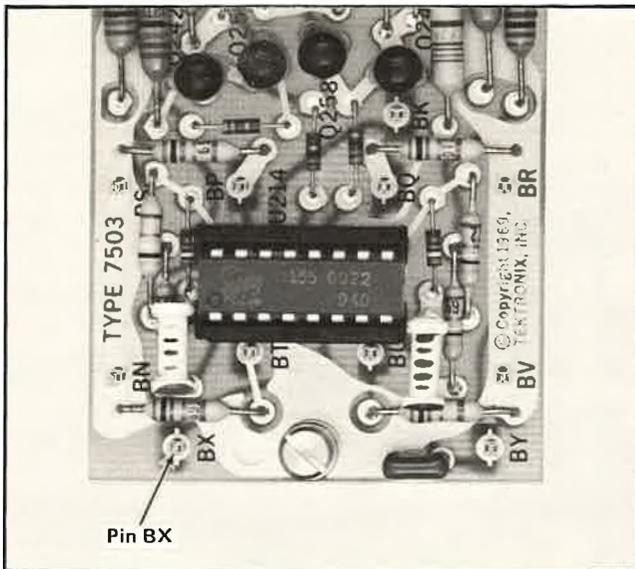


Fig. 5-13. Location of pin BX on Vertical Interface circuit board.

- i. Disconnect the test oscilloscope and the 10X probe.

24. Check External Z-Axis Inputs

- a. Set the 7503 VERTICAL MODE switch to RIGHT.
- b. Connect the output of the Type 191 Constant-Amplitude Signal Generator to the Input connector of the 7A16 using a 5 ns GR cable, a 50-ohm termination with GR to BNC connectors, and a BNC T-connector.
- c. Set the Type 191 frequency range switch to 50 kHz.
- d. Adjust the output amplitude of the Type 191 for two volts.
- e. Adjust the 7B52 Level/Slope control for a stable display.
- f. Remove the grounding covers from the EXT Z AXIS INPUTS.
- g. Connect the open end of the T-connector to the HIGH SENSITIVITY input on the 7503 using a 50-ohm BNC cable.
- h. CHECK—CRT display for blanking of the top portion of the displayed waveform.

- i. Remove the 50-ohm BNC cable from the HIGH SENSITIVITY connector and connect it to the HIGH SPEED input.

- j. Change the output amplitude of the Type 191 to maximum.

- k. CHECK—CRT display for reduced intensity of the top portion of the displayed waveform.

- l. Disconnect the Type 191, the 5 ns GR cable, 50-ohm termination, T-connector and 50-ohm BNC cable.

- m. Replace the grounding covers on the EXT Z AXIS INPUTS.

25. Check/Adjust Z-Axis Amplifier Compensation

- a. Connect the P6053 probe to the 7A16 Input connector.
- b. Set the 7B52 Time/Div switch to .1 μ s.
- c. Connect the P6053 probe tip to test point 739 on the Z-Axis/HV Osc board (see Fig. 5-4).
- d. Set the 7A16 Volts/Div switch to .5 V.
- e. Adjust the INTENSITY control for a CRT display 6 divisions in amplitude.
- f. Center the display with the 7A16 Position control.
- g. Adjust the 7B52 Level/Slope control for a stable display.
- h. CHECK—CRT display for optimum square leading corner and a waveform risetime of 30 nanoseconds or less (use 7B52 X10 Mag).
- i. ADJUST—C736 and R712 (see Fig. 5-4) for optimum square leading corner and a waveform risetime of 30 nanoseconds or less (use 7B52 X10 Mag).
- j. Remove the P6053 probe from the test point and from the 7A16 Input connector.

26. Check/Adjust Calibrator Amplitude ①

a. Connect the precision DC voltmeter to the CAL OUT connector using a 50-ohm BNC cable and a BNC female to clip lead adapter.

b. CHECK—Output voltage measurement of 0.4 volt ± 0.004 volt (± 0.008 volt if measurement is made in the 0°C to $+50^{\circ}\text{C}$ temperature range).

c. ADJUST—0.4 Volt adjustment, R695 (see Fig. 5-14), for a reading of 0.4 volt.

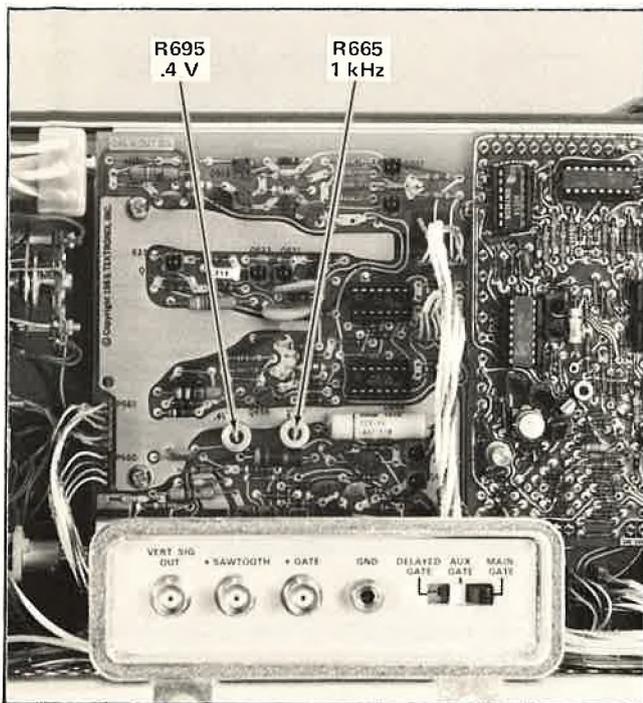


Fig. 5-14. Location of adjustments on the Calibrator and Output Signals board.

d. Connect a 50-ohm termination between the CAL OUT connector and the 50-ohm BNC cable.

e. CHECK—Precision DC voltmeter for a reading of 0.2 volt, ± 0.002 volt (± 0.004 volt if measurement is made in the 0°C to $+50^{\circ}\text{C}$ temperature range).

f. Disconnect the precision DC voltmeter, 50-ohm BNC cable, 50-ohm termination and BNC female to clip lead adapter.

27. Check/Adjust Calibrator Repetition Rate ①

a. Install the 067-0587-00 Calibration Fixture in the Left Vertical compartment.

b. Set the calibration fixture Test mode switch to Aux In.

c. Connect one millisecond time markers from the 2901 Time Mark Generator to the Input connector of the 7A16 using a 50-ohm BNC cable and a 50-ohm termination.

d. Set the calibration RATE switch to 1 kHz and the CALIBRATOR switch to 4 V.

e. Connect a 50-ohm BNC cable between the CAL OUT connector and the Aux In connector on the calibration fixture.

f. Press the ALT pushbutton on the VERTICAL MODE switch.

g. Set the 7B52 Time/Div switch to 1 ms and the X10 Mag Off.

h. Adjust the deflection factors of the two vertical plug-in units to obtain about 2 divisions of deflection of time markers and 2 divisions of calibrator square wave.

i. Adjust the 7B52 Level/Slope control for a stable display.

j. CHECK—Leading edges of calibrator square wave align with the 1 millisecond time markers.

k. ADJUST—1 kHz adjustment, R665 (see Fig. 5-14), to align the leading edges of the calibrator square wave with the 1 millisecond time markers.

l. Press the RIGHT VERT pushbutton of the TRIGGER SOURCE switch.

m. Set the VERTICAL MODE switch to ADD.

n. Set the 7B52 Time/Div switch to .2 ms.

o. CHECK—Minimum drift of time markers across calibrator square wave.

p. ADJUST—R665 (see Fig. 5-14) for slowest drift of time markers across calibrator square wave.

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- q. Set the TRIGGER SOURCE switch to VERT MODE.
- r. Set the 7B52 Level/Slope control so a triggered trace is present only when the time markers occur during the positive portion of the calibrator square wave.
- s. Set the 7B52 Main Triggering Coupling switch to AC LF REJ.
- t. Set the 7B52 Time/Div switch to .2 s.
- u. CHECK—The amount of time required for the timing markers to drift across the positive level of the calibrator square wave to the negative level, and back to the positive level; must be more than 0.4 second (more than 0.2 second if check is being made in the 0°C to +50°C temperature range).
- v. ADJUST—Repeat parts l through p to adjust R665 for slowest drift of time markers.
- w. Disconnect the 2901 Time Mark Generator, the 50-ohm BNC cable and the 50-ohm termination.

28. Check Calibrator Risetime

- a. Set the VERTICAL MODE switch to RIGHT.
- b. Disconnect the 50-ohm BNC cable from the calibration fixture and connect it to the 7A16 Input connector.
- c. Set the 7A16 Volts/Div switch to 1 V.
- d. Set the 7B52 Main Triggering Coupling switch to AC and the Time/Div switch to 1 μ s.
- e. Adjust the 7B52 Level/Slope control for a stable display triggered on the rising portion of the square wave.
- f. Set the 7B52 X10 Mag On.
- g. CHECK—Displayed waveform has a risetime from the 10% to the 90% point of 0.25 μ s or less (see Fig. 5-15).
- h. Adjust the 7B52 Level/Slope control for a stable display triggered on the falling portion of the square wave.

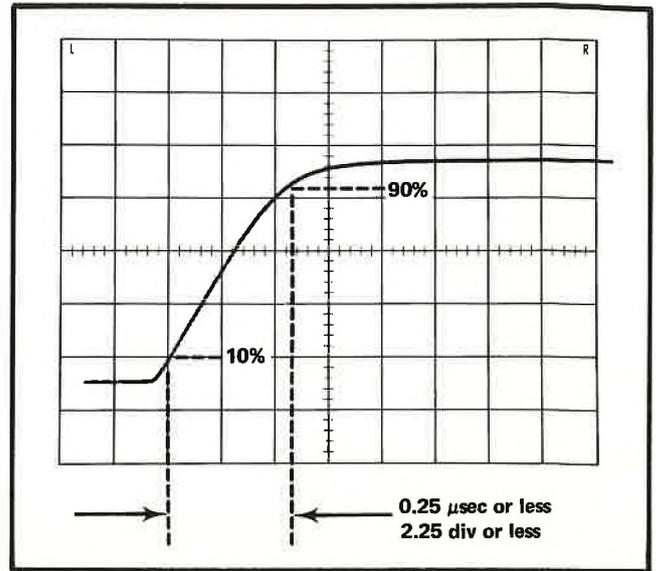


Fig. 5-15. Typical CRT display when checking calibrator risetime.

- i. CHECK—Displayed waveform has a falltime from the 90% to the 10% point of 0.25 μ s or less.
- j. Set the 7B52 Time/Div switch to 10 μ s and the X10 Mag On.
- k. Change the CALIBRATOR switch to 40 V.
- l. Disconnect the 50-ohm BNC cable.
- m. Connect the probe tip to BNC connector adapter to the CAL OUT connector.
- n. Connect the P6053 10X probe to the 7A16 Input connector.
- o. Connect the P6053 probe tip to the probe tip to BNC connector adapter which was connected in part m of this step.
- p. Set the 7A16 Volts/Div switch to .5 V and adjust the Variable control for a display of 4 divisions.
- q. CHECK—With the 7B52 Level/Slope control set to trigger on the falling portion of the square wave, falltime from the 90% to the 10% point must be 2 μ s or less.
- r. Set the 7B52 Level/Slope control to trigger on the rising portion of the square wave.

s. CHECK—Displayed waveform for a risetime from the 10% point to the 90% point of $2 \mu\text{s}$ or less.

t. Disconnect the P6053 X10 probe and the probe tip to BNC adapter.

u. Return the 7A16 Variable control to Cal and the 7B52 X10 Mag Off.

29. Check/Adjust X-Y Phasing

a. Remove the 067-0587-00 Calibration Fixture from the Left Vertical compartment.

b. Remove the 7B52 Time Base from the Horizontal compartment.

c. Install a 7A16 Amplifier unit in the Horizontal compartment.

d. Set the Volts/Div switches on the 7A16's to 10 mV.

e. Connect the output of the Type 191 Constant-Amplitude Signal Generator to the input connectors of the 7A16's using a 5 ns GR cable, a 50-ohm termination with GR to BNC connectors and a dual-input coupler.

f. Set the Type 191 for an output frequency of 2 megahertz.

g. Obtain a display similar to the one shown in Fig. 5-16 by adjusting the output amplitude of the Type 191 for 8 divisions of horizontal deflection; then adjust the Variable (Volts/Div) control of the 7A16 in the Right Vertical compartment for 8 divisions of vertical deflection. Center the display with the 7A16 Position controls as necessary.

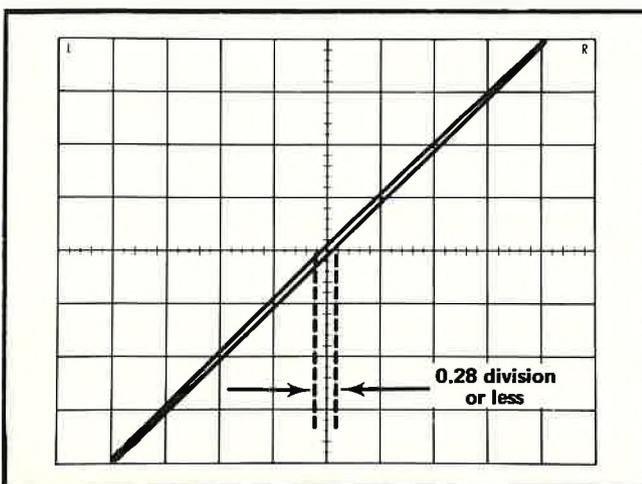


Fig. 5-16. Typical CRT display when checking X-Y phasing.

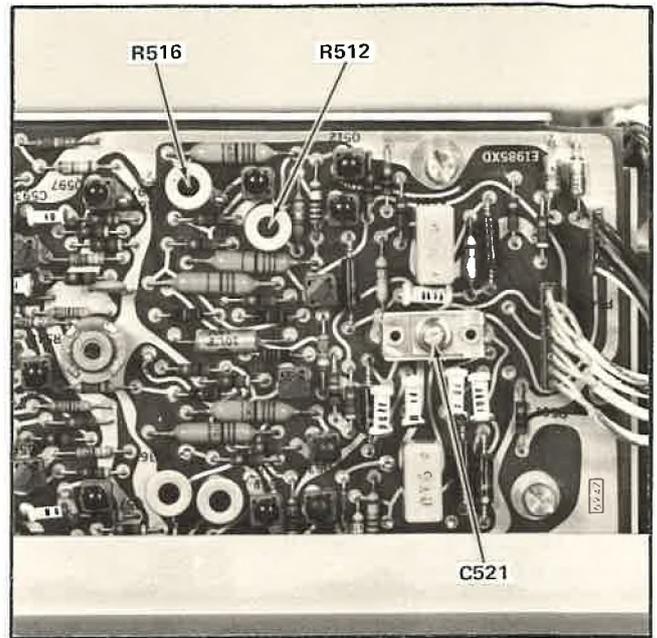


Fig. 5-17. Location of Horizontal Amplifier adjustments.

h. CHECK—Eye opening in the CRT display of 0.28 divisions or less (see Fig. 5-16).

i. ADJUST—C521 (see Fig. 5-17) for an eye opening of 0.28 divisions or less.

j. Remove the 7A16 from the Right Vertical compartment and install it in the Left Vertical compartment.

k. Change the VERTICAL MODE switch to LEFT.

l. CHECK—Eye opening in the CRT display of 0.28 divisions or less.

m. ADJUST—C521, as necessary for an eye opening of 0.28 division or less. Compromise the adjustment of C521 for smallest eye opening in parts h and l.

n. Disconnect the dual-input coupler from the input connectors of the two 7A16's and from the 50-ohm termination. Leave the 5 ns GR cable and the 50-ohm termination connected to the Type 191 output.

30. Check Horizontal Bandwidth

a. Remove the 7A16 from the Left Vertical compartment.

b. Install the 7B52 Time Base in the Left Vertical compartment.

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- c. Set the 7A16 Volts/Div switch to .1 V.
- d. Connect the 5 ns GR cable and 50-ohm termination from the Type 191 output to the Input connector of the 7A16.
- e. Set the output amplitude of the Type 191 for 8 divisions of horizontal deflection at a reference frequency of 50 kHz.
- f. Without changing the output amplitude, increase the output frequency of the Type 191 to 2 MHz.
- g. CHECK—Horizontal deflection of CRT display should not be reduced to less than 5.6 divisions (−3 dB point for a 2 MHz signal).
- h. Disconnect the Type 191, the 5 ns GR cable and the 50-ohm termination.
- i. Interchange the 7A16 and 7B52 in the 7503.

31. Check +SAWTOOTH Output

- a. Connect a 50-ohm BNC cable between the +SAWTOOTH connector on the 7503 side panel and the vertical input connector of the test oscilloscope.
- b. Set the test oscilloscope for a vertical deflection factor of 2 V/Division, DC coupled at a sweep rate of 1 ms/Div.
- c. Set the 7B52 Time Base Time/Div switch to .5 ms.
- d. Adjust the 7B52 Level/Slope control for a free-running sweep.
- e. CHECK—Test oscilloscope display for sawtooth waveform approximately 5 divisions in amplitude.

32. Check +GATE Output

- a. Remove the 50-ohm BNC cable from the +SAWTOOTH connector and connect it to the +GATE connector.
- b. Set the gate selector switch to MAIN GATE.

- c. CHECK—Test oscilloscope for gate waveform display approximately 5 divisions in amplitude.

33. Check VERT SIG OUT

- a. Disconnect the 50-ohm BNC cable from the +GATE connector and connect it to the VERT SIG OUT connector.
- b. Set the 7A16 Volts/Div switch to .1 V.
- c. Connect a 50-ohm BNC cable between the CAL OUT connector and the 7A16 Input connector.
- d. Set the CALIBRATOR switch to 0.4 V.
- e. Set the test oscilloscope for a vertical deflection factor of 0.5 volts/division at a sweep rate of one millisecond/division, and adjust the trigger controls for a stable display.
- f. CHECK—Test oscilloscope display for 4 divisions of vertical deflection (within $\pm 10\%$).

- g. Disconnect the test oscilloscope and the two 50-ohm BNC cables.

NOTE

If the 7503 being calibrated contains Option 1 (read-out deleted), omit step 34.

34. Check/Adjust Readout Character

- a. Remove the 7A16 from the Left Vertical compartment.
- b. Press the RIGHT pushbutton on the VERTICAL MODE switch.
- c. Set the 7B52 Time Base unit Display Mode switch to Mixed and both Time/Div switches to .1 μ s.
- d. Turn the READOUT control clockwise to obtain a visible readout display of the 7B52 Main and Delayed sweep rates.

e. CHECK—Readout display of 100 μ s should be located vertically approximately in the middle of the extreme upper and lower graticule divisions.

NOTE

Some of these tolerances are provided as a guide to correct instrument operation and are not instrument specifications.

f. ADJUST—Readout Vertical Separation adjustment R1285 (see Fig. 5-18) to position the readout characters

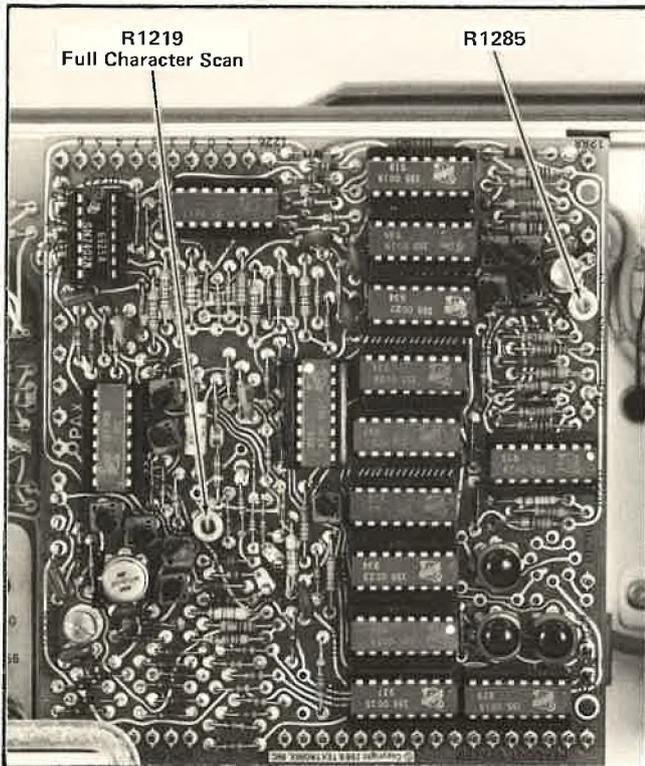


Fig. 5-18. Location of adjustments on the Readout Systems board.

approximately in the middle of the extreme upper and lower graticule divisions.

g. CHECK—Readout display for completeness of characters; the O's should be a complete ring without any overscanning (overscanning produces a spot of increased brightness at the top of the "O").

h. ADJUST—Full Character Scan adjustment, R1219 (see Fig. 5-18), for completeness of characters without overscanning.

i. Install the 7A16 Amplifier unit in the Right Vertical compartment.

j. Press the 7A16 Identify pushbutton.

k. CHECK—While pressing the 7A16 Identify pushbutton, the Right Vertical unit readout display for word size and horizontal position; word "IDENTIFY" should occupy the center two divisions (horizontally) of the graticule area.

l. ADJUST—R516 and R512 (see Fig. 5-17) on Horizontal Amplifier board, for Right Vertical unit readout display word "IDENTIFY" to occupy the center two divisions (horizontally) of the graticule area.

This completes the calibration/checkout procedure for the 7503. Remove all plug-in units, turn the 7503 POWER switch to OFF and disconnect the instrument from the power source. Replace the bottom and side covers. If the instrument has been completely checked and adjusted to the tolerances given in this procedure, it will meet or exceed the specifications given in Section 1.

PARTS LIST ABBREVIATIONS

BHB	binding head brass	int	internal
BHS	binding head steel	lg	length or long
cap.	capacitor	mef.	metal
cer	ceramic	mtg hdw	mounting hardware
comp	composition	OD	outside diameter
conn	connector	OHB	oval head brass
CRT	cathode-ray tube	OHS	oval head steel
csk	countersunk	P/O	part of
DE	double end	PHB	pan head brass
dia	diameter	PHS	pan head steel
div	division	plstc	plastic
elect.	electrolytic	PMC	paper, metal cased
EMC	electrolytic, metal cased	poly	polystyrene
EMT	electrolytic, metal tubular	prec	precision
ext	external	PT	paper, tubular
F & I	focus and intensity	PTM	paper or plastic, tubular, molded
FHB	flat head brass	RHB	round head brass
FHS	flat head steel	RHS	round head steel
Fil HB	fillister head brass	SE	single end
Fil HS	fillister head steel	SN or S/N	serial number
h	height or high	S or SW	switch
hex.	hexagonal	TC	temperature compensated
HHB	hex head brass	THB	truss head brass
HHS	hex head steel	thk	thick
HSB	hex socket brass	THS	truss head steel
HSS	hex socket steel	tub.	tubular
ID	inside diameter	var	variable
inc	incandescent	w	wide or width
		WW	wire-wound

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 or model 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.

SPECIAL NOTES AND SYMBOLS

- | | |
|-----------------|---|
| ×000 | Part first added at this serial number |
| 00× | Part removed after this serial number |
| *000-0000-00 | Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components. |
| Use 000-0000-00 | Part number indicated is direct replacement. |

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SECTION 6

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description		
CHASSIS						
Bulb						
DS786A	150-0030-00			Neon, NE 2 V	GE	
DS786B	150-0030-00			Neon, NE 2 V	GE	
DS786C	150-0030-00			Neon, NE 2 V	GE	
Capacitors						
Tolerance $\pm 20\%$ unless otherwise indicated.						
C569	283-0002-00			0.01 μF	Cer	500 V
C744	283-0021-00	B010100	B109999	0.001 μF	Cer	5000 V
C744	283-0033-00	B110000		0.001 μF	Cer	6000 V
C767	283-0082-00			0.01 μF	Cer	4000 V +80% -20%
C769	283-0082-00			0.01 μF	Cer	4000 V +80% -20%
C772 ¹						
C773 ¹						
C774 ¹						
C775	283-0082-00			0.01 μF	Cer	4000 V +80% -20%
C785	285-0082-00			0.01 μF	Cer	4000 V +80% -20%
C788	283-0082-00			0.01 μF	Cer	4000 V +80% -20%
C797	283-0033-01	XB070000		0.001 μF	Cer	6000 V +100% -0%
C789	283-0082-00			0.01 μF	Cer	4000 V +80% -20%
C822	290-0466-00			1800 μF	Elect.	100 V +75% -10%
C852	290-0469-00			8300 μF	Elect.	30 V +75% -10%
C882	290-0467-00			42,000 μF	Elect.	15 V +75% -10%
C912	290-0465-00			19,000 μF	Elect.	30 V +75% -10%
C942	290-0466-00			1800 μF	Elect.	100 V +75% -10%
Semiconductor Device, Diodes						
CR767	152-0408-00			Silicon		Rectifier 10 kV 5 mA Fast reverse recovery
CR772 ¹						
CR773 ¹						
CR774 ¹						
CR775	152-0408-00			Silicon		Rectifier 10 kV 5 mA Fast reverse recovery
VR786	152-0100-00			Zener		1N3046B 1 W, 120 V, 5%
CR1041	152-0423-00			Silicon		Rectifier, 300 V, 3 A
CR1042	152-0423-00			Silicon		Rectifier, 300 V, 3 A

¹Furnished as a unit with H.V. Power Supply sub-assembly (*119-0235-00).

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
Filter				
FL801	119-0113-05		5.25 A	250 V AC
Fuses				
F801	159-0027-00		4 A	3 AG Slo-Blo
F802	159-0005-00		3 A	3 AG Slo-Blo
Connectors				
J619	131-0818-00			Receptacle, electrical, BNC, female
J629	131-0818-00			Receptacle, electrical, BNC, female
J659	131-0818-00			Receptacle, electrical, BNC, female
J699	131-0818-00			Receptacle, electrical, BNC, female
J1055	131-0106-00	B010100	B049999	Receptacle, electrical, BNC, female
J1055	131-0955-00	B050000		Receptacle, electrical, BNC, female
J1060	131-0106-00	B010100	B049999	Receptacle, electrical, BNC, female
J1060	131-0955-00	B050000		Receptacle, electrical, BNC, female
J1075	136-0089-00			Socket, 9 pin
J1080	131-0771-00			Receptacle, electrical 4 contact
J1085	131-0771-00			Receptacle, electrical 4 contact
Inductors				
L485	*114-0159-00			0.7-1.1 μ H, Var Core 276-0506-00
L568	*108-0015-00			255 μ H
L588	*108-0015-00			255 μ H
L779	*108-0544-00			Trace rotator
L788	108-0553-00			47 μ H
L794	*108-0605-00			Y Axis alignment
LR486	*108-0006-00			0.13 μ H (wound on a 100 Ω resistor)
LR487	*108-0006-00			0.13 μ H (wound on a 100 Ω resistor)
Transistors				
Q484	*151-0211-00		Silicon	NPN TO-5 Selected from 2N3866
Q486	*151-0211-00		Silicon	NPN TO-5 Selected from 2N3866
Q568	*151-0274-00		Silicon	NPN TO-5 Selected from 2N3501
Q588	*151-0274-00		Silicon	NPN TO-5 Selected from 2N3501
Q823	*151-0209-00		Silicon	NPN TO-3 Selected from 2N3442
Q853	*151-0140-00		Silicon	NPN TO-3 Selected from 2N3055
Q883	151-0275-00		Silicon	NPN TO-3 2N3771
Q884	*151-0148-00		Silicon	NPN TO-66 Tek Spec
Q910	151-0507-00		Silicon	Controlled rectifier 2N3669
Q913	*151-0140-00		Silicon	NPN TO-3 Selected from 2N3055

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Transistors (cont)				
Q914	*151-0148-00		Silicon	NPN TO-66 Tek Spec
Q943	*151-0209-00		Silicon	NPN TO-3 Selected from 2N3442
Q973	*151-0149-00		Silicon	NPN TO-66 Tek Spec
Q997	151-0201-00		Silicon	NPN TO-66 2N3739

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R102 ²	311-0945-00		5 k Ω , Var			
R481	303-0470-00		47 Ω	1 W		5%
R482	308-0430-00		500 Ω	8 W	WW	1%
R483	308-0430-00		500 Ω	8 W	WW	1%
R567	301-0101-00		100 Ω	1/2 W		5%
R568	308-0632-00		2.5 k Ω	10 W	WW	1%
R569	302-0470-00		47 Ω	1/2 W		
R587	301-0101-00		100 Ω	1/2 W		5%
R588	308-0632-00		2.5 k Ω	10 W	WW	1%
R774A R744B R744C R744D R767	*307-0205-03	B010100	180 k Ω 470 k Ω 29.45 M Ω 19 M Ω 80 M Ω		Film Assembly	
R774A R774B R774C R774D R774E R774F	*307-0294-00	B070000	180 k Ω 470 k Ω 29.45 M Ω 19 M Ω 80 M Ω 30 M Ω		Film Assembly	
R768	311-0990-00		5 M, Var			
R769	316-0393-00		39 k Ω	1/4 W		
R770	316-0105-00		1 M Ω	1/4 W		
R771	316-0156-00		15 M Ω	1/4 W		
R776 ³						
R779	311-0964-00		2.5 k Ω , Var			
R785	301-0225-00	XB070000	2.2 M Ω	1/2 W		5%
R787 ⁴	311-0945-00		5 M Ω , Var			
R788	325-0073-00		3.57 M Ω	1 W	Prec	1%
R789	301-0471-00		470 Ω	1/2 W		5%
R796	311-0467-00		100 k Ω , Var			
R810 ⁵	311-0973-00		5 k Ω , Var			
R1040 ⁶						

²Furnished as a unit with R787.³Furnished as a unit with H.V. Power Supply sub-assembly (*119-0235-00).⁴Furnished as a unit with R102.⁵Furnished as a unit with S455.⁶Furnished as a unit with S1040A,B.

Electrical Parts List—7503

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Switches				
	Wired or Unwired			
S455 ⁷	311-0973-00			BEAM FINDER
S640	260-0450-00		Slide	
S800	260-0907-00		Thermostatic	Open 208°F, Close 168°F
S801	260-1060-00		Lever	POWER ON
S802 ⁸				
S803 ⁹				
S1040A,B ⁹	260-1138-00		Rotary	CONTROL ILLUM

Transformers

T764	*120-0627-00	B010100	B069999	HV Power
T764	*120-0627-01	B070000		HV Power
T801	*120-0664-00			LV Power

Electron Tube

V799	*154-0608-00		T7500-31-1	CRT Standard Phosphor
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READOUT Circuit Board Assembly

*670-0635-01	B010100	B010132	Complete Board
*670-0635-02	B010133	B069999	Complete Board
*670-0635-04	B070000	B079999	Complete Board
*670-0635-05	B080000	B089999	Complete Board
*670-0635-07	B090000		Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C1141	283-0032-00		470 pF	Cer	500 V	5%
C1166	283-0004-00	XB080000	0.02 μ F	Cer	150 V	
C1180	283-0032-00		470 pF	Cer	500 V	5%
C1186	283-0004-00	XB080000	0.02 μ F	Cer	150 V	
C1190	283-0000-00		0.001 μ F	Cer	500 V	
C1214	285-0698-00		0.0082 μ F	PTM	100 V	5%
C1222	283-0103-00		180 pF	Cer	500 V	5%
C1227	283-0103-00		180 pF	Cer	500 V	5%
C1230	283-0000-00		0.001 μ F	Cer	500 V	
C1237	283-0000-00	XB070000	0.001 μ F	Cer	500 V	
C1266	283-0103-00		180 pF	Cer	500 V	5%
C1267	283-0000-00		0.001 μ F	Cer	500 V	
C1268	283-0177-00		1 μ F	Cer	25 V	+80%—20%
C1291	283-0177-00		1 μ F	Cer	25 V	+80%—20%
C1294	283-0177-00		1 μ F	Cer	25 V	+80%—20%
C1297	283-0177-00		1 μ F	Cer	25 V	+80%—20%

⁷Furnished as a unit with R810.

⁸See Mechanical Parts List. Line Voltage Selector Body.

⁹Furnished as a unit with R1040.

READOUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Semiconductor Device, Diodes				
CR1112	*152-0185-00			Silicon Replaceable by 1N4152
CR1113	*152-0185-00			Silicon Replaceable by 1N4152
CR1117	*152-0185-00			Silicon Replaceable by 1N4152
CR1118	*152-0185-00			Silicon Replaceable by 1N4152
CR1122	*152-0185-00			Silicon Replaceable by 1N4152
CR1123	*152-0185-00			Silicon Replaceable by 1N4152
CR1127	*152-0185-00			Silicon Replaceable by 1N4152
CR1128	*152-0185-00			Silicon Replaceable by 1N4152
CR1132	*152-0185-00	XB070000		Silicon Replaceable by 1N4152
CR1133	*152-0185-00	XB070000		Silicon Replaceable by 1N4152
CR1135	*152-0185-00	XB070000		Silicon Replaceable by 1N4152
CR1137	*152-0185-00	XB070000		Silicon Replaceable by 1N4152
CR1141	*152-0185-00	XB010133	B079999X	Silicon Replaceable by 1N4152
CR1142	*152-0185-00	XB070000	B079999X	Silicon Replaceable by 1N4152
CR1155	*152-0185-00			Silicon Replaceable by 1N4152
CR1206	*152-0185-00			Silicon Replaceable by 1N4152
CR1207	*152-0185-00			Silicon Replaceable by 1N4152
CR1208	*152-0185-00			Silicon Replaceable by 1N4152
CR1213	*152-0185-00	XB070000		Silicon Replaceable by 1N4152
CR1216	*152-0185-00			Silicon Replaceable by 1N4152
CR1217	*152-0185-00			Silicon Replaceable by 1N4152
CR1222	*152-0185-00			Silicon Replaceable by 1N4152
CR1223	*152-0185-00			Silicon Replaceable by 1N4152
CR1224	*152-0185-00			Silicon Replaceable by 1N4152
CR1227	*152-0185-00			Silicon Replaceable by 1N4152
CR1231	*152-0185-00			Silicon Replaceable by 1N4152
VR1260	152-0405-00			Zener 1 W, 15 V, 5%
VR1261	152-0405-00			Zener 1 W, 15 V, 5%
VR1262	152-0405-00			Zener 1 W, 15 V, 5%
Inductor				
L1270	*108-0331-00			0.75 μ H
Transistors				
Q1143	151-0232-00			Silicon NPN TO-77 Dual
Q1150	151-0190-00			Silicon NPN TO-92 2N3904
Q1152	151-0190-00			Silicon NPN TO-92 2N3904
Q1155	151-0188-00			Silicon PNP TO-92 2N3906
Q1163	151-0190-00			Silicon NPN TO-92 2N3904
Q1185	*151-0192-00			Silicon NPN TO-92 Replaceable by MPS 6521
Q1223	151-0188-00			Silicon PNP TO-92 2N3906
Q1226	151-0190-00			Silicon NPN TO-92 2N3904
Q1274	151-0188-00			Silicon PNP TO-92 2N3906
Q1278	151-0188-00			Silicon PNP TO-92 2N3906
Q1284	151-0188-00			Silicon PNP TO-92 2N3906
Q1288	151-0188-00			Silicon PNP TO-92 2N3906

READOUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors						
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.						
R1111	317-0102-00			1 k Ω	1/8 W	5%
R1112	317-0751-00			750 Ω	1/8 W	5%
R1113	317-0751-00			750 Ω	1/8 W	5%
R1116	317-0102-00			1 k Ω	1/8 W	5%
R1117	317-0751-00			750 Ω	1/8 W	5%
R1118	317-0751-00			750 Ω	1/8 W	5%
R1121	317-0102-00			1 k Ω	1/8 W	5%
R1122	317-0751-00			750 Ω	1/8 W	5%
R1123	317-0751-00			750 Ω	1/8 W	5%
R1126	317-0102-00			1 k Ω	1/8 W	5%
R1127	317-0751-00			750 Ω	1/8 W	5%
R1128	317-0751-00			750 Ω	1/8 W	5%
R1131	317-0513-00			51 k Ω	1/8 W	5%
R1132	317-0133-00			13 k Ω	1/8 W	5%
R1133	317-0133-00			13 k Ω	1/8 W	5%
R1134	317-0753-00			75 k Ω	1/8 W	5%
R1135	321-0310-00	B010100	B069999	51 k Ω	1/8 W	Prec 1%
R1135	321-0308-00	B070000		15.8 k Ω	1/8 W	Prec 1%
R1136	317-0513-00			16.5 k Ω	1/8 W	5%
R1137	321-0321-00	B010100	B069999	21.5 k Ω	1/8 W	Prec 1%
R1137	321-0319-00	B070000		20.5 k Ω	1/8 W	Prec 1%
R1138	321-0335-00			30.1 k Ω	1/8 W	Prec 1%
R1140	317-0752-00			7.5 k Ω	1/8 W	5%
R1141	321-0261-00	B010100	B089999	5.11 k Ω	1/8 W	Prec 1%
R1141	321-0258-00	B090000		4.75 k Ω	1/8 W	Prec 1%
R1142	311-0634-00	XB090000		500 Ω , Var		
R1143	317-0133-00			13 k Ω	1/8 W	5%
R1144	317-0154-00	B010100	B079999	150 k Ω	1/8 W	5%
R1144	317-0124-00	B080000		120 k Ω	1/8 W	5%
R1146	321-0181-00			750 Ω	1/8 W	Prec 1%
R1147	321-0299-00	B010100	B010132	12.7 k Ω	1/8 W	Prec 1%
R1147	321-0297-00	B010133	B079999	12.1 k Ω	1/8 W	Prec 1%
R1147	321-0299-00	B080000		12.7 k Ω	1/8 W	Prec 1%
R1148	321-0212-00	B010100	B069999	1.58 k Ω	1/8 W	5%
R1148	317-0102-00	B070000	B079999	1 k Ω	1/8 W	5%
R1148	321-0212-00	B080000		1.58 k Ω	1/8 W	Prec 1%
R1152	317-0152-00			1.5 k Ω	1/8 W	5%
R1155	317-0562-00	B010100	B069999	5.6 k Ω	1/8 W	5%
R1155	317-0222-00	B070000		2.2 k Ω	1/8 W	5%
R1156	321-0297-00	B010100	B069999	12.1 k Ω	1/8 W	Prec 1%
R1156	321-0268-00	B070000		6.04 k Ω	1/8 W	Prec 1%
R1163	317-0243-00			24 k Ω	1/8 W	5%
R1171	317-0154-00			150 k Ω	1/8 W	5%
R1172	321-0335-00			30.1 k Ω	1/8 W	Prec 1%
R1173	321-0344-00			37.4 k Ω	1/8 W	Prec 1%
R1174	321-0335-00			30.1 k Ω	1/8 W	
R1175	317-0513-00			51 k Ω	1/8 W	5%
R1176	317-0154-00			150 k Ω	1/8 W	5%
R1177	321-0335-00			30.1 k Ω	1/8 W	Prec 1%
R1178	321-0335-00			30.1 k Ω	1/8 W	Prec 1%
R1180	321-0262-00	B010100	B069999	5.23 k Ω	1/8 W	Prec 1%

READOUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
Resistors (cont)							
R1180	321-0264-00	B070000	B089999	5.49 k Ω	1/8 W	Prec	1%
R1180	321-0261-00	B090000		5.11 k Ω	1/8 W	Prec	1%
R1181	321-0371-00	B010100	B069999	71.5 k Ω	1/8 W	Prec	1%
R1181	321-0367-00	B070000	B079999	64.9 k Ω	1/8 W	Prec	1%
R1181	321-0372-00	B080000		73.2 k Ω	1/8 W	Prec	1%
R1182	311-0634-00	XB090000		500 Ω , Var			
R1183	321-0401-00	B010100	B079999	147 k Ω	1/8 W	Prec	1%
R1183	321-0407-00	B080000		169 k Ω	1/8 W	Prec	1%
R1185	317-0103-00			10 k Ω	1/8 W		5%
R1190	317-0303-00			30 k Ω	1/8 W		5%
R1191	317-0203-00			20 k Ω	1/8 W		5%
R1193	317-0203-00			20 k Ω	1/8 W		5%
R1195	317-0203-00			20 k Ω	1/8 W		5%
R1197	317-0203-00			20 k Ω	1/8 W		5%
R1205	317-0432-00			4.3 k Ω	1/8 W		5%
R1206	317-0683-00			68 k Ω	1/8 W		5%
R1210	317-0104-00			100 k Ω	1/8 W		5%
R1214	317-0393-00			39 k Ω	1/8 W		5%
R1215	317-0332-00	B010100	B069999	3.3 k Ω	1/8 W		5%
R1215	317-0302-00	B070000		3 k Ω	1/8 W		5%
R1216	315-0152-00			1.5 k Ω	1/4 W		5%
R1218	317-0183-00			18 k Ω	1/8 W		5%
R1219	311-0634-00	B010100	B069999	500 Ω , Var			
R1219	311-0635-00	B070000		1 k Ω , Var			
R1220	317-0103-00			10 k Ω	1/8 W		5%
R1221	317-0752-00			7.5 k Ω	1/8 W		5%
R1223	315-0242-00			2.4 k Ω	1/4 W		5%
R1226	317-0152-00			1.5 k Ω	1/8 W		5%
R1227	317-0512-00			5.1 k Ω	1/8 W		5%
R1230	317-0512-00			5.1 k Ω	1/8 W		5%
R1231	317-0332-00	XB080000		3.3 k Ω	1/8 W		5%
R1235	317-0512-00	XB070000		5.1 Ω	1/8 W		5%
R1237	317-0222-00	XB070000		2.2 k Ω	1/8 W		5%
R1255	321-0222-00	B010100	B069999	2 k Ω	1/8 W	Prec	1%
R1255	321-0176-00	B070000		665 Ω	1/8 W	Prec	1%
R1256	321-0176-00	B010100	B069999	665 Ω	1/8 W	Prec	1%
R1256	321-0153-00	B070000		383 Ω	1/8 W	Prec	1%
R1257	321-0250-00			3.92 k Ω	1/8 W	Prec	1%
R1258	317-0223-00			22 k Ω	1/8 W		5%
R1260	317-0102-00			1 k Ω	1/8 W		5%
R1264	317-0272-00			2.7 k Ω	1/8 W		5%
R1265	317-0512-00			5.1 k Ω	1/8 W		5%
R1266	317-0822-00	B010100	B069999	8.2 k Ω	1/8 W		5%
R1266	317-0912-00	B070000		9.1 k Ω	1/8 W		5%
R1268	321-0296-00			11.8 k Ω	1/8 W	Prec	1%
R1269	317-0823-00			82 k Ω	1/8 W		5%
R1270	321-0222-00			2 k Ω	1/8 W	Prec	1%
R1271	321-0216-00			1.74 k Ω	1/8 W	Prec	1%
R1272	321-0245-00			3.48 k Ω	1/8 W	Prec	1%
R1274	321-0209-00			1.47 k Ω	1/8 W	Prec	1%

READOUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
Resistors (cont)				
R1276	321-0241-00			3.16 kΩ 1/8 W Prec 1%
R1277	321-0255-00			4.42 kΩ 1/8 W Prec 1%
R1278	315-0152-00			1.5 kΩ 1/4 W 5%
R1280	321-0273-00			6.81 kΩ 1/8 W Prec 1%
R1281	321-0193-00			1 kΩ 1/8 W Prec 1%
R1284	321-0199-00			1.15 kΩ 1/8 W Prec 1%
R1285	311-0635-00			1 kΩ, Var
R1286	321-0204-00			1.3 kΩ 1/8 W Prec 1%
R1287	321-0245-00			3.48 kΩ 1/8 W Prec 1%
R1288	315-0152-00			1.5 kΩ 1/4 W 5%
R1289	315-0511-00			510 Ω 1/4 W 5%

Integrated Circuits

U1130	*155-0015-00			Monolithic
U1166	*155-0014-00			Monolithic
U1170	*155-0015-00			Monolithic
U1186	*155-0014-00			Monolithic
U1190	*155-0018-00			Monolithic
U1210	*155-0021-00			Monolithic
U1226	*155-0017-00			Monolithic
U1227	156-0043-00			Quad 2 input NOR gate Replaceable by T. I. SN7402N
U1230	156-0012-00			Clocked J-K flip-flop Replaceable by Fairchild μL923
U1231	156-0012-00			Clocked J-K flip-flop Replaceable by Fairchild μL923
U1232	156-0012-00			Clocked J-K flip-flop Replaceable by Fairchild μL923
U1236	156-0011-00	XB070000		Dual 2 input gate Replaceable by Fairchild μL914
U1251	*155-0023-00			Monolithic
U1252	*155-0024-00			Monolithic
U1253	*155-0025-00			Monolithic
U1254	*155-0026-00			Monolithic
U1255	*155-0027-00			Monolithic
U1260	*155-0019-00			Monolithic
U1270	*155-0020-00			Monolithic

GRATICULE LIGHT Circuit Board Assembly

*670-0702-00

Complete Board

Bulbs

DS817	150-0029-00	GE 349
DS818	150-0029-00	GE 349
DS819	150-0029-00	GE 349

INTERFACE-TRIGGER SELECTOR Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
	*670-0858-00	B010100	B069999	Complete Board
	*670-0858-01	B070000		Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C301	283-0003-00		0.01 μF	Cer	150 V	
C305	283-0004-00		0.02 μF	Cer	150 V	
C322	281-0616-00		6.8 pF	Cer	200 V	
C329	281-0616-00		6.8 pF	Cer	200 V	
C342	283-0000-00		0.001 μF	Cer	500 V	
C343	281-0505-00	XB070000	12 pF	Cer	500 V	10%
C348	283-0000-00		0.001 μF	Cer	500 V	

Semiconductor Device, Diodes

CR341	152-0141-02		Silicon		1N4152	
CR349	152-0141-02		Silicon		1N4152	

Transistors

Q314	151-0225-00		Silicon	NPN	TO-18	2N3563
Q334	151-0259-00		Silicon	NPN	TO-106	Selected from 2N3563
Q336	151-0259-00		Silicon	NPN	TO-106	Selected from 2N3563
Q344	151-0221-00		Silicon	PNP	TO-18	2N4258
Q346	151-0221-00		Silicon	PNP	TO-18	2N4258

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R301	307-0106-00		4.7 Ω	$\frac{1}{4}$ W		5%
R303	307-0106-00		4.7 Ω	$\frac{1}{4}$ W		5%
R305	307-0103-00		2.7 Ω	$\frac{1}{4}$ W		5%
R310	315-0103-00		10 k Ω	$\frac{1}{4}$ W		5%
R312	315-0562-00		5.6 k Ω	$\frac{1}{4}$ W		5%
R314	315-0103-00		10 k Ω	$\frac{1}{4}$ W		5%
R315	315-0513-00		51 k Ω	$\frac{1}{4}$ W		5%
R317	321-0069-00		51.1 Ω	$\frac{1}{8}$ W	Prec	1%
R319	321-0069-00		51.1 Ω	$\frac{1}{8}$ W	Prec	1%
R320	321-0218-00		1.82 k Ω	$\frac{1}{8}$ W	Prec	1%
R321	321-0061-00		42.2 Ω	$\frac{1}{8}$ W	Prec	1%
R322	315-0101-00		100 Ω	$\frac{1}{4}$ W		5%
R323	321-0061-00		42.2 Ω	$\frac{1}{8}$ W	Prec	1%
R324	322-0184-00		806 Ω	$\frac{1}{4}$ W	Prec	1%
R326	321-0061-00		42.2 Ω	$\frac{1}{8}$ W	Prec	1%

INTERFACE-TRIGGER SELECTOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R327	322-0184-00		806 Ω	1/4 W	Prec	1%
R328	321-0061-00		42.2 Ω	1/8 W	Prec	1%
R329	315-0101-00		100 Ω	1/4 W		5%
R330	321-0044-00		28 Ω	1/8 W	Prec	1%
R332	321-0220-00		1.19 kΩ	1/8 W	Prec	1%
R333	321-0143-00		301 Ω	1/8 W	Prec	1%
R335	321-0044-00		28 Ω	1/8 W	Prec	1%
R336	321-0129-00		215 Ω	1/8 W	Prec	1%
R337	321-0129-00		215 Ω	1/8 W	Prec	1%
R339	315-0101-00		100 Ω	1/4 W		5%
R340	321-0214-00		1.65 kΩ	1/8 W	Prec	1%
R341	315-0101-00		100 Ω	1/4 W		5%
R342	315-0301-00		300 Ω	1/4 W		5%
R343	315-0101-00	XB070000	100 Ω	1/4 W		5%
R344	321-0035-00		22.6 Ω	1/8 W	Prec	1%
R345	315-0561-00		560 Ω	1/4 W		5%
R346	321-0035-00		22.6 Ω	1/8 W	Prec	1%
R348	315-0301-00		300 Ω	1/4 W		5%
R349	315-0101-00		100 Ω	1/4 W		5%
R350	321-0214-00		1.65 Ω	1/8 W	Prec	1%
R352	315-0430-00		43 Ω	1/4 W		5%

Integrated Circuit

U324	*155-0022-00	Monolithic
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INTERFACE-MAIN Circuit Board Assembly

*670-0859-00

Complete Board

Capacitors

Tolerance ±20% unless otherwise indicated.

