

INSTRUCTION MANUAL

7403N

OSCILLOSCOPE



MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

INSTRUCTION MANUAL

Serial Number 13051564

7403N
OSCILLOSCOPE

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CHANGE INFORMATION

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.

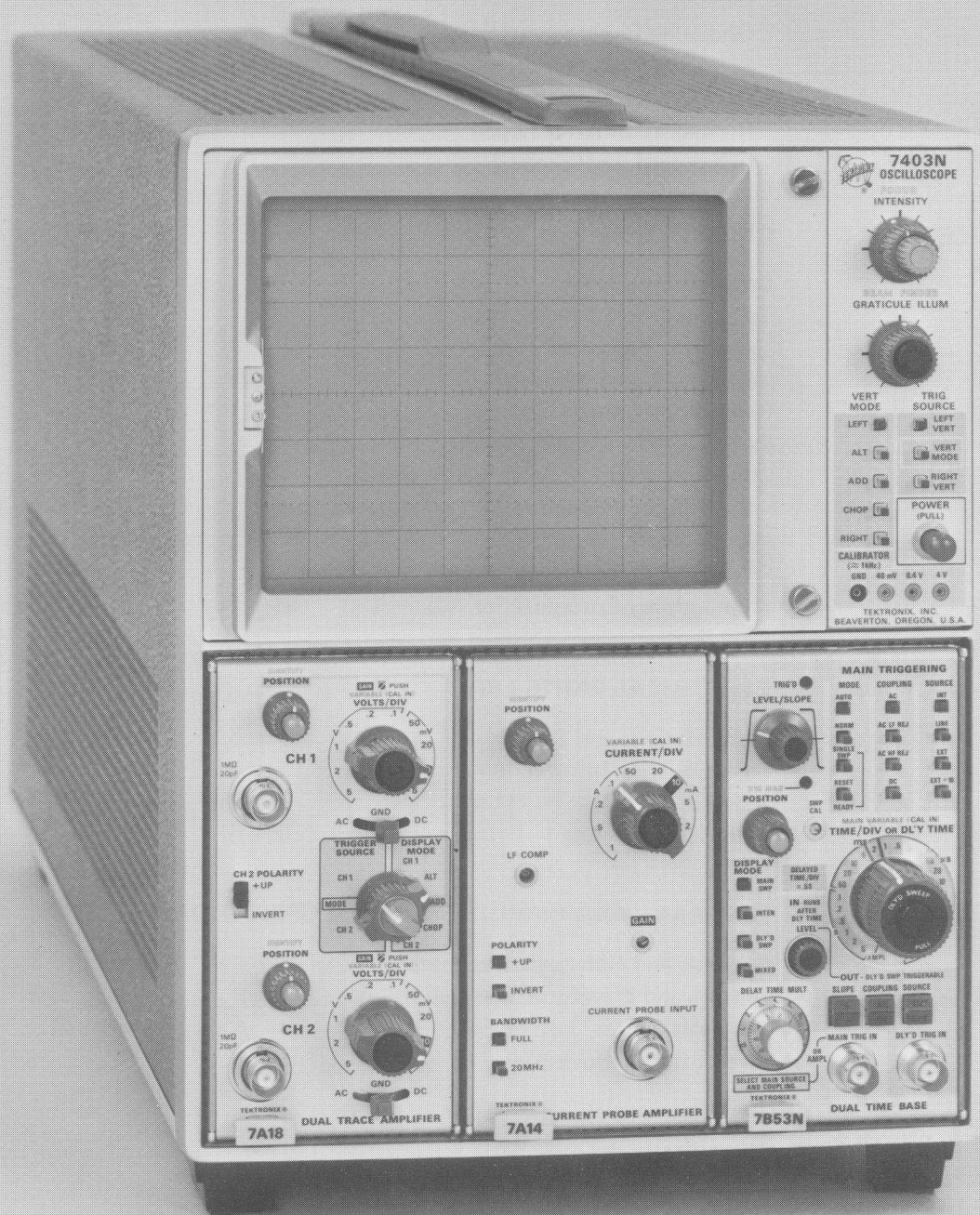


Fig. 1-1. 7403N Oscilloscope.