C1	290-0302-00	100 μF	Elect.	20 V	10%
C3	290-0271-00	9 μF	Elect.	125 V	+20%—15%
C5	290-0302-00	100 μF	Elect.	20 V	10%
C7	290-0302-00	100 μF	Elect.	20 V	10%
C9	290-0271-00	9 μF	Elect.	125 V	+20%—15%
C44	283-0068-00	0.01 μF	Cer	500 V	
C47	281-0638-00	240 pF	Cer	500 V	5%
C48	283-0068-00	0.01 μF	Cer	500 V	

INTERFACE-MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Semiconductor Device, Diodes (cont)				
CR26	*152-0185-00		Silicon	Replaceable by 1N4152
CR27	*152-0185-00		Silicon	Replaceable by 1N4152
CR33	*152-0185-00		Silicon	Replaceable by 1N4152
CR42	*152-0185-00		Silicon	Replaceable by 1N4152
CR49	*152-0185-00		Silicon	Replaceable by 1N4152
Connectors				
J1	131-0767-00			Receptacle, electrical
J2	131-0767-02			Receptacle, electrical
J3	131-0767-02			Receptacle, electrical
Meter				
M10	149-0030-00			Elapsed time
Resistors				
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.				
R10	315-0395-00		3.9 M Ω	$\frac{1}{4}$ W 5%
R12	321-0260-00		4.99 k Ω	$\frac{1}{8}$ W Prec 1%
R14	321-0260-00		4.99 k Ω	$\frac{1}{8}$ W Prec 1%
R20	315-0560-00		56 Ω	$\frac{1}{4}$ W 5%
R21	315-0511-00		510 Ω	$\frac{1}{4}$ W 5%
R23	315-0511-00		510 Ω	$\frac{1}{4}$ W 5%
R24	315-0560-00		56 Ω	$\frac{1}{4}$ W 5%
R28	315-0510-00		51 Ω	$\frac{1}{4}$ W 5%
R29	315-0510-00		51 Ω	$\frac{1}{4}$ W 5%
R31	315-0122-00		1.2 k Ω	$\frac{1}{4}$ W 5%
R33	315-0682-00		6.8 k Ω	$\frac{1}{4}$ W 5%
R35	315-0122-00		1.2 k Ω	$\frac{1}{4}$ W 5%
R37	315-0122-00		1.2 k Ω	$\frac{1}{4}$ W 5%
R40	321-0231-00		2.49 k Ω	$\frac{1}{8}$ W Prec 1%
R42	315-0105-00		1 M Ω	$\frac{1}{4}$ W 5%
R44	315-0334-00		330 k Ω	$\frac{1}{4}$ W 5%
R46	315-0151-00		150 Ω	$\frac{1}{4}$ W 5%
R47	315-0683-00		68 k Ω	$\frac{1}{4}$ W 5%
R48	315-0334-00		330 k Ω	$\frac{1}{4}$ W 5%
R49	315-0105-00		1 M Ω	$\frac{1}{4}$ W 5%

VERT INTERFACE Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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*670-0860-00

Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C208	281-0528-00	82 pF	Cer	500 V	10%
C209	281-0599-00	1 pF	Cer	200 V	± 0.25 pF
C212	281-0537-00	0.68 pF	Cer	500 V	
C215	281-0589-00	170 pF	Cer	500 V	5%
C220	283-0177-00	1 μ F	Cer	25 V	+80%—20%
C227	281-0578-00	18 pF	Cer	500 V	5%

Semiconductor Device, Diodes

CR230	*152-0185-00	Silicon		Replaceable by 1N4152
CR264 } CR266 }	*153-0025-00	Silicon		Tek Spec (matched pair)

Transistors

Q224 } Q228 }	*153-0587-00	Silicon	NPN	TO-92	Tek Spec (matched pair)
Q232	*151-0190-01	Silicon	NPN	TO-106	Tek Spec
Q242	151-0221-00	Silicon	PNP	TO-18	2N4258
Q248	151-0221-00	Silicon	PNP	TO-18	2N4258
Q252	151-0221-00	Silicon	PNP	TO-18	2N4258
Q258	151-0221-00	Silicon	PNP	TO-18	2N4258
Q262	*151-0212-00	Silicon	NPN	TO-18	Tek Spec
Q268	*151-0212-00	Silicon	NPN	TO-18	Tek Spec

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R200	321-1068-02	50.5 Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{2}\%$
R202	321-1068-02	50.5 Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{2}\%$
R204	321-1068-02	50.5 Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{2}\%$
R206	321-1068-02	50.5 Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{2}\%$
R208	317-0393-00	39 k Ω	$\frac{1}{8}$ W		5%
R209	321-0741-02	40.9 Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{2}\%$
R211	322-0197-00	1.1 k Ω	$\frac{1}{4}$ W	Prec	1%
R212	321-0741-02	40.9 Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{2}\%$
R214	322-0212-00	1.58 k Ω	$\frac{1}{4}$ W	Prec	1%
R215	317-0393-00	39 k Ω	$\frac{1}{8}$ W		5%
R216	321-0741-02	40.9 Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{2}\%$
R218	322-0197-00	1.1 k Ω	$\frac{1}{4}$ W	Prec	1%
R219	321-0741-02	40.9 Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{2}\%$
R221	317-0330-00	33 Ω	$\frac{1}{8}$ W		5%
R222	317-0330-00	33 Ω	$\frac{1}{8}$ W		5%

VERT INTERFACE Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description		
Resistors (cont)						
R223	315-0510-00		51 Ω	$\frac{1}{4}$ W		5%
R224	321-1068-02		50.5 Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{2}$ %
R225	317-0511-00		510 Ω	$\frac{1}{8}$ W		5%
R226	321-0062-00		43.2 Ω	$\frac{1}{8}$ W	Prec	1%
R228	321-0062-00		43.2 Ω	$\frac{1}{8}$ W	Prec	1%
R229	317-0511-00		510 Ω	$\frac{1}{8}$ W		5%
R230	317-0912-00		9.1 k Ω	$\frac{1}{8}$ W		5%
R232	322-0207-00		1.4 k Ω	$\frac{1}{4}$ W	Prec	1%
R234	321-0164-00		499 Ω	$\frac{1}{8}$ W	Prec	1%
R235	321-0164-00		499 Ω	$\frac{1}{8}$ W	Prec	1%
R237	317-0100-00		10 Ω	$\frac{1}{8}$ W		5%
R238	321-0214-00		1.65 k Ω	$\frac{1}{8}$ W	Prec	1%
R240	317-0100-00		10 Ω	$\frac{1}{8}$ W		5%
R241	321-0214-00		1.65 k Ω	$\frac{1}{8}$ W	Prec	1%
R243	322-0145-00		316 Ω	$\frac{1}{4}$ W	Prec	1%
R245	322-0145-00		316 Ω	$\frac{1}{4}$ W	Prec	1%
R252	315-0200-00		20 Ω	$\frac{1}{4}$ W		5%
R253	321-0097-00		100 Ω	$\frac{1}{8}$ W	Prec	1%
R255	317-0331-00		330 Ω	$\frac{1}{8}$ W		5%
R257	315-0200-00		20 Ω	$\frac{1}{4}$ W		5%
R258	321-0097-00		100 Ω	$\frac{1}{8}$ W	Prec	1%
R260	322-0216-00		1.74 k Ω	$\frac{1}{4}$ W	Prec	1%
R261	322-0216-00		1.74 k Ω	$\frac{1}{4}$ W	Prec	1%
R263	321-0097-00		100 Ω	$\frac{1}{8}$ W	Prec	1%
R265	317-0134-00		130 k Ω	$\frac{1}{8}$ W		5%
R271	321-0098-00		102 Ω	$\frac{1}{8}$ W	Prec	1%

Transformer

T270	*120-0628-00	Toroid, two 2 turn windings
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Integrated Circuit

U214	*155-0022-00	Monolithic
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REGULATOR Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
	*670-0861-00	B010100	B049999	Complete Board
	*670-0861-01	B050000	B059999	Complete Board
	*670-0861-02	B060000	B079999	Complete Board
	*670-0861-03	B080000		Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C834	281-0536-00			1000 pF	Cer	500 V	10%
C840	290-0297-00			39 μ F	Elect.	10 V	10%
C864	285-0598-00			0.01 μ F	PTM	100 V	5%
C894	290-0282-00			0.047 μ F	Elect.	35 V	10%
C898	290-0269-00			0.22 μ F	Elect.	35 V	5%
C908	283-0000-00	B010100	B069999	0.001 μ F	Cer	500 V	
C908	283-0192-00	B070000		0.47 μ F	Cer	3 V	+80%—20%
C924	285-0719-00			0.015 μ F	PTM	100 V	5%
C928	285-0629-00			0.047 μ F	PTM	100 V	
C960	285-0598-00			0.01 μ F	PTM	100 V	5%
C985	283-0119-00			2200 pF	Cer	200 V	5%
C989	283-0092-00			0.03 μ F	Cer	200 V	+80%—20%
C995	283-0000-00			0.001 μ F	Cer	500 V	
C996	283-0092-00			0.03 μ F	Cer	200 V	+80%—20%

Semiconductor Device, Diodes

CR825	*152-0185-00			Silicon		Replaceable by 1N4152
CR826	*152-0185-00			Silicon		Replaceable by 1N4152
CR832	*152-0185-00			Silicon		Replaceable by 1N4152
CR833	*152-0185-00			Silicon		Replaceable by 1N4152
VR840	152-0411-00			Zener		1N937 9 V, 5% TC
CR843	*152-0185-00			Silicon		Replaceable by 1N4152
CR849	152-0423-00			Silicon		Rectifier, 300 V, 3 A
CR856	*152-0185-00			Silicon		Replaceable by 1N4152
CR863	*152-0185-00			Silicon		Replaceable by 1N4152
CR873	*152-0185-00			Silicon		Replaceable by 1N4152
CR874	*152-0185-00			Silicon		Replaceable by 1N4152
CR879	152-0423-00			Silicon		Rectifier, 300 V, 3 A
CR891	*152-0185-00			Silicon		Replaceable by 1N4152
CR895	*152-0185-00			Silicon		Replaceable by 1N4152
CR900	*152-0185-00			Silicon		Replaceable by 1N4152
CR903	*152-0185-00			Silicon		Replaceable by 1N4152
CR904	*152-0185-00			Silicon		Replaceable by 1N4152
VR907	152-0212-00	B010100	B059999	Zener		1N936 500 mW, 9 V, 5% TC
VR907	152-0175-00	B060000		Zener		1N752A 400 mW, 5.6 V, 5%
CR909	152-0423-00			Silicon		Rectifier, 300 V, 3 A
CR921	*152-0185-00			Silicon		Replaceable by 1N4152

REGULATOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Semiconductor Device, Diodes (cont)				
CR925	*152-0185-00		Silicon	Replaceable by 1N4152
CR930	*152-0185-00		Silicon	Replaceable by 1N4152
CR933	*152-0185-00		Silicon	Replaceable by 1N4152
CR934	*152-0185-00		Silicon	Replaceable by 1N4152
CR939	152-0423-00		Silicon	Rectifier, 300 V, 3 A
VR943	152-0226-00		Zener	1N751A 400 mW, 5.1 V, 5%
CR945	152-0423-00		Silicon	Rectifier, 300 V, 3 A
CR946	*152-0185-00		Silicon	Replaceable by 1N4152
CR957	*152-0185-00		Silicon	Replaceable by 1N4152
CR960	*152-0185-00		Silicon	Replaceable by 1N4152
CR961	*152-0185-00		Silicon	Replaceable by 1N4152
CR962	*152-0185-00		Silicon	Replaceable by 1N4152
CR966	*152-0185-00		Silicon	Replaceable by 1N4152
CR967	*152-0185-00		Silicon	Replaceable by 1N4152
CR973	152-0423-00		Silicon	Rectifier, 300 V, 3 A
CR974	*152-0061-00		Silicon	Tek Spec
CR977	*152-0185-00		Silicon	Replaceable by 1N4152
CR985	*152-0185-00		Silicon	Replaceable by 1N4152
CR989	152-0423-00		Silicon	Rectifier, 300 V, 3 A

Transistors

Q825	*151-0192-00		Silicon	NPN	TO-92	Replaceable by MPS 6521
Q827	*151-0192-00		Silicon	NPN	TO-92	Replaceable by MPS 6521
Q855	151-0183-00		Silicon	NPN	TO-5	Selected from 2N2192
Q857	*151-0192-00		Silicon	NPN	TO-92	Replaceable by MPS 6521
Q895	151-0188-00		Silicon	PNP	TO-92	2N3906
Q909	151-0508-00		Silicon	PNPN	TO-98	Programmable, unijunction, D13T1
Q925	151-0188-00		Silicon	PNP	TO-92	2N3906
Q944	151-0096-00		Silicon	NPN	TO-5	Selected from 2N1893
Q947	151-0250-00		Silicon	NPN	TO-104	2N5184
Q974	*151-0228-00		Silicon	PNP	TO-5	Tek Spec
Q982	151-0250-00		Silicon	NPN	TO-104	2N5184
Q984	151-0250-00		Silicon	NPN	TO-104	2N5184
Q995	151-0250-00		Silicon	NPN	TO-104	2N5184

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R823	*308-0141-00	1 Ω	$\frac{1}{2}$ W	WW	
R825	315-0431-00	430 Ω	$\frac{1}{4}$ W		5%
R827	301-0102-00	1 k Ω	$\frac{1}{2}$ W		5%
R829	315-0104-00	100 k Ω	$\frac{1}{4}$ W		5%
R830	321-0093-00	90.9 Ω	$\frac{1}{8}$ W	Prec	1%

REGULATOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R831	301-0103-00		10 k Ω	1/2 W		5%
R832	315-0683-00		68 k Ω	1/4 W		5%
R833	315-0472-00		4.7 k Ω	1/4 W		5%
R834	315-0242-00		2.4 k Ω	1/4 W		5%
R836	315-0433-00		43 k Ω	1/4 W		5%
R838	321-0222-00		2 k Ω	1/8 W	Prec	1%
R839	321-0085-00		75 Ω	1/8 W	Prec	1%
R840	323-0264-00		6.49 k Ω	1/2 W	Prec	1%
R841	321-0189-00		909 Ω	1/8 W	Prec	1%
R843	315-0203-00		20 k Ω	1/4 W		5%
R844	321-0194-08		1.02 k Ω	1/8 W	Prec	1%
R845	321-0337-00		31.6 k Ω	1/8 W	Prec	1%
R846	323-0260-08		4.99 k Ω	1/2 W	Prec	1%
R848	311-0883-00		50 k Ω , Var			
R853	308-0643-00		0.1 Ω	3 W	WW	
R855	301-0100-00		10 Ω	1/2 W		5%
R857	315-0511-00		510 Ω	1/4 W		5%
R859	315-0104-00		100 k Ω	1/4 W		5%
R860	321-0080-00		66.5 Ω	1/8 W	Prec	1%
R861	301-0163-00		16 k Ω	1/2 W		5%
R863	315-0513-00		51 k Ω	1/4 W		5%
R864	315-0391-00		390 Ω	1/4 W		5%
R866	315-0432-00		4.3 k Ω	1/4 W		5%
R867	321-0252-00		4.12 k Ω	1/8 W	Prec	1%
R870	323-0758-07		3 k Ω	1/2 W	Prec	1/10%
R871	323-0763-07		7 k Ω	1/2 W	Prec	1/10%
R872	315-0153-00		15 k Ω	1/4 W		5%
R873	315-0183-00		18 k Ω	1/4 W		5%
R874	315-0123-00		12 k Ω	1/4 W		5%
R875	321-0224-00		2.1 k Ω	1/8 W	Prec	1%
R884	307-0051-00		2.7 Ω	1/2 W		5%
R885	308-0548-00		0.1 Ω	5 W	WW	
R886	321-0085-00		75 Ω	1/8 W	Prec	1%
R887	321-0177-00		681 Ω	1/8 W	Prec	1%
R888	321-0255-00		4.42 k Ω	1/8 W	Prec	1%
R890	301-0682-00		6.8 k Ω	1/2 W		5%
R892	315-0272-00		2.7 k Ω	1/4 W		5%
R893	315-0101-00		100 Ω	1/4 W		5%
R894	315-0124-00		120 k Ω	1/4 W		5%
R896	315-0103-00		10 k Ω	1/4 W		5%

REGULATOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R897	315-0152-00		1.5 k Ω	1/4 W		5%
R898	315-0101-00		100 Ω	1/4 W		5%
R900	321-0189-00		909 Ω	1/8 W	Prec	1%
R901	315-0243-00		24 k Ω	1/4 W		5%
R903	321-0193-03		1 k Ω	1/8 W	Prec	1/4%
R904	323-0289-07		10 k Ω	1/2 W	Prec	1/10%
R907	315-0301-00		300 Ω	1/4 W		5%
R908	315-0101-00		100 Ω	1/4 W		5%
R910	315-0510-00		51 Ω	1/4 W		5%
R914	301-0100-00		10 Ω	1/2 W		5%
R915	308-0643-00		0.1 Ω	3 W	WW	
R916	321-0085-00		75 Ω	1/8 W	Prec	1%
R917	315-0392-00		3.9 k Ω	1/4 W		5%
R918	321-0255-00		4.42 k Ω	1/8 W	Prec	1%
R920	301-0822-00		8.2 k Ω	1/2 W		5%
R922	315-0133-00		13 k Ω	1/4 W		5%
R923	315-0271-00		270 Ω	1/4 W		5%
R924	315-0105-00		1 M Ω	1/4 W		5%
R926	315-0473-00		47 k Ω	1/4 W		5%
R927	315-0152-00		1.5 k Ω	1/4 W		5%
R928	315-0361-00		360 Ω	1/4 W		5%
R930	321-0228-00		2.32 k Ω	1/8 W	Prec	1%
R931	315-0243-00		24 k Ω	1/4 W		5%
R933	323-0758-07		3 k Ω	1/2 W	Prec	1/10%
R934	323-0289-07		10 k Ω	1/2 W	Prec	1/10%
R943	308-0292-00		2.2 k Ω	3 W	WW	
R947	301-0153-00		15 k Ω	1/2 W		5%
R948	315-0181-00		180 Ω	1/4 W		5%
R950	*308-0141-00		1 Ω	1/2 W	WW	
R951	321-0143-00		301 Ω	1/8 W	Prec	1%
R952	315-0473-00		47 k Ω	1/4 W		5%
R953	321-0267-00		5.9 k Ω	1/8 W	Prec	1%
R955	315-0433-00		43 k Ω	1/4 W		5%
R957	315-0512-00		5.1 k Ω	1/4 W		5%
R959	315-0105-00		1 M Ω	1/4 W		5%
R960	315-0101-00		100 Ω	1/4 W		5%
R962	315-0753-00		75 k Ω	1/4 W		5%
R963	321-0260-00		4.99 k Ω	1/8 W	Prec	1%
R964	315-0243-00		24 k Ω	1/4 W		5%
R966	323-0289-07		10 k Ω	1/2 W	Prec	1/10%

Electrical Parts List—7503

REGULATOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R967	323-0289-07		10 kΩ	1/2 W	Prec	1/10%
R974	307-0052-00		3 Ω	1/2 W		5%
R976	307-0052-00		3 Ω	1/2 W		5%
R977	315-0751-00		750 Ω	1/4 W		5%
R978	315-0753-00		75 kΩ	1/4 W		5%
R979	315-0203-00		20 kΩ	1/4 W		5%
R981	323-0307-00		15.4 kΩ	1/2 W	Prec	1%
R982	323-0306-00		15 kΩ	1/2 W	Prec	1%
R984	315-0154-00		150 kΩ	1/4 W		5%
R985	315-0151-00		150 Ω	1/4 W		5%
R986	323-0307-00		15.4 kΩ	1/2 W	Prec	1%
R987	323-0292-00		10.7 kΩ	1/2 W	Prec	1%
R988	315-0103-00		10 kΩ	1/4 W		5%
R995	301-0752-00		7.5 kΩ	1/2 W		5%

Integrated Circuits

U840	156-0048-00	Linear		Replaceable by RCA CA 3046
U870	156-0048-00	Linear		Replaceable by RCA CA 3046
U890	156-0048-00	Linear		Replaceable by RCA CA 3046
U920	156-0048-00	Linear		Replaceable by RCA CA 3046
U960	156-0048-00	Linear		Replaceable by RCA CA 3046

RECTIFIER Circuit Board Assembly

*670-0862-00

Complete Board

Capacitors

Tolerance ±20% unless otherwise indicated.

C805	285-0566-00	0.022 μF	PTM	200 V	10%
C807	283-0080-00	0.022 μF	Cer	25 V	+80%—20%
C821	285-0566-00	0.022 μF	PTM	200 V	10%
C851	285-0566-00	0.022 μF	PTM	200 V	10%
C881	285-0566-00	0.022 μF	PTM	200 V	10%
C911	285-0566-00	0.022 μF	PTM	200 V	10%
C941	285-0566-00	0.022 μF	PTM	200 V	10%
C971	285-0566-00	0.022 μF	PTM	200 V	10%
C972	290-0468-00	250 μF	Elect.	150 V	+75%—10%
C991	285-0566-00	0.022 μF	PTM	200 V	10%
C992	290-0468-00	250 μF	Elect.	150 V	+75%—10%

RECTIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Semiconductor Device, Diodes				
CR805	152-0066-01		Silicon	400 V, 0.75A
CR806	152-0066-01		Silicon	400 V, 0.75A
CR821	152-0200-00		Rectifier bridge	MDA 942-5
CR851	152-0406-00		Silicon	Rectifier assembly, full wave bridge, 3A, 250 V
CR881A, B, C, D	152-0423-00		Silicon	Rectifier, 300 V, 3 A
CR911	152-0406-00		Silicon	Rectifier assembly, full wave bridge, 3A, 250 V
CR941	152-0200-00		Rectifier bridge	MDA 942-5
CR971A, B, C, D	*152-0107-00		Silicon	Replaceable by 1N647
CR991A, B, C, D	*152-0107-00		Silicon	Replaceable by 1N647
CR993	152-0423-00		Silicon	Rectifier, 300 V, 3 A
CR994	*152-0107-00		Silicon	Replaceable by 1N647
Fuses				
F882	159-0013-00		6 A	3AG Fast-Blo
F912	159-0021-00		2 A	3AG Fast-Blo
Transistors				
Q813	151-0223-00		Silicon	NPN TO-18 2N4275
Q815	151-0223-00		Silicon	NPN TO-18 2N4275
Q817	*151-0148-00		Silicon	NPN TO-66 Tek Spec
Resistors				
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.				
R804	308-0245-00		0.6 Ω	2 W WW
R806	315-0102-00		1 k Ω	1/4 W 5%
R807	315-0151-00		150 Ω	1/4 W 5%
R808	315-0470-00		47 Ω	1/4 W 5%
R811	315-0512-00		5.1 k Ω	1/4 W 5%
R812	315-0432-00		4.3 k Ω	1/4 W 5%
R814	315-0911-00		910 Ω	1/4 W 5%
R815	315-0392-00		3.9 k Ω	1/4 W 5%
R816	315-0683-00		68 k Ω	1/4 W 5%
R818	307-0054-00		3.6 Ω	1/2 W 5%
R819	307-0054-00		3.6 Ω	1/2 W 5%
R972	*308-0141-00		1 Ω	1/2 W WW
R992	*308-0141-00		1 Ω	1/2 W WW
R994	301-0752-00		7.5 k Ω	1/2 W 5%

Electrical Parts List—7503

HORIZ AMP SIG DELAY Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
	*670-0863-00	B010100	B069999	Complete Board
	*670-0863-01	B070000	B099999	Complete Board
	*670-0863-02	B100000		Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C500A	283-0000-00	0.001 μF	Cer	500 V	
C500B	290-0267-00	1 μF	Elect.	35 V	
C501	290-0267-00	1 μF	Elect.	35 V	
C502	290-0267-00	1 μF	Elect.	35 V	
C521	281-0125-00	90-400 pF, Var	Mica	175 V	
C522	281-0546-00	330 pF	Cer	500 V	10%
C523	281-0605-00	200 pF	Cer	500 V	
C524	281-0580-00	470 pF	Cer	500 V	10%
C525	281-0580-00	470 pF	Cer	500 V	10%
C526	281-0605-00	200 pF	Cer	500 V	
C548	290-0167-00	10 μF	Elect.	15 V	
C558	281-0550-00	120 pF	Cer	500 V	10%
C559	281-0550-00	120 pF	Cer	500 V	10%
C570	281-0619-00	1.2 pF	Cer	200 V	
C573	281-0092-00	9-35 pF, Var	Cer		
C579	281-0617-00	15 pF	Cer	200 V	
C584	290-0267-00	1 μF	Elect.	35 V	
C590	281-0619-00	1.2 pF	Cer	200 V	
C593	281-0092-00	9-35 pF, Var	Cer		
C599	281-0617-00	15 pF	Cer	200 V	

Semiconductor Device, Diodes

CR505	*152-0185-00	Silicon	Replaceable by 1N4152
CR525	*152-0185-00	Silicon	Replaceable by 1N4152
CR542	*152-0153-00	Silicon	Tek Spec
CR543	*152-0153-00	Silicon	Tek Spec
CR545	*152-0153-00	Silicon	Tek Spec
CR547	*152-0153-00	Silicon	Tek Spec
CR560	*152-0185-00	Silicon	Replaceable by 1N4152
CR563	*152-0185-00	Silicon	Replaceable by 1N4152

Relays

K521	*148-0034-00	Armature, dpdt	15 V DC
K525	*148-0034-00	Armature, dpdt	15 V DC

Inductors

L521	*108-0103-00	2.5 μH
L522	*108-0103-00	2.5 μH
L523	*108-0549-00	4.55 μH
L524	*108-0548-00	2 μH
L525	*108-0548-00	2 μH

HORIZ AMP SIG DELAY Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Inductors (cont)				
L526	*108-0549-00			4.55 μ H
L530	276-0507-00			Core, ferramic suppressor
L534	276-0507-00			Core, ferramic suppressor
L566	276-0507-00			Core, ferramic suppressor
Transistors				
Q500	151-0188-00			Silicon PNP TO-92 2N3906
Q503	151-0188-00			Silicon PNP TO-92 2N3906
Q510	151-0223-00			Silicon NPN TO-18 2N4275
Q512	151-0223-00			Silicon NPN TO-18 2N4275
Q519	*151-0190-01			Silicon NPN TO-106 Tek Spec
Q530	151-0223-00			Silicon NPN TO-18 2N4275
Q534	151-0223-00			Silicon NPN TO-18 2N4275
Q538	*151-0190-01			Silicon NPN TO-106 Tek Spec
Q550	151-0188-00			Silicon PNP TO-92 2N3906
Q556	151-0188-00			Silicon PNP TO-92 2N3906
Q560	151-0223-00			Silicon NPN TO-18 2N4275
Q563	151-0223-00			Silicon NPN TO-18 2N4275
Q566	*151-0103-00			Silicon NPN TO-5 Replaceable by 2N2219
Q577	*151-0190-01			Silicon NPN TO-106 Tek Spec
Q583	151-0223-00			Silicon NPN TO-18 2N4275
Q586	151-0103-00			Silicon NPN TO-5 Replaceable by 2N2219
Q597	*151-0190-01			Silicon NPN TO-106 Tek Spec
Resistors				
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.				
R503	315-0100-00			10 Ω $\frac{1}{4}$ W 5%
R504	321-0221-00			1.96 k Ω $\frac{1}{8}$ W Prec 1%
R505	315-0471-00			470 Ω $\frac{1}{4}$ W 5%
R506	315-0103-00			10 k Ω $\frac{1}{4}$ W 5%
R507	315-0911-00			910 Ω $\frac{1}{4}$ W 5%
R508	315-0510-00			51 Ω $\frac{1}{4}$ W 5%
R510	321-0089-00	B010100	B099999	82.5 Ω $\frac{1}{8}$ W Prec 1%
R510	321-0077-00	B100000		61.9 Ω $\frac{1}{8}$ W Prec 1%
R511	321-0104-00			118 Ω $\frac{1}{8}$ W Prec 1%
R512	311-0884-00			100 Ω , Var $\frac{1}{4}$ W 5%
R513	315-0510-00			51 Ω $\frac{1}{4}$ W 5%
R514	315-0100-00			10 Ω $\frac{1}{4}$ W 5%
R515	323-0165-00			511 Ω $\frac{1}{2}$ W Prec 1%
R516	311-0884-00			100 Ω , Var $\frac{1}{2}$ W Prec 1%
R517	323-0165-00			511 Ω $\frac{1}{2}$ W Prec 1%
R519	315-0102-00			1 k Ω $\frac{1}{4}$ W 5%
R520	315-0100-00			10 Ω $\frac{1}{4}$ W 5%
R521	321-0068-00			49.9 Ω $\frac{1}{8}$ W Prec 1%
R522	321-0068-00			49.9 Ω $\frac{1}{8}$ W Prec 1%
R529	321-0069-00			51.1 Ω $\frac{1}{8}$ W Prec 1%
R530	311-0884-00			100 Ω , Var $\frac{1}{8}$ W Prec 1%

HORIZ AMP SIG DELAY Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description			
Resistors (cont)						
R531	321-0109-00		133 Ω	$\frac{1}{8}$ W	Prec	1%
R532	321-0106-00		125 Ω	$\frac{1}{8}$ W	Prec	1%
R533	321-0069-00		51.1 Ω	$\frac{1}{8}$ W	Prec	1%
R535	323-0165-00		511 Ω	$\frac{1}{2}$ W	Prec	1%
R536	311-0884-00		100 Ω , Var			
R537	323-0165-00		511 Ω	$\frac{1}{2}$ W	Prec	1%
R539	315-0102-00		1 k Ω	$\frac{1}{4}$ W		5%
R540	315-0820-00		82 Ω	$\frac{1}{4}$ W		5%
R541	315-0820-00		82 Ω	$\frac{1}{4}$ W		5%
R542	315-0820-00		82 Ω	$\frac{1}{4}$ W		5%
R543	315-0820-00		82 Ω	$\frac{1}{4}$ W		5%
R545	323-0157-00		422 Ω	$\frac{1}{2}$ W	Prec	1%
R546	315-0470-00		47 Ω	$\frac{1}{4}$ W		5%
R547	323-0157-00		422 Ω	$\frac{1}{2}$ W	Prec	1%
R548	311-0510-00		10 k Ω , Var			
R549	321-0267-00		5.9 k Ω	$\frac{1}{8}$ W	Prec	1%
R551	321-0267-00		5.9 k Ω	$\frac{1}{8}$ W	Prec	1%
R553	321-0210-00		1.5 k Ω	$\frac{1}{8}$ W	Prec	1%
R554	315-0270-00		27 Ω	$\frac{1}{4}$ W		5%
R555	315-0221-00		220 Ω	$\frac{1}{4}$ W		5%
R556	315-0270-00		27 Ω	$\frac{1}{4}$ W		5%
R557	321-0210-00		1.5 k Ω	$\frac{1}{8}$ W	Prec	1%
R558	315-0121-00		120 Ω	$\frac{1}{4}$ W		5%
R559	315-0121-00		120 Ω	$\frac{1}{4}$ W		5%
R560	315-0470-00		47 Ω	$\frac{1}{4}$ W		5%
R561	315-0103-00		10 k Ω	$\frac{1}{4}$ W		5%
R562	315-0100-00		10 Ω	$\frac{1}{4}$ W		5%
R563	315-0470-00		47 Ω	$\frac{1}{4}$ W		5%
R564	315-0103-00		10 k Ω	$\frac{1}{4}$ W		5%
R565	315-0470-00		47 Ω	$\frac{1}{4}$ W		5%
R566	307-0106-00		4.7 Ω	$\frac{1}{4}$ W		5%
R570	323-0287-00		9.53 k Ω	$\frac{1}{2}$ W	Prec	1%
R571	323-0287-00		9.53 k Ω	$\frac{1}{2}$ W	Prec	1%
R573	315-0681-00		680 Ω	$\frac{1}{4}$ W		5%
R574	321-0230-00		2.43 k Ω	$\frac{1}{8}$ W	Prec	1%
R575	321-0215-00		1.69 k Ω	$\frac{1}{8}$ W	Prec	1%
R577	315-0470-00		47 Ω	$\frac{1}{4}$ W		5%
R578	315-0432-00		4.3 k Ω	$\frac{1}{4}$ W		5%
R579	321-0164-00		499 Ω	$\frac{1}{8}$ W	Prec	1%
R580	315-0301-00		300 Ω	$\frac{1}{4}$ W		5%
R581	315-0751-00		750 Ω	$\frac{1}{4}$ W		5%
R583	315-0101-00		100 Ω	$\frac{1}{4}$ W		5%
R584	315-0102-00		1 k Ω	$\frac{1}{4}$ W		5%
R585	315-0470-00		47 Ω	$\frac{1}{4}$ W		5%
R586	315-0100-00		10 Ω	$\frac{1}{4}$ W		5%

HORIZ AMP SIG DELAY Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R590	323-0287-00		9.53 kΩ	1/2 W	Prec	1%
R591	323-0287-00		9.53 kΩ	1/2 W	Prec	1%
R593	315-0511-00		510 Ω	1/4 W		5%
R594	321-0230-00		2.43 kΩ	1/8 W	Prec	1%
R595	321-0215-00		1.69 kΩ	1/8 W	Prec	1%
R597	315-0470-00		47 Ω	1/4 W		5%
R598	315-0432-00		4.3 kΩ	1/4 W		5%
R599	321-0164-00		499 Ω	1/8 W	Prec	1%

POWER SUPPLY INTERCONNECT Circuit Board Assembly

*670-0866-00

Complete Board

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R849	315-0200-00		20 Ω	1/4 W		5%
R879	315-0101-00		100 Ω	1/4 W		5%
R880	315-0100-00		10 Ω	1/4 W		5%
R881	308-0441-00		3 Ω	3 W	WW	5%
R905	315-0200-00		20 Ω	1/4 W		5%
R939	315-0510-00		51 Ω	1/4 W		5%
R969	315-0200-00		20 Ω	1/4 W		5%

HV OSC & Z AXIS Circuit Board Assembly

*670-0868-00

B010100

B069999

Complete Board

*670-0868-01

B070000

Complete Board

Capacitors

Tolerance ±20% unless otherwise indicated.