SECTION 1

7403N SPECIFICATION

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

Introduction

The Tektronix 7403N Oscilloscope is a solid state, light weight instrument designed for general-purpose applications. This instrument has three plug-in compartments that accept Tektronix 7-series plug-in units to form a complete measurement system. The two plug-in compartments on the left are connected to the vertical deflection system. The right plug-in compartment is connected to the horizontal deflection system. Electronic switching between the vertical plug-in compartments allows a multi-trace vertical display. The flexibility of this plug-in feature and the variety of plug-in units available allow this system to be used for many measurement applications.

This instrument features a large-screen, 8 X 10 division display; each division equals 1.22 centimeter. The cathode-ray tube (CRT) provides small spot size and good writing rate. Regulated DC power supplies 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 is about 130 watts (60 hertz, 115-volt line).

This instrument will meet the electrical characteristics listed in the Performance Requirement column of Table 1-1 following complete calibration as given in Section 5. The performance check procedure which is also given in Section 5 provides a convenient method of checking instrument performance without making internal checks or adjustments. The following electrical characteristics apply over 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 7403N Oscilloscope only. See the system specification later in this section for characteristics of the complete system.

TABLE 1-1
ELECTRICAL

Characteristic	Performance Requirement	Supplemental Information	
VERTICAL DEFLECTION SYSTEM			
Deflection Factor	Compatible with all 7-series plug-in units.		
Deflection Accuracy	Less than 1% difference between vertical compartments.		
Low-Frequency Linearity	0.1 division or less compression or expansion of a center-screen two-division signal when positioned anywhere vertically within the graticule area.		
Bandwidth	Varies with vertical plug-in selected. See System Specifications.	Bandwidth of 7403N vertical system only	
		+20°C to +30°C	0°C to +50°C
		DC to at least 67 megahertz	DC to at least 65 megahertz

TABLE 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
Isolation between Vertical Compartments	At least 100:1 from DC to 50 megahertz.	
Chopped Mode		
Repetition rate	One megahertz $\pm 20\%$	
Time segment from each compartment	0.4 to 0.6 microsecond	
Delay Line		Permits viewing leading edge of triggering signal.
Difference in Delay between Vertical Compartments		0.5 nanosecond or less
Vertical Display Modes	LEFT: Left vertical unit only. ALT: Dual-trace, alternate between vertical units. ADD: Added algebraically. CHOP: Dual-trace, chopped between vertical units. RIGHT: Right vertical unit only.	Selected by VERT MODE switch.

TRIGGERING

Trigger Source	LEFT VERT: From left vertical unit only. VERT MODE: Determined by vertical mode. RIGHT VERT: From right vertical unit only.	Selected by TRIG SOURCE switch.
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HORIZONTAL DEFLECTION SYSTEM

Deflection Factor	Compatible with all 7-series plug-in units.	
Fastest Calibrated Sweep Rate	Five nanoseconds/division.	
DC Linearity	0.1 division or less compression or expansion of a center-screen two-division signal when positioned anywhere horizontally within the graticule area.	
Bandwidth (eight division reference)		At least two megahertz.
Phase Shift Between Vertical and Horizontal Deflection Systems		Less than 2° from DC to 35 kilohertz.

TABLE 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
CALIBRATOR		
Waveshape	Square wave or DC voltage.	DC voltage available only when BEAM FINDER switch is actuated (out).
Polarity	Positive-going referenced to baseline at zero volts.	
Output Voltage	40 millivolts, 0.4 volt, 4 volts.	Into one-megohm load.
Voltage Accuracy		
+15°C to +35°C	Within 1%.	
0°C to +50°C	Within 2%.	
Output Current		40 milliamperes with optional current-loop accessory 012-0259-00 connected between 4 V and GND pin jacks.
Repetition Rate		One kilohertz $\pm 20\%$.
Output Resistance		
40 mV and 0.4 V		Approximately 50 ohms.
4 V		Approximately 450 ohms.