C702	281-0504-00		10 pF	Cer	500 V	10%
C705	283-0081-00		0.1 μF	Cer	25 V	+80%—20%
C710	281-0572-00		6.8 pF	Cer	500 V	±0.5 pF
C712	283-0078-00		0.001 μF	Cer	500 V	
C719	283-0080-00		0.022 pF	Cer	25 V	+80%—20%
C722	283-0080-00		0.022 μF	Cer	25 V	+80%—20%
C725	283-0080-00		0.022 μF	Cer	25 V	+80%—20%
C727	283-0078-00		0.001 μF	Cer	500 V	
C729	283-0110-00		0.005 μF	Cer	150 V	
C730	290-0149-00		5 μF	Elect.	150 V	

Electrical Parts List—7503

HV OSC & Z AXIS Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Capacitors (cont)						
C733	283-0092-00		0.03 μ F	Cer	200 V	+80%—20%
C736	281-0064-00		0.25-1.5 pF, Var	Plastic		
C740	290-0410-00		15 μ F	Elect.	100 V	+50%—10%
C742	283-0092-00	XB070000	0.03 μ F	Cer	200 V	+80%—20%
C743	283-0010-00	XB070000	0.05 μ F	Cer	50 V	
C745	285-0622-00		0.1 μ F	PTM	100 V	
C750	285-0629-00		0.047 μ F	PTM	100 V	
C752	285-0862-00		0.001 μ F	PTM	100 V	10%
C761	285-0703-00		0.1 μ F	PTM	100 V	5%
C762	290-0312-00		47 μ F	Elect.	35 V	10%
C764	281-0064-00	XB070000	0.25-1.5 pF, Var	Plastic		
C765	285-0629-00		0.047 μ F	PTM	100 V	
C766	283-0032-00		470 pF	Cer	500 V	5%
C773	281-0593-00	XB070000	3.9 pF	Cer		10%
C775	283-0081-00	XB070000	0.1 μ F	Cer	25 V	+80%—20%
C778	283-0081-00	XB070000	0.1 μ F	Cer	25 V	+80%—20%
C783	281-0546-00		330 pF	Cer	500 V	10%
C790	281-0629-00	XB070000	33 pF	Cer	600 V	5%
C792	283-0002-00		0.01 μ F	Cer	500 V	
C796	283-0002-00		0.01 μ F	Cer	500 V	
C799	283-0092-00		0.03 μ F	Cer	200 V	+80%—20%

Semiconductor Device, Diodes

CR714	*152-0185-00		Silicon	Replaceable by 1N4152
CR731	*152-0107-00		Silicon	Replaceable by 1N647
CR735	*152-0185-00		Silicon	Replaceable by 1N4152
CR740	*152-0061-00		Silicon	Tek Spec
CR753	152-0333-00	XB070000	Silicon	High speed and conductance
VR755	152-0282-00	XB070000	Zener	1N972B 400 mV, 30 V, 5%
CR760	*152-0185-00		Silicon	Replaceable by 1N4152
CR776	*152-0185-00	XB070000	Silicon	Replaceable by 1N4152
CR786	*152-0185-00	XB070000	Silicon	Replaceable by 1N4152
CR793	*152-0185-00	XB070000	Silicon	Replaceable by 1N4152
CR795	*152-0107-00	XB070000	Silicon	Replaceable by 1N4152

Inductors

L762	*108-0422-00		80 μ H
L765	*108-0231-00		4.5 μ H

Transistors

Q707	*151-0190-01		Silicon	NPN	TO-106 Tek Spec
Q714	151-0220-00		Silicon	PNP	TO-18 2N4122
Q718	151-0220-00		Silicon	PNP	TO-18 2N4122
Q733	151-0214-00		Silicon	PNP	TO-5 2N3495
Q735	*151-0124-00		Silicon	NPN	TO-5 Selected from 2N3119
Q752	*151-0126-00		Silicon	NPN	TO-18 Replaceable by 2N2484

HV OSC & Z AXIS Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Transistors (cont)						
Q756	151-0188-00		Silicon	PNP	TO-92	2N3906
Q760	*151-0136-00		Silicon	NPN	TO-5	Replaceable by 2N3053
Q761	151-0280-00	XB070000	Silicon	PNP	TO-39	MM4003
Q763	151-0280-00	XB070000	Silicon	PNP	TO-39	MM4003
Q764	*151-0140-00		Silicon	NPN	TO-3	Selected from 2N3055
Q766	*151-0140-00		Silicon	NPN	TO-3	Selected from 2N3055
Q775	151-0223-00	XB070000	Silicon	NPN	TO-18	2N4275
Q786	*151-0274-00	XB070000	Silicon	NPN	TO-5	Selected from 2N3501
Q793	*151-0274-00	XB070000	Silicon	NPN	TO-5	Selected from 2N3501

ResistorsResistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R700	315-0471-00		470 Ω	$\frac{1}{4}$ W		5%
R701	315-0100-00		10 Ω	$\frac{1}{4}$ W		5%
R702	315-0470-00		47 Ω	$\frac{1}{4}$ W		5%
R704	315-0100-00		10 Ω	$\frac{1}{4}$ W		5%
R705	315-0470-00		47 Ω	$\frac{1}{4}$ W		5%
R706	321-0219-00		1.87 k Ω	$\frac{1}{8}$ W	Prec	1%
R707	315-0121-00		120 Ω	$\frac{1}{4}$ W		5%
R709	321-0261-00		5.11 k Ω	$\frac{1}{8}$ W	Prec	1%
R712	311-0442-00		250 Ω , Var			
R715	315-0161-00		160 Ω	$\frac{1}{4}$ W		5%
R716	303-0121-00		120 Ω	1 W		5%
R718	323-0145-00		316 Ω	$\frac{1}{2}$ W	Prec	1%
R719	321-0060-00		41.2 Ω	$\frac{1}{8}$ W	Prec	1%
R720	315-0131-00		130 Ω	$\frac{1}{4}$ W		5%
R722	323-0139-00		274 Ω	$\frac{1}{2}$ W	Prec	1%
R724	303-0471-00		470 Ω	1 W		5%
R725	315-0470-00		47 Ω	$\frac{1}{4}$ W		5%
R727	315-0750-00		75 Ω	$\frac{1}{4}$ W		5%
R729	315-0102-00		1 k Ω	$\frac{1}{4}$ W		5%
R730	321-0320-00		21 k Ω	$\frac{1}{8}$ W	Prec	1%
R731	323-0360-00		54.9 k Ω	$\frac{1}{2}$ W	Prec	1%
R733	303-0432-00	B010100	4.3 k Ω	1 W		5%
R733	303-0332-00	B070000	3.3 k Ω	1 W		5%
R734	303-0203-00	B010100	20 k Ω	1 W		5%
R734	303-0153-00	B070000	15 k Ω	1 W		5%
R736	323-0307-00		15.4 k Ω	$\frac{1}{2}$ W	Prec	1%
R738	315-0200-00		20 Ω	$\frac{1}{4}$ W		5%
R739	301-0101-00		100 Ω	$\frac{1}{2}$ W		5%
R740	315-0824-00		820 k Ω	$\frac{1}{4}$ W		5%
R742	315-0181-00	XB070000	180 Ω	$\frac{1}{4}$ W		5%
R743	315-0331-00	XB070000	330 Ω	$\frac{1}{4}$ W		5%
R746	311-0831-00		100 k Ω , Var			
R748	325-0074-00		3.935 M Ω	1 W	Prec	1%
R749	315-0473-00		47 k Ω	$\frac{1}{4}$ W		5%

Electrical Parts List—7503

HV OSC & Z AXIS Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R750	315-0302-00			3 kΩ	1/4 W	5%
R753	322-0385-00	XB070000		100 kΩ	1/4 W	Prec 1%
R752	316-0474-00			470 kΩ	1/4 W	
R754	315-0102-00			1 kΩ	1/4 W	5%
R755	315-0471-00	XB070000		470 Ω	1/4 W	5%
R756	321-0349-00	XB070000		42.2 kΩ	1/8 W	Prec 1%
R757	315-0102-00			1 kΩ	1/4 W	5%
R758	316-0104-00			100 kΩ	1/4 W	
R759	315-0624-00	XB070000		620 kΩ	1/4 W	5%
R760	315-0302-00			3 kΩ	1/4 W	5%
R761	311-0698-00	XB070000		1 MΩ, Var		
R762	315-0625-00	XB070000		6.2 MΩ	1/4 W	5%
R763	315-0625-00	XB070000		6.2 MΩ	1/4 W	5%
R764	315-0392-00	XB070000		3.9 kΩ	1/4 W	5%
R765	321-0335-00	XB070000		30.1 kΩ	1/8 W	Prec 1%
R766	311-1035-00	XB070000		50 kΩ, Var		
R773	315-0472-00	XB070000		4.7 kΩ	1/4 W	5%
R774	321-0359-00	XB070000		53.6 kΩ	1/8 W	Prec 1%
R775	315-0821-00	XB070000		820 Ω	1/4 W	5%
R777	315-0332-00	XB070000		3.3 kΩ	1/4 W	5%
R778	315-0101-00	XB070000		100 Ω	1/4 W	5%
R783	301-0103-00	B010100	B010124	10 kΩ	1/2 W	5%
R783	301-0471-00	B010125		470 Ω	1/2 W	5%
R784	315-0470-00			47 Ω	1/4 W	5%
R785	305-0123-00	XB070000		12 kΩ	2 W	5%
R786	301-0562-00	XB070000		5.6 kΩ	1/2 W	Prec 5%
R790	307-0272-00	XB070000		130 kΩ	1/4 W	1%
R791	315-0223-00			22 kΩ	1/4 W	5%
R792	311-0465-00			100 kΩ, Var		
R794	311-0463-00			5 kΩ, Var		
R795	315-0154-00	XB070000		150 kΩ	1/4 W	5%
R797	301-0101-00	XB070000		100 Ω	1/2 W	5%
R798	315-0242-00			2.4 kΩ	1/4 W	5%
R799	315-0103-00			10 kΩ	1/4 W	5%

VERT OUTPUT Circuit Board Assembly

*670-0869-00

Complete Board

Capacitors

Tolerance ±20% unless otherwise indicated.

C400	281-0547-00	2.7 pF	Cer	500 V	10%
C401	281-0612-00	5.6 pF	Cer	200 V	±0.5 pF
C402	281-0629-00	33 pF	Cer	600 V	5%
C407	281-0612-00	5.6 pF	Cer	200 V	±0.5 pF
C411	283-0088-00	1100 pF	Cer	500 V	5%

VERT OUTPUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Capacitors (cont)						
C412	283-0088-00			1100 pF	Cer	500 V 5%
C428	283-0088-00			1100 pF	Cer	500 V 5%
C429	283-0088-00			1100 pF	Cer	500 V 5%
C434	281-0122-00	B010100	B029999	2.5-9 pF, Var	Cer	100 V
C434	281-0161-00	B030000		5-15 pF, Var	Cer	350 V
C435	281-0122-00			2.5-9 pF, Var	Cer	100 V
C436	281-0617-00			15 pF	Cer	200 V
C437	283-0636-00			36 pF	Mica	100 V ±0.5 pF
C439	283-0649-00			105 pF	Mica	300 V 1%
C450	281-0123-00			5-25 pF, Var	Cer	100 V
C454	283-0177-00			1 μF	Cer	25 V +80%—20%
C456	283-0088-00			1100 pF	Cer	500 V 5%
C459	283-0088-00			1100 pF	Cer	500 V 5%
C468	283-0177-00			1 μF	Cer	25 V +80%—20%
C471	281-0616-00			6.8 pF	Cer	200 V
C472	283-0000-00			0.001 μF	Cer	500 V
C484	283-0000-00			0.001 μF	Cer	500 V
C486	283-0000-00			0.001 μF	Cer	500 V
C491	290-0309-00			100 μF	Elect.	25 V
C496	283-0177-00			1 μF	Cer	25 V +80%—20%
C497	283-0177-00			1 μF	Cer	25 V +80%—20%
C498	283-0177-00			1 μF	Cer	25 V +80%—20%
C499	283-0003-00			0.01 μF	Cer	150 V

Semiconductor Device, Diodes

CR431	152-0422-00		Silicon	Volt. var. cap., 7 pF at 4 V
CR432	152-0422-00		Silicon	Volt. var. cap., 7 pF at 4 V
CR450	*152-0185-00		Silicon	Replaceable by 1N4152
CR451	*152-0185-00		Silicon	Replaceable by 1N4152
CR455	152-0066-01		Silicon	400 V, 0.75A
CR485	*152-0242-00		Silicon	Selected from 1N486A
CR491	*152-0185-00		Silicon	Replaceable by 1N4152
CR493	*152-0185-00		Silicon	Replaceable by 1N4152

Inductors

L447	*114-0292-00		170-290 nH, Var	Core 276-0506-00
L454	*120-0382-00		Toroid, 14 turns, single	
L474	*108-0421-00		60 nH	
L476	*108-0421-00		60 nH	
L496	*120-0382-00		Toroid, 14 turns, single	
L497	*120-0382-00		Toroid, 14 turns, single	

VERT OUTPUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Transistors						
Q404	151-0225-00	B010100	B029999	Silicon	NPN	TO-18 2N3563
Q404	*151-0269-00	B030000		Silicon	NPN	TO-106 Selected from SE 3005
Q406	151-0225-00	B010100	B029999	Silicon	NPN	TO-18 2N3563
Q406	*151-0269-00	B030000		Silicon	NPN	TO-106 Selected from SE 3005
Q424	*151-0271-00			Silicon	PNP	TO-18 Tek Spec
Q426	*151-0271-00			Silicon	PNP	TO-46 2N4251
Q444	151-0221-00			Silicon	PNP	TO-18 Tek Spec
Q446	151-0221-00			Silicon	PNP	TO-18 2N4258
Q454	151-0222-00			Silicon	NPN	TO-18 2N4258
Q456	151-0222-00			Silicon	NPN	TO-46 2N4251
Q464	151-0225-00	B010100	B029999	Silicon	NPN	TO-18 2N3563
Q464	*151-0269-00	B030000		Silicon	NPN	TO-106 Selected from SE 3005
Q466	151-0225-00	B010100	B029999	Silicon	NPN	TO-18 2N3563
Q466	*151-0269-00	B030000		Silicon	NPN	TO-106 Selected from SE 3005
Q474	*151-0213-00			Silicon	NPN	TO-46 Selected from 2N4251
Q476	*151-0213-00			Silicon	NPN	TO-46 Selected from 2N4251
Q494	*151-0190-01			Silicon	NPN	TO-106 Tek Spec

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R401	321-0065-00	46.4 Ω	$\frac{1}{8}$ W	Prec	1%
R402	317-0750-00	75 Ω	$\frac{1}{8}$ W		5%
R403	321-0164-00	499 Ω	$\frac{1}{8}$ W	Prec	1%
R404	321-0164-00	499 Ω	$\frac{1}{8}$ W	Prec	1%
R405	311-0732-00	1 k Ω , Var			
R406	311-0480-00	500 Ω , Var			
R407	321-0065-00	46.4 Ω	$\frac{1}{8}$ W	Prec	1%
R408	321-0197-00	1.1 k Ω	$\frac{1}{8}$ W	Prec	1%
R409	321-0153-00	383 Ω	$\frac{1}{8}$ W	Prec	1%
R411	315-0431-00	430 Ω	$\frac{1}{4}$ W		5%
R412	315-0431-00	430 Ω	$\frac{1}{4}$ W		5%
R413	321-0149-00	348 Ω	$\frac{1}{8}$ W	Prec	1%
R414	315-0101-00	100 Ω	$\frac{1}{4}$ W		5%
R415	311-0622-00	100 Ω , Var			
R416	321-0149-00	348 Ω	$\frac{1}{8}$ W	Prec	1%
R421	321-0060-00	41.2 Ω	$\frac{1}{8}$ W	Prec	1%
R422	315-0272-00	2.7 k Ω	$\frac{1}{4}$ W		5%
RT423	307-0124-00	5 k Ω	Thermal		
RT424	307-0124-00	5 k Ω	Thermal		
R426	321-0329-00	26.1 k Ω	$\frac{1}{8}$ W	Prec	1%
R427	315-0270-00	27 Ω	$\frac{1}{4}$ W		5%
R428	315-0361-00	360 Ω	$\frac{1}{4}$ W		5%
R429	315-0361-00	360 Ω	$\frac{1}{4}$ W		5%
R431	321-0097-00	100 Ω	$\frac{1}{8}$ W	Prec	1%
R432	321-0097-00	100 Ω	$\frac{1}{8}$ W	Prec	1%

VERT OUTPUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R434	311-0622-00		100 Ω , Var			
R435	311-0609-00		2 k Ω , Var			
R436	317-0272-00		2.7 k Ω	$\frac{1}{8}$ W		5%
R437	317-0512-00		5.1 k Ω	$\frac{1}{8}$ W		5%
R439	317-0163-00		16 k Ω	$\frac{1}{8}$ W		5%
R441	317-0470-00		47 Ω	$\frac{1}{8}$ W		5%
R442	317-0470-00		47 Ω	$\frac{1}{8}$ W		5%
R443	315-0331-00		330 Ω	$\frac{1}{4}$ W		5%
R444	315-0562-00		5.6 k Ω	$\frac{1}{4}$ W		5%
R445	321-0097-00		100 Ω	$\frac{1}{8}$ W	Prec	1%
R446	311-0605-00		200 Ω , Var			
R447	317-0510-00		51 Ω	$\frac{1}{8}$ W		5%
R448	321-0097-00		100 Ω	$\frac{1}{8}$ W	Prec	1%
R449	323-0141-00		287 Ω	$\frac{1}{2}$ W	Prec	1%
R450	321-0041-00		26.1 Ω	$\frac{1}{8}$ W	Prec	1%
R451	321-0041-00		26.1 Ω	$\frac{1}{8}$ W	Prec	1%
R452	321-0227-00		2.26 k Ω	$\frac{1}{8}$ W	Prec	1%
R453	308-0387-00		178 Ω	3 W	WW	
R454	315-0182-00		1.8 k Ω	$\frac{1}{4}$ W		5%
R456	317-0470-00		47 Ω	$\frac{1}{8}$ W		5%
R457	315-0241-00		240 Ω	$\frac{1}{4}$ W		5%
R458	315-0241-00		240 Ω	$\frac{1}{4}$ W		5%
R459	317-0470-00		47 Ω	$\frac{1}{8}$ W		5%
R461	321-0193-00		1 k Ω	$\frac{1}{8}$ W	Prec	1%
R462	321-0193-00		1 k Ω	$\frac{1}{8}$ W	Prec	1%
R464	321-0181-00		750 Ω	$\frac{1}{8}$ W	Prec	1%
R465	321-0172-00		604 Ω	$\frac{1}{8}$ W	Prec	1%
R467	321-0097-00		100 Ω	$\frac{1}{8}$ W	Prec	1%
R468	322-0076-00		60.4 Ω	$\frac{1}{4}$ W	Prec	1%
R469	321-0097-00		100 Ω	$\frac{1}{8}$ W	Prec	1%
R471	321-0026-00		18.2 Ω	$\frac{1}{8}$ W	Prec	1%
R472	308-0451-00		91 Ω	3 W	WW	
R473	321-0026-00		18.2 Ω	$\frac{1}{8}$ W	Prec	1%
R474	301-0330-00		33 Ω	$\frac{1}{2}$ W		5%
R475	321-0201-00		1.21 k Ω	$\frac{1}{8}$ W	Prec	1%
R476	301-0330-00		33 Ω	$\frac{1}{2}$ W		5%
R477	321-0201-00		1.21 k Ω	$\frac{1}{8}$ W	Prec	1%
R484	315-0100-00		10 Ω	$\frac{1}{4}$ W		5%
R486	315-0100-00		10 Ω	$\frac{1}{4}$ W		5%
R491	315-0104-00		100 k Ω	$\frac{1}{4}$ W		5%
R492	315-0102-00		1 k Ω	$\frac{1}{4}$ W		5%
R493	315-0203-00		20 k Ω	$\frac{1}{4}$ W		5%
R494	321-0222-00		2 k Ω	$\frac{1}{8}$ W	Prec	1%

OUTPUT SIGNAL & CALIB Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
	*670-0870-00	B010100	B069999	Complete Board
	*670-0870-01	B070000		Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C602	283-0000-00			0.001 μF	Cer	500 V	
C608	283-0000-00			0.001 μF	Cer	500 V	
C609	283-0000-00			0.001 μF	Cer	500 V	
C615	283-0003-00			0.01 μF	Cer	500 V	
C618	283-0000-00			0.001 μF	Cer	500 V	
C626	283-0081-00			0.1 μF	Cer	25 V	+80%—20%
C628	281-0511-00			22 pF	Cer	500 V	10%
C632	283-0081-00			0.1 μF	Cer	25 V	+80%—20%
C640	283-0077-00	XB070000		330 pF	Cer	500 V	5%
C646	281-0547-00	XB070000		2.7 pF	Cer	500 V	10%
C650	283-0004-00	XB070000		0.02 μF	Cer	150 V	
C654	283-0026-00	B010100	B069999	0.2 μF	Cer	25 V	
C654	283-0164-00	B070000		2.2 μF	Cer	25 V	
C658	283-0602-00			53 pF	Mica	300 V	5%
C660	283-0003-00	XB070000		0.01 μF	Cer	500 V	
C667	283-0095-00			56 pF	Cer	200 V	10%
C669	285-0824-00			0.047 μF	PTM	100 V	2%
C673	283-0000-00			0.001 μF	Cer	500 V	
C677	283-0004-00			0.02 μF	Cer	150 V	
C690	283-0003-00			0.01 μF	Cer	150 V	
C694	283-0000-00			0.001 μF	Cer	500 V	

Semiconductor Device, Diodes

CR616	*152-0185-00	Silicon	Replaceable by 1N4152
CR617	*152-0185-00	Silicon	Replaceable by 1N4152
CR624	*152-0185-00	Silicon	Replaceable by 1N4152
CR630	*152-0185-00	Silicon	Replaceable by 1N4152
CR655	*152-0185-00	Silicon	Replaceable by 1N4152
CR657	*152-0185-00	Silicon	Replaceable by 1N4152
CR658	152-0333-00	Silicon	High speed and conductance
CR681	*152-0185-00	Silicon	Replaceable by 1N4152

Inductor

LR615	*108-0184-00	3.2 μH	(wound on a 10 Ω resistor)
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Transistors

Q603	151-0221-00	Silicon	PNP	TO-18	2N4258
Q607	151-0221-00	Silicon	PNP	TO-18	2N4258
Q610	151-0188-00	Silicon	PNP	TO-92	2N3906
Q613	151-0188-00	Silicon	PNP	TO-92	2N3906
Q621	*151-0190-01	Silicon	NPN	TO-106	Tek Spec

OUTPUT SIGNAL & CALIB Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Transistors (cont)				
Q623	*151-0190-01		Silicon	NPN TO-106 Tek Spec
Q627	151-0220-00		Silicon	PNP TO-18 2N4122
Q640	151-0221-00	XB070000	Silicon	PNP TO-18 2N4258
Q656	151-0188-00		Silicon	PNP TO-92 2N3906
Q660	151-0223-00	XB070000	Silicon	NPN TO-18 2N4275
Q666	151-0273-00		Silicon	NPN TO-98 2N5249
Q670	151-0273-00		Silicon	NPN TO-98 2N5249
Q680	*151-0190-01		Silicon	NPN TO-106 Tek Spec
Q682	*151-0190-01		Silicon	NPN TO-106 Tek Spec
Q684	151-0276-00		Silicon	PNP TO-92 2N5087
Q688	151-0276-00		Silicon	PNP TO-92 2N5087
Q690	*151-0190-01		Silicon	NPN TO-106 Tek Spec

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R600	321-0069-00		51.1 Ω	$\frac{1}{8}$ W	Prec	1%
R601	321-0069-00		51.1 Ω	$\frac{1}{8}$ W	Prec	1%
R602	321-0082-00		69.8 Ω	$\frac{1}{8}$ W	Prec	1%
R604	321-0020-00		15.8 Ω	$\frac{1}{8}$ W	Prec	1%
R605	321-0091-00		86.6 Ω	$\frac{1}{8}$ W	Prec	1%
R606	321-0020-00		15.8 Ω	$\frac{1}{8}$ W	Prec	1%
R608	315-0151-00		150 Ω	$\frac{1}{4}$ W		5%
R609	315-0151-00		150 Ω	$\frac{1}{4}$ W		5%
R611	321-0229-00		2.37 k Ω	$\frac{1}{8}$ W	Prec	1%
R612	321-0244-00		3.4 k Ω	$\frac{1}{8}$ W	Prec	1%
R616	321-0224-00		2.1 k Ω	$\frac{1}{8}$ W	Prec	1%
R617	323-0208-00		1.43 k Ω	$\frac{1}{2}$ W	Prec	1%
R618	307-0106-00		4.7 Ω	$\frac{1}{4}$ W		5%
R619	321-0097-00		100 Ω	$\frac{1}{8}$ W	Prec	1%
R620	315-0101-00		100 Ω	$\frac{1}{4}$ W		5%
R622	315-0222-00		2.2 k Ω	$\frac{1}{4}$ W		5%
R624	315-0241-00		240 Ω	$\frac{1}{4}$ W		5%
R626	315-0101-00		100 Ω	$\frac{1}{4}$ W		5%
R628	315-0152-00		1.5 k Ω	$\frac{1}{4}$ W		5%
R629	323-0190-00		931 Ω	$\frac{1}{2}$ W	Prec	1%
R630	315-0272-00		2.7 k Ω	$\frac{1}{4}$ W		5%
R631	321-0260-00		4.99 k Ω	$\frac{1}{8}$ W	Prec	1%
R632	315-0220-00		22 Ω	$\frac{1}{4}$ W		5%
R634	315-0101-00		100 Ω	$\frac{1}{4}$ W		5%
R635	315-0822-00		8.2 k Ω	$\frac{1}{4}$ W		5%
R637	315-0822-00		8.2 k Ω	$\frac{1}{4}$ W		5%
R638	315-0101-00		100 Ω	$\frac{1}{4}$ W		5%
R639	315-0822-00		8.2 k Ω	$\frac{1}{4}$ W		5%
R640	315-0102-00	XB070000	1 k Ω	$\frac{1}{4}$ W		5%
R641	315-0822-00		8.2 k Ω	$\frac{1}{4}$ W		5%
R642	315-0101-00		100 Ω	$\frac{1}{4}$ W		5%
R643	315-0102-00	XB070000	1 k Ω	$\frac{1}{4}$ W		5%

OUTPUT SIGNAL & CALIB Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
Resistors (cont)							
R644	315-0153-00	XB070000	15 kΩ	1/4 W		5%	
R645	315-0822-00		8.2 kΩ	1/4 W		5%	
R646	315-0202-00		2 kΩ	1/4 W		5%	
R648	315-0333-00		33 kΩ	1/4 W		5%	
R649	321-0143-00		301 Ω	1/8 W	Prec	1%	
R650	315-0682-00	XB070000	6.8 kΩ	1/4 W		5%	
R651	315-0103-00		10 kΩ	1/4 W		5%	
R652	315-0151-00		150 Ω	1/4 W		5%	
R653	315-0472-00		4.7 kΩ	1/4 W		5%	
R654	307-0106-00		4.7 Ω	1/4 W		5%	
R655	321-0180-00		732 Ω	1/8 W	Prec	1%	
R656	321-0226-00		2.21 kΩ	1/8 W	Prec	1%	
R657	323-0189-00		909 Ω	1/2 W	Prec	1%	
R658	315-0270-00		27 Ω	1/4 W		5%	
R569	315-0390-00		39 Ω	1/4 W		5%	
R660	315-0221-00	XB070000	220 Ω	1/4 W		5%	
R661	315-0822-00		8.2 kΩ	1/4 W		5%	
R663	321-0281-06		8.25 kΩ	1/8 W	Prec	1/4%	
R665	311-0704-00		500 Ω, Var				
R666	308-0569-00		2.7 kΩ	3 W	WW		
R667	315-0272-00		2.7 kΩ	1/4 W		5%	
R668	315-0513-00		51 kΩ	1/4 W		5%	
R670	315-0153-00		15 kΩ	1/4 W		5%	
R671	315-0102-00		1 kΩ	1/4 W		5%	
R672	315-0623-00		62 kΩ	1/4 W		5%	
R673	321-0285-00		9.09 kΩ	1/8 W	Prec	1%	
R674	315-0512-00		5.1 kΩ	1/4 W		5%	
R675	315-0302-00		3 kΩ	1/4 W		5%	
R676	315-0302-00		3 kΩ	1/4 W		5%	
R677	315-0560-00		56 Ω	1/4 W		5%	
R678	315-0511-00		510 Ω	1/4 W		5%	
R679	315-0513-00		51 kΩ	1/4 W		5%	
R681	315-0473-00		47 kΩ	1/4 W		5%	
R683	315-0183-00		18 kΩ	1/4 W		5%	
R685	303-0362-00		3.6 kΩ	1 W		5%	
R688	321-1188-06		898 Ω	1/8 W		5%	
R689	315-0112-00		1.1 kΩ	1/4 W		5%	
R690	315-0102-00		1 kΩ	1/4 W		5%	
R691	315-0103-00		10 kΩ	1/4 W		5%	
R692	321-0281-06		8.25 kΩ	1/8 W	Prec	1/4%	
R693	321-0820-06		42 kΩ	1/8 W	Prec	1/4%	
R694	315-0913-00		91 kΩ	1/4 W		5%	
R695	311-0885-00		200 kΩ, Var				

OUTPUT SIGNAL & CALIB Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R696	321-0068-00		49.9 Ω	1/8 W	Prec	1%
R697A	323-0761-07		4.05 kΩ	1/2 W	Prec	1/10%
R696B	321-0815-07		4.1 kΩ	1/8 W	Prec	1/10%
R697C	321-0812-07		455 Ω	1/8 W	Prec	1/10%
R697D	321-0811-07		56.3 Ω	1/8 W	Prec	1/10%
R697E	321-0813-07		495 Ω	1/8 W	Prec	1/10%
R697F	321-0810-07		55 Ω	1/8 W	Prec	1/10%
R697G	321-0816-07		5 kΩ	1/8 W	Prec	1/10%
R697H	321-1068-07		50.5 Ω	1/8 W	Prec	1/10%

Switches

Wired or Unwired

S664	260-0723-00	XB070000		Slide		
S670 ¹⁰	*670-0870-00	B010100	B079999	Cam	RATE	
S670 ¹⁰	*670-0870-01	B080000		Cam	RATE	
S699 ¹⁰	*670-0870-00	B010100	B069999	Cam	CALIBRATOR	
S699 ¹⁰	*670-0870-01	B070000		Cam	CALIBRATOR	

Integrated Circuits

U636	156-0048-00			Linear	Replaceable by RCA CA 3046
U644	156-0048-00			Linear	Replaceable by RCA CA 3046
U677	156-0012-00			Clocked T-K flip-flop	Replaceable by Fairchild μL 923

VERTICAL MODE SWITCH Circuit Board Assembly

*670-0871-00

Complete Board

Bulbs

DS1021	*150-0057-01			Incandescent, 7153AS15,	selected
DS1023	*150-0057-01			Incandescent, 7153AS15,	selected
DS1025	*150-0057-01			Incandescent, 7153AS15,	selected
DS1027	*150-0057-01			Incandescent, 7153AS15,	selected
DS1029	*150-0057-01			Incandescent, 7153AS15,	selected

Semiconductor Device, Diodes

CR1021	*152-0185-00			Silicon	Replaceable by 1N4152
CR1023	*152-0185-00			Silicon	Replaceable by 1N4152
CR1024	*152-0185-00			Silicon	Replaceable by 1N4152
CR1026	*152-0185-00			Silicon	Replaceable by 1N4152

¹⁰See Mechanical Parts List for replacement parts.

Electrical Parts List—7503

VERTICAL MODE SWITCH Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
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Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R1020	315-0150-00		15 Ω	$\frac{1}{4}$ W	5%
R1022	315-0303-00		30 k Ω	$\frac{1}{4}$ W	5%

Switch

	Wired or Unwired			
S1021 ¹¹	*670-0871-00		Pushbutton	VERTICAL MODE

TRIGGER SELECTOR SWITCH Circuit Board Assembly

*670-0872-00 Complete Board

Bulb

DS1011	*150-0057-01		Incandescent, 7153AS15, selected	
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Switch

	Wired or Unwired			
S1011 ¹¹	*670-0872-00		Pushbutton	TRIGGER SOURCE

LOGIC Circuit Board Assembly

*670-0873-00 Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C58	283-0003-00	0.01 μ F	Cer	150 V	
C59	281-0605-00	200 pF	Cer	500 V	
C60	281-0564-00	24 pF	Cer	500 V	
C73	283-0003-00	0.01 μ F	Cer	150 V	5%
C75	283-0000-00	0.001 μ F	Cer	500 V	

¹¹See Mechanical Parts List for replacement parts.

LOGIC Circuit Board Assembly (cont)

Kct. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Capacitors (cont)					
C89	283-0003-00		0.01 μ F	Cer	150 V
C135	281-0503-00		8 pF	Cer	500 V
C136	281-0547-00		2.7 pF	Cer	500 V
C137	283-0000-00		0.001 μ F	Cer	500 V
C145	281-0503-00		8 pF	Cer	500 V
					± 0.5 pF 10%
C146	281-0547-00		2.7 pF	Cer	500 V
C147	283-0000-00		0.001 μ F	Cer	500 V
C152	283-0000-00		0.001 μ F	Cer	500 V
C165	281-0503-00		8 pF	Cer	500 V
C166	281-0547-00		2.7 pF	Cer	500 V
					± 0.5 pF 10%
C185	281-0503-00		8 pF	Cer	500 V
C186	281-0547-00		2.7 pF	Cer	500 V
C187	283-0000-00		0.001 μ F	Cer	500 V
C193	283-0026-00		0.2 μ F	Cer	25 V
C195	283-0026-00		0.2 μ F	Cer	25 V
					± 0.5 pF 10%
C196	283-0004-00		0.02 μ F	Cer	150 V
C198	283-0026-00		0.2 μ F	Cer	25 V

Semiconductor Device, Diodes

CR62	*152-0153-00		Silicon	Tek Spec	
CR67	*152-0185-00		Silicon	Replaceable by 1N4152	
CR84	152-0333-00		Silicon	High speed and conductance	
CR85	152-0333-00		Silicon	High speed and conductance	
CR108	*152-0185-00		Silicon	Replaceable by 1N4152	
CR113	*152-0185-00		Silicon	Replaceable by 1N4152	
CR124	*152-0185-00		Silicon	Replaceable by 1N4152	
CR125	*152-0185-00		Silicon	Replaceable by 1N4152	
CR126	*152-0185-00		Silicon	Replaceable by 1N4152	
CR130	*152-0185-00		Silicon	Replaceable by 1N4152	
CR140	*152-0185-00		Silicon	Replaceable by 1N4152	
CR155	*152-0185-00		Silicon	Replaceable by 1N4152	
CR157	*152-0185-00		Silicon	Replaceable by 1N4152	
CR159	*152-0185-00		Silicon	Replaceable by 1N4152	
CR160	*152-0185-00		Silicon	Replaceable by 1N4152	
CR170	*152-0185-00		Silicon	Replaceable by 1N4152	
CR172	*152-0185-00		Silicon	Replaceable by 1N4152	
CR173	*152-0185-00		Silicon	Replaceable by 1N4152	
CR180	*152-0185-00		Silicon	Replaceable by 1N4152	

LOGIC Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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Inductors

LR193	*108-0604-00		3.2 μ H	(wound on a 7.5 Ω resistor)
LR195	*108-0604-00		3.2 μ H	(wound on a 7.5 Ω resistor)
LR197	*108-0604-00		3.2 μ H	(wound on a 7.5 Ω resistor)
LR198	*108-0604-00		3.2 μ H	(wound on a 7.5 Ω resistor)

Transistors

Q71	151-0223-00		Silicon	NPN	TO-18	2N4275
Q90	151-0232-00		Silicon	NPN	TO-77	Dual
Q108	*151-0199-00		Silicon	PNP	TO-92	Replaceable by MOT MPS 3640
Q118	151-0225-00		Silicon	NPN	TO-18	2N3563
Q132	*151-0199-00		Silicon	PNP	TO-92	Replaceable by MOT MPS 3640
Q137	151-0223-00		Silicon	NPN	TO-18	2N4275
Q142	*151-0199-00		Silicon	PNP	TO-92	Replaceable by MOT MPS 3640
Q147	151-0223-00		Silicon	NPN	TO-18	2N4275
Q150	151-0223-00		Silicon	NPN	TO-18	2N4275
Q162	*151-0199-00		Silicon	PNP	TO-92	Replaceable by MOT MPS 3640
Q167	151-0223-00		Silicon	NPN	TO-18	2N4275
Q173	151-0221-00		Silicon	PNP	TO-18	2N4258
Q182	*151-0199-00		Silicon	PNP	TO-92	Replaceable by MOT MPS 3640
Q187	151-0223-00		Silicon	NPN	TO-18	2N4275

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R50	315-0223-00	22 k Ω	$\frac{1}{4}$ W		5%
R51	321-0193-00	1 k Ω	$\frac{1}{8}$ W	Prec	1%
R53	315-0223-00	22 k Ω	$\frac{1}{4}$ W		5%
R54	321-0193-00	1 k Ω	$\frac{1}{8}$ W	Prec	1%
R56	315-0471-00	470 Ω	$\frac{1}{4}$ W		5%
R57	315-0562-00	5.6 k Ω	$\frac{1}{4}$ W		5%
R58	315-0101-00	100 Ω	$\frac{1}{4}$ W		5%
R59	315-0103-00	10 k Ω	$\frac{1}{4}$ W		5%
R60	315-0512-00	5.1 k Ω	$\frac{1}{4}$ W		5%
R62	315-0103-00	10 k Ω	$\frac{1}{4}$ W		5%
R64	315-0473-00	47 k Ω	$\frac{1}{4}$ W		5%
R65	321-0193-00	1 k Ω	$\frac{1}{8}$ W	Prec	1%
R66	315-0103-00	10 k Ω	$\frac{1}{4}$ W		5%
R67	315-0683-00	68 k Ω	$\frac{1}{4}$ W		5%
R68	315-0154-00	150 k Ω	$\frac{1}{4}$ W		5%

LOGIC Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Resistors (cont)					
R69	315-0154-00		150 k Ω	1/4 W	5%
R71	315-0103-00		10 k Ω	1/4 W	5%
R73	315-0510-00		51 Ω	1/4 W	5%
R74	315-0510-00		51 Ω	1/4 W	5%
R75	311-0609-00		2 k Ω , Var		
R76	315-0132-00		1.3 k Ω	1/4 W	5%
R77	315-0392-00		3.9 k Ω	1/4 W	5%
R78	321-0260-00		4.99 k Ω	1/8 W	Prec 1%
R80	315-0392-00		3.9 k Ω	1/4 W	5%
R82	315-0510-00		51 Ω	1/4 W	5%
R83	315-0510-00		51 Ω	1/4 W	5%
R84	315-0510-00		51 Ω	1/4 W	5%
R85	315-0241-00		240 Ω	1/4 W	5%
R86	315-0100-00		10 Ω	1/4 W	5%
R88	321-0223-00		2.05 k Ω	1/8 W	Prec 1%
R89	315-0511-00		510 Ω	1/4 W	5%
R90	315-0362-00		3.6 k Ω	1/4 W	5%
R92	322-0202-00		1.24 k Ω	1/4 W	Prec 1%
R93	315-0102-00		1 k Ω	1/4 W	5%
R95	315-0152-00		1.5 k Ω	1/4 W	5%
R96	315-0511-00		510 Ω	1/4 W	5%
R98	315-0511-00		510 Ω	1/4 W	5%
R99	315-0221-00		220 Ω	1/4 W	5%
R101	315-0302-00		3 k Ω	1/4 W	5%
R104	315-0103-00		10 k Ω	1/4 W	5%
R105	315-0472-00		4.7 k Ω	1/4 W	5%
R106	315-0273-00		27 k Ω	1/4 W	5%
R108	321 0237-00		2.87 k Ω	1/8 W	Prec 1%
R109	315-0471-00		470 Ω	1/4 W	5%
R110	321-0097-00		100 Ω	1/8 W	Prec 1%
R112	321-0097-00		100 Ω	1/8 W	Prec 1%
R115	315-0512-00		5.1 k Ω	1/4 W	5%
R116	315-0510-00		51 Ω	1/4 W	5%
R118	315-0472-00		4.7 k Ω	1/4 W	5%
R120	315-0472-00		4.7 k Ω	1/4 W	5%
R121	315-0472-00		4.7 k Ω	1/4 W	5%
R122	315-0472-00		4.7 k Ω	1/4 W	5%
R123	315-0223-00		22 k Ω	1/4 W	5%
R124	315-0511-00		510 Ω	1/4 W	5%
R125	315-0102-00		1 k Ω	1/4 W	5%

LOGIC Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Resistors (cont)					
R126	315-0102-00		1 kΩ	1/4 W	5%
R128	315-0510-00		51 Ω	1/4 W	5%
R129	315-0223-00		22 kΩ	1/4 W	5%
R130	315-0102-00		1 kΩ	1/4 W	5%
R132	315-0222-00		2.2 kΩ	1/4 W	5%
R133	315-0102-00		1 kΩ	1/4 W	5%
R134	315-0821-00		820 Ω	1/4 W	5%
R135	315-0123-00		12 kΩ	1/4 W	5%
R136	315-0681-00		680 Ω	1/4 W	5%
R137	315-0221-00		220 Ω	1/4 W	5%
R138	315-0472-00		4.7 kΩ	1/4 W	5%
R140	315-0391-00		390 Ω	1/4 W	5%
R141	315-0122-00		1.2 kΩ	1/4 W	5%
R142	315-0222-00		2.2 kΩ	1/4 W	5%
R143	315-0102-00		1 kΩ	1/4 W	5%
R144	315-0821-00		820 Ω	1/4 W	5%
R145	315-0123-00		12 kΩ	1/4 W	5%
R146	315-0681-00		680 Ω	1/4 W	5%
R147	315-0181-00		180 Ω	1/4 W	5%
R148	315-0472-00		4.7 kΩ	1/4 W	5%
R149	315-0100-00		10 Ω	1/4 W	5%
R150	315-0103-00		10 kΩ	1/4 W	5%
R152	315-0101-00		100 Ω	1/4 W	5%
R154	315-0223-00		22 kΩ	1/4 W	5%
R155	315-0391-00		390 Ω	1/4 W	5%
R157	315-0103-00		10 kΩ	1/4 W	5%
R158	315-0473-00		47 kΩ	1/4 W	5%
R159	315-0510-00		51 Ω	1/4 W	5%
R160	315-0391-00		390 Ω	1/4 W	5%
R161	315-0122-00		1.2 kΩ	1/4 W	5%
R162	315-0222-00		2.2 kΩ	1/4 W	5%
R163	315-0102-00		1 kΩ	1/4 W	5%
R164	315-0821-00		820 Ω	1/4 W	5%
R165	315-0123-00		12 kΩ	1/4 W	5%
R166	315-0681-00		680 Ω	1/4 W	5%
R168	315-0472-00		4.7 kΩ	1/4 W	5%
R170	315-0472-00		4.7 kΩ	1/4 W	5%
R174	315-0121-00		120 Ω	1/4 W	5%
R180	315-0391-00		390 Ω	1/4 W	5%
R181	315-0122-00		1.2 kΩ	1/4 W	5%

LOGIC Circuit Board Assembly (cont)

Ckt. No.	Part No. Tektronix	Serial/Model No. Eff Disc	Description
Resistors (cont)			
R182	315-0222-00	2.2 k Ω	1/4 W 5%
R183	315-0102-00	1 k Ω	1/4 W 5%
R184	315-0821-00	820 Ω	1/4 W 5%
R185	315-0123-00	12 k Ω	1/4 W 5%
R186	315-0681-00	680 Ω	1/4 W 5%
R188	315-0472-00	4.7 k Ω	1/4 W 5%
R189	315-0100-00	10 Ω	1/4 W 5%
Integrated Circuits			
U55	*155-0011-00	Monolithic	
U99	156-0048-00	Linear	Replaceable by RCA CA 3046
U117	156-0041-00	Dual D flip-flop	Replaceable by T.I. SN7474N
U123	156-0041-00	Dual D flip-flop	Replaceable by T.I. SN7474N
U156	156-0041-00	Dual D flip-flop	Replaceable by T.I. SN7474N

PROBE POWER Circuit Board Assembly

*670-0874-00

Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C1056	281-0501-00	4.7 pF	Cer	500 V	± 1 pF
C1057	281-0625-00	35 pF	Cer	500 V	5%
C1081	283-0177-00	1 μ F	Cer	25 V	+80%—20%
C1082	283-0177-00	1 μ F	Cer	25 V	+80%—20%
C1083	283-0177-00	1 μ F	Cer	25 V	+80%—20%

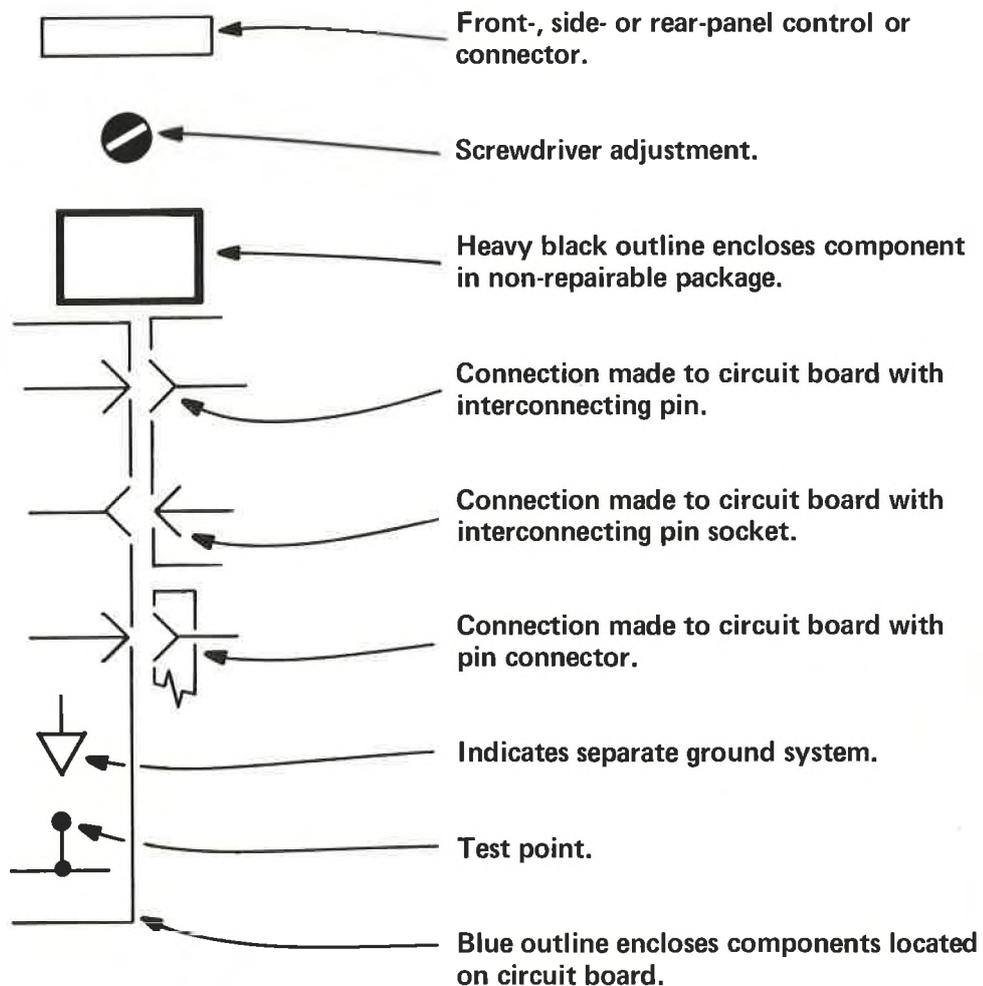
Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R1056	315-0562-00	5.6 k Ω	1/4 W	5%
R1058	315-0103-00	10 k Ω	1/4 W	5%
R1060	315-0241-00	240 Ω	1/4 W	5%

SECTION 7 DIAGRAMS AND MECHANICAL PARTS ILLUSTRATIONS

The following special symbols are used on the Diagrams:



VOLTAGE AND WAVEFORM TEST CONDITIONS

Typical voltage measurements were obtained under the following conditions unless noted otherwise on the individual diagrams:

Test Oscilloscope (with 10X Probe)

Frequency response	DC to 30 MHz
Deflection factor (with probe)	50 millivolts to 50 volts/division
Input impedance	10 megohm, 13 picofarads
Probe ground	7503 chassis ground
Trigger source	External from +GATE connector to indicate true time relationship between signals
Recommended type (as used for waveforms on diagrams)	Tektronix 7504 with 7A16 and 7B50 plug-in units

Voltmeter

Type	Non-loading digital multimeter
Input impedance	0 to 1.5 volts; $\geq 1 \text{ k}\Omega$ 15 to 1000 volts; 10 M Ω
Range	0 to 1000 volts
Reference voltage	7503 chassis ground
Recommended type (as used for voltages on diagrams)	Fairchild Model 7050

7503 Conditions

Line voltage	115 volts
Signal applied	No signal applied for voltage measurements. Apply 4 volts of 1 kHz calibrator signal from test scope to + INPUT of 7A22 for waveforms only. No connections for voltage measurements. For waveforms CAL out signal is applied to external trigger input of test scope. Also see Signal applied above.
Connectors	
Trace position	Centered
Control settings	As follows except as noted otherwise on individual diagrams.

7503

INTENSITY	Counterclockwise
FOCUS	Midrange
BEAM FINDER	Released
READOUT	OFF
CONTROL ILLUM	OFF
GRAT ILLUM	Counterclockwise
CALIBRATOR	4 V
RATE	1 kHz
VERTICAL MODE	LEFT
TRIGGER SOURCE	VERT MODE
Internal Gate switch	MAIN SWEEP

Left Vertical Plug-In (7A22)

Position	Centered
Volts/Div	1 V
Variable	Cal
Offset	Centered
HF -3 dB Point	1 MHz
LF -3 dB Point	DC
+ Input	Gnd
- Input	Gnd

Right Vertical Plug-In (7A16)

Position	Centered
Polarity	+ UP
Input Coupling	Gnd
BW	Full
Volts/Div	.1
Variable	Cal

Horiz Plug-In (7B52)

Level/Slope	Midrange, positive slope
Position	Centered
Delay Time Mult	0.0
Triggering	
Mode	NORM
Coupling	AC
Source	Int
Magnifier	X1
Time/Div	1 ms
Variable	Cal
Display Mode	Main Sweep

The following control settings and connections were changed to obtain waveform photographs.

Left Vert (7A22)

+ Input	DC
Position	Vertically center display
Apply 4 volts of 1 kHz calibrator to the + Input	

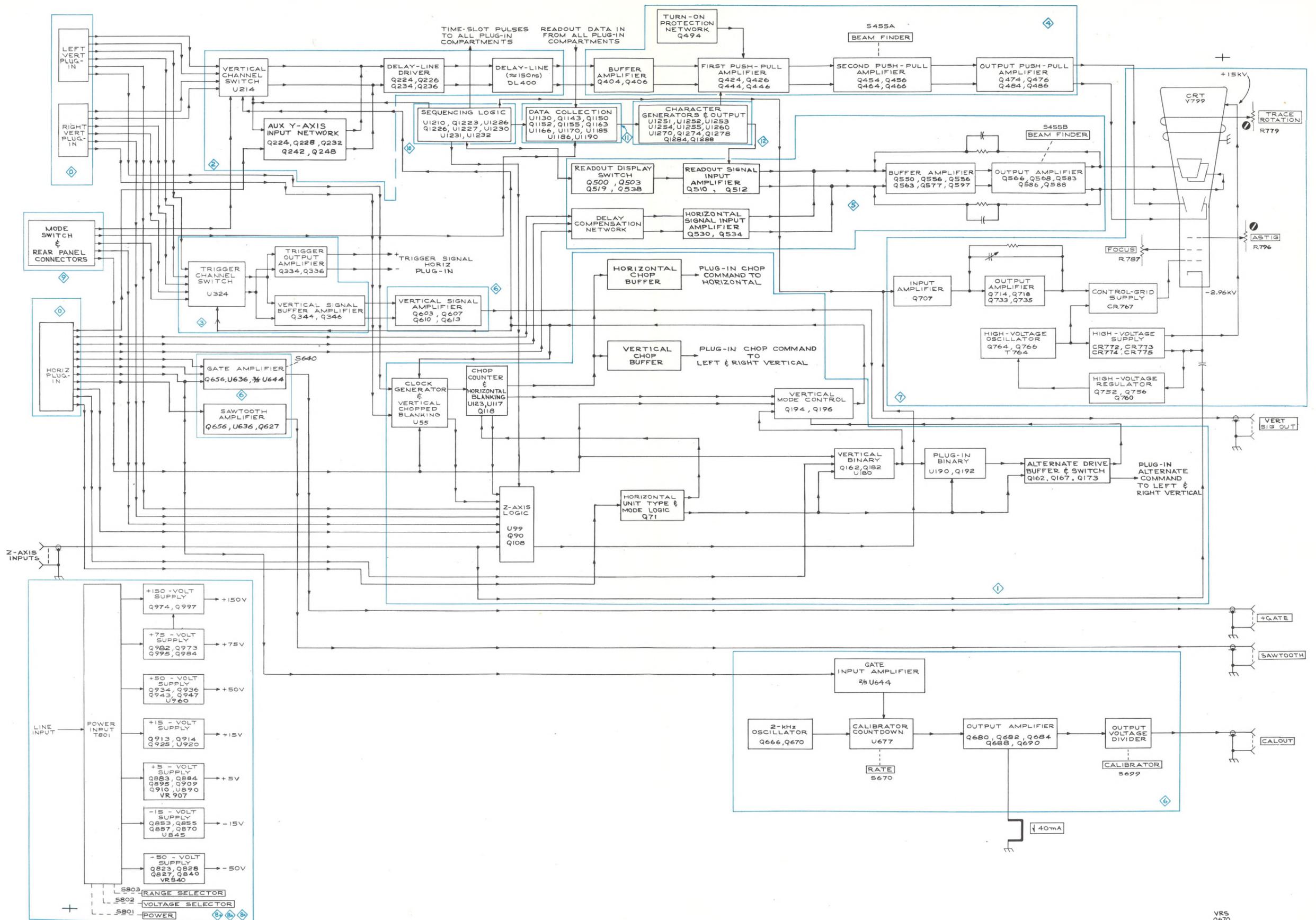
Horiz (7B52)

Triggering Mode	Auto
-----------------	------

All voltages given on the diagrams are in volts. Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule. Readouts are simulated in larger-than-normal type. Voltages and waveforms on the diagrams (shown in blue) are not absolute and may vary between instruments because of differing component tolerances, internal calibration or front-panel control settings.

NOTE

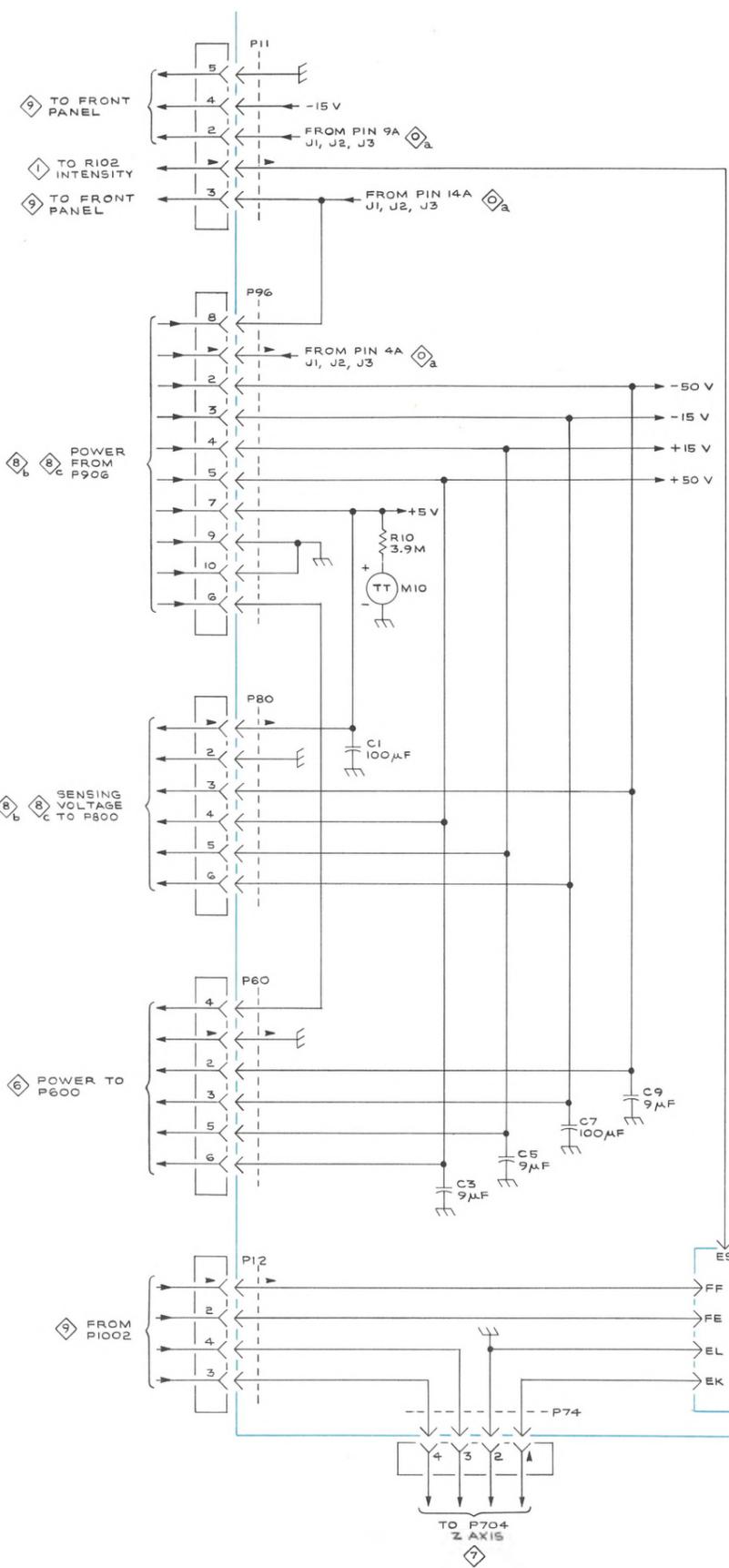
The spring tension of the pin sockets insures a good connection between the circuit board and the pin. This spring tension can be destroyed by using the pin sockets as a connection point for spring-loaded probe tips, alligator clips, etc.



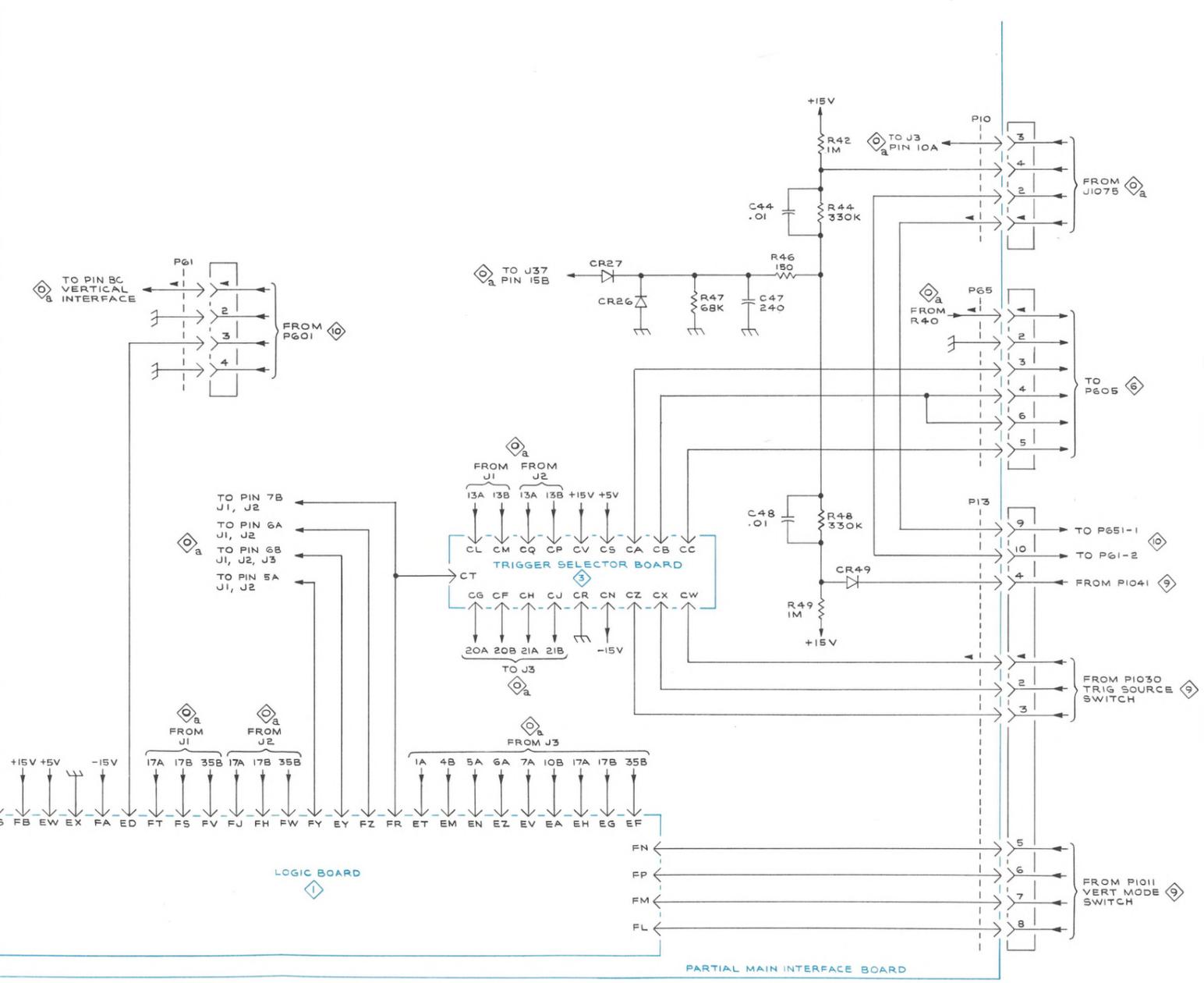
7503

BLOCK DIAGRAM

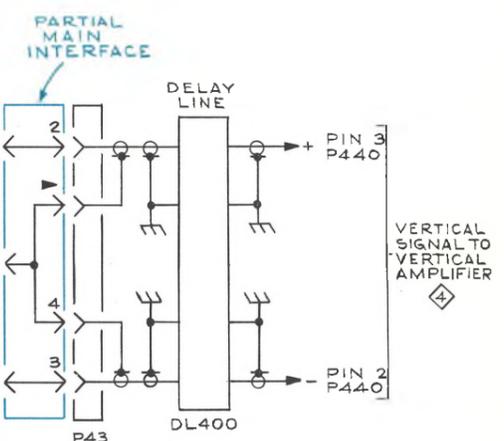
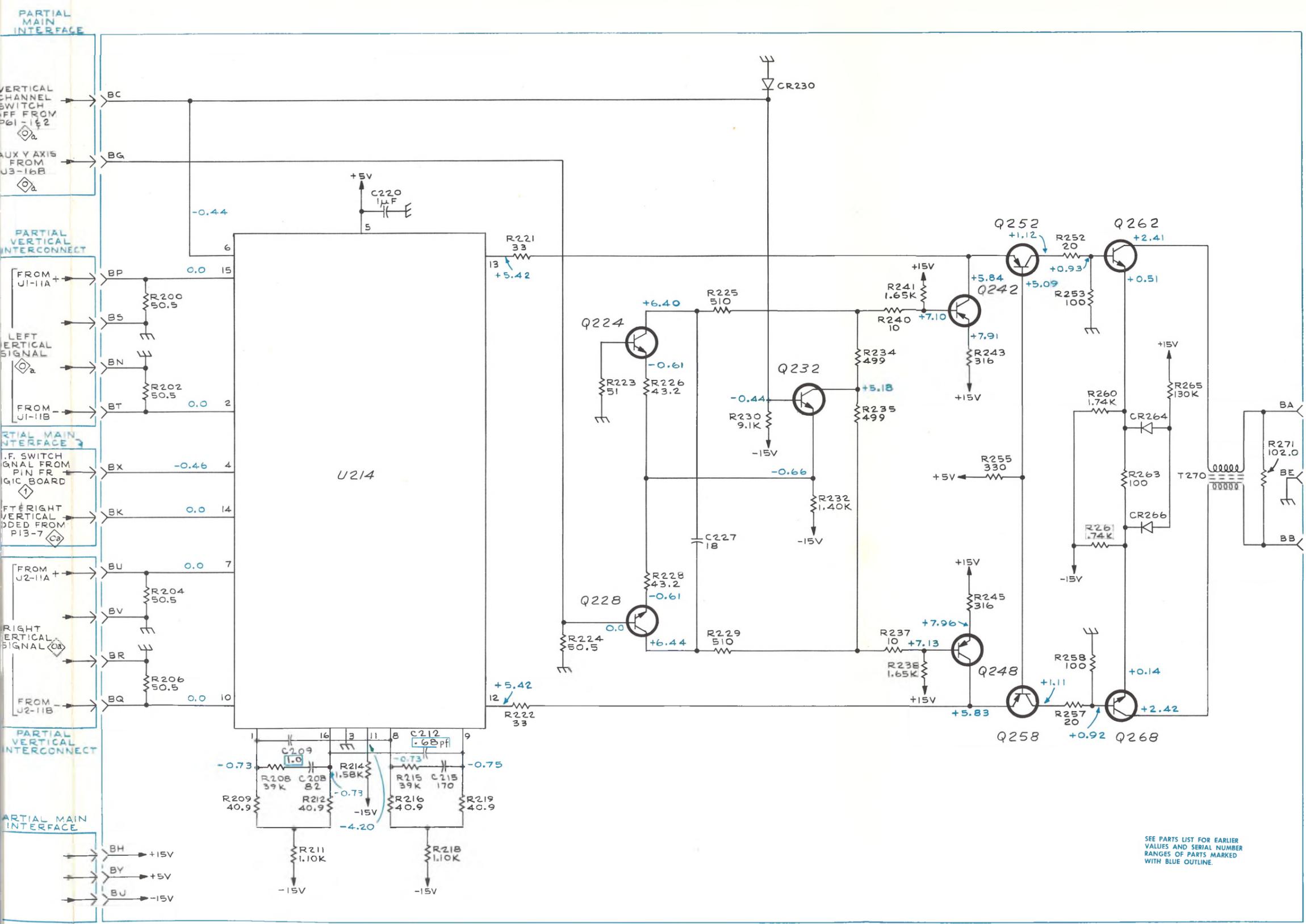
VRS 0670



- REFERENCE DIAGRAM**
- ① MAIN INTERFACE
 - ② LOGIC
 - ③ OUTPUT SIGNALS & CALIBRATOR
 - ④ CRT CIRCUIT
 - ⑤ LV REGULATOR
 - ⑥ LV REGULATOR
 - ⑦ MODE SWITCHING & REAR PANEL CONNECTORS
 - ⑧ SEQUENCING LOGIC



MAIN INTERFACE 0b



REFERENCE DIAGRAMS

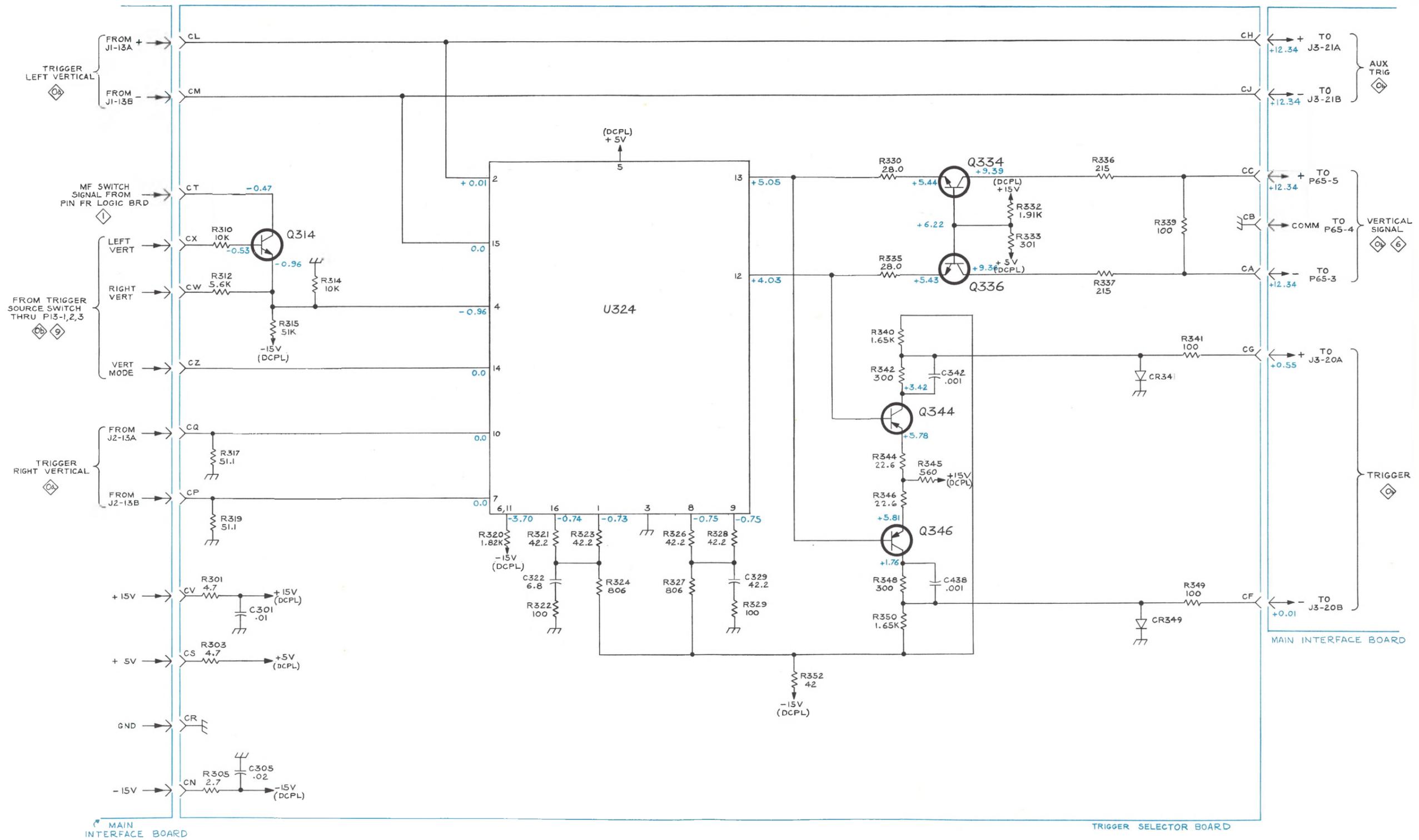
- ⊠ MAIN INTERFACE
- ⊠ LOGIC
- ⊠ VERTICAL AMPLIFIER

NOTE:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES.

VOLTAGES obtained under conditions given on Diagram ⊠ except as follows:
VOLTAGE measurements made with both Vertical Plug-ins removed.

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

VERTICAL INTERFACE



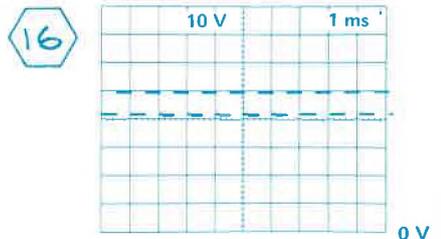
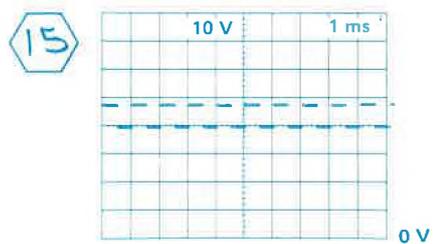
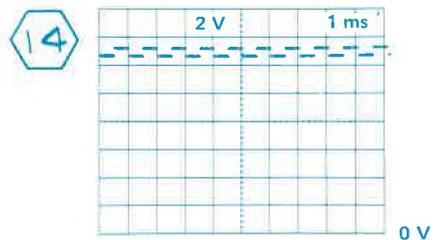
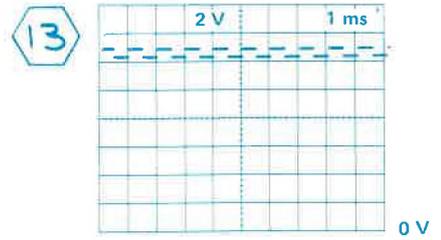
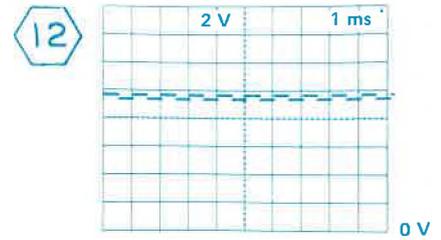
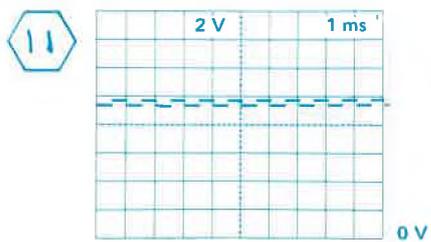
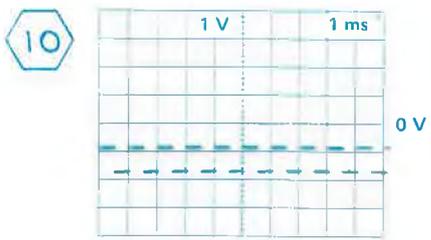
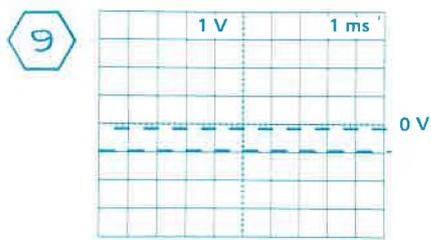
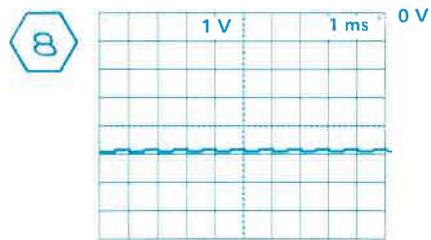
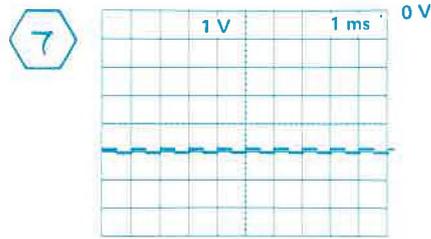
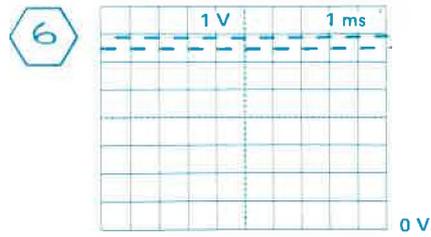
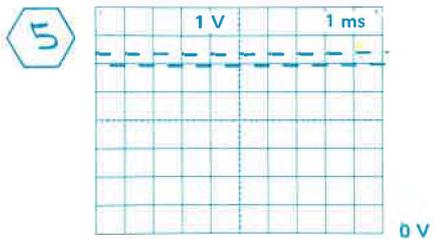
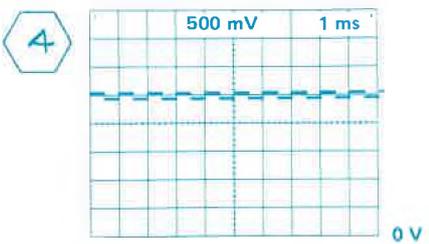
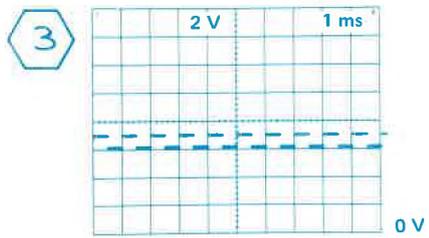
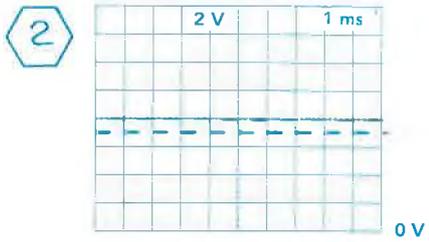
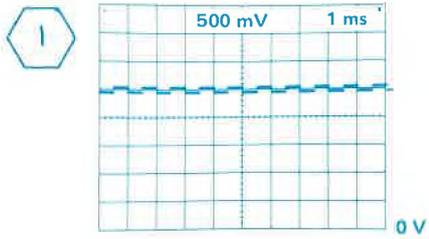
7503

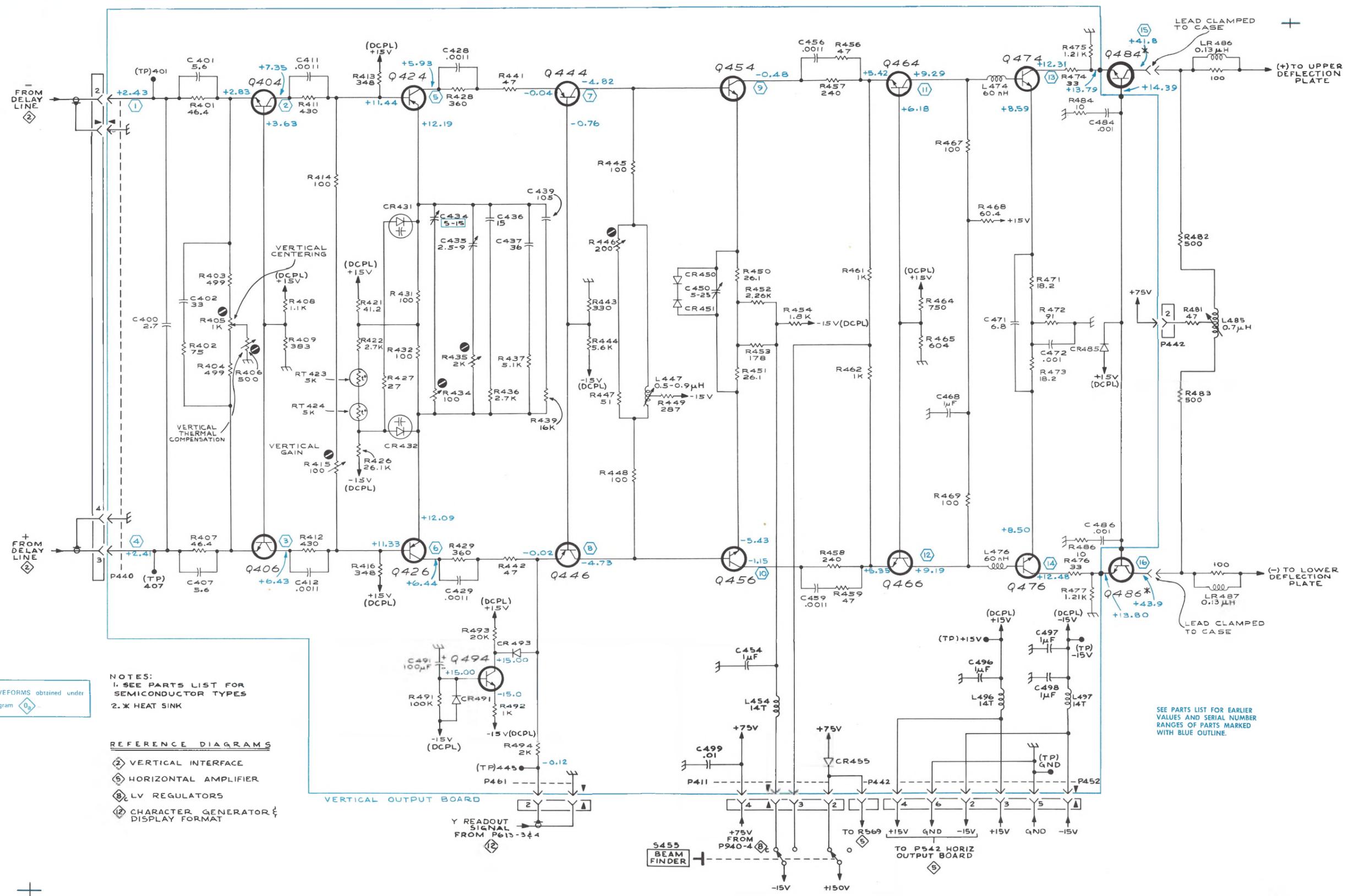
VOLTAGES obtained under conditions given on Diagram \diamond_4 except as follows:
 VOLTAGE measurements made with Right Vertical and Horizontal Plugs removed.

- REFERENCE DIAGRAMS
- \diamond_1 MAIN INTERFACE
 - \diamond_6 OUTPUT SIGNALS \neq CALIBRATOR
 - \diamond_9 MODE SWITCHING & REAR PANEL CONNECTORS

NOTES:
 1 - SEE PARTS LIST FOR SEMICONDUCTOR TYPES

TRIGGER SELECTOR \diamond_3





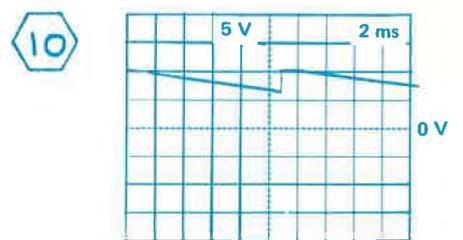
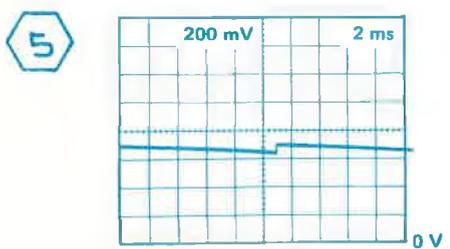
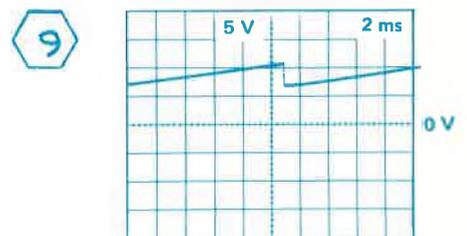
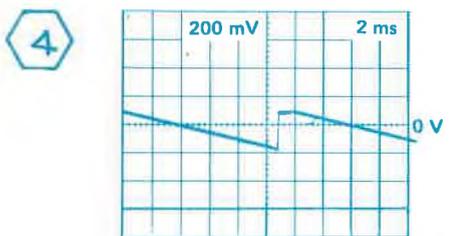
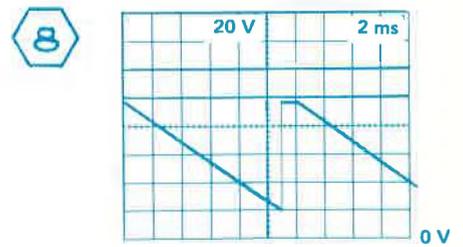
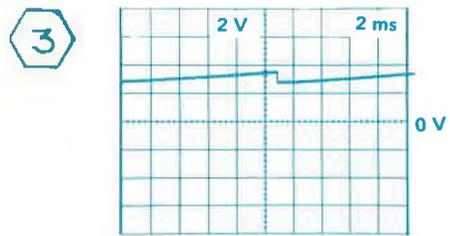
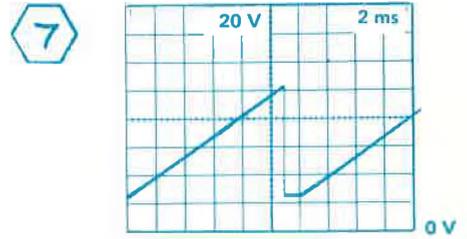
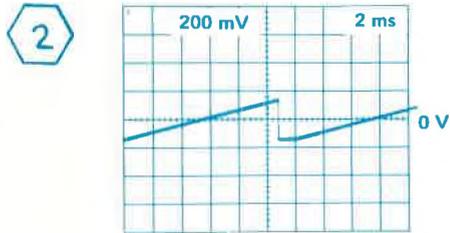
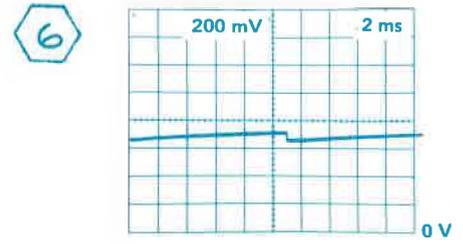
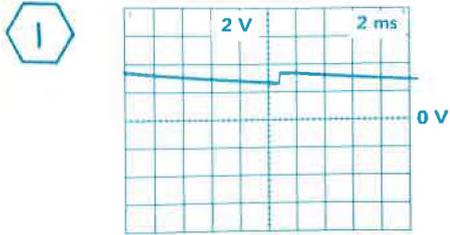
VOLTAGES and WAVEFORMS obtained under conditions given on Diagram 0₃

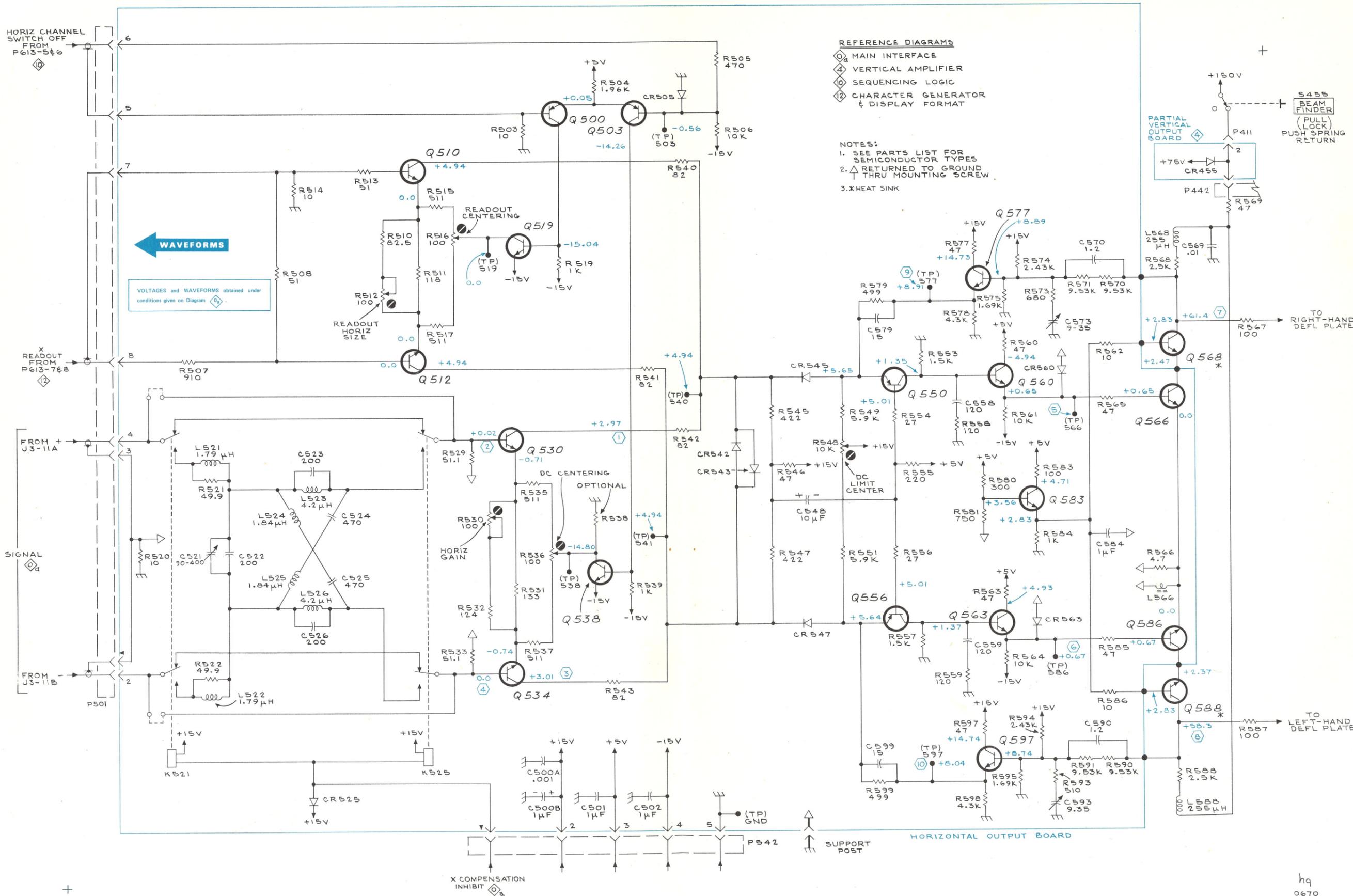
- NOTES:
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
 2. * HEAT SINK