EXTERNAL Z-AXIS INPUTS

Sensitivity	Two volts peak to peak provides trace modulation over full intensity range.	
Useful Input Voltage versus Repetition Frequency	Two volts peak to peak, DC to two megahertz; reducing to 0.4 volt peak to peak at 10 megahertz.	
Polarity of Operation	Positive-going signal decreases trace intensity; negative-going signal increases trace intensity.	
Maximum Safe Input Voltage		10 volts (DC + peak AC)
Input Resistance at DC		Approximately 500 ohms

TABLE 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information	
DISPLAY			
Graticule			
Type	Internal, illuminated with variable edge lighting.		
Area	Eight divisions vertical by 10 divisions horizontal. Each division equals 1.22 centimeter.		
Phosphor	P31 standard.	Other available on special order.	
Beam Finder		Limits display within graticule area when actuated (out).	
Minimum Photographic Writing Speed With Polaroid ¹ Type 410 Film (without film fogging techniques)		P31	P11
Tektronix C-51-R Camera with f1.2 lens and 1:0.5 object-to-image ratio		850 centimeters/microsecond (700 divisions/microsecond)	1830 centimeters/microsecond (1500 divisions/microsecond)
Tektronix C-27-R Camera with f1.3 lens and 1:0.5 object-to-image ratio		580 centimeters/microsecond (475 divisions/microsecond)	1400 centimeters/microsecond (1150 divisions/microsecond)
POWER SUPPLY			
Line Voltage Range		Selected by Range Selector jumper inside instrument.	
110-volts nominal	100 volts ±10%. 110 volts ±10% 120 volts ±10%.		
220-volts nominal	200 volts ±10%. 220 volts ±10%. 240 volts ±10%.		
Line Frequency		50 to 400 hertz.	
Maximum Power Consumption		130 watts, 2.0 amperes at 60 hertz, 115 volt line.	

¹ Registered trademark Polaroid Corporation.

TABLE 1-2

ENVIRONMENTAL CHARACTERISTICS

Characteristic	Performance
NOTE <i>This instrument will meet the electrical characteristics given in the Performance Requirement column of Table 1-1 over the following environmental limits.</i>	
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.
Transportation (packaged instrument, without plug-in units)	Qualifies under National Safe Transit test procedure 1A, Category II.

TABLE 1-3

PHYSICAL CHARACTERISTICS

Characteristic	Information
Ventilation	Safe operating temperature maintained by convection cooling. Automatic resetting thermal cutout protects instrument from overheating.
Finish	Anodized aluminum front panel. Painted cabinet.
Overall Dimensions (measured at maximum points)	
Height	12.0 inches (30.4 centimeters).
Width	8.7 inches (22.0 centimeters).
Length	22.7 inches (57.6 centimeters).
Net Weight (instrument only)	30 pounds (13.6 kilograms).

STANDARD ACCESSORIES

Standard accessories supplied with the 7403N are given in the Mechanical Parts List illustrations. For optional accessories available for use with this instrument, see the Tektronix, Inc. catalog.

SYSTEM SPECIFICATIONS

Your Tektronix 7400-series oscilloscope system provides exceptional flexibility in operation with a wide choice of general and special purpose plug-in units. The type number of a particular plug-in unit identifies its usage as follows:

The first digit (7) denotes the oscilloscope system for which the plug-in unit is designed (7000-series).

The second letter describes the purpose of the plug-in unit:

A — Amplifier unit.

B — "Real time" time-base unit.

J — Spectrum analyzer, single width.

K — Spectrum analyzer, single width.

L — Spectrum analyzer, double width.

M — Miscellaneous.

S — Sampling unit.

T — Sampling time-base unit.

The third and fourth digits of the plug-in type number are sequence numbers and do not carry any special connotation.

7400-SERIES OSCILLOSCOPE SYSTEM VERTICAL SPECIFICATIONS

This table lists the vertical specifications which are system dependent. For more complete specifications on plug-in units for the 7000-Series Oscilloscope System, refer to the Tektronix Catalog.