REFERENCE DIAGRAMS

- ② VERTICAL INTERFACE
- ⑤ HORIZONTAL AMPLIFIER
- ⑧ LV REGULATORS
- ⑫ CHARACTER GENERATOR & DISPLAY FORMAT

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

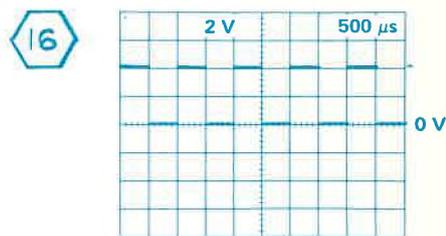
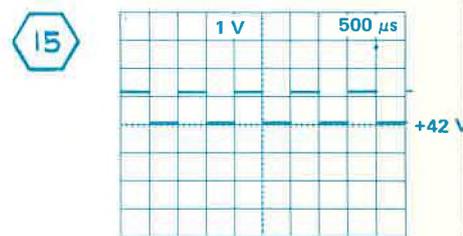
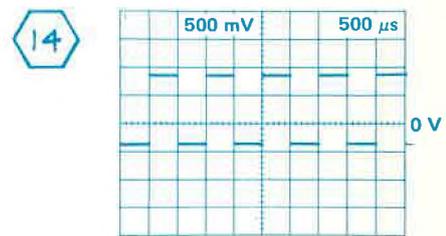
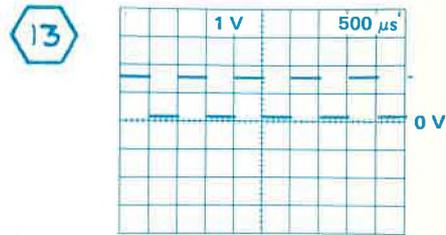
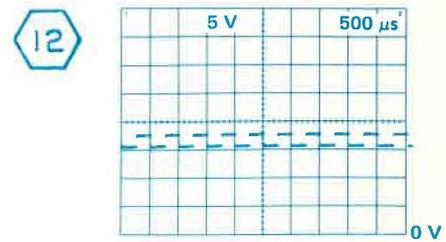
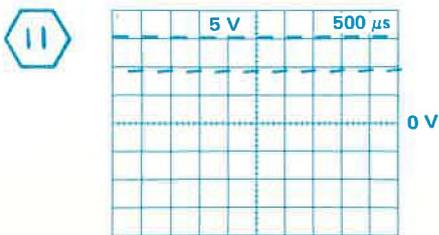
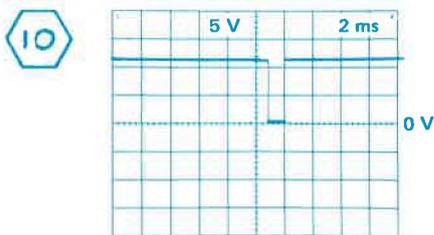
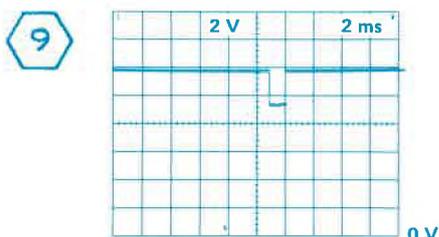
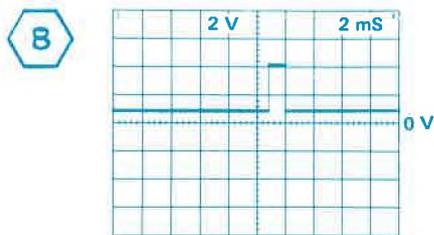
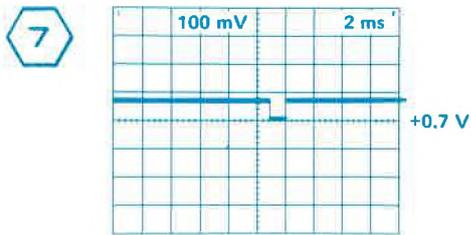
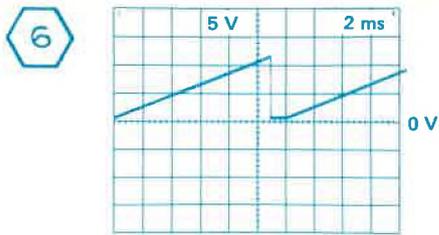
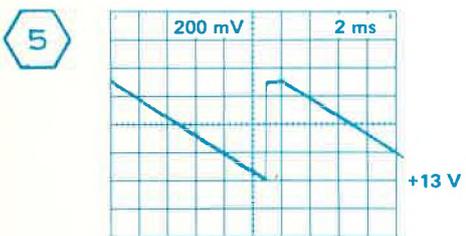
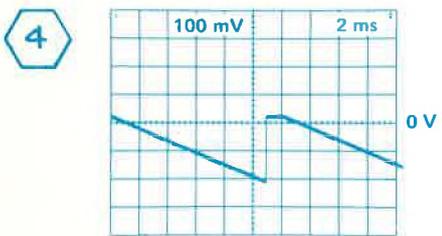
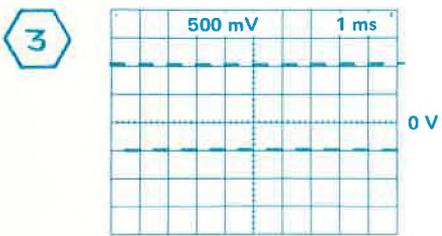
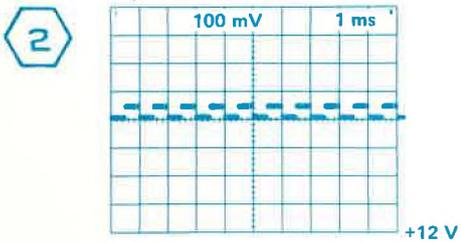
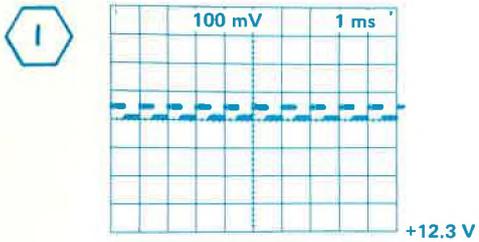


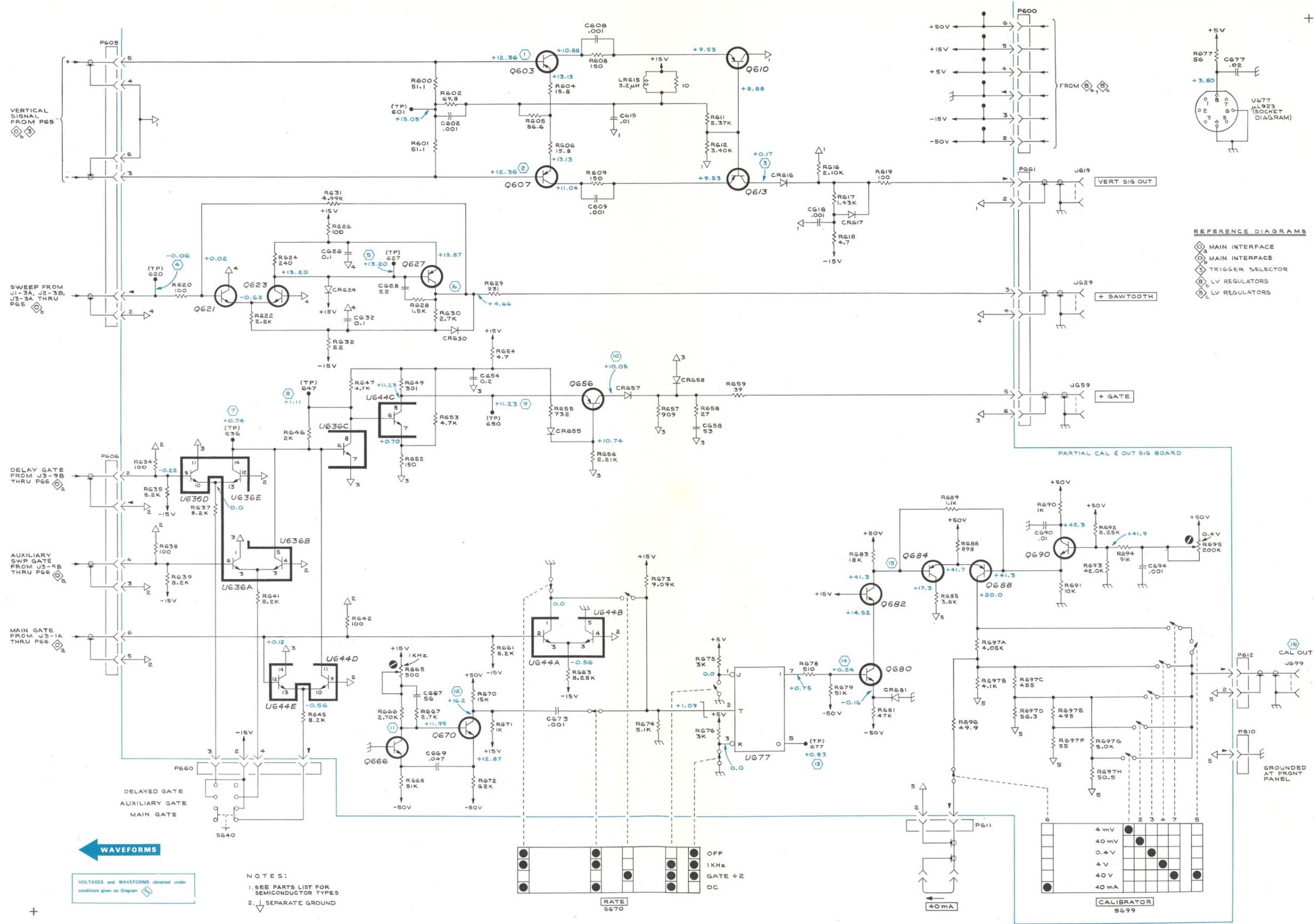


REFERENCE DIAGRAMS

- ① MAIN INTERFACE
- ② VERTICAL AMPLIFIER
- ③ SEQUENCING LOGIC
- ④ CHARACTER GENERATOR & DISPLAY FORMAT

NOTES:
 1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
 2. ∇ RETURNED TO GROUND THRU MOUNTING SCREW
 3. * HEAT SINK





REFERENCE DIAGRAMS

- ① MAIN INTERFACE
- ② MAIN INTERFACE
- ③ TRIGGER SELECTOR
- ④ LV REGULATORS
- ⑤ LV REGULATORS

WAVEFORMS

VOLTAGES and WAVEFORMS obtained under conditions given on Diagram

NOTES:
 1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
 2. SEPARATE GROUND

OFF
 1KHz
 GATE +2
 DC

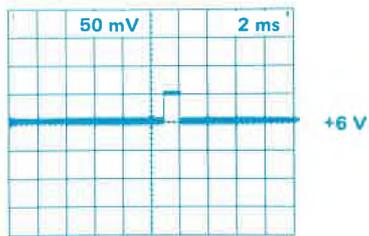
RATE
 S670

4 mV
 40 mV
 0.4 V
 4 V
 40 V
 40 mA

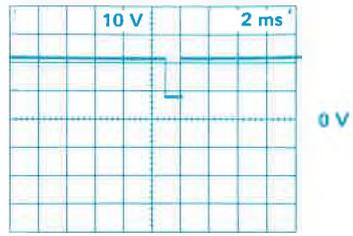
CALIBRATOR
 S699

OUTPUT SIGNALS & CALIBRATOR

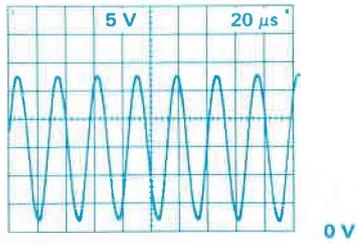
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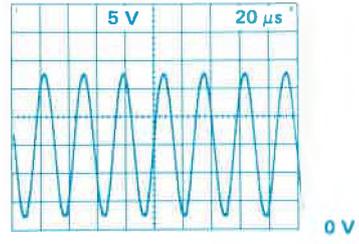
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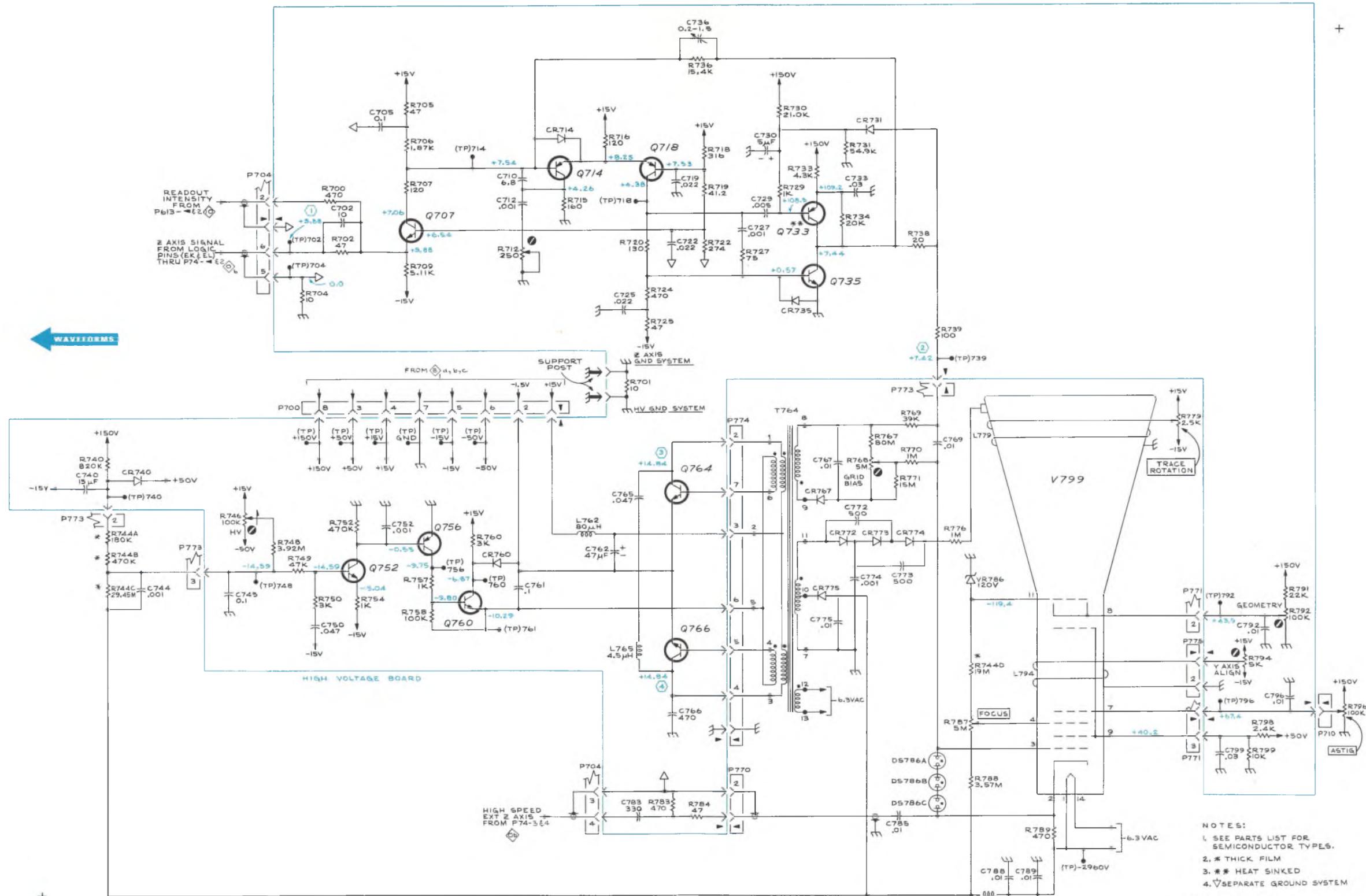
3



4



← WAVEFORMS



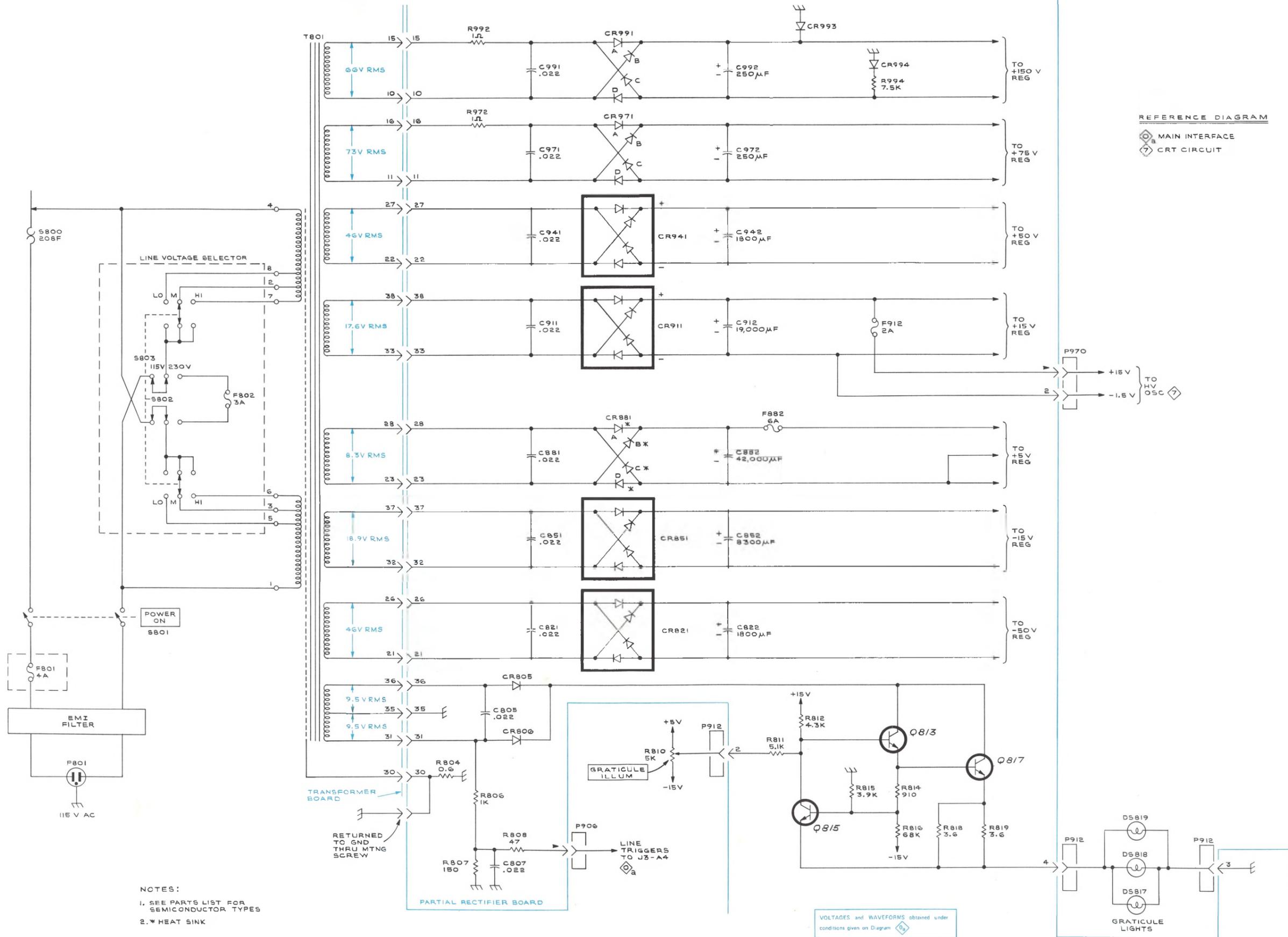
- NOTES:
- SEE PARTS LIST FOR SEMICONDUCTOR TYPES.
 - * THICK FILM
 - ** HEAT SINKED
 - ∇ SEPARATE GROUND SYSTEM

- REFERENCE DIAGRAMS
- ⊙ MAIN INTERFACE
 - ⊕ LV RECTIFIERS
 - ⊖ LV REGULATORS
 - ⊗ LV REGULATORS
 - ⊘ SEQUENCING LOGIC

VOLTAGE and WAVEFORMS measured under conditions given on Diagram except as follows:

For Resistor ② and ④ see note on page 6 of this manual.

RM 6 0670



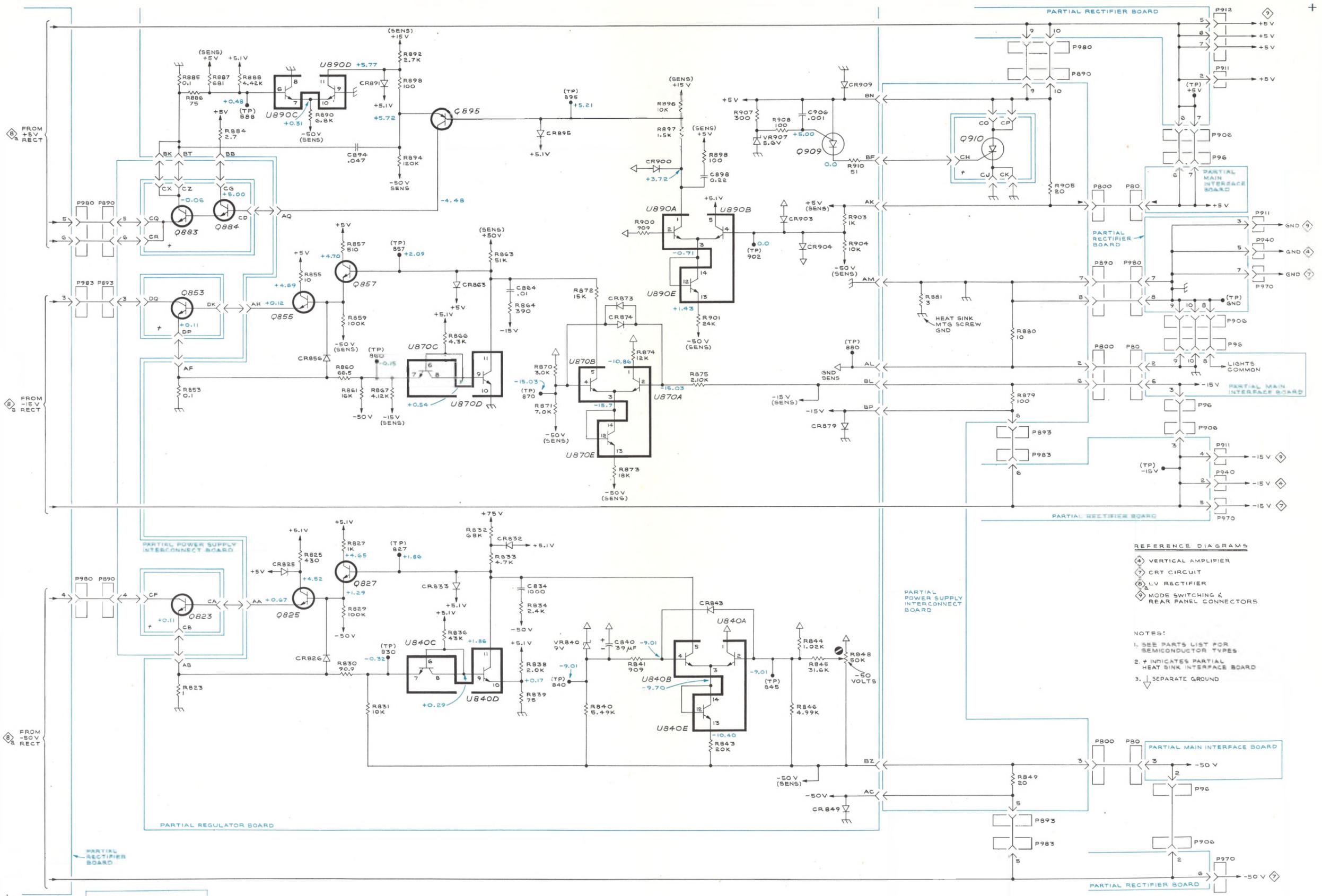
NOTES:
 1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
 2. * HEAT SINK

REFERENCE DIAGRAM

- ⊠ MAIN INTERFACE
- ⊡ CRT CIRCUIT

LV RECTIFIER

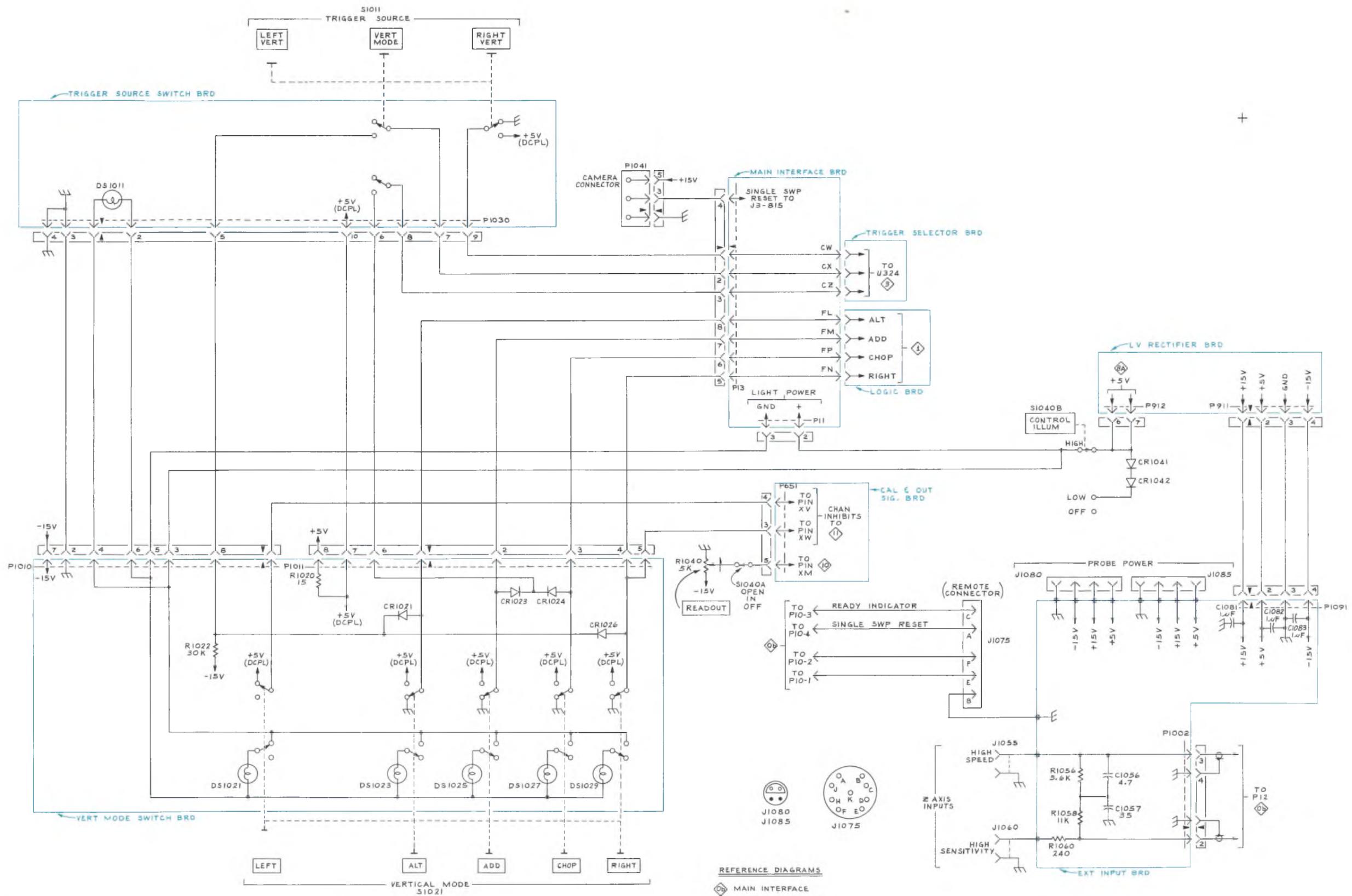
8



REFERENCE DIAGRAMS

- ④ VERTICAL AMPLIFIER
- ⑦ CRT CIRCUIT
- ⑥ LV RECTIFIER
- ⑤ MODE SWITCHING & REAR PANEL CONNECTORS

- NOTES:
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
 2. + INDICATES PARTIAL HEAT SINK INTERFACE BOARD
 3. ↓ SEPARATE GROUND

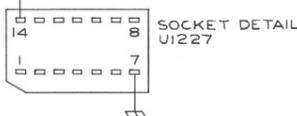
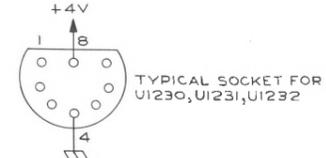
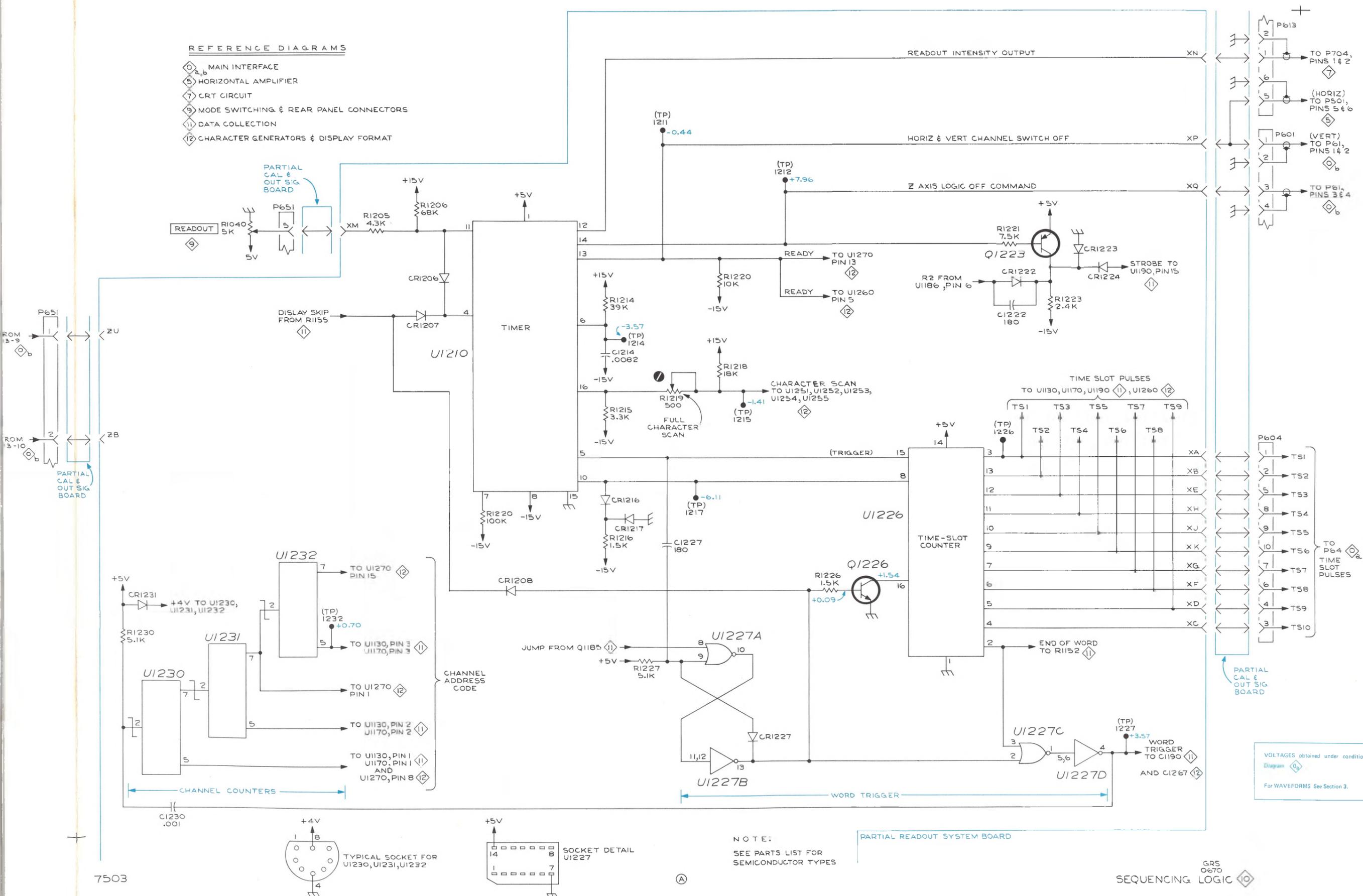


NOTE:
SEE PARTS LIST FOR
SEMICONDUCTOR TYPES.

- REFERENCE DIAGRAMS
- ② MAIN INTERFACE
 - ③ TRIGGER SELECTOR
 - ④ LV RECTIFIER
 - ⑤ SEQUENCING LOGIC
 - ⑥ DATA COLLECTION

REFERENCE DIAGRAMS

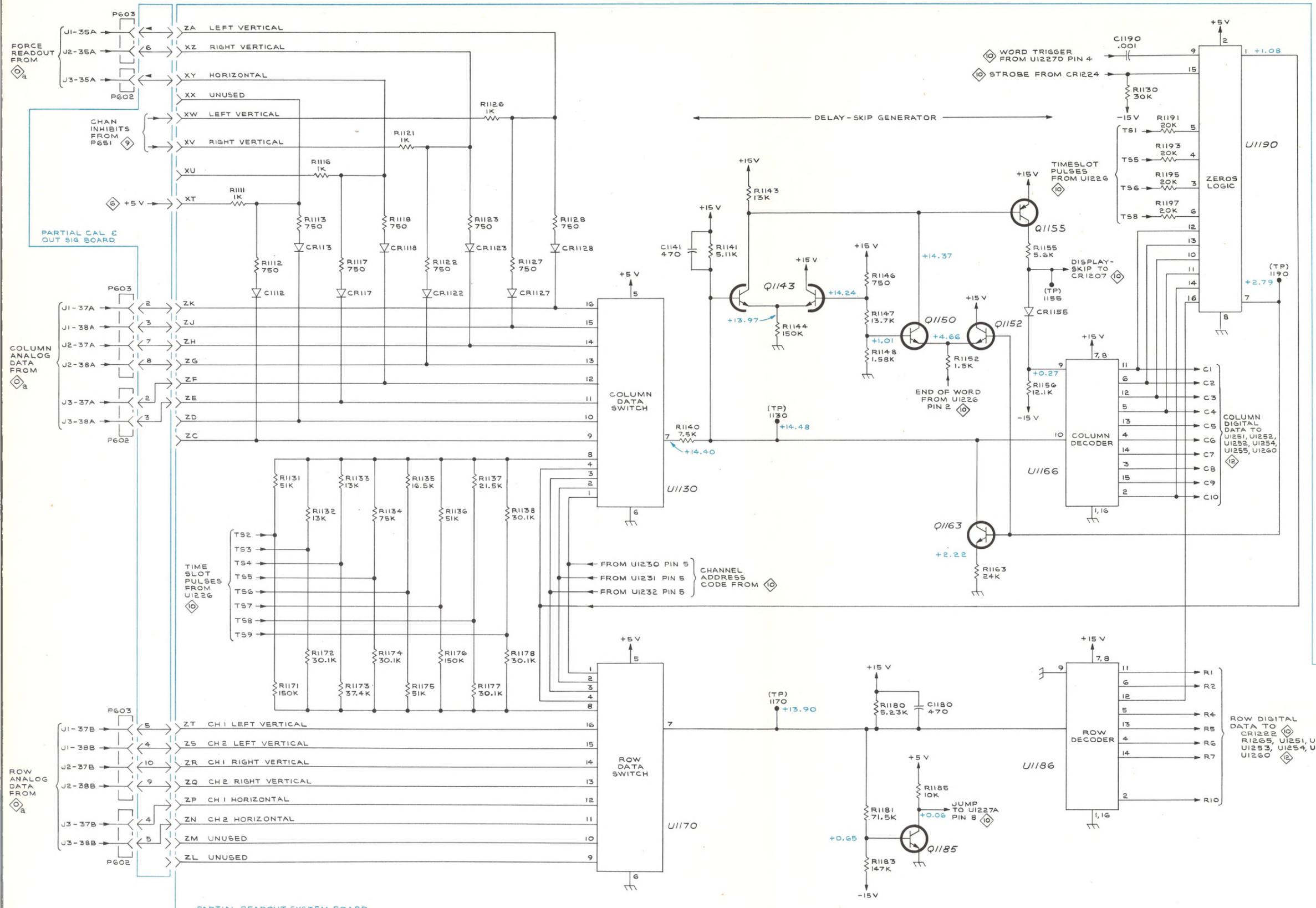
- ① MAIN INTERFACE
- ② HORIZONTAL AMPLIFIER
- ③ CRT CIRCUIT
- ④ MODE SWITCHING & REAR PANEL CONNECTORS
- ⑤ DATA COLLECTION
- ⑥ CHARACTER GENERATORS & DISPLAY FORMAT



NOTE:
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

PARTIAL READOUT SYSTEM BOARD

VOLTAGES obtained under conditions given on Diagram ④
For WAVEFORMS See Section 3.



REFERENCE DIAGRAMS

- ⓐ MAIN INTERFACE
- ⓑ OUTPUT SIGNALS & CALIBRATOR
- ⓓ MODE SWITCHING & REAR PANEL CONNECTORS
- ⓔ SEQUENCING LOGIC
- ⓕ CHARACTER GENERATORS & DISPLAY FORMAT

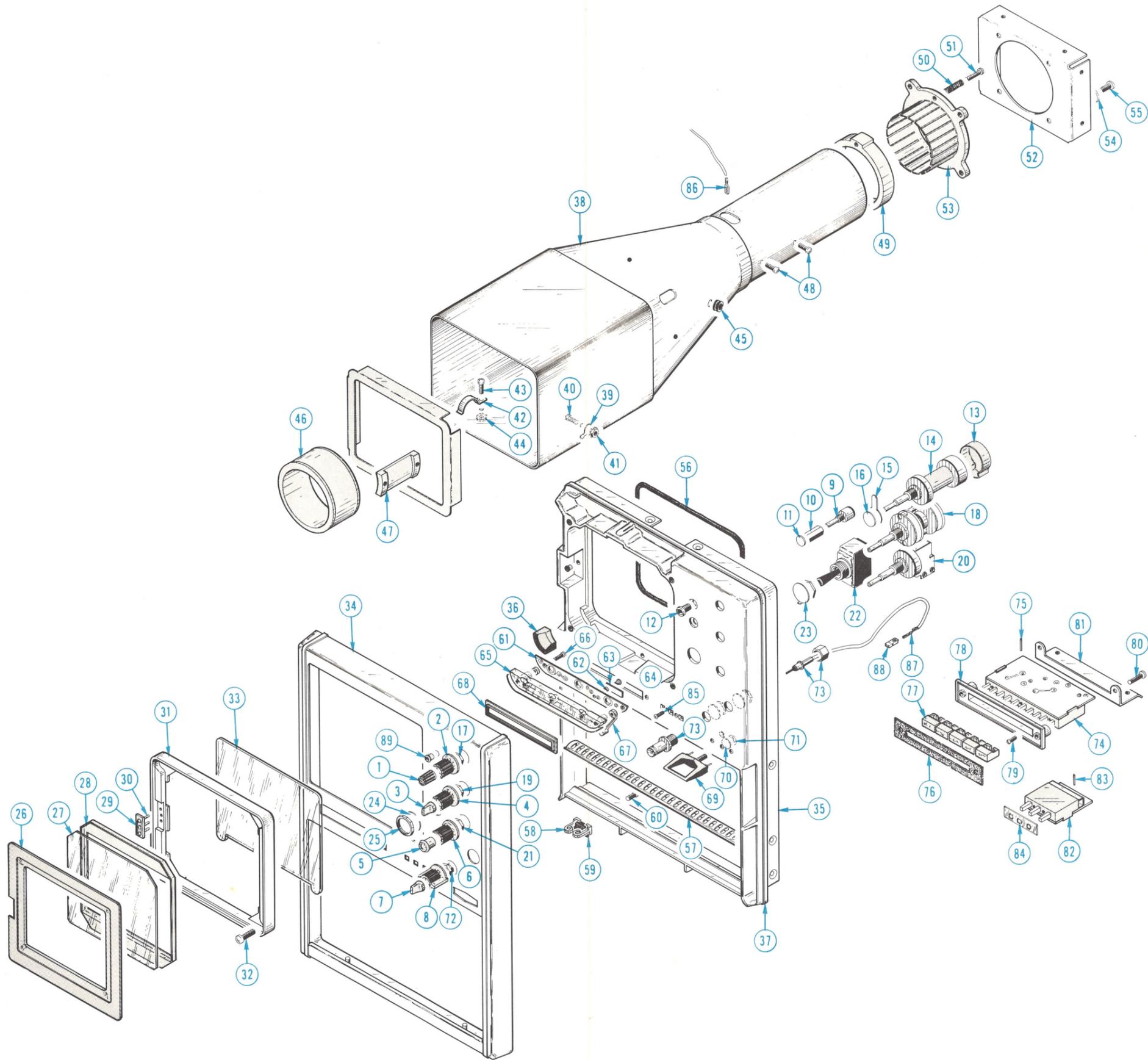
- NOTES:
1. C - COLUMN DIGITAL DATA
R - ROW DIGITAL DATA
TS - TIME SLOT PULSE
 2. SEE PARTS LIST FOR SEMICONDUCTOR TYPES

VOLTAGES obtained under conditions given on Diagram ⓐ.
For WAVEFORMS See Section 3.

DATA COLLECTION

+

FIG. 1 FRONT

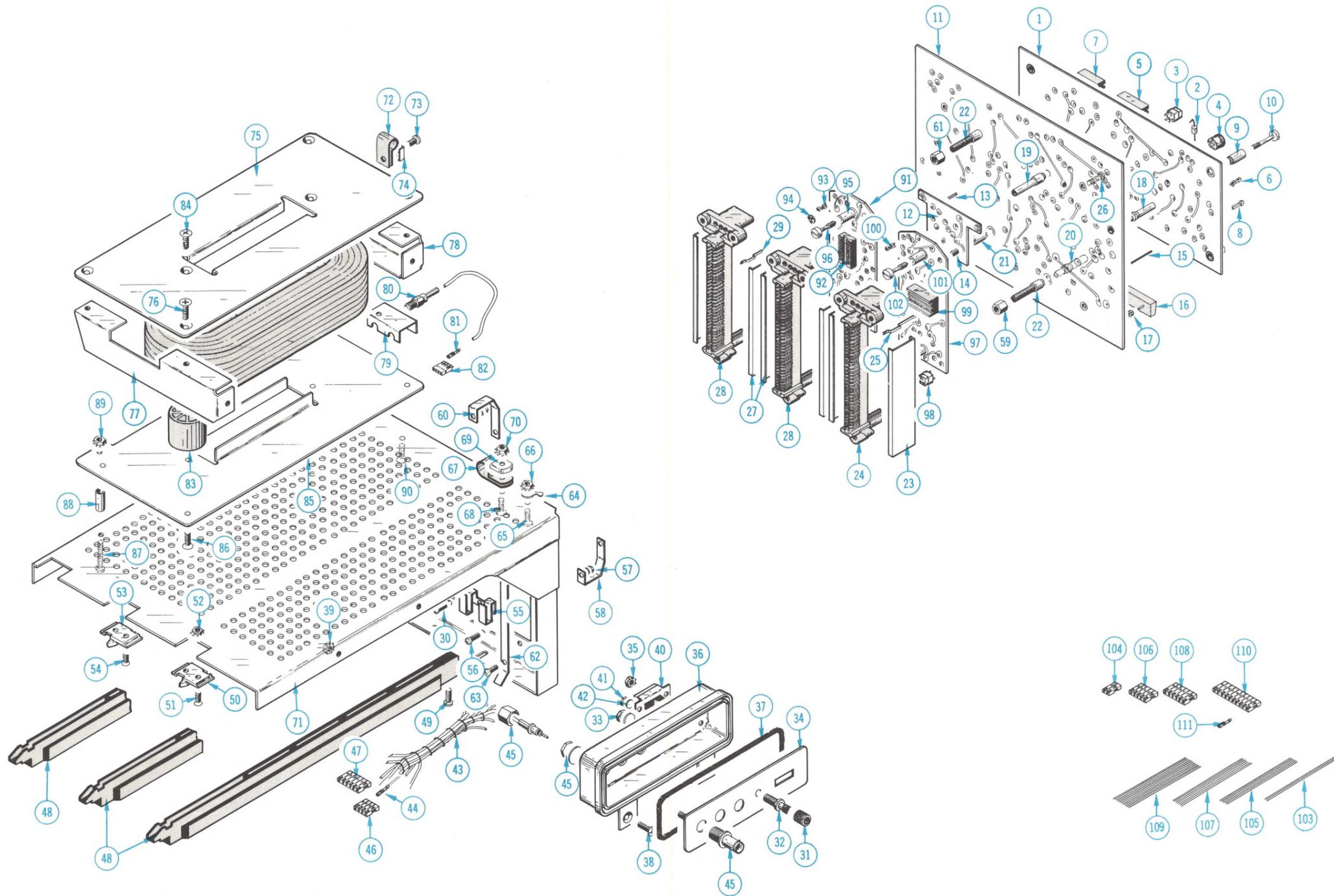


7503 OSCILLOSCOPE

+

+

FIG. 2 CHASSIS



7503 OSCILLOSCOPE

+

+

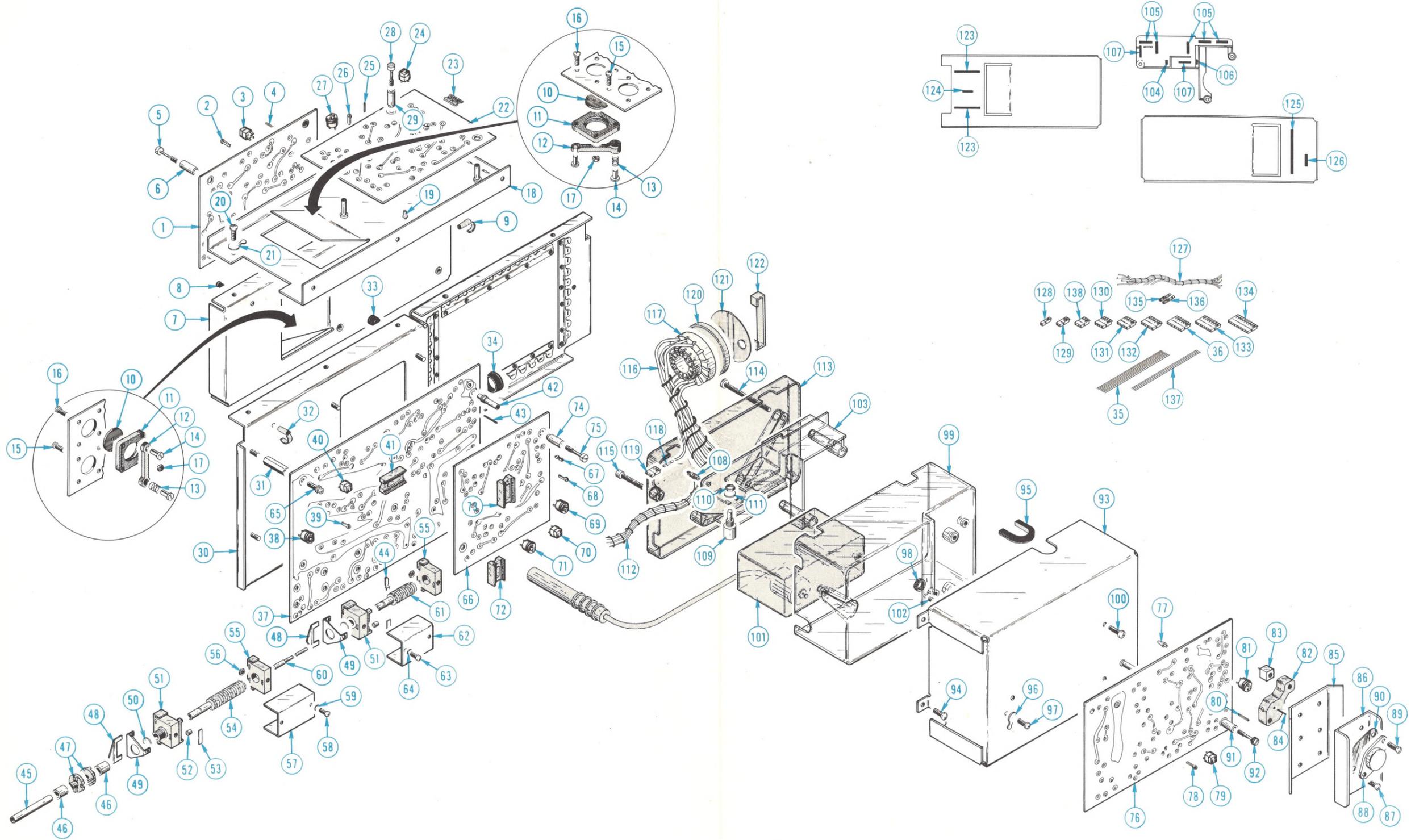
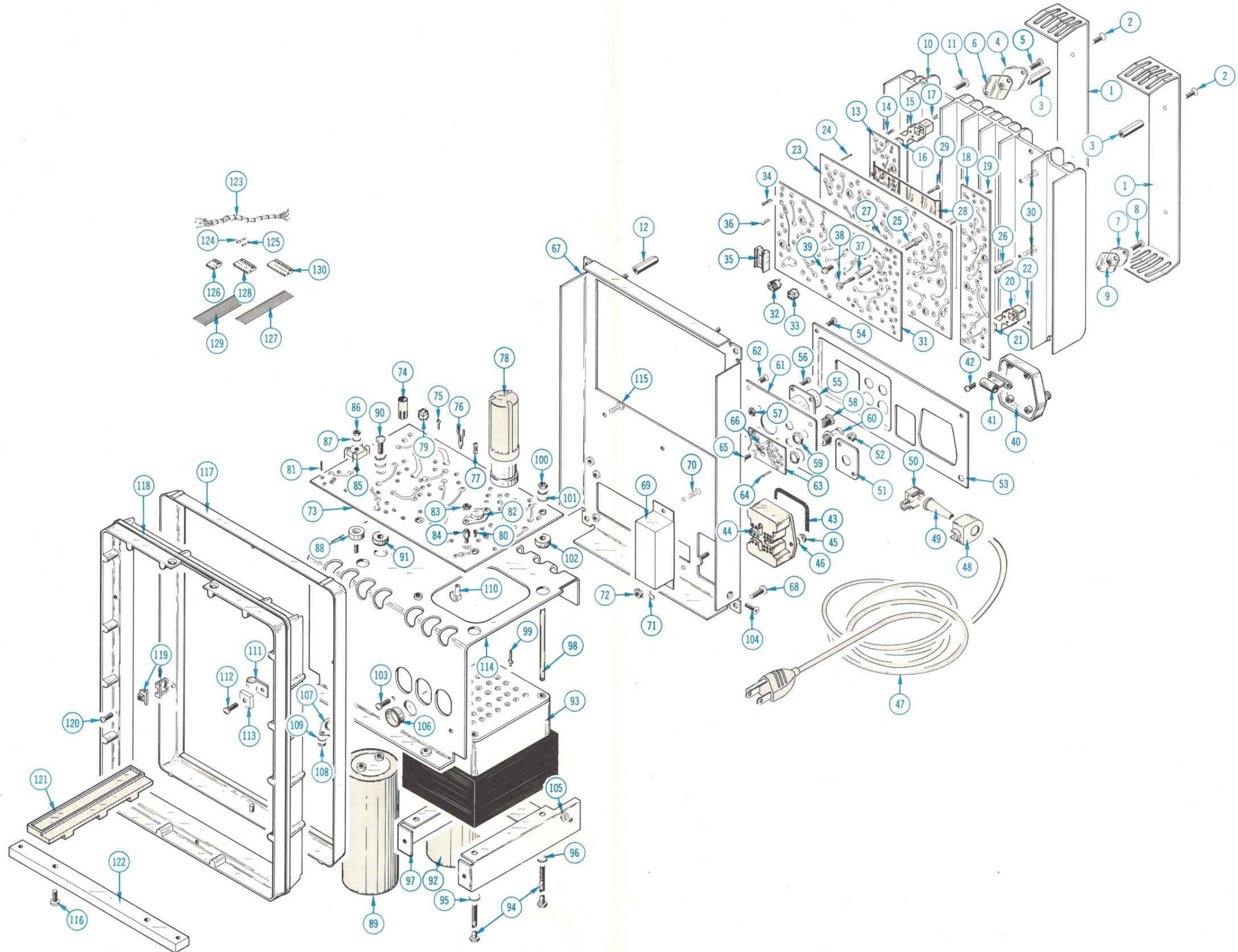


FIG. 3 HIGH VOLTAGE POWER

7503 OSCILLOSCOPE

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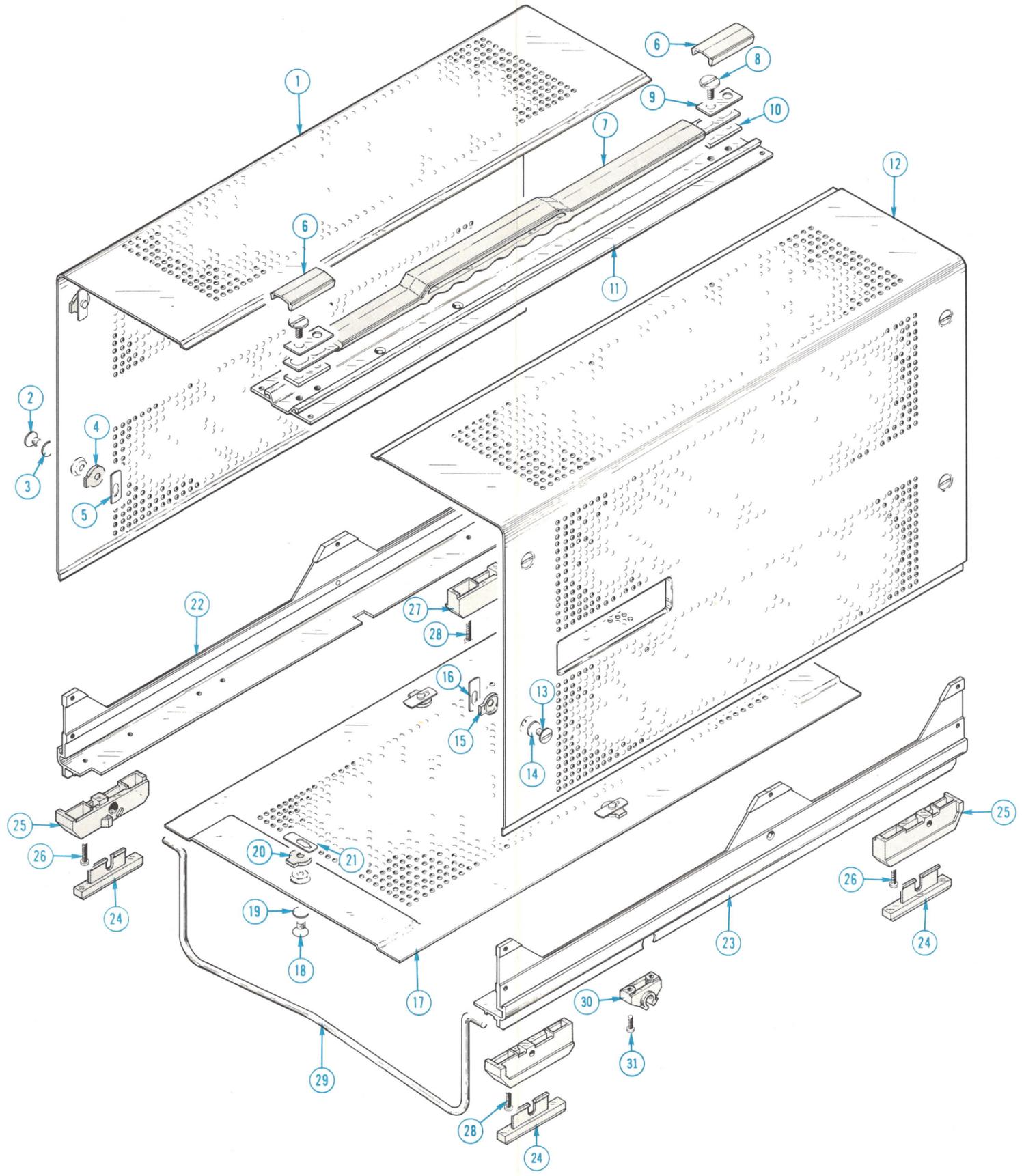
FIG. 4 REAR



7503 OSCILLOSCOPE

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FIG. 5 CABINET



7503 OSCILLOSCOPE

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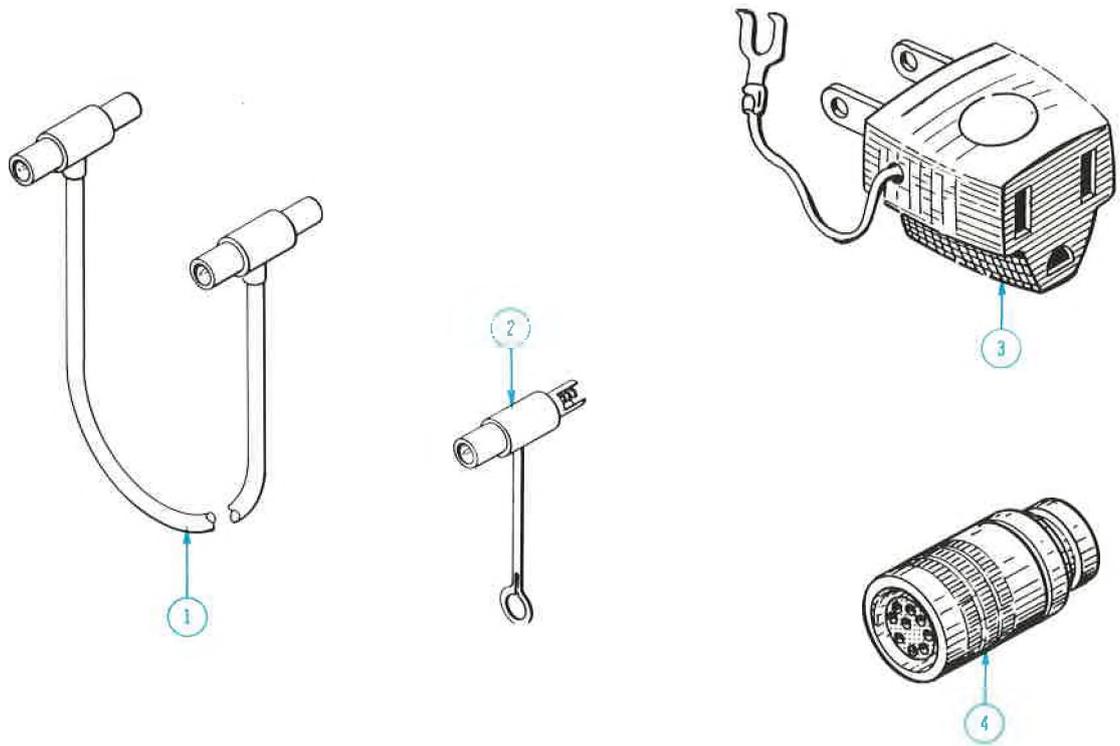


Fig & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q † y	1 2 3 4 5					Description
					1	2	3	4	5	
6-1	012-0087-00			2						PATCH CORD, BNC-BNC, 18 inches long
-2	012-0092-00			1						JACK, BNC-post
-3	103-0013-00			1						ADAPTER, power cord, 3 wire to 2. wire
-4	134-0049-00 070-1039-00			1						PLUG, 9 pin, w/male insert
				2						MANUAL, instruction (not shown)

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OPTION 1
without READOUT Circuit Board Assembly

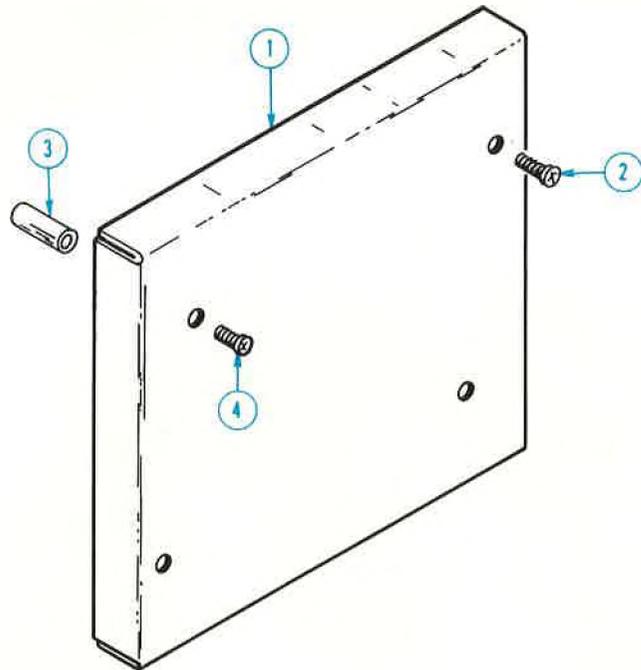


Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description
				y	1	2	3	4	
1	200-1139-00			1					COVER, readout board pins - mounting hardware: (not included w/cover)
2	211-0012-00			2					SCREW, 4-40 x 0.375, PHS
3	129-0249-00			2					POST, plastic, 0.68 inch long - mounting hardware for each: (not included w/post)
4	213-0010-00			1					SCREW, thread cutting, 4-40 x 0.25 inch, RHS

STANDARD ACCESSORIES same as Type 7503

7503 OSCILLOSCOPE

OPTION 3 Electromagnetic Interference (EMI)

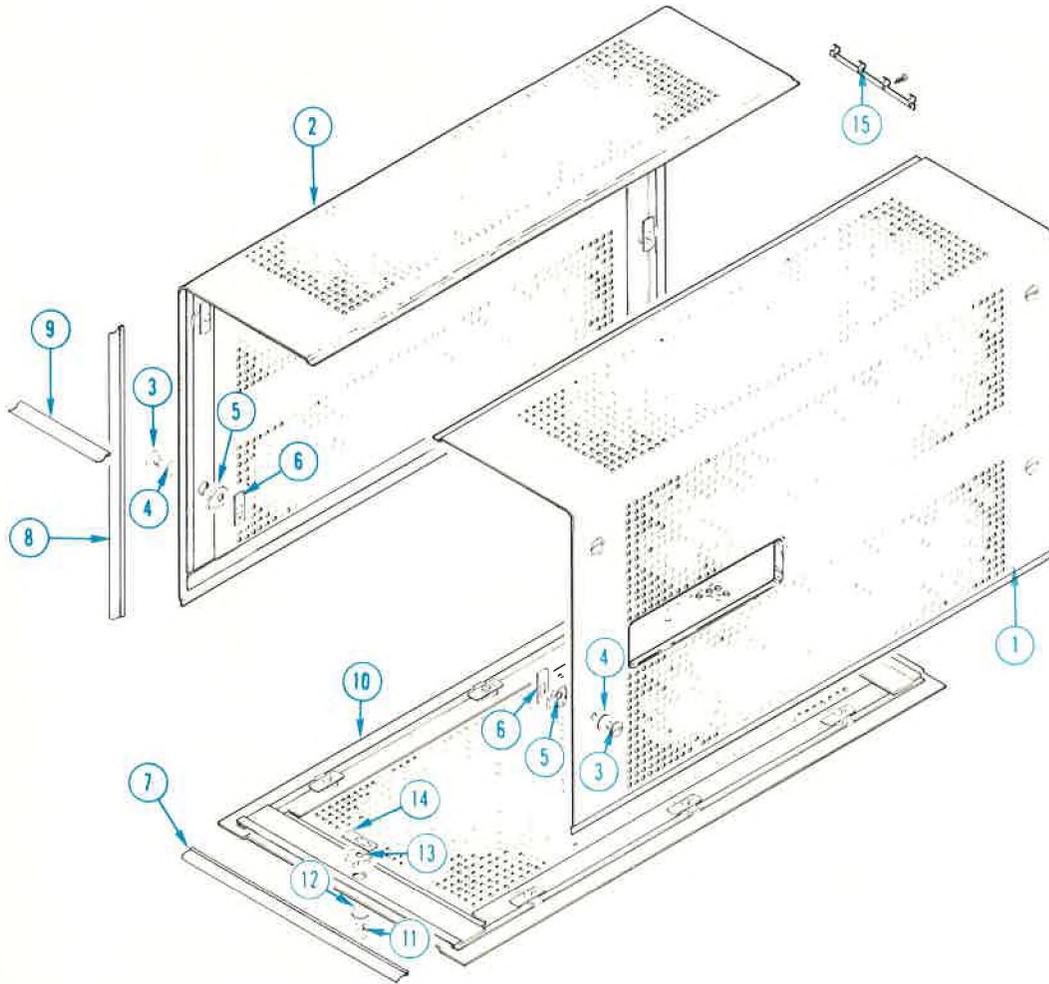


Fig. &
Index Tektronix
No. Part No.

Serial/Model No.
Eff Disc

Q
†
Y 1 2 3 4 5

Description

1	390-0151-00		1	CABINET SIDE, right, w/shielding gasket
2	390-0152-00		1	CABINET SIDE, left, w/shielding gasket
-	-		-	each cabinet side includes:
3	214-0603-01		4	PIN, securing
4	214-0604-00		4	SPRING
5	386-1634-00		4	PLATE, index, plastic
6	386-1633-00		4	PLATE, locking
7	348-0241-00		1	SHIELDING GASKET, 7.168 inches long
8	348-0246-00		1	SHIELDING GASKET, 7.998 inches long
9	348-0247-00		1	SHIELDING GASKET, 3.432 inches long
10	390-0150-00		1	CABINET BOTTOM, w/shielding gasket
-	-		-	cabinet bottom includes:
11	214-0603-01		4	PIN, securing
12	214-0604-00		4	SPRING
13	386-1634-00		4	PLATE, index, plastic
14	386-1633-00		4	PLATE, locking
15	348-0221-00		2	SHIELDING GASKET, electrical

STANDARD ACCESSORIES same as Type 7503—also includes:

378-0625-00	1	FILTER, CRT, light (not shown)
426-0514-00	1	FRAME, mask, plastic (not shown)

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CARTON ASSEMBLY
(Part No. 065-0137-00)

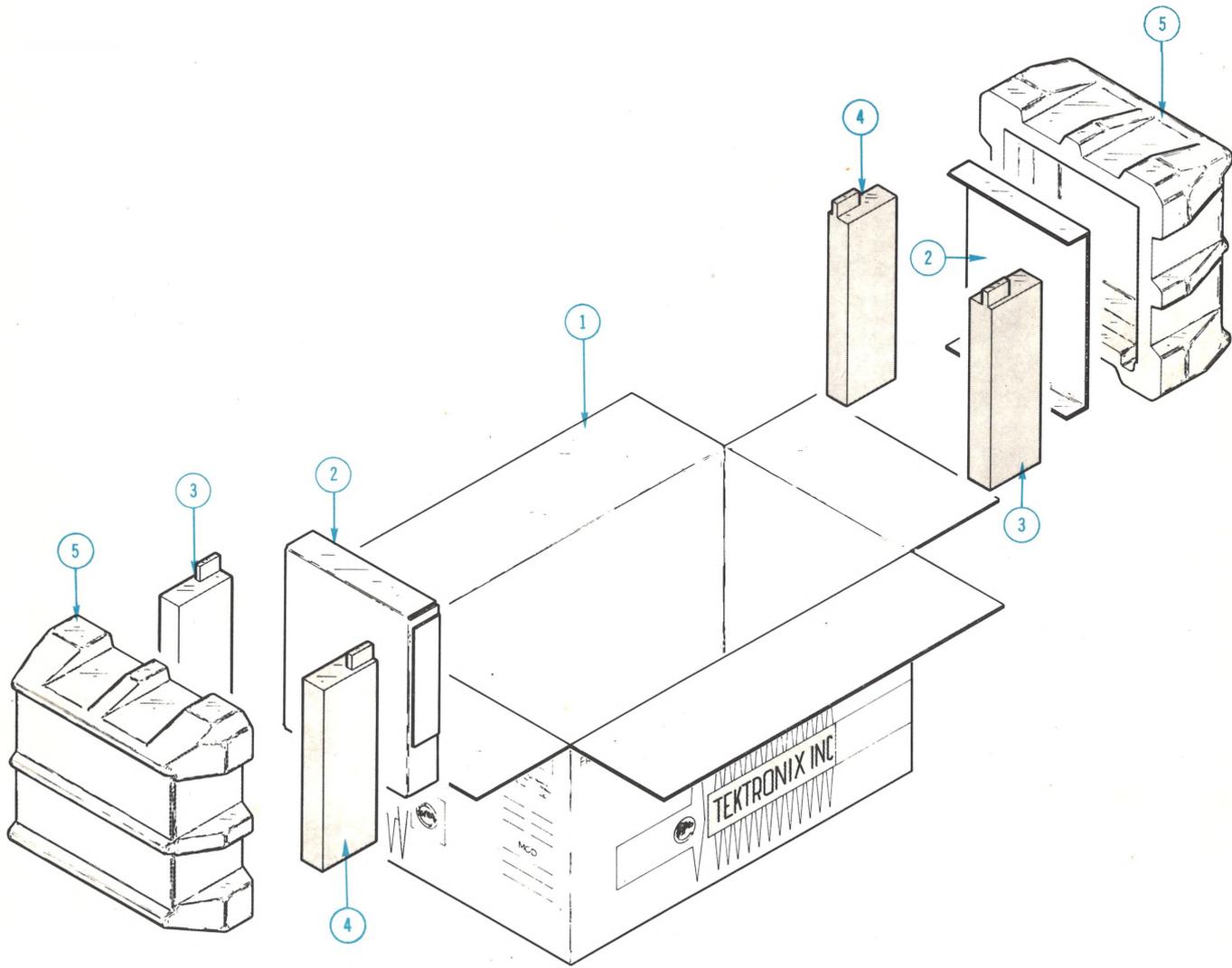


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q						Description	Ⓐ	
					y	1	2	3	4			5
8-	065-0137-00			1							CARTON ASSEMBLY, for 7503 carton assembly includes:	
-1	004-0751-00			1							CARTON	
-2	004-1075-00			1							PAD SET, 2 piece	
-3	004-0275-00			2							INSERT, left	
-4	004-0258-00			2							INSERT, right	
-5	004-0246-00			2							END CAP, plastic	

7503 OSCILLOSCOPE

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FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear either on the back of the diagrams or on pullout pages immediately following the diagrams of the instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicated item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears 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.

Mounting hardware must be purchased separately, unless otherwise specified.

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 or model 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.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL AND REPACKAGING PARTS ILLUSTRATIONS

Title	Location (reverse side of)
Figure 1 Front	CRT Circuit Diagram
Figure 2 Chassis	LV Rectifier Diagram
Figure 3 High Voltage Power	LV Regulators Diagram
Figure 4 Rear	LV Regulators Diagram
Figure 5 Cabinet	Mode Switching & Rear Panel Connectors Diagram
Figure 7 Instrument Options	Data Collection Diagram
Figure 8 Repackaging	Character Generators & Display Format Diagram

SECTION 8 MECHANICAL PARTS LIST

FIGURE 1 FRONT

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description			
				†	y	1	2	3		4	5	
1-1	366-1146-00			1						1	KNOB, gray—FOCUS knob includes:	
	213-0153-00			1							1	SETSCREW, 5-40 x 0.125 inch, HSS
-2	366-1025-01			1							1	KNOB, charcoal—INTENSITY knob includes:
	213-0153-00			2								SETSCREW, 5-40 x 0.125 inch, HSS
-3	366-1163-00			1							1	KNOB, gray—CONTROL ILLUM knob includes:
	213-0153-00			1								SETSCREW, 5-40 x 0.125 inch, HSS
-4	366-1164-00			1							1	KNOB, charcoal—READOUT knob includes:
	213-0153-00			1								SETSCREW, 5-40 x 0.125 inch, HSS
-5	366-1122-00			1							1	KNOB, gray—BEAM FINDER knob includes:
	213-0153-00			1								SETSCREW, 5-40 x 0.125 inch, HSS
-6	366-1120-00			1							1	KNOB, charcoal—GRATICULE ILLUM knob includes:
	213-0153-00			1								SETSCREW, 5-40 x 0.125 inch, HSS
-7	366-1163-00			1							1	KNOB, gray—RATE knob includes:
	213-0153-00			1								SETSCREW, 5-40 x 0.125 inch, HSS
-8	366-1165-00			1							1	KNOB, charcoal—CALIBRATOR knob includes:
	213-0153-00			1								SETSCREW, 5-40 x 0.125 inch, HSS
-9				2								RESISTOR, variable mounting hardware for each: (not included w/resistor)
-10	210-0471-00			1								NUT, hex., 0.25-32 x 0.312 inch
-11	210-1026-00			1								WASHER, lock, external, 0.25 inch OD
-12	358-0409-00			1								BUSHING, machine threaded, 0.275 inch long
-13	200-0745-00			1								COVER, resistor, plastic
-14				1								RESISTOR, variable mounting hardware: (not included w/resistor)
-15	210-0207-00			1								LUG, solder, 0.375 inch
-16	210-0012-00			1								WASHER, lock, internal, 0.375 inch
-17	210-0590-00			1								NUT, hex., 0.375-32 x 0.437 inch
-18	260-1138-00			1								SWITCH, rotary—READOUT, unwired mounting hardware: (not included w/switch)
-19	210-0590-00			1								NUT, hex., 0.375-32 x 0.437 inch
-20				1								RESISTOR, variable mounting hardware: (not included w/resistor)
-21	210-0590-00			1								NUT, hex., 0.375-32 x 0.437 inch

FIGURE 1 FRONT (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q t y	Description
		Eff	Disc		
1 2 3 4 5					
1-22	260-1060-00			1	SWITCH, toggle—POWER, w/hardware
	- - - - -			-	mounting hardware: (not included w/switch)
-23	354-0055-00			1	RING, locking
-24	210-0902-00			1	WASHER, flat, 0.47 ID x 0.656 inch OD
-25	210-0473-00			1	NUT, 12 sided, 0.468-32 x 0.634 inch
-26	426-0514-00			1	FRAME, mask, plastic
-27	378-0625-00			1	FILTER, light, CRT
-28	331-0245-00			1	MASK, CRT
-29	204-0380-00			1	BODY, terminal, plastic
-30	131-0765-00			3	TERMINAL, feed-thru
-31	200-0939-01			1	BEZEL, CRT
	- - - - -			-	mounting hardware: (not included w/bezel)
-32	212-0023-00			4	SCREW, 8-32 x 0.375 inch, PHS
-33	337-1159-00			1	SHIELD, implosion
-34	333-1264-00			1	PANEL, front
-35	426-0576-03			1	FRAME-PANEL, cabinet, front
	- - - - -			-	frame-panel includes:
-36	386-1517-00			4	SUPPORT, CRT, front
-37	354-0345-00			1	RING, ornamental
-38	337-1126-01			1	SHIELD, CRT
-39	210-0201-00			1	LUG, solder, SE #4
	- - - - -			-	mounting hardware: (not included w/lug)
-40	211-0147-00			1	SCREW, 4-40 x 0.25 inch, PHS
-41	210-0586-00			1	NUT, keps, 4-40 x 0.25 inch
-42	131-0807-00			1	CONTACT, CRT grounding
	- - - - -			-	mounting hardware: (not included w/contact)
-43	211-0147-00			1	SCREW, 4-40 x 0.25 inch, PHS
-44	210-0586-00			1	NUT, keps, 4-40 x 0.25 inch
-45	348-0002-00			2	GROMMET, rubber, 0.25 inch diameter
-46	- - - - -			1	COIL
	- - - - -			-	mounting hardware: (not included w/coil)
-47	343-0217-00			1	CLAMP
-48	213-0138-00			2	SCREW, thread forming, 4-40 x 0.187 inch, PHS
-49	354-0347-00			1	RING, clamp, CRT
	- - - - -			-	mounting hardware: (not included w/ring)
-50	214-1333-00			2	SPRING, helical compression, 0.93 inch long
-51	211-0170-00			2	SCREW, 4-40 x 0.275 inches, PHS

FIGURE 1 FRONT (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q t Y	Description
		Eff	Disc		
1-52	407-0724-00			1	BRACKET, CRT, rear
-53	343-0205-00			1	RETAINER, CRT
	- - - - -			-	mounting hardware: (not included w/retainer)
-54	210-0949-00			4	WASHER, flat, 0.14 ID x 0.50 inch OD
-55	211-0507-00			4	SCREW, 6-32 x 0.312 inch, PHS
	- - - - -				
-56	348-0216-00			1	SHIELDING GASKET, electrical
-57	348-0234-00			2	GASKET, shielding
-58	105-0151-00			2	CATCH, panel
	- - - - -			-	mounting hardware: (not included w/catch)
-59	343-0248-00			1	RETAINER, panel catch
-60	213-0119-00			1	SCREW, thread forming, 4-40 x 0.375 inch, PHS
	- - - - -				
-61	670-0702-00			1	CIRCUIT BOARD ASSEMBLY—GRATICULE LIGHT
	- - - - -			-	circuit board assembly includes:
	388-127400			1	CIRCUIT BOARD
	- - - - -			-	circuit board includes:
-62	210-0957-00			3	WASHER, flat, 0.062 ID x 0.125 inch OD
-63	131-0704-00			3	CONTACT, electrical, 0.70 inch long
-64	210-0759-00			3	EYELET, 0.192 inch long
-65	378-0614-00			1	REFLECTOR, light
	- - - - -			-	mounting hardware: (not included w/reflector)
-66	211-0062-00			2	SCREW, 2-56 x 0.312 inch, RHS
-67	344-0179-00			2	CLIP, reflector
-68	200-0984-00			1	BEZEL, plastic (5 button switch)
-69	119-0199-00			1	CURRENT LOOP
	- - - - -			-	mounting hardware: (not included w/current loop)
-70	210-0202-00			1	LUG, solder, SE #6
-71	210-0457-00			1	NUT, keps, 6-32 x 0.312 inch
	- - - - -				
-72	358-0029-00			1	BUSHING, hex., 0.50 inch long, w/hardware
-73	131-0818-00			1	CONNECTOR, receptacle, female, BNC, w/hardware
-74	670-0871-00			1	CIRCUIT BOARD ASSEMBLY—VERT MODE
	- - - - -			-	circuit board assembly includes:
-75	131-0608-00			16	TERMINAL, pin, 0.365 inch long
-76	337-1157-00			1	SHIELD, electrical
-77	366-1222-00			1	PUSHBUTTON ASSEMBLY, 5 button
-78	380-0147-00			1	HOUSING, front, plastic
	- - - - -			-	mounting hardware: (not included w/housing)
-79	211-0125-00			3	SCREW, 1-72 x 0.25 inch, PHS
	- - - - -			-	mounting hardware: (not included w/circuit board assembly)
-80	211-0504-00			2	SCREW, 6-32 x 0.25 inch, PHS
-81	407-0762-00			1	BRACKET, switch

FIGURE 1 FRONT (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q t y	1 2 3 4 5	Description
		Eff	Disc			
1-82	670-0872-00			1		CIRCUIT BOARD ASSEMBLY—TRIG SOURCE
	- - - - -			-		circuit board assembly includes:
-83	131-0608-00			10		TERMINAL, pin, 0.365 inch long
	380-0154-00			1		HOUSING, light, 3 button
	- - - - -			-		mounting hardware: (not included w/housing)
	213-0181-00			1		SCREW, thread forming, #2 x 0.375 inch, PHS
	- - - - -			-		mounting hardware: (not included w/circuit board assembly)
-84	255-0375-02			ft		PLASTIC STRIP, switch alignment, 1.50 inches long
-85	211-0156-00			2		SCREW, 1-72 x 0.25 inch, 82° csk, FHS
-86	131-0865-00			4		TERMINAL, pin
-87	131-0708-00			1		CONNECTOR, terminal
-88	352-0169-02			1		HOLDER, terminal connector, 2 wire (red)
-89	358-0301-02			2		BUSHING, plastic

FIGURE 2 CHASSIS

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description	
				f	y	1	2	3		4
2-1	670-0873-00			1						CIRCUIT BOARD ASSEMBLY—LOGIC
	388-1521-00			-						circuit board assembly includes:
				1						CIRCUIT BOARD
-2	131-0566-00			4						LINK, terminal connecting
-3	136-0220-00			13						SOCKET, transistor, 3 pin, square
-4	136-0235-00			1						SOCKET, transistor, 6 pin
-5	136-0260-01			1						SOCKET, integrated circuit, 16 contact
-6	136-0263-03			33						SOCKET, terminal pin
-7	136-0269-00			4						SOCKET, integrated circuit, 14 contact
-8	214-0579-00			7						PIN, test point
-9	361-0238-00			4						SPACER, sleeve, 0.34 inch long
-10	211-0155-00			4						SCREW, relieved shank, 4-40 x 0.375 inch
-11	670-0859-00			1						CIRCUIT BOARD ASSEMBLY—MAIN INTERFACE
	388-1507-00			-						circuit board assembly includes:
				1						CIRCUIT BOARD
-12	388-1382-00			1						CIRCUIT BOARD
				-						circuit board includes:
-13	131-0787-00			8						TERMINAL, pin, 0.64 inch long
				-						mounting hardware: (not included w/circuit board)
-14	211-0008-00			2						SCREW, 4-40 x 0.25 inch, PHS
-15	131-0590-00			33						TERMINAL, pin, 0.71 inch long
	131-0592-00			29						TERMINAL, pin, 0.882 inch long
	131-0608-00			99						TERMINAL, pin, 0.365 inch long
-16	149-0030-00			1						METER, elapsed time
				-						mounting hardware: (not included w/meter)
-17	166-0292-00			2						SPACER
-18	351-0185-00			2						GUIDE-POST, lock, 0.65 inch long
-19	351-0186-00			1						GUIDE-POST, lock, 0.84 inch long
-20	351-0188-00			2						GUIDE-POST, lock, 0.65 inch long
-21	351-0213-00			2						GUIDE-POST, lock, 0.285 inch long
-22	351-0227-00			3						GUIDE-POST, lock, 0.84 inch long
	131-0767-00			2						CONNECTOR, receptacle, 76 contact
				-						connector includes:
-23	200-0950-00			2						COVER, plastic
-24	204-0365-00			1						BODY, plastic
-25	131-0726-00			2						CONTACT SET, straight, 19 contacts each set
	131-0727-00			2						CONTACT SET, offset, 19 contacts each set
				-						mounting hardware: (not included w/connector)
-26	213-0113-00			2						SCREW, thread forming, 2-56 x 0.312 inch, PHS
	131-0767-02			2						CONNECTOR, receptacle, 76 contact
				-						each connector includes:
-27	200-0950-00			2						COVER, plastic
-28	204-0365-00			1						BODY, plastic
-29	131-0726-00			2						CONTACT SET, straight, 19 contact each set
	131-0727-00			2						CONTACT SET, offset, 19 contacts each set
				-						mounting hardware for each: (not included w/connector)
	213-0113-00			2						SCREW, thread forming, 2-56 x 0.312 inch, PHS
				-						mounting hardware: (not included w/circuit board assembly)
-30	213-0034-00			9						SCREW, thread forming, 4-40 x 0.312 inch, RHS

FIGURE 2 CHASSIS (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description
				Y	1	2	3	4	
2-	129-0053-00			1					BINDING POST ASSEMBLY
				-					binding post assembly includes:
-31	200-0103-00			1					CAP, binding post
-32	355-0507-00			1					STEM, binding post
	210-0046-00			1					WASHER, lock, internal, 0.261 ID x 0.40 inch OD
-33	210-0455-00			1					NUT, hex., 0.25-28 x 0.375 inch
-34	333-1298-00			1					PANEL, side
				-					mounting hardware: (not included w/panel)
-35	210-0586-00			2					NUT, keps, 4-40 x 0.25 inch
-36	441-0924-01			1					CHASSIS, external input
				-					chassis includes:
-37	348-0243-00			1					SHIELDING GASKET
				-					mounting hardware: (not included w/chassis)
-38	212-0559-00			2					SCREW, 6-32 x 0.312 inch, 100° csk, FHS
-39	210-0457-00			2					NUT, 6-32 x 0.312 inch
-40	260-0450-00			1					SWITCH, slide—GATE
				-					mounting hardware: (not included w/switch)
-41	210-0406-00			2					NUT, hex., 4-40 x 0.188 inch
-42	210-0054-00			2					WASHER, lock, splint, #4
-43	179-1533-00			1					WIRING HARNESS—EXTERNAL INPUT
				-					wiring harness includes:
-44	131-0707-00			7					CONNECTOR, terminal
	131-0708-00			3					CONNECTOR, terminal
-45	131-0818-00			3					CONNECTOR, receptacle, female BNC, w/hardware
-46	352-0162-00			1					HOLDER, terminal connector, 4 wire, black
-47	352-0164-01			1					HOLDER, terminal connector, 6 wire, brown
-48	351-0181-00			3					GUIDE, slide, lower, plastic
				-					mounting hardware for each: (not included w/guide)
-49	213-0041-00			1					SCREW, 6-32 x 0.375 inch, THS
	213-0012-00			1					SCREW, thread forming, 4-40 x 0.312 inch, 100° csk, FHS
-50	351-0202-00			1					GUIDE, plug-in, upper
				-					mounting hardware: (not included w/guide)
-51	211-0038-00			2					SCREW, 4-40 x 0.312 inch, 100° csk, FHS
-52	210-0586-00			2					NUT, keps, 4-40 x 0.25 inch
-53	351-0202-00			2					GUIDE, plug-in, upper
				-					mounting hardware for each: (not included w/guide)
-54	211-0038-00			2					SCREW, 4-40 x 0.312 inch, 100° csk, FHS

FIGURE 2 CHASSIS (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y						Description
					1	2	3	4	5	
2-55	131-0930-00			4						CONTACT, electrical, plug-in ground
	- - - - -			-						mounting hardware for each: (not included w/contact)
-56	211-0008-00			1						SCREW, 4-40 x 0.25 inch, PHS
-57	210-0586-00			1						NUT, keps, 4-40 x 0.25 inch
-58	131-0805-00			2						LINK, terminal connector, 0.80 x 0.90 inch
	- - - - -			-						mounting hardware for each: (not included w/link)
-59	220-0561-00			1						NUT, hex., 10-32 x 0.25 inch
-60	131-0804-00			1						LINK, terminal connector, 0.80 x 1.15 inches
	- - - - -			-						mounting hardware: (not included w/link)
-61	220-0561-00			1						NUT, hex., 10-32 x 0.25 inch
-62	131-0800-00			2						CONTACT, electrical, plug-in ground
	- - - - -			-						mounting hardware for each: (not included w/contact)
-63	211-0008-00			2						SCREW, 4-40 x 0.25 inch, PHS
	210-0586-00			2						NUT, keps, 4-40 x 0.25 inch
-64	210-0202-00			1						LUG, solder, SE #6
	- - - - -			-						mounting hardware: (not included w/lug)
-65	211-0541-00			1						SCREW, 6-3 x 0.25 inch, 100° csk, FHS
-66	210-0457-00			1						Keps, 6-32 x 0.312 inch
-67	343-0007-00			1						CLAMP, cable, 0.625 inch diameter, plastic
	- - - - -			-						mounting hardware: (not included w/clamp)
-68	211-0559-00			1						SCREW, 6-32 x 0.375 inch, 100° csk, FHS
-69	210-0863-00			1						WASHER, D shape, 0.191 ID x 0.515 inch
-70	210-0457-00			1						NUT, keps, 6-32 x 0.312 inch
-71	380-0190-00			1						HOUSING, plug-in
	- - - - -			-						mounting hardware: (not included w/housing)
	212-0070-00			6						SCREW, 8-32 x 0.312 inch, 100° csk, FHS (not shown)
	210-0458-00			2						NUT, keps, 8-32 x 0.375 inch (not shown)
-72	343-0004-00			1						CLAMP, cable, 0.312 inch diameter
	- - - - -			-						mounting hardware: (not included w/clamp)
-73	211-0510-00			1						SCREW, 6-32 x 0.375 inch, PHS
-74	210-0863-00			1						WASHER, D shape, 0.191 ID x 0.515 inch

FIGURE 2 CHASSIS (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
2-	119-0216-00			1						DELAY LINE ASSEMBLY
	- - - - -			-						delay line assembly includes:
-75	200-1070-00			1						COVER, delay line, top
	- - - - -			-						mounting hardware: (not included w/cover)
-76	211-0541-00			4						SCREW, 6-32 x 0.25 inch, 100° csk, FHS
-77	386-1684-00			1						SUPPORT, delay line, front
-78	386-1685-00			1						SUPPORT, delay line, rear
-79	407-0723-00			1						BRACKET, delay line
-80	131-0788-00			4						TERMINAL, feed-thru
-81	131-0707-00			8						CONNECTOR, terminal
-82	352-0162-00			1						HOLDER, terminal connector, 4 wire (black)
	352-0162-03			1						HOLDER, terminal connector, 4 wire (orange)
-83	129-0215-00			2						POST, plastic, 1 inch OD x 1.05 inches long
	- - - - -			-						mounting hardware for each: (not included w/post)
-84	213-0229-00			2						SCREW, thread forming, 6-32 x 0.375 inch, 100° csk, FHS
-85	200-1069-00			1						COVER, delay line, bottom
	- - - - -			-						mounting hardware: (not included w/cover)
-86	211-0541-00			4						SCREW, 6-32 x 0.25 inch, 100° csk, FHS
	- - - - -			-						mounting hardware: (not included w/delay line assembly)
-87	211-0523-00			1						SCREW, 6-32 x 0.875 inch, 100° csk, FHS
-88	166-0034-00			1						TUBE, spacer, 0.438 inch long
-89	210-0457-00			1						NUT, keps, 6-32 x 0.312 inch
-90	211-0538-00			2						SCREW, 6-32 x 0.312 inch, 100° csk, FHS
	211-0507-00			2						SCREW, 6-32 x 0.312 inch, PHS (not shown)
-91	670-0860-00			1						CIRCUIT BOARD ASSEMBLY—VERT INTERFACE
	- - - - -			-						circuit board assembly includes:
	388-1508-00			1						CIRCUIT BOARD
-92	136-0260-01			1						SOCKET, integrated circuit, 16 contact
-93	136-0263-03			18						SOCKET, terminal pin
-94	136-0350-00			9						SOCKET, transistor, 3 pin, low profile
-95	361-0238-00			2						SPACER, sleeve, 0.34 inch long
-96	211-0155-00			2						SCREW, relieved shank, 4-40 x 0.375 inch
-97	670-0858-00			1						CIRCUIT BOARD ASSEMBLY—TRIGGER SELECTOR
	- - - - -			-						circuit board assembly includes:
	388-1506-00			1						CIRCUIT BOARD
-98	136-0220-00			5						SOCKET, transistor, 3 pin, square
-99	136-0260-01			1						SOCKET, integrated circuit, 16 contact
-100	136-0263-03			19						SOCKET, terminal pin
-101	361-0238-00			2						SPACER, sleeve, 0.34 inch long
-102	211-0155-00			2						SCREW, relieved shank, 4-40 x 0.375 inch
-103	175-0825-00			ft						WIRE, electrical, 2 wire ribbon, 12 inches
-104	352-0169-00			2						HOLDER, terminal connector, 2 wire (black)
	352-0169-02			3						HOLDER, terminal connector, 2 wire (red)
-105	175-0828-00			ft						WIRE, electrical, 5 wire ribbon, 6.5 inches
-106	352-0163-02			2						HOLDER, terminal connector, 5 wire (red)