Amplifier Plug-In Unit	Probe	BW	T _r	Vertical System Deflection Factor Accuracy*		
				EXT CAL 0 to 50°C	INT CAL 15 to 35°C	INT CAL 0 to 50°C
7A11	Integral	60 MHz	5.9 ns	2%	3%	4%
7A12	None	55 MHz	6.4 ns	2%	3%	4%
	P6054	55 MHz	6.4 ns	3%	4%	5%
7A13	None	55 MHz	6.4 ns	1.5%	2.5%	3.5%
	P6054	55 MHz	6.4 ns	1.5%	2.5%	3.5%
	P6055	45 MHz	7.8 ns	1.5%	2.5%	3.5%
7A14	P6021	40 MHz	8.8 ns	2%	3%	4%
	P6022	55 MHz	6.4 ns	2%	3%	4%
7A15	None	50 MHz	7.0 ns	2%	3%	4%
	P6054 and P6061	50 MHz	7.0 ns	3%	4%	5%
7A16	None	60 MHz	5.9 ns	2%	3%	4%
	P6054	60 MHz	5.9 ns	3%	4%	5%
7A18	None	50 MHz	7.0 ns	2%	3%	4%
	P6054 and P6061	50 MHz	7.0 ns	3%	4%	5%
7A22	None or any	1.0 MHz ±10%	350 ns ±9%	2%	3%	4%

*Deflection Factor accuracy is checked as follows:

EXT CAL 0°C to 50°C—Plug-in gain set at a temperature within 10°C of operating temperature, using an external calibrator whose accuracy is within 0.25%.

INT CAL 15°C to 35°C—Plug-in gain 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 set using the oscilloscope calibrator (within 10°C of the operating temperature) in a temperature range between 0°C and +50°C.

SECTION 2

OPERATING INSTRUCTIONS

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

General

To effectively use the 7403N, the operation and capabilities of the instrument must be known. This section describes the operation of the front- and rear-panel controls and connectors and gives simplified 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 7403N can be operated from either a 110-volt or a 220-volt nominal line-voltage source. In addition, three operating ranges can be selected within each nominal line voltage source. The voltage-selector jumper on the Rectifier board (see Fig. 2-1) allows selection of the operating voltage (remove power unit for access to Rectifier

board). To convert the instrument from one regulating range to another, first disconnect the instrument from the power source. Then, remove the voltage-selector jumper and re-install it on the set of pins which represent the desired regulating range. Select a range which is centered about the average line voltage to which the instrument is to be connected (see Table 2-1).

TABLE 2-1

Regulating Range and Fuse Data

Pins Selected	Regulating Range	
	110-volts nominal	220-volts nominal
LOW	90 to 110 volts	180 to 220 volts
MED	99 to 121 volts	198 to 242 volts
HI	108 to 132 volts	218 to 262 volts
Line Fuse	2 A slow-blow	1 A slow-blow

To convert from 110-volts to 220-volts nominal line voltage, or vice versa, remove the voltage-selector jumper and replace it with the spare jumper (stored on pins adjacent to voltage selector area). The jumpers are color-coded to indicate the nominal voltage for which they are intended; brown for 110-volt nominal operation and red for 220-volt nominal operation. Change the line fuse to provide protection for the selected nominal line voltage (see Table 2-1 for value). Use the fuse located in the ALT FUSE holder on the Rectifier board (see Fig. 2-1). Also, change the line-cord plug to match the power-source receptacle or use a suitable adapter.

NOTE

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

Line	Black
Neutral	White
Safety earth (ground)	Green

The 7403N is designed to be used with a three-wire AC power system. If a three- to two-wire adapter is used to connect this instrument to a two-wire AC power system, be sure to connect the ground lead of the adapter to earth (ground). Failure to complete the ground system may allow the chassis of this instrument to be elevated above ground potential and pose a shock hazard.