FIGURE 2 CHASSIS (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
2-107	175-0829-00			ft						WIRE, electrical, 6 wire ribbon, 17 inches
-108	352-0164-00			2						HOLDER, terminal connector, 6 wire (black)
-109	175-0833-00			ft						WIRE, electrical, 10 wire ribbon, 12.5 inches, #26 AWG
-110	352-0168-03			2						HOLDER, terminal connector, 10 wire (orange)
	352-0168-04			2						HOLDER, terminal connector, 10 wire (yellow)
	175-0855-00			ft						WIRE, electrical, 10 wire ribbon, 13 inches, #22 AWG
	352-0168-06			2						HOLDER, terminal connector, 10 wire (blue)
-111	131-0707-00			86						CONNECTOR, terminal
	131-0708-00			2						CONNECTOR, terminal

FIGURE 3 HIGH VOLTAGE POWER

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
3-1	670-0869-00			1						CIRCUIT BOARD ASSEMBLY—VERTICAL OUTPUT
	- - - - -			-						circuit board assembly includes:
	388-1517-00			1						CIRCUIT BOARD
-2	214-0579-00			6						PIN, test point
-3	136-0220-00			13						SOCKET, transistor, 3 pin, square
-4	131-0608-00			18						TERMINAL, pin, 0.365 inch long
-5	211-0155-00			4						SCREW, 4-40 x 0.375 inch, PHS
-6	361-0238-00			4						SPACER, sleeve
-7	441-0914-00			1						CHASSIS, vertical amp
-8	348-0031-00			2						GROMMET, plastic, 0.25 inch
-9	343-0089-00			1						CLAMP, cable, plastic, large
-10	214-1138-00			4						HEAT SINK
-11	352-0062-00			4						HOLDER, heat sink
-12	343-0097-00			4						CLAMP
	210-0627-00			4						RIVET (not shown)
-13	214-0368-00			4						SPRING, helical compression
-14	210-0599-00			8						NUT, sleeve
-15	211-0101-00			8						SCREW, 4-40 x 0.25 inch, 100° csk, FHS
-16	211-0025-00			8						SCREW, 4-40 x 0.375 inch, 100° csk, FHS
-17	210-0406-00			16						NUT, hex., 4-40 x 0.188 inch
-18	441-0911-00			1						CHASSIS, horizontal amp
-19	386-1556-00			3						SUPPORT, circuit board
-20	210-0002-00			1						LUG, solder, SE #6
	- - - - -			-						mounting hardware: (not included w/lug)
-21	211-0504-00			1						SCREW, 6-32 x 0.25 inch, PHS
-22	670-0863-00			1						CIRCUIT BOARD ASSEMBLY—HORIZONTAL OUTPUT
	- - - - -			-						circuit board assembly includes:
	388-1511-00			1						CIRCUIT BOARD
-23	136-0337-00			2						SOCKET, relay, 8 pin
-24	136-0220-00			15						SOCKET, transistor, 3 pin, square
-25	131-0608-00			13						TERMINAL, pin, 0.365 inch long
-26	214-0579-00			10						PIN, test point
-27	136-0183-00			2						SOCKET, transistor, 3 pin
-28	361-0238-00			3						SPACER, sleeve
-29	211-0155-00			3						SCREW, 4-40 x 0.375 inch, PHS
-30	441-0917-00			1						CHASSIS, main
-31	129-0254-00			6						POST, hex., 0.74 inch long
-32	343-0213-00			3						CLAMP, cable, plastic
-33	348-0067-00			1						GROMMET, plastic, 0.312 inch diameter
-34	348-0064-00			1						GROMMET, plastic, 0.625 inch diameter
-35	175-0830-00			ft						WIRE, electrical, 7 wire ribbon, 10 inches long
-36	352-0164-04			1						HOLDER, terminal connector, 7 wire (yellow)

FIGURE 3 HIGH VOLTAGE POWER (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
3-37	670-0870-00			1						CIRCUIT BOARD ASSEMBLY—CALIBRATION
	- - - - -			-						circuit board assembly includes:
	388-1518-00			1						CIRCUIT BOARD
-38	136-0237-00			1						SOCKET, semiconductor device, 8 pin
-39	214-0579-00			13						PIN, test point
-40	136-0220-00			15						SOCKET, transistor, 3 pin, square
-41	136-0269-00			2						SOCKET, integrated circuit, 14 contact
-42	351-0188-00			2						GUIDE-POST, lock, 0.65 inch long
-43	131-0590-00			40						TERMINAL, pin, 0.71 inch long
	131-0608-00			68						TERMINAL, pin, 0.365 inch long
-44	131-0604-00			12						CONTACT, electrical, spring
-45	384-1010-00			1						SHAFT, extension, outer, 1.644 inches long
-46	376-0100-00			2						COUPLER HALF, shaft
	- - - - -			-						coupler half includes:
	213-0048-00			3						SETSCREW, 4-40 x 0.125 inch, HSS
-47	376-0064-00			2						COUPLER HALF, shaft, slide type, plastic
-48	131-0840-00			2						CONTACT, electrical, grounding
-49	407-0714-00			2						BRACKET, grounding
-50	354-0219-00			2						RING, retaining
-51	401-0058-00			2						BEARING, cam switch, front
	- - - - -			-						mounting hardware for each: (not included w/bearing)
	211-0116-00			2						SCREW, sems, 4-40 x 0.312 inch, PHB
	210-0406-00			2						NUT, hex., 4-40 x 0.188 inch
-52	214-1127-00			2						ROLLER, detent
-53	214-1139-00 ¹			-						SPRING, flat, gold
	214-1139-02 ¹			-						SPRING, flat, green
	214-1139-03 ¹			-						SPRING, flat, red
-54	105-0191-00			1						DRUM, cam
-55	401-0061-00			2						BEARING, cam switch, rear
	- - - - -			-						mounting hardware for each: (not included w/bearing)
	211-0116-00			2						SCREW, sems, 4-40 x 0.312 inch, PHB
-56	210-0406-00			2						NUT, hex., 4-40 x 0.188 inch
-57	200-1032-00			1						COVER, cam switch
	- - - - -			-						mounting hardware: (not included w/cover)
-58	211-0002-00			2						SCREW, 2-56 x 0.25 inch, RHS
-59	210-0001-00			2						WASHER, lock, internal, #2
	210-0405-00			2						NUT, hex., 2-56 x 0.188 inch
-60	384-0173-00			1						ROD, extension, 6.437 inches long
-61	105-0190-00			1						DRUM, cam
	- - - - -			-						drum includes:
	213-0076-00			2						SETSCREW, 2-56 x 0.125 inch, HSS
-62	200-1032-00			1						COVER, cam switch
	- - - - -			-						mounting hardware: (not included w/cover)
-63	211-0002-00			2						SCREW, 2-56 x 0.25 inch, RHS
-64	210-0001-00			2						WASHER, lock, internal, #2
	210-0405-00			2						NUT, hex., 2-56 x 0.188 inch
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
-65	211-0601-00			5						SCREW, sems, 6-32 x 0.312 inch, PHS

¹Replace only with part bearing the same color code as the original part in your instrument.

FIGURE 3 HIGH VOLTAGE POWER (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
3-66	670-0635-01			1						CIRCUIT BOARD ASSEMBLY—READOUT
	- - - - -			-						circuit board assembly includes:
	388-1166-00			1						CIRCUIT BOARD
-67	136-0263-03			46						SOCKET, pin, terminal
-68	214-0579-00			18						PIN, test point
-69	136-0237-00			4						SOCKET, semiconductor device, 8 pin
-70	136-0220-00			11						SOCKET, transistor, 3 pin, square
-71	136-0235-00			1						SOCKET, semiconductor device, 6 pin
-72	136-0269-00			1						SOCKET, integrated circuit, 14 contact
-73	136-0260-01			14						SOCKET, connector pin
-74	361-0238-00			2						SPACER, sleeve
-75	211-0155-00			2						SCREW, 4-40 x 0.375 inch, PHS
-76	670-0868-00			1						CIRCUIT BOARD ASSEMBLY—Z AXIS & HV OSC.
	- - - - -			-						circuit board assembly includes:
	388-1516-00			1						CIRCUIT BOARD
-77	386-1556-00			2						SUPPORT, circuit board
-78	214-0579-00			21						PIN, test point
-79	136-0220-00			5						SOCKET, transistor, 3 pin, square
-80	131-0608-00			32						TERMINAL, pin, 0.365 inch long
-81	136-0183-00			3						SOCKET, transistor, 3 pin
-82	136-0361-00			2						SOCKET, transistor
-83	131-0847-00			4						TERMINAL POST, 0.435 inch long
-84	136-0384-00			4						SOCKET, pin terminal
-85	214-1329-00			1						HEAT SINK, outer
-86	214-1421-00			1						HEAT SINK, inner
	- - - - -			-						mounting hardware:
-87	213-0124-00			2						SCREW, sheet metal, #6 x 0.25 inch long, PHS
-88	- - - - -			2						TRANSISTOR
	- - - - -			-						mounting hardware for each: (not included w/transistor)
-89	211-0578-00			2						SCREW, 6-32 x 0.438 inch, PHS
-90	386-0786-00			1						PLATE, mica, insulator
-91	361-0238-00			4						SPACER, sleeve
-92	211-0155-00			4						SCREW, 4-40 x 0.375 inch, PHS
-93	337-1245-00			1						SHIELD, high voltage
	- - - - -			-						mounting hardware: (not included w/shield)
-94	211-0507-00			3						SCREW, 6-32 x 0.312 inch, PHS
-95	348-0145-00			2						GROMMET, plastic, U shape
-96	210-0202-00			1						LUG, solder, SE 6
	- - - - -			-						mounting hardware: (not included w/lug)
-97	213-0044-00			1						SCREW, thread forming, 5-32 x 0.188 inch, PHS
-98	210-1093-00			2						WASHER, plastic, 0.187 ID x 0.312 inch OD
-99	380-0166-00			1						HOUSING, high voltage
	- - - - -			-						mounting hardware: (not included w/housing)
-100	211-0507-00			3						SCREW, 6-32 x 0.312 inch, PHS
-101	119-0235-00			1						POWER SUPPLY SUBASSEMBLY, high voltage
	- - - - -			-						mounting hardware: (not included w/power supply subassembly)
-102	211-0507-00			1						SCREW, 6-32 x 0.312 inch, PHS

FIGURE 3 HIGH VOLTAGE POWER (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				f	1	2	3	4		5
3-103	441-0879-00			1						CHASSIS, high voltage
				-						chassis includes:
-104	124-0163-00			1						STRIP, ceramic, 2 notches
-105	124-0164-00			5						STRIP, ceramic, 4 notches
-106	124-0175-00			1						STRIP, ceramic, 2 notches
-107	124-0176-00			2						STRIP, ceramic, 4 notches
	131-0864-00			1						CONTACT, electrical, test point
-108	131-0403-00			1						CONNECTOR, feed-thru
-109				1						RESISTOR, variable
				-						mounting hardware: (not included w/resistor)
-110	210-0583-00			1						NUT, hex., 0.25-32 x 0.312 inch
-111	210-0046-00			1						WASHER, lock, internal, 0.261 ID x 0.40 inch OD
-112	179-1531-00			1						WIRING HARNESS, high voltage
-113	200-0988-00			1						COVER, high voltage box
				-						mounting hardware: (not included w/cover)
-114	211-0530-00			2						SCREW, 6-32 x 1.75 inches, Fil HS
-115	211-0529-00			1						SCREW, 6-32 x 1.50 inches, Fil HS
-116	136-0390-00			1						CRT SOCKET & CABLE ASSEMBLY
				-						crt socket & cable assembly includes:
-117	136-0304-02			1						SOCKET, CRT
-118	131-0707-00			3						CONNECTOR, terminal
-119	352-0161-01			1						HOLDER, terminal connector, 3 wire (brown)
-120	200-0917-01			1						COVER, CRT socket
-121	343-0254-00			1						CLAMP, CRT socket
-122	367-0117-00			1						HANDLE, CRT socket
-123	124-0157-00			2						STRIP, ceramic, 0.437 inch h, w/9 notches
				-						strip includes:
	355-0046-00			2						STUD, plastic
				-						mounting hardware for each: (not included w/strip)
	361-0007-00			2						SPACER, plastic, 0.188 inch long
-124	124-0162-00			1						TERMINAL STRIP, ceramic, 0.437 inch h, w/4 notches
				-						strip includes:
	355-0046-00			1						STUD, plastic
				-						mounting hardware: (not included w/strip)
	361-0007-00			1						SPACER, plastic, 0.188 inch long
-125	124-0095-00			1						TERMINAL STRIP, ceramic, 0.437 inch h, w/9 notches
				-						strip includes:
	355-0046-00			2						STUD, plastic
				-						mounting hardware: (not included w/strip)
	361-0008-00			2						SPACER, plastic, 0.281 inch long
-126	124-0092-00			1						TERMINAL STRIP, ceramic, 0.437 inch h, w/3 notches
				-						strip includes:
	355-0046-00			1						STUD, plastic
				-						mounting hardware: (not included w/strip)
	361-0008-00			1						SPACER, plastic, 0.281 inch long

FIGURE 3 HIGH VOLTAGE POWER (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				†	y	1	2	3		4
3-127	179-1528-00			1						WIRING HARNESS, main
				-						wiring harness includes:
-128	352-0171-00			3						HOLDER, terminal connector, 1 wire
-129	352-0169-01			1						HOLDER, terminal connector, 2 wire (brown)
-130	352-0162-01			4						HOLDER, terminal connector, 4 wire (brown)
	352-0162-04			1						HOLDER, terminal connector, 4 wire (yellow)
-131	352-0163-00			1						HOLDER, terminal connector, 5 wire
	352-0163-01			2						HOLDER, terminal connector, 5 wire (brown)
	352-0163-02			1						HOLDER, terminal connector, 5 wire (red)
-132	352-0164-00			2						HOLDER, terminal connector, 6 wire
	352-0164-02			1						HOLDER, terminal connector, 6 wire (red)
	352-0164-04			4						HOLDER, terminal connector, 6 wire (yellow)
	352-0164-05			2						HOLDER, terminal connector, 6 wire (green)
	352-0164-06			2						HOLDER, terminal connector, 6 wire (blue)
-133	352-0166-00			1						HOLDER, terminal connector, 8 wire
	352-0166-01			2						HOLDER, terminal connector, 8 wire (brown)
	352-0166-02			1						HOLDER, terminal connector, 8 wire (red)
	352-0166-03			1						HOLDER, terminal connector, 8 wire (orange)
-134	352-0168-00			1						HOLDER, terminal connector, 10 wire
	352-0168-03			1						HOLDER, terminal connector, 10 wire (orange)
-135	131-0707-00			125						CONNECTOR, terminal
-136	131-0708-00			32						CONNECTOR, terminal
-137	175-0826-00			ft						WIRE, electrical, 3 wire ribbon, 6 inches long
-138	352-0161-03			1						HOLDER, terminal connector, 3 wire (orange)

FIGURE 4 REAR

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	Y	1	2	3		4
4-1	200-1079-00			2						COVER, transistor, 8.322 inches long
				-						mounting hardware for each: (not included w/cover)
-2	211-0038-00			2						SCREW, 6-32 x 0.312 inch, 100° csk, FHS
-3	361-0076-00			2						SPACER, hex., 0.25 x 0.65 inch
-4				6						TRANSISTOR
				-						mounting hardware for each: (not included w/transistor)
-5	211-0511-00			2						SCREW, 6-32 x 0.50 inch, PHS
-6	386-0786-00			1						PLATE, insulating, mica, 1 x 1.531 inches
-7				4						TRANSISTOR
				-						mounting hardware for each: (not included w/transistor)
-8	211-0511-00			2						SCREW, 6-32 x 0.50 inch, PHS
-9	386-0143-00			1						PLATE, insulating, mica, 0.80 x 1.35 inches
-10	214-1310-00			1						HEAT SINK, 8.35 inches long
				-						mounting hardware: (not included w/heat sink)
-11	212-0039-00			4						SCREW, 8-32 x 0.375 inch, THS
-12	129-0255-00			4						POST, metallic, 0.875 inch long
-13	670-0865-00			1						CIRCUIT BOARD ASSEMBLY—TRANSISTOR, left
				-						circuit board assembly includes:
	388-1513-00			1						CIRCUIT BOARD
-14	136-0263-03			17						SOCKET, pin terminal, for 0.025 inch diameter pin
-15	136-0361-00			5						SOCKET, transistor
-16	131-0847-00			10						TERMINAL, post, 0.437 inch long
-17	136-0384-00			8						SOCKET, pin terminal, for 0.04 inch diameter pin
	136-0383-00			2						SOCKET, pin terminal, for 0.03 inch diameter pin
-18	670-0864-00			1						CIRCUIT BOARD ASSEMBLY—TRANSISTOR, right
				-						circuit board assembly includes:
	388-1512-00			1						CIRCUIT BOARD
-19	136-0263-03			13						SOCKET, pin terminal, for 0.025 inch diameter pin
-20	136-0361-00			5						SOCKET, transistor
-21	131-0847-00			10						TERMINAL, post, 0.437 inch long
-22	136-0383-00			6						SOCKET, pin terminal, for 0.03 inch diameter pin
	136-0384-00			4						SOCKET, pin terminal, for 0.04 inch diameter pin
-23	670-0866-00			1						CIRCUIT BOARD ASSEMBLY—POWER INTERCONNECT
				-						circuit board assembly includes:
	388-1514-00			1						CIRCUIT BOARD
-24	131-0590-00			33						TERMINAL, pin, 0.71 inch long
	131-0591-00			30						TERMINAL, pin, 0.835 inch long
	131-0608-00			26						TERMINAL, pin, 0.365 inch long
-25	351-0185-00			4						GUIDE-POST, lock, 0.65 inch long
-26	351-0234-00			6						GUIDE-POST, lock, 0.875 inch long
-27	351-0213-00			1						GUIDE-POST, lock, 0.285 inch long

FIGURE 4 REAR (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q f y	1 2 3 4 5					Description
					1	2	3	4	5	
4-28	337-1290-00			1						SHIELD, circuit board, plastic
	- - - - -			-						mounting hardware: (not included w/shield)
-29	214-0565-00			2						FASTENER, pin, plastic
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
-30	211-0014-00			6						SCREW, 4-40 x 0.50 inch, PHS
-31	670-0861-00			1						CIRCUIT BOARD ASSEMBLY—POWER REGULATOR
	- - - - -			-						circuit board assembly includes:
	388-1509-00			1						CIRCUIT BOARD
-32	136-0183-00			3						SOCKET, transistor, 3 pin
-33	136-0220-00			10						SOCKET, transistor, 3 pin, square
-34	136-0263-03			33						SOCKET, pin terminal, for 0.025 inch diameter pin
-35	136-0269-00			5						SOCKET, integrated circuit, 14 contact
-36	214-0579-00			23						PIN, test point
-37	361-0238-00			4						SPACER, sleeve
-38	211-0155-00			4						SCREW, relieved shank, 4-40 x 0.375 inch
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
-39	211-0116-00			1						SCREW, sems, 4-40 x 0.312 inch, PHB
-40	200-0704-00			1						COVER ASSEMBLY, line voltage selector
	- - - - -			-						cover assembly includes:
-41	352-0102-00			2						HOLDER, fuse, plastic
	- - - - -			-						mounting hardware for each: (not included w/holder)
-42	213-0088-00			2						SCREW, thread forming, #4 x 0.25 inch, PHS
-43	214-0776-00			1						GASKET, line voltage selector
-44	204-0279-00			1						BODY ASSEMBLY, line voltage selector
	- - - - -			-						mounting hardware: (not included w/body assembly)
-45	210-0407-00			2						NUT, hex., 6-32 x 0.25 inch
-46	210-0006-00			2						WASHER, lock, internal, #6
-47	161-0033-03			1						CABLE ASSEMBLY, power
-48	358-0372-00			1						BUSHING, strain relief, bottom
-49	200-1004-00			1						CABLE NIPPLE, plastic
-50	358-0371-00			1						BUSHING, strain relief, top
-51	386-1717-00			1						PLATE, cable access
	- - - - -			-						mounting hardware: (not included w/plate)
-52	210-0401-00			2						NUT, cap, 6-32 x 0.312 inch
-53	386-1715-00			1						PANEL, rear
	- - - - -			-						mounting hardware: (not included w/panel)
-54	211-0008-00			1						SCREW, 4-40 x 0.25 inch, PHS
-55	136-0089-00			1						SOCKET, 9 pin, chassis mounted
	- - - - -			-						mounting hardware: (not included w/socket)
-56	211-0008-00			4						SCREW, 4-40 x 0.25 inch, PHS
-57	210-0586-00			2						NUT, keps, 4-40 x 0.25 inch

FIGURE 4 REAR (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y	1 2 3 4 5					Description
					1	2	3	4	5	
4-58	131-0771-00			2						CONNECTOR, receptacle, 4 contact
	- - - - -			-						mounting hardware for each: (not included w/connector)
.59	220-0551-00			1						NUT, hex., 0.437 inch
	- - - - -									
-60	131-0106-00			2						CONNECTOR, receptacle, BNC, w/hardware
-61	386-1709-00			1						PLATE, component mounting
	- - - - -			-						mounting hardware: (not included w/plate)
-62	211-0101-00			4						SCREW, 4-40 x 0.25 inch, 100° csk, FHS
	- - - - -									
-63	670-0874-00			1						CIRCUIT BOARD ASSEMBLY—EXT IN
	- - - - -			-						circuit board assembly includes:
	388-1522-00			1						CIRCUIT BOARD
-64	131-0608-00			8						TERMINAL, pin, 0.365 inch long
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
-65	211-0116-00			2						SCREW, sems, 4-40 x 0.312 inch, PHB
-66	129-0098-00			2						POST, metallic, 0.25 x 0.406 inch
	- - - - -									
-67	386-1721-00			1						SUBPANEL, rear
	- - - - -			-						mounting hardware: (not included w/subpanel)
-68	212-0039-00			4						SCREW, 8-32 x 0.375 inch, THS
	- - - - -									
-69	- - - - -			1						LINE FILTER
	- - - - -			-						mounting hardware: (not included w/line filter)
-70	211-0538-00			2						SCREW, 6-32 x 0.312 inch, 100° csk, FHS
-71	210-0202-00			1						LUG, solder, SE #6
-72	210-0457-00			2						NUT, keps, 6-32 x 0.312 inch
	- - - - -									
-73	670-0862-00			1						CIRCUIT BOARD ASSEMBLY—RECTIFIER
	- - - - -			-						circuit board assembly includes:
	388-1510-00			1						CIRCUIT BOARD
-74	214-0269-00			4						HEAT SINK
-75	214-0579-00			6						PIN, test point
-76	344-0154-00			6						CLIP, fuse, electrical
-77	136-0286-00			18						SOCKET, terminal pin, for 0.062 inch diameter pin
-78	200-0257-00			2						COVER, capacitor, plastic, 1 x 2.531 inches
-79	136-0220-00			2						SOCKET, transistor, 3 pin, square
-80	136-0254-00			2						SOCKET, connector pin, for 0.04 inch diameter pin
-81	131-0608-00			55						TERMINAL, pin, 0.365 inch long
-82	- - - - -			1						TRANSISTOR
	- - - - -			-						mounting hardware: (not included w/transistor)
-83	210-0586-00			2						NUT, keps, 4-40 x 0.25 inch
-84	355-0108-00			2						STUD, terminal

FIGURE 4 REAR (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
4-85	- - - - -			2						DIODE
	- - - - -			-						mounting hardware for each: (not included w/diode)
-86	210-0407-00			1						NUT, hex., 6-32 x 0.25 inch
-87	210-0802-00			1						WASHER, flat, 0.15 ID x 0.312 inch OD
-88	214-1340-00			1						HEAT SINK, 0.156 ID x 0.50 inch OD
-89	- - - - -			3						CAPACITOR
	- - - - -			-						mounting hardware for each: (not included w/capacitor)
-90	212-0557-00			2						SCREW, 10-32 x 0.50 inch, RHS
	210-0056-00			2						WASHER, lock, split, #10
	210-1003-00			2						WASHER, flat, #10
-91	342-0023-00			2						INSULATOR, bushing, plastic
-92	- - - - -			2						CAPACITOR
	- - - - -			-						mounting hardware for each: (not included w/capacitor)
	212-0509-00			2						SCREW, 10-32 x 0.625 inch, PHS
	210-0056-00			2						WASHER, lock, split, #10
	210-1003-00			2						WASHER, flat, #10
	342-0023-00			2						INSULATOR, bushing, plastic
-93	- - - - -			1						TRANSFORMER
	- - - - -			-						transformer includes:
-94	212-0565-00			4						SCREW, 10-32 x 4.25 inches, HHS
-95	210-0805-00			1						WASHER, flat, #10 x 0.437 inch OD
-96	210-0813-00			3						WASHER, fiber, shouldered, #10
-97	386-1686-00			1						SUPPORT, transformer
-98	161-0229-00			4						TUBE, insulating, plastic, 3.25 inches long
-99	131-0879-00			18						TERMINAL, pin, feed-thru
	- - - - -			-						mounting hardware: (not included w/transformer)
-100	210-0410-00			2						NUT, hex., 10-32 x 0.312 inch
	210-0009-00			2						WASHER, lock, internal, #10
-101	210-1003-00			2						WASHER, flat, #10
-102	342-0023-00			2						INSULATOR, bushing, plastic
-103	211-0510-00			2						SCREW, 6-32 x 0.375 inch, PHS
-104	211-0559-00			2						SCREW, 6-32 x 0.375 inch, 100° csk, FHS
-105	210-0457-00			2						NUT, keps, 6-32 x 0.312 inch
-106	348-0063-00			2						GROMMET, plastic, 0.50 inch diameter
-107	- - - - -			1						THERMO CUTOUT
	- - - - -			-						mounting hardware: (not included w/thermo cutout)
-108	210-0406-00			2						NUT, hex., 4-40 x 0.188 inch
-109	210-0054-00			2						WASHER, lock, split, #4
-110	343-0089-00			2						CLAMP, cable, plastic, snap on
-111	343-0005-00			1						CLAMP, cable, 0.437 inch
	- - - - -			-						mounting hardware: (not included w/clamp)
-112	211-0511-00			1						SCREW, 6-32 x 0.50 inch, PHS
-113	210-0863-00			1						WASHER, D shape, 0.191 ID x 0.515 inch OD
-114	441-0915-00			1						CHASSIS, power supply
	- - - - -			-						mounting hardware: (not included w/chassis)
-115	212-0023-00			3						SCREW, 8-32 x 0.375 inch, PHS
-116	212-0010-00			2						SCREW, 8-32 x 0.625 inch, PHS

FIGURE 4 REAR (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q					Description
			†	Y	1	2	3	
4-117	200-1087-00		1					COVER, frame, rear
-118	426-0593-01		1					FRAME, cabinet rear
-119	105-0151-00		6					CATCH, panel, plastic
	- - - - -		-					mounting hardware for each: (not included w/catch)
-120	213-0088-00		1					SCREW, thread forming, #4 x 0.25 inch, PHS
-121	351-0229-00		2					GUIDE, slide, plastic
	- - - - -		-					mounting hardware for each: (not included w/guide)
	213-0012-00		2					SCREW, thread forming, 4-40 x 0.312 inch, 100° csk, FHS
-122	381-0314-00		1					BAR, support, power chassis
	- - - - -		-					mounting hardware: (not included w/bar)
	212-0043-00		2					SCREW, 8-32 x 0.50 inch, 100° csk, FHS
-123	179-1530-00		1					WIRING HARNESS, AC
	- - - - -		-					wiring harness includes:
	214-0768-00		8					CONTACT, female
	179-1529-00		1					WIRING HARNESS, probe power
	- - - - -		-					wiring harness includes:
-124	131-0707-00		16					CONNECTOR, terminal
-125	131-0708-00		4					CONNECTOR, terminal
-126	352-0162-00		1					HOLDER, terminal connector, 4 wire (black)
	352-0162-01		2					HOLDER, terminal connector, 4 wire (brown)
	352-0162-02		2					HOLDER, terminal connector, 4 wire (brown)
-127	175-0831-00		ft					WIRE, electrical, 8 wire ribbon, 9.50 inches
	131-0707-00		16					CONNECTOR, terminal
-128	352-0116-00		2					HOLDER, terminal connector, 8 wire (black)
-129	175-0855-00		ft					WIRE, electrical, 10 wire ribbon, 5.50 inches
	131-0707-00		40					CONNECTOR, terminal
-130	352-0168-00		2					HOLDER, terminal connector, 10 wire (black)
	352-0168-03		2					HOLDER, terminal connector, 10 wire (orange)

FIGURE 5 CABINET

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q					Description	
			t	Y	1	2	3		4
5-1	390-0144-00		1						CABINET SIDE, left
	214-0812-00		4						cabinet side includes: LATCH ASSEMBLY
									each latch assembly includes:
-2	214-0603-01		1						PIN, securing
-3	214-0604-00		1						SPRING
-4	386-0227-00		1						PLATE, index, plastic
-5	386-0226-00		1						PLATE, locking
-6	200-0973-00		2						COVER, plastic
-7	367-0108-00		1						HANDLE, carrying
									mounting hardware: (not included w/handle)
-8	213-0211-00		4						SCREW, 10-32 x 0.512 inch, FHS
-9	386-1624-00		2						PLATE, retaining
-10	386-1623-00		2						PLATE, spacer
-11	426-0597-00		1						FRAME SECTION, cabinet top
	211-0541-00								mounting hardware: (not included w/frame section)
	212-0070-00		5						SCREW, 6-32 x 0.25 inch, 100° csk, FHS (not shown)
	210-0458-00		4						SCREW, 8-32 x 0.312 inch, 100° csk, FHS (not shown)
			3						NUT, keps, 8-32 x 0.375 inch (not shown)
-12	390-0143-00		1						CABINET SIDE, right
	214-0812-00		4						cabinet side includes: LATCH ASSEMBLY
									each latch assembly includes:
-13	214-0603-01		1						PIN, securing
-14	214-0604-00		1						SPRING
-15	386-0227-00		1						PLATE, index, plastic
-16	386-0226-00		1						PLATE, locking
-17	390-0145-00		1						CABINET BOTTOM
	214-0812-00		4						cabinet bottom includes: LATCH ASSEMBLY
									each latch assembly includes:
-18	214-0603-01		1						PIN, securing
-19	214-0604-00		1						SPRING
-20	386-0227-00		1						PLATE, index, plastic
-21	386-0226-00		1						PLATE, locking

FIGURE 5 CABINET (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
522	426-0599-00			1						FRAME SECTION, cabinet, lower left - mounting hardware: (not included w/frame section)
	212-0002-00			4						SCREW, 8-32 x 0.25 inch, 100° csk, FHS (not shown)
	212-0070-00			4						SCREW, 8-32 x 0.312 inch, 100° csk, FHS (not shown)
	210-0458-00			4						NUT, keps, 8-32 x 0.375 inch (not shown)
-23	426-0598-00			1						FRAME SECTION, cabinet, lower right - mounting hardware: (not included w/frame section)
	212-0002-00			4						SCREW, 8-32 x 0.25 inch, 100° csk, FHS (not shown)
	212-0070-00			4						SCREW, 8-32 x 0.312 inch, 100° csk, FHS (not shown)
	210-0458-00			4						NUT, keps, 8-32 x 0.375 inch (not shown)
-24	348-0182-00			4						PAD, cabinet foot
-25	348-0180-00			2						FOOT, cabinet, left front & right rear - mounting hardware for each: (not included w/foot)
-26	211-0513-00			2						SCREW, 6-32 x 0.625 inch, BHS
-27	348-0181-00			2						FOOT, cabinet, right front & left rear - mounting hardware for each: (not included w/foot)
-28	211-0513-00			2						SCREW, 6-32 x 0.625 inch, BHS
-29	348-0236-00			1						FLIP-STAND, cabinet
-30	343-0256-00			2						RETAINER, black - mounting hardware for each: (not included w/retainer)
-31	212-0091-00			2						SCREW, 8-32 x 0.625 inch, Fil HS
	210-0458-00			2						NUT, keps, 8-32 x 0.344 inch (not shown)

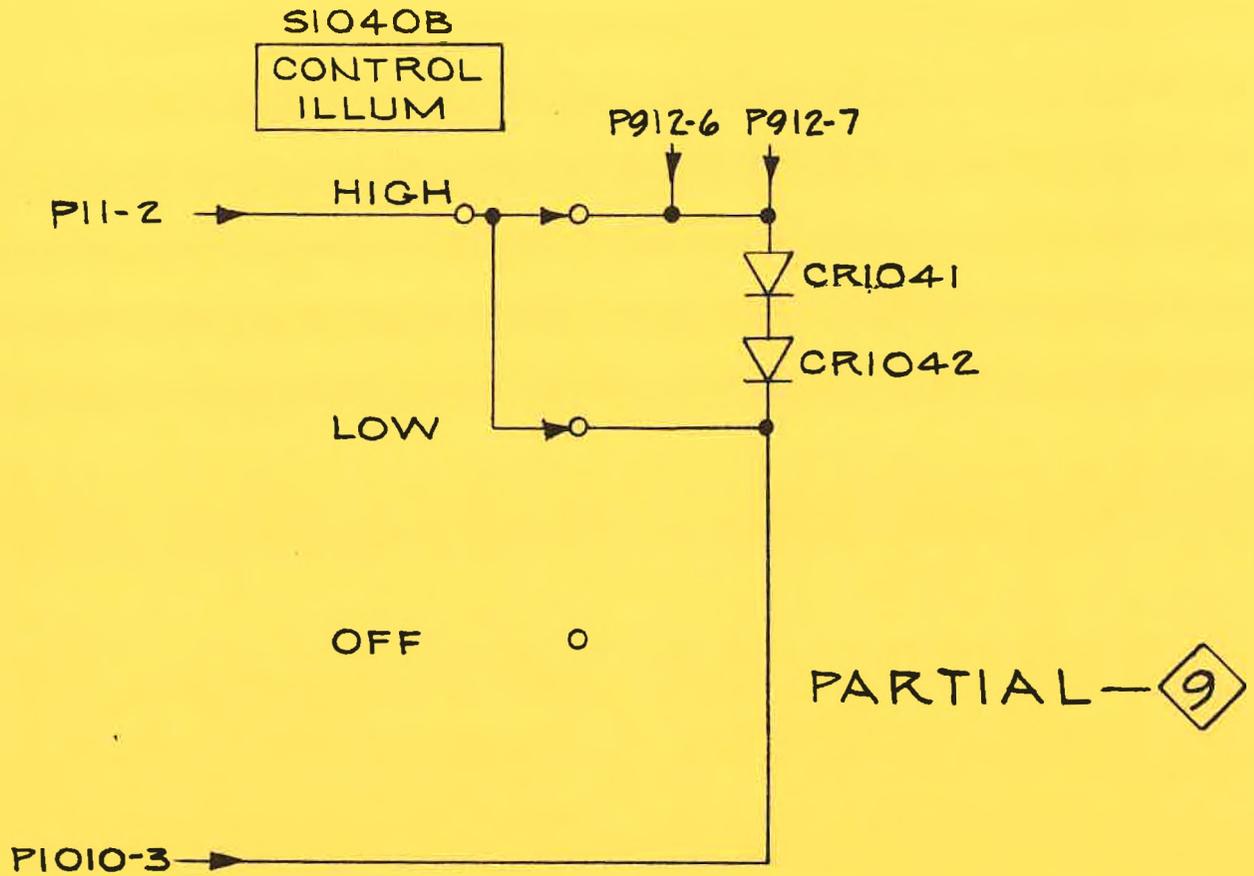
MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

SCHEMATIC CORRECTION



ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

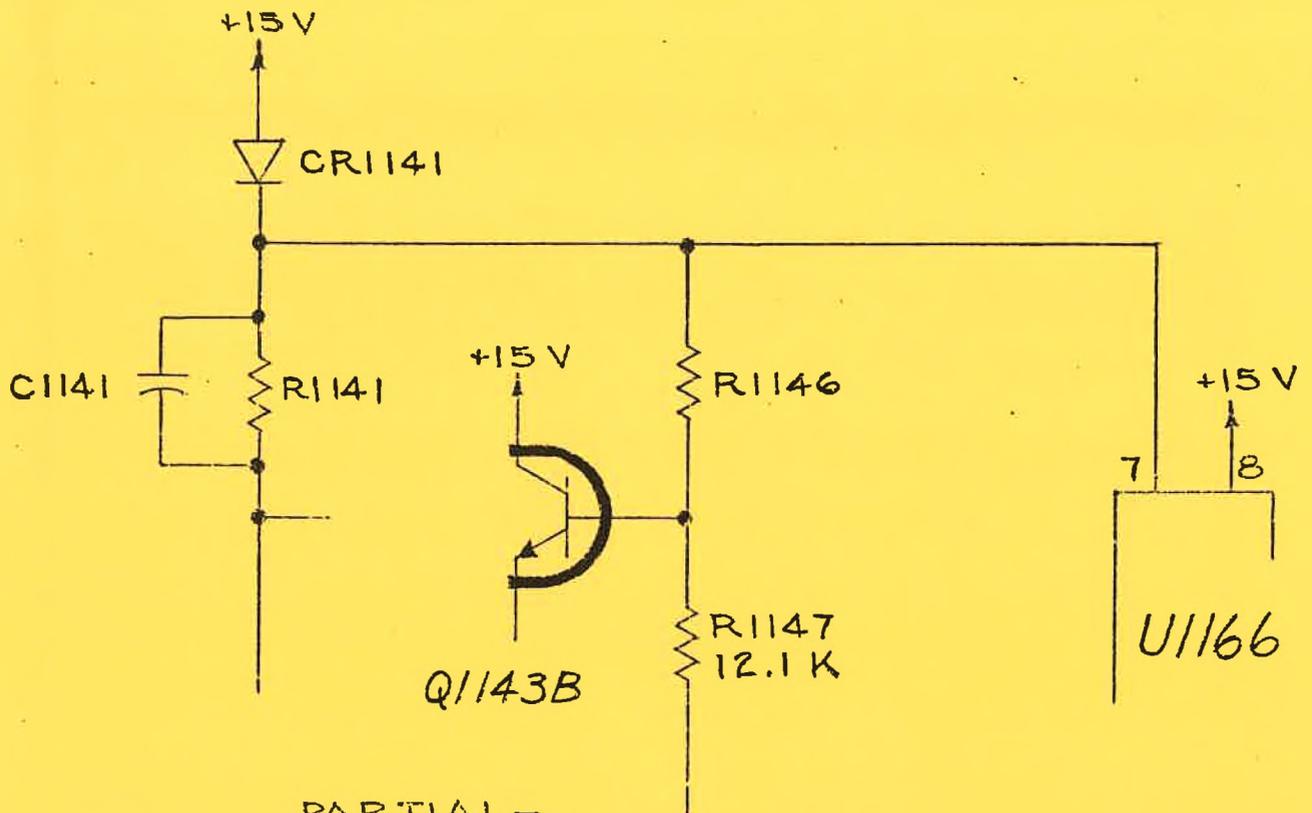
READOUT Circuit Board Assembly

CHANGE TO:

R1147	321-0297-00	12.1 k Ω	1/8 W	1%
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ADD:

CR1141	152-0185-00	Silicon	Replaceable by 1N4152
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PARTIAL-
DATA COLLECTION

TEXT CORRECTION

Section 2 Operating Instructions

Page 2-13, Readout

REPLACE: the last two sentences of first paragraph with the following:

The Readout Mode switch (located behind right side panel) determines the operating mode of the Readout System. When this switch is in the Free-Run Remote position, the Readout System operates in a free-running mode to randomly interrupt the waveform display to present characters. However, the waveform display is interrupted for only about 20 microseconds for each character that is displayed. The Readout System can also be remotely switched to the single-shot mode when in this position (see Remote Readout for further information). In the Gate Trig'd position, the Readout System is locked out so no characters are displayed during the sweep. At the end of the sweep, the Readout System is triggered and a complete frame of all applicable readout words are displayed. The trigger for the Readout System in the Gate Trig'd mode is produced from the sweep gate selected by the Gate switch (located on same board as Remote Readout switch) and is the same as the gate signal connected to the front-panel +GATE connector (time-base unit must be installed in selected horizontal compartment).

Page 2-14

ADD: the following, Remote Readout, preceding Vertical Mode:

Remote Readout

The operating mode of the Readout System can be remotely controlled through the rear-panel REMOTE CONTROL connector J1075. Requirements for remote readout operation are:

REMOTE READOUT LOCKOUT

Pin of J1075	E
Signal	Closure to ground (within 0.1 volt) from a positive level locks out Readout System
Maximum current required	Two milliamperes
Maximum open circuit voltage	+2 volts
Maximum input voltage	+5 volts, -1 volt (DC + peak AC)

REMOTE SINGLE-SHOT READOUT

Pin of J1075

F

Signal required

Closure to ground (within 0.4 volts) from a positive level with Pin E grounded allows Readout System to display one complete frame. Rate of change must be at least 0.1 volt/microsecond.

Maximum current required

Three milliampetes

Maximum open circuit voltage

+10 volts

Maximum input voltage

-10 volts, -5 volts (DC + peak AC)

Section 5

ADD: the following step 8A preceding step 9

8A. Adjust Auto Focus Operation

- a. Set the 7B52 for a sweep rate of 0.05 microsecond/division.
- b. Connect a test oscilloscope probe to TP794; connect the probe to chassis ground with a short ground strap.
- c. Set the test oscilloscope for a vertical deflection factor of five volts/division (50 volts/division at probe tip) at a sweep rate of 0.5 microsecond/division. Set the triggering controls for a stable display triggered on the negative-going slope.
- d. Establish the ground reference level on the test oscilloscope. Then, set the test oscilloscope for DC input coupling.
- e. Change the following control settings:

INTENSITY	Counterclockwise
READOUT	OFF
- f. CHECK-DC level of trace +140 volts \pm 7 volts.