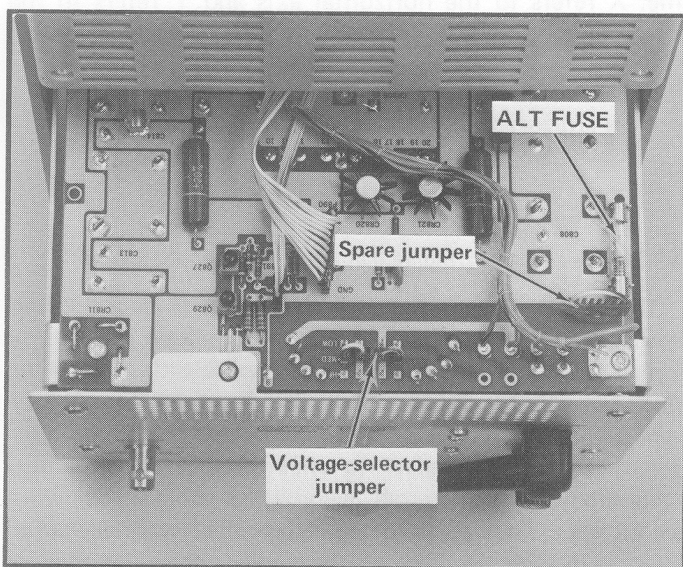


Fig. 2-1. Locations of voltage-selector jumper, spare jumper, and ALT FUSE in power-unit (shown removed).

Operating Temperature

The 7403N 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 7403N 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. 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 bale-type stand is mounted on the bottom of this instrument. This stand permits the 7403N to be tilted up about 10° for more convenient viewing.

DISPLAY DEFINITIONS

General

The following definitions describe the types of displays which can be obtained with a 7403N Oscilloscope system with real-time amplifiers, time-base units, or combinations of these. Use of special purpose plug-in units may result in different types of displays, which are defined in the instruction manuals for these special units. The following terminology will be used throughout this manual.

Alternate Mode

A time-sharing method of displaying two or more signals on a single cathode-ray tube beam. Channel switching is sequential and occurs at the end of each sweep.

Chopped Mode

A time-sharing method of displaying two or more signals on a single cathode-ray tube beam. Channel switching is sequential and occurs at a rate determined by an internal clock generator (chopping rate).

NOTE

See Simplified Operating Instructions in this section for set-up information to obtain each of the following displays.

Single Trace

A display of a single plot produced by one vertical signal and one sweep.

Dual Trace

A display of two plots produced by two vertical signals and one sweep. The two signals share a single cathode-ray tube beam.

Delayed Sweep — Single Trace

A display of a single plot produced by one vertical signal and a delayed sweep. Two sweeps are used to produce this display; the sweeps are operating with a delaying/delayed relationship where one sweep (identified as the delaying sweep) delays the start of the second sweep (identified as the delayed sweep).

Delayed Sweep — Dual Trace

A display of two plots produced by combining two vertical signals and a delayed sweep. Two sweeps are used to produce this display; the sweeps are operating with a delaying/delayed relationship. Each vertical signal is displayed against the delayed sweep.

X-Y

A plot of two variables, neither of which represents time. X refers to the horizontal axis and Y refers to the vertical axis.

PLUG-IN UNITS

General

The 7403N 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. For complete information on plug-ins available for use with this instrument, see the current Tektronix, Inc. catalog.

Plug-In 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 plug-in 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 plug-in compartment. Plug-in units can be removed or installed without turning off the instrument power.

It is not necessary that all of the plug-in compartments be filled to operate the instrument; the only plug-in units needed are those required for the measurement to be made. However, at environmental extremes, excess radiation may be radiated into or out of this instrument through the open plug-in compartments. Blank plug-in panels are available from Tektronix, Inc. to cover the unused compartments; order Tektronix Part No. 016-0155-00.

When the 7403N is calibrated in accordance with the calibration procedure given in this instruction manual, the vertical and horizontal gain are standardized. 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 unit 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 versatility of the 7403N allows a variety of display modes with many different plug-in units. 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, install a 7B-series plug-in unit in the horizontal compartment. X-Y displays can be obtained in two ways with the 7403N system. If a 7B-series time-base plug-in unit is available which has an amplifier feature, the X signal can either be routed through one of the vertical units via the internal-trigger pickoff circuitry to the horizontal system, or connected to the external horizontal

input connector of the time-base unit. Then, the vertical signal (Y) is connected to the remaining vertical unit. Also, a 7A-series amplifier unit can be installed in the horizontal compartment for X-Y operation.

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

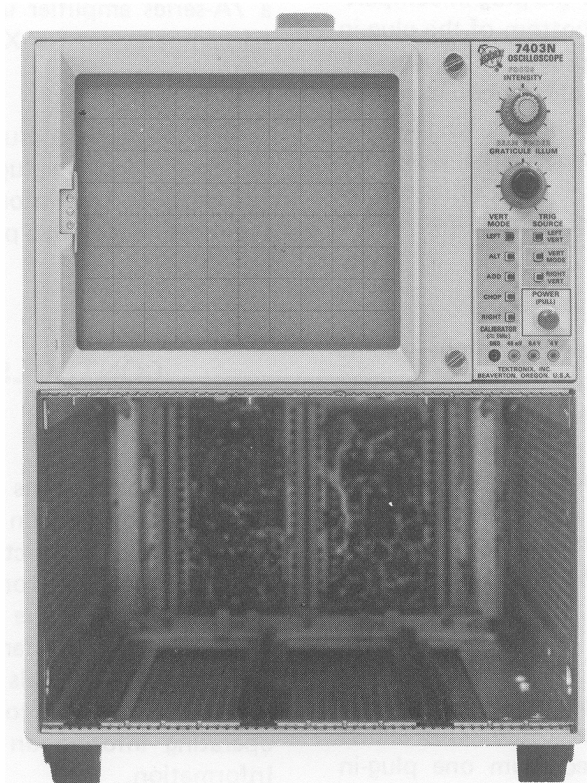
CONTROLS AND CONNECTORS

General

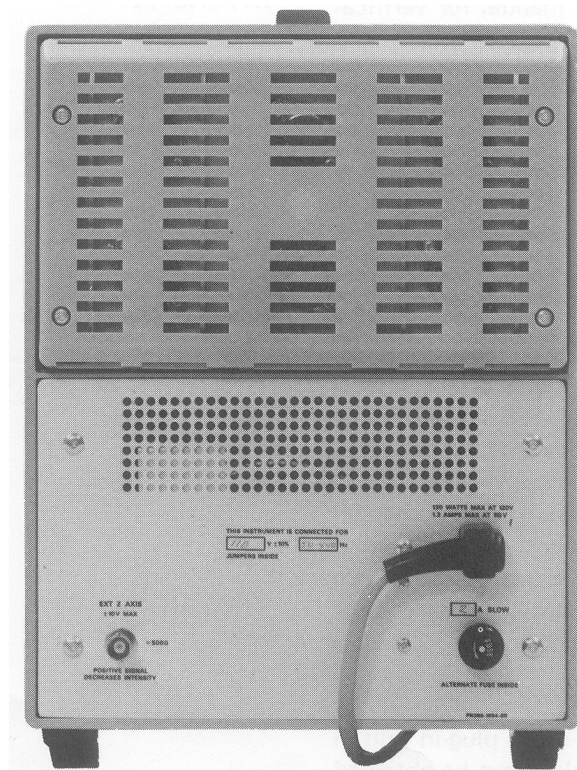
The major controls and connectors for operation of the 7403N are located on the front panel of the instrument. Several auxiliary functions are provided on the rear panel. Fig. 2-2 shows the front and rear panels of the 7403N. To make full use of the capabilities of this instrument, the operator should 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.

Front Panel

INTENSITY	Controls brightness of the display. Control is inoperative when the horizontal compartment is vacant.
FOCUS	Provides adjustment for optimum display definition.
GRATICULE ILLUM	Controls graticule illumination.
BEAM FINDER	When pressed and released (knob out), the display is compressed within the graticule area independent of display position or applied signals. Also switches the Calibrator from one-kilohertz to DC operation. When pressed in, the display returns to normal operation.
VERT MODE	Selects vertical mode of operation. LEFT: Signal from plug-in unit in left vertical compartment is displayed. ALT: Signals from plug-in units in both the left vertical and right vertical compartments are displayed. Display switched between vertical plug-in units after each sweep.