NOTE

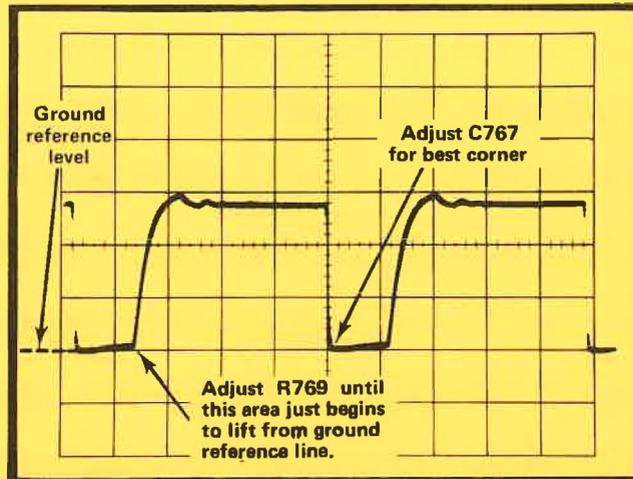
This tolerance is provided as a guide to correct instrument operation and is not an instrument specification.

- g. Set the INTENSITY control fully clockwise.

M16,948/271

(Rev.)

h. ADJUST-Focus Gain adjustment R769 until the baseline of the waveform just begins to lift from the zero-volt level (see typical waveform).



i. Turn the INTENSITY control counterclockwise until the baseline of the waveform raises about 0.5 division from the zero-volt level.

j. ADJUST-Focus Compensation adjustment C767 for best square corner on the negative portion of the displayed waveform. Rotate the INTENSITY control between midrange and maximum; if necessary, compromise the adjustment of C767 for best square corner throughout the rotation of the INTENSITY control.

k. Disconnect the test oscilloscope.

l. Set the 7B52 for a sweep rate of one microsecond/division.

m. Set the INTENSITY control for low trace intensity.

n. Set the FOCUS control for the thinnest displayed trace.

o. Set the INTENSITY control fully clockwise.

p. ADJUST-Focus Level adjustment R761 for the thinnest displayed trace.

q. Repeat parts m through p until no interaction is noted.

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

CHASSIS

ADD:

C797	283-0033-01	0.001 μ F	Cer	6 kV	
R785	301-0225-00	2.2 M Ω	1/2 W		5%

CHANGE TO:

R744A	} 307-0294-00	180 k Ω	Film Assembly		
R744B		470 k Ω			
R744C		29.45 M Ω			
R744D		19 M Ω			
CHANGE R767 TO: R744E		80 M Ω			
ADD: R744F		30 M Ω			

READOUT

Circuit Board Assembly

670-0635-03

Complete Board

CHANGE TO:

C1237	283-0000-00	0.001 μ F	Cer	500 V	
R1155	317-0222-00	2.2 k Ω	1/8 W		5%
R1156	321-0268-00	6.04 k Ω	1/8 W	Prec	1%
R1235	317-0512-00	5.1 k Ω	1/8 W		5%
R1255	321-0176-00	665 Ω	1/8 W	Prec	1%
R1237	317-0222-00	2.2 k Ω	1/8 W		5%
U1236	156-0011-00	Dual	2 Input Gate		

HV OSC & Z AXIS

Circuit Board Assembly

670-0868-01

Complete Board

CHANGE TO:

R733	303-0332-00	3.3 k Ω	1 W		5%
R734	303-0153-00	15 k Ω	1 W		5%

ADD:

C742	283-0092-00	0.03 μ F	Cer	200 V	
C743	283-0010-00	0.05 μ F	Cer	50 V	
C764	281-0064-00	0.25-1.5 pF, Var			
C773	281-0593-00	3.9 pF	Cer		
C775	283-0081-00	0.1 μ F	Cer	25 V	
C778	283-0081-00	0.1 μ F	Cer	25 V	
C790	281-0629-00	33 pF	Cer	600 V	
CR753	152-0333-00	Silicon	High Speed and Conductance		
VR755	152-0282-00	Zener	1N972B		
CR776	152-0185-00	Silicon	Replaceable by 1N4152		
CR786	152-0185-00	Silicon	Replaceable by 1N4152		
CR793	152-0185-00	Silicon	Replaceable by 1N4152		
CR795	152-0107-00	Silicon	Replaceable by 1N4152		
Q761	151-0280-00	Silicon	MM 4003		
Q763	151-0280-00	Silicon	MM 4003		
Q775	151-0223-00	Silicon	2N4275		
Q786	151-0274-00	Silicon	Tek Spec		
Q793	151-0274-00	Silicon	Tek Spec		
R742	315-0181-00	180 Ω	1/4 W		5%
R743	315-0331-00	330 Ω	1/4 W		5%
R753	322-0385-00	100 k Ω	1/4 W	MF	1%
R755	315-0471-00	470 Ω	1/4 W		5%
R756	321-0349-00	42.2 k Ω	1/8 W	MF	1%
R759	315-0624-00	620 k Ω	1/4 W		5%
R762	315-0625-00	6.2 M Ω	1/4 W		5%
R763	315-0625-00	6.2 M Ω	1/4 W		5%
R764	315-0392-00	3.9 k Ω	1/4 W		5%
R765	321-0335-00	30.1 k Ω	1/8 W	MF	1%
R766	311-1035-00	50 k Ω , Var			
R773	315-0472-00	4.7 k Ω	1/4 W		5%
R774	321-0359-00	53.6 k Ω	1/8 W	MF	1%
R775	315-0821-00	820 Ω	1/4 W		5%
R777	315-0332-00	3.3 k Ω	1/4 W		5%

R778	315-0101-00	100 Ω	1/4 W		5%
R785	305-0123-00	12 k Ω	2 W		5%
R786	301-0562-00	5.6 k Ω	1/2 W		5%
R790	307-0272-00	130 k Ω	1/4 W	MF	1%
R795	315-0154-00	150 k Ω	1/4 W		5%
R797	301-0101-00	100 Ω	1/2 W		5%
TP793	214-0579-00	Test Point			

OUTPUT SIGNAL & CALIB Circuit Board Assembly

670-0870-01 Complete Board

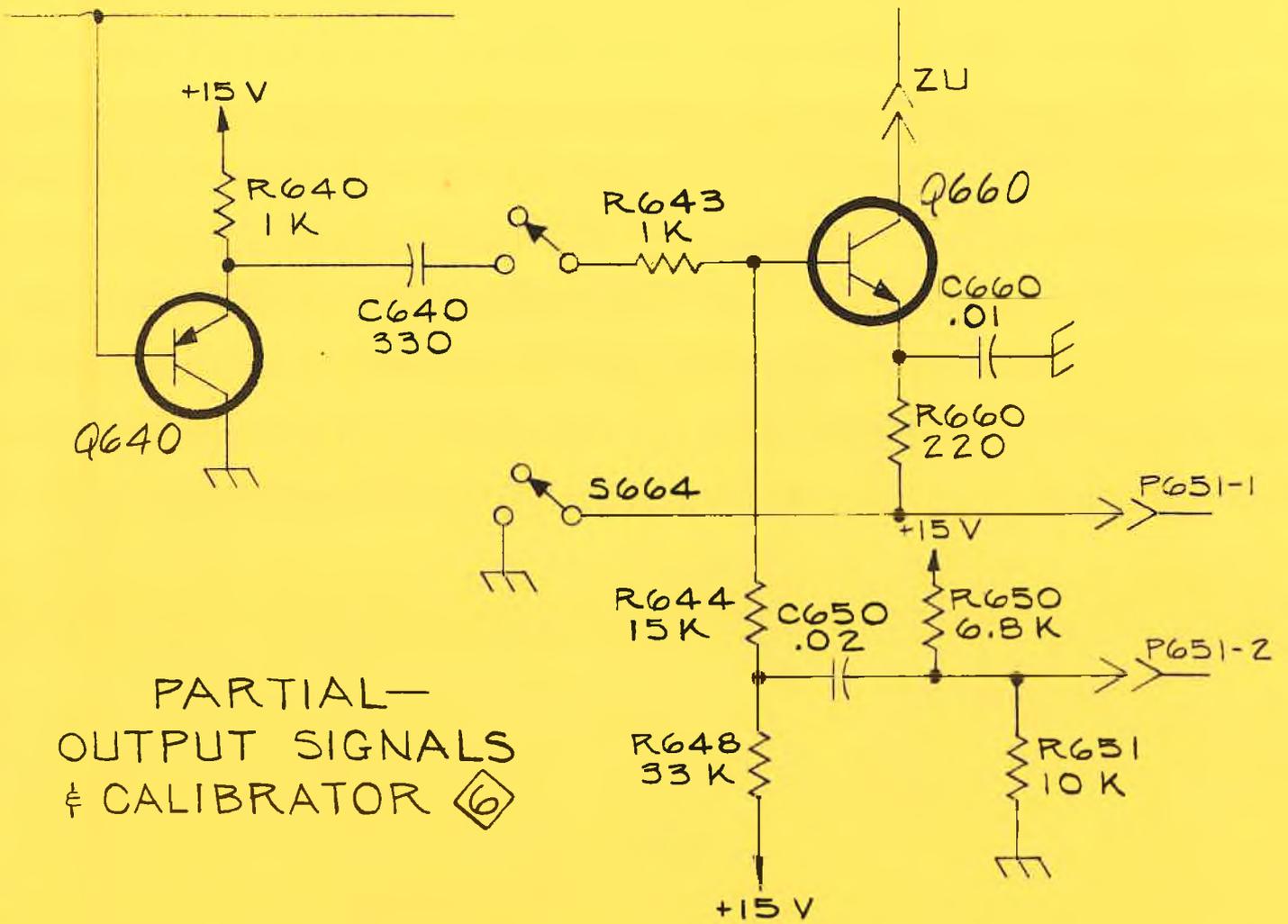
ADD:

C640	283-0077-00	330 pF	Cer	500 V	
C646	281-0547-00	2.7 pF	Cer	500 V	
C650	283-0004-00	0.02 μ F	Cer	150 V	
C660	283-0003-00	0.01 μ F	Cer	150 V	
Q640	151-0221-00	Silicon		2N4228	
Q660	151-0223-00	Silicon		2N4275	
R640	315-0102-00	1 k Ω	1/4 W		5%
R643	315-0102-00	1 k Ω	1/4 W		5%
R644	315-0153-00	15 k Ω	1/4 W		5%
R648	315-0333-00	33 k Ω	1/4 W		5%
R650	315-0682-00	6.8 k Ω	1/4 W		5%
R651	315-0103-00	10 k Ω	1/4 W		5%
R660	315-0221-00	220 Ω	1/4 W		5%
S664	260-0723-00	Slide	DPDT		

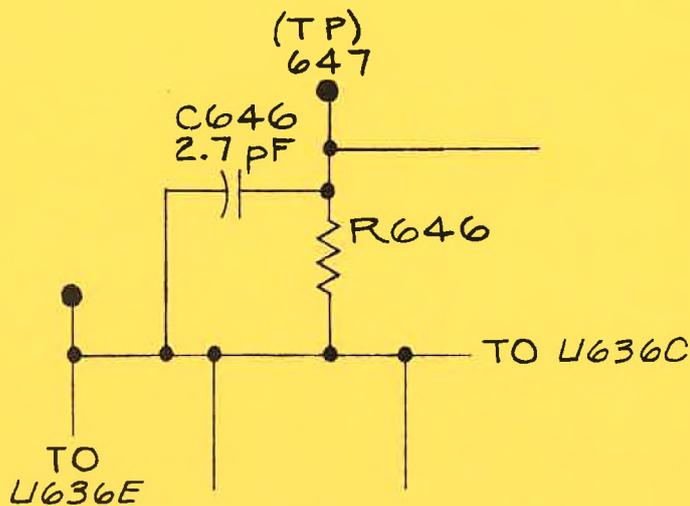
CHANGE TO:

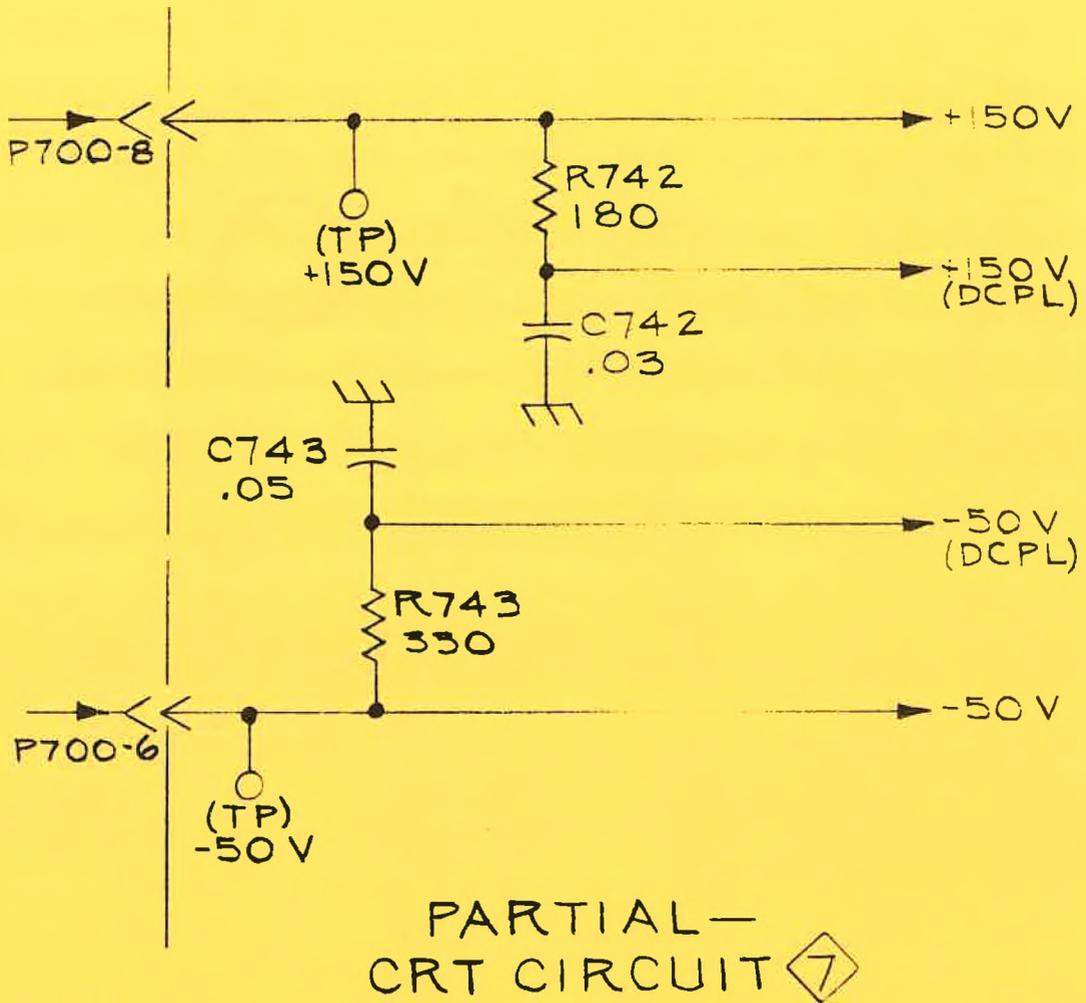
C654	283-0164-00	2.2 μ F	Cer	25 V	
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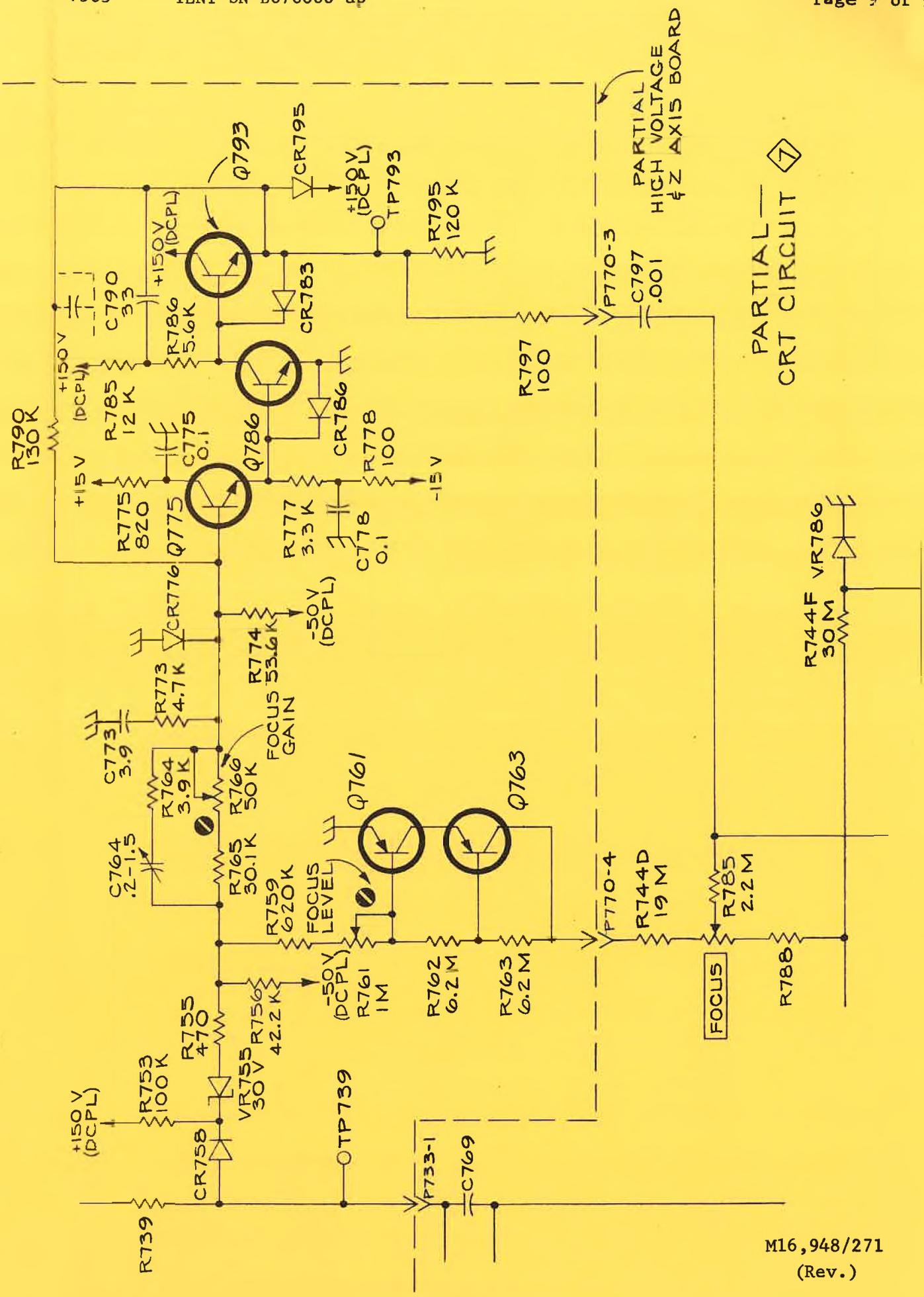
SCHEMATIC CORRECTIONS



PARTIAL-
OUTPUT SIGNALS
& CALIBRATOR 6



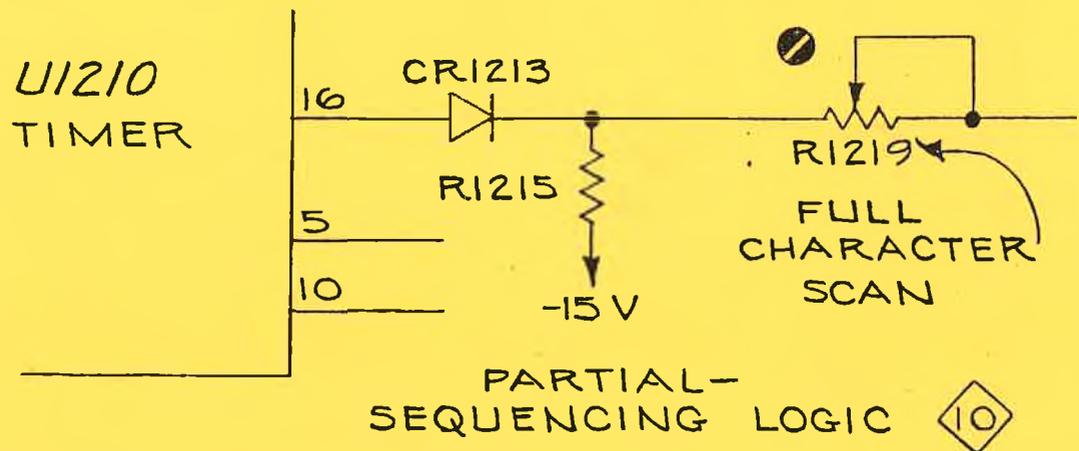


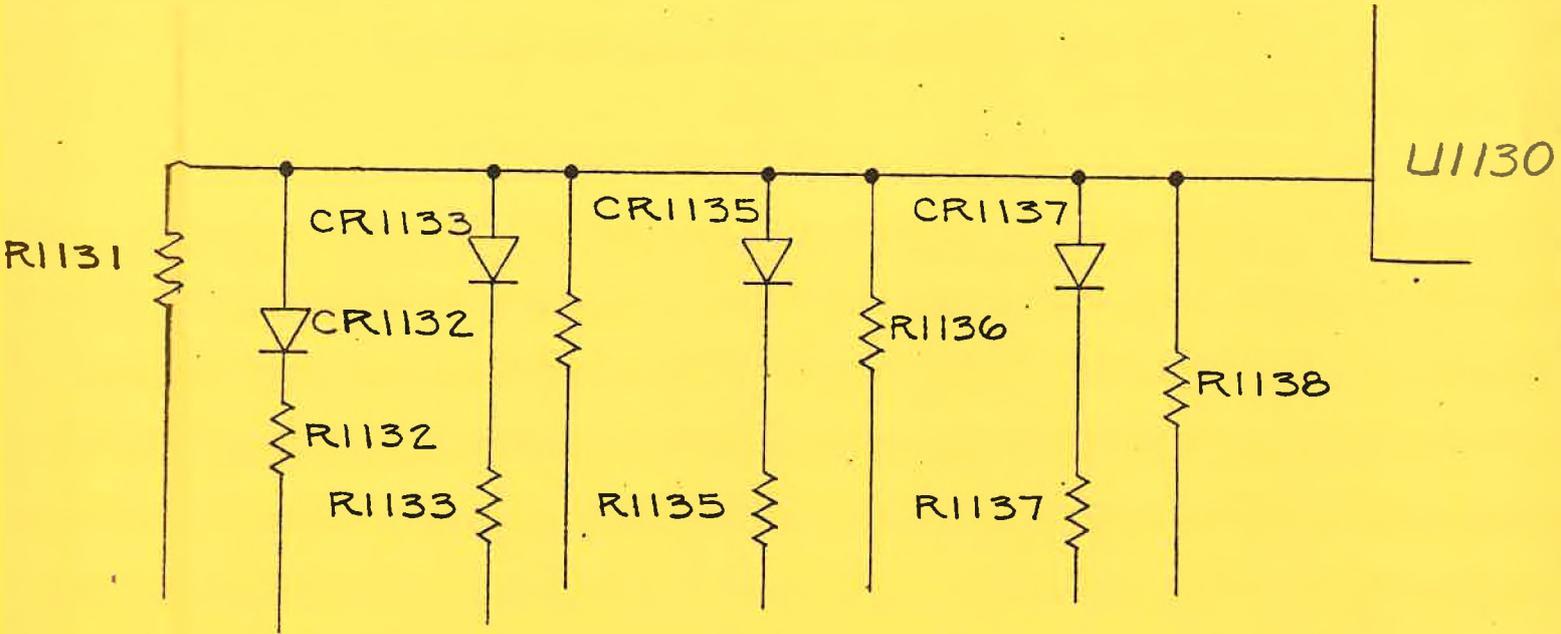


PARTIAL
CRT CIRCUIT

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

	READOUT	Circuit Board Assembly			
CHANGE TO:					
R1135	321-0308-00	15.8 k Ω	1/8 W	Prec	1%
R1137	321-0319-00	20.5 k Ω	1/8 W	Prec	1%
R1163	317-0243-00	24 k Ω	1/8 W		5%
R1180	321-0264-00	5.49 k Ω	1/8 W	Prec	1%
R1215	317-0302-00	3 k Ω	1/8 W		5%
R1219	311-0635-00	1 k Ω , Var			
R1266	317-0912-00	9.1 k Ω	1/8 W		5%
ADD:					
CR1132	152-0185-00	Silicon	Replaceable by 1N4152		
CR1133	152-0185-00	Silicon	Replaceable by 1N4152		
CR1135	152-0185-00	Silicon	Replaceable by 1N4152		
CR1137	152-0185-00	Silicon	Replaceable by 1N4152		
CR1213	152-0185-00	Silicon	Replaceable by 1N4152		





PARTIAL-DATA COLLECTION 

7503 TENT SN BC90000-up
 7504 TENT SN B140000-up
 7514 TENT SN B070000-up
 7704 TENT SN B200000-up
 R7704 TENT SN B040000-up

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

READOUT Circuit Board Assembly

CHANGE TO:

670-0635-05

Complete Board

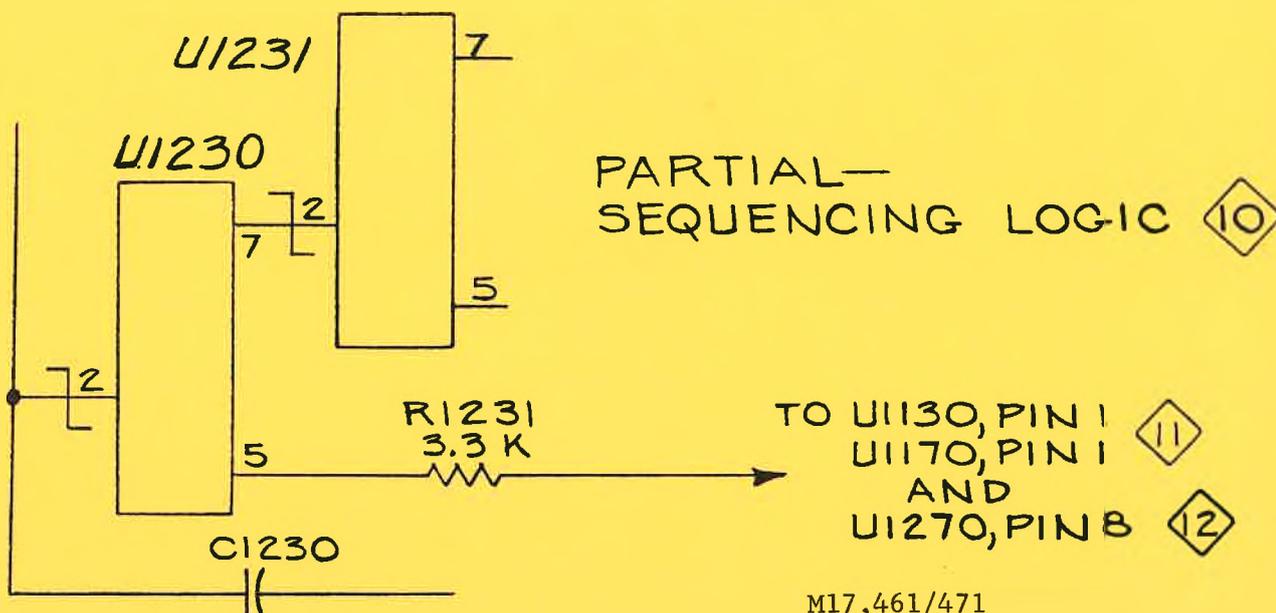
Part No.	Part No.	Value	Power	Prec	Tol
R1144	317-0124-00	120 k Ω	1/8 W		5%
R1147	321-0299-00	12.7 k Ω	1/8 W	Prec	1%
R1148	321-0212-00	1.58 k Ω	1/8 W	Prec	1%
R1181	321-0372-00	73.2 k Ω	1/8 W	Prec	1%
R1183	321-0407-00	169 k Ω	1/8 W	Prec	1%

REMOVE:

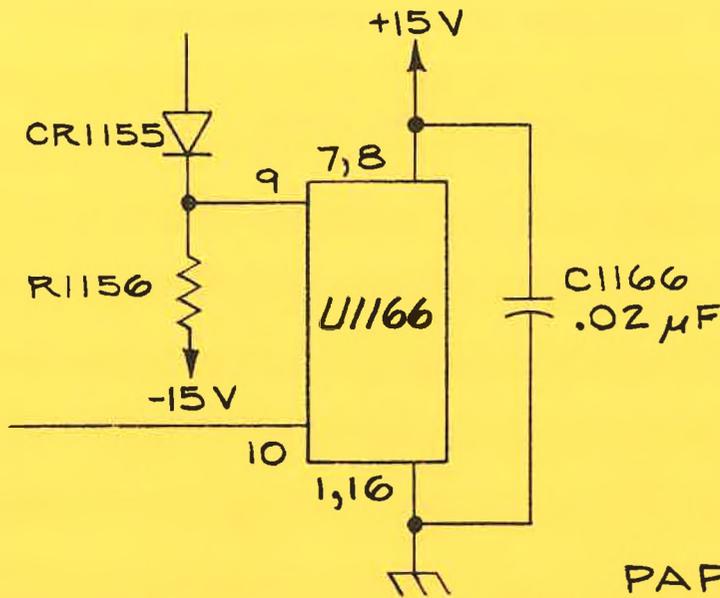
CR1141	152-0185-00	Silicon	Replaceable by 1N4152
CR1186	152-0185-00	Silicon	Replaceable by 1N4152

ADD:

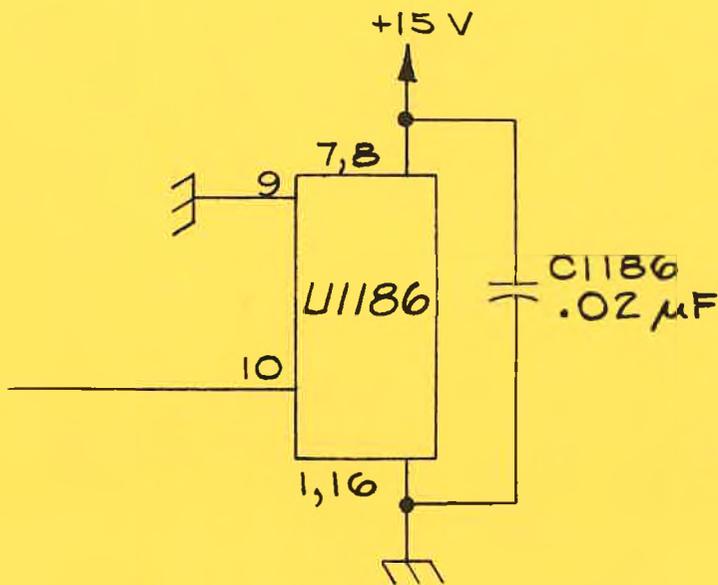
C1166	283-0004-02	0.02 μ F	Cer	150 V
C1186	283-0004-02	0.02 μ F	Cer	150 V
R1231	317-0332-00	3.3 k Ω	1/8 W	5%



7503 TENT SN B090000-up
7504 TENT SN B140000-up
7514 TENT SN B0700000up
7704 TENT SN B200000-up
R7704 TENT SN B040000-up



PARTIAL-
DATA COLLECTION 



ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

INTERFACE-TRIGGER SELECTOR

Circuit Board Assembly

ADD:

C343	281-0505-00	12 pF	Cer	500 V	±1.2pF
R343	315-0101-00	100 Ω	1/4 W		5%

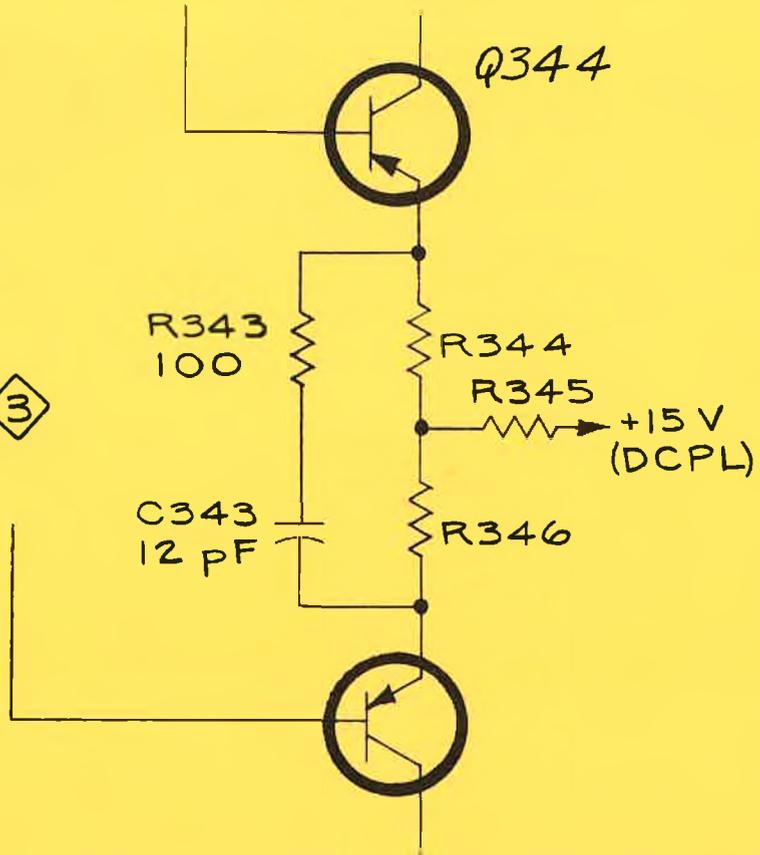
HORIZONTAL AMP SIG DELAY

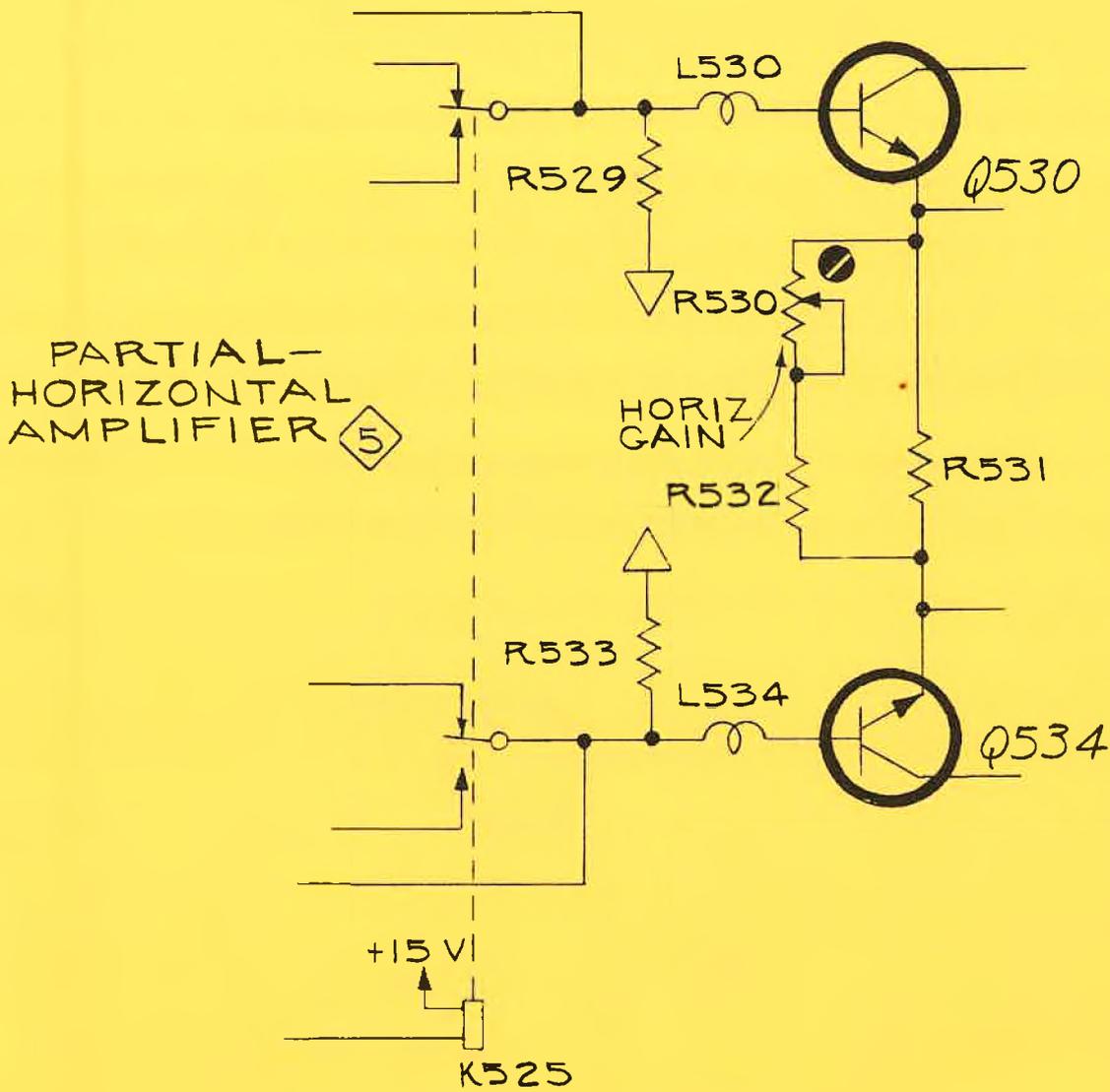
Circuit Board Assembly

ADD:

L530	276-0507-00	Core, Ferramic Suppressor
L534	276-0507-00	Core, Ferramic Suppressor

PARTIAL-
TRIGGER
SELECTOR 3





7503

ELECTRICAL PARTS LIST CORRECTION

HORIZONTAL AMP SIG DELAY Circuit Board Assembly

CHANGE TO:

Q566	151-0103-01	Silicon	Replaceable by 2N2219
Q586	151-0103-01	Silicon	Replaceable by 2N2219

v. ADJUST - R1182 (added in series with R1180, see Fig. 4-16) for correct readout indication. Set R1182 to the center of the range of adjustment which provides correct readout indication. Release the Identify button and disconnect the 10 k Ω resistor.

Alternative Procedure

w. Press and hold the Identify button on the amplifier unit being displayed.

x. CHECK - Readout display for correct indication of 'IDENTIFY'.

y. ADJUST - R1142 and R1182 (added in series with R1141 and R1180 respectively, see Fig. 4-16) for correct readout indication. Set these adjustments to the center of the range of adjustment that provides correct readout indication. Release the Identify button.

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

READOUT

Circuit Board Assembly

CHANGE TO:

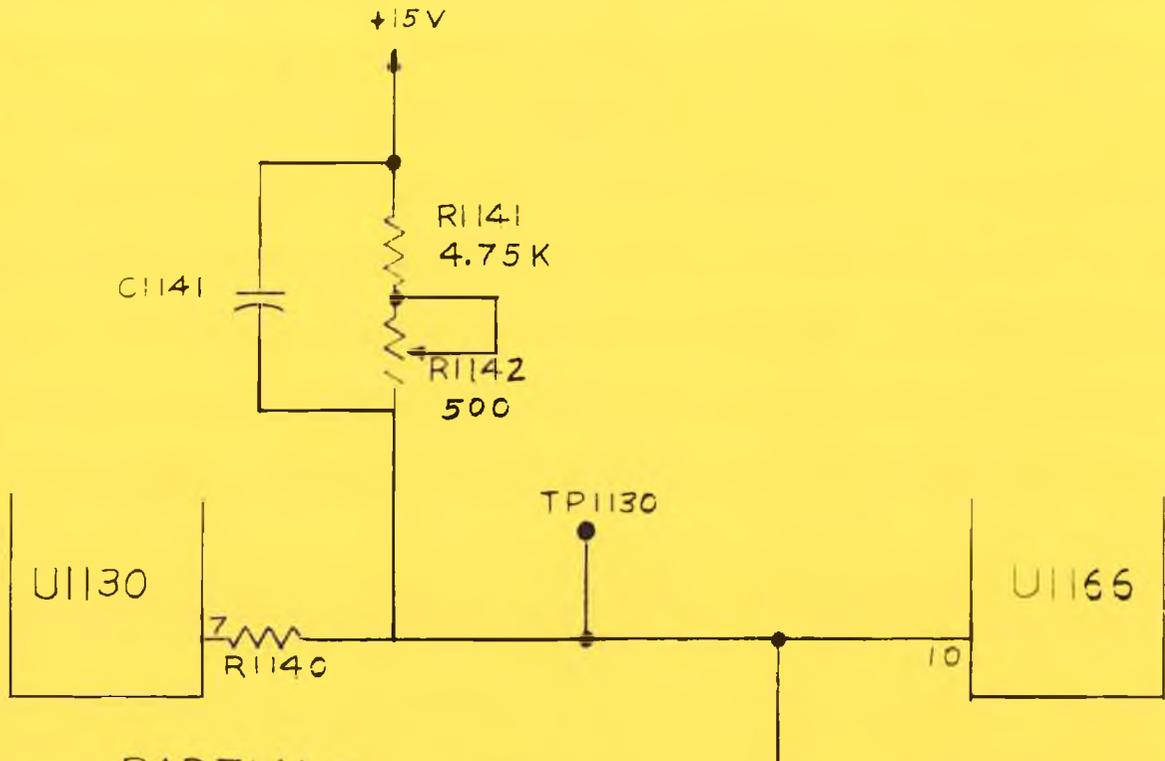
670-0635-07		Complete Board		
R1141	321-0258-00	4.75 k Ω	1/8 W	1%
R1180	321-0261-00	5.11 k Ω	1/8 W	1%

ADD:

R1142	311-0634-00	500 Ω	Var
R1182	311-0634-00	500 Ω	Var

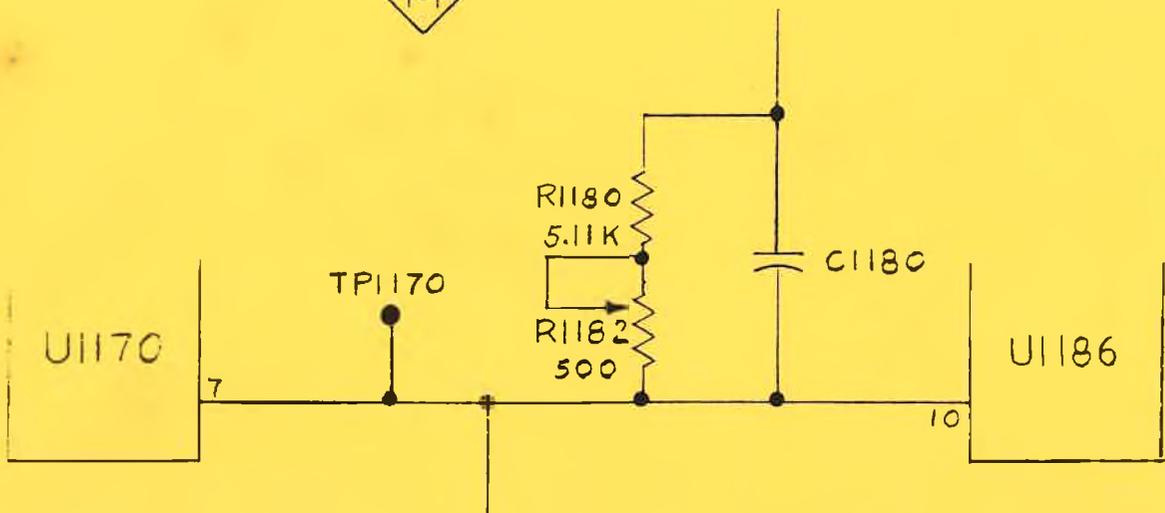
7503 TENT SN B090000-up
 7504 TENT SN B150000-up
 7514 TENT SN B080000-up
 7704 TENT SN B210000-up
 R7704 TENT SN B050000-up

SCHEMATIC CORRECTION



PARTIAL-
DATA COLLECTION

14



750³ EFF SN B100000-up

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

READOUT Circuit Board Assembly

CHANGE TO:

670-0635-08		Complete Board				
R1181	321-0371-00	71.5 k Ω	1/8 W	Prec	1%	
R1183	321-0403-00	154 k Ω	1/8 W	Prec	1%	