A. Front panel.



B. Rear panel.

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

ADD: Signals from plug-in units in both the left vertical and right vertical compartments are algebraically added and the algebraic sum is displayed on the CRT.

CHOP: Signals from plug-in units in both the left vertical and right vertical compartments are displayed. Display switched between vertical plug-in units at a one-megahertz repetition rate.

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

TRIG SOURCE

Selects source of internal trigger signal for the time-base unit in the horizontal compartment.

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

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

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

POWER

Controls power to the instrument.

CALIBRATOR (4 V, 0.4 V, 40 mV, GND)

Calibrator output pin-jacks. Normal repetition rate of calibrator is one-kilohertz (BEAM FINDER in). When the BEAM FINDER switch is pressed and released, DC voltage output is provided.

Camera Power (not labeled)

Three-pin connector on CRT bezel provides power output and receives remote single-sweep reset signal from compatible camera systems.

Rear Panel

EXT Z AXIS

Input connector for intensity modulation of the CRT display.

described elsewhere 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 one time-base unit. For simplicity of explanation, the vertical unit is installed in the left vertical compartment. The right vertical compartment can be used if the procedure is changed accordingly.

1. Install a 7A-series vertical unit in the left vertical compartment.
2. Press the LEFT button of the VERT MODE switch.
3. Install a 7B-series time-base unit in the horizontal compartment.
4. Press the VERT MODE button of the TRIG 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 factors.
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 and release 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; press the BEAM FINDER in.) 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.

SIMPLIFIED OPERATING INSTRUCTIONS

General

The following information is provided to aid in quickly obtaining the correct setting for the 7403N controls to present a display. The operator should be familiar with the complete function and operation of this instrument as

12. Adjust the time-base position control so the display begins at the left edge 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 against one time-base unit.

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

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

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

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

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

6. Connect the signal 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 and release 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; press the BEAM FINDER switch in.) 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 VERT MODE switch.

12. Set the RIGHT vertical unit deflection factor for a display 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 unit position control.

13. Press the ALT or CHOP button of the VERT MODE switch. A dual-trace display of the signal from the left vertical and right vertical plug-in units 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 edge of the graticule. Set the time-base sweep rate for the desired horizontal display.

Delayed Sweep — Single Trace

The following procedure will provide a delayed-sweep display of a single-trace vertical unit.

1. Follow the complete procedure given under Single-Trace Displays.

2. Be sure the time-base unit installed in the horizontal compartment is a dual time-base with delaying/delayed capabilities.

3. Follow the procedure given in the instruction manual for the dual time-base unit to obtain a delayed-sweep display.

Delayed Sweep — Dual Trace

The following procedure will provide a delayed-sweep display of two single-trace vertical units.

1. Follow the complete procedure given under Dual-Trace Displays.

2. Be sure the time-base unit installed in the horizontal compartment is a dual time-base unit with delaying/delayed capabilities.

3. Follow the procedure given in the instruction manual for the dual time-base unit to obtain a delayed-sweep 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 vertical and the horizontal compartments.
2. Press the LEFT button of the VERT MODE switch.
3. Set the POWER switch to ON. Allow several minutes warmup.
4. Connect the X-signal to the amplifier unit in the horizontal compartment.
5. Connect the Y-signal to the amplifier unit in the left vertical 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 and release 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; press the BEAM FINDER switch in.) Adjust the FOCUS control for a well-defined display.

GENERAL OPERATING INFORMATION

Intensity Control

The setting of the INTENSITY control may affect the correct focus of the display. Slight re-adjustment of the FOCUS control may be necessary when the intensity level is changed to protect the CRT phosphor; do not turn the INTENSITY control 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 control to a setting that may burn the phosphor. 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 level 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.

Display Focus

The FOCUS control allows adjustment for best definition of the CRT display. Slight re-adjustment of this control may be necessary as the display conditions change. If a properly focused display cannot be obtained with the FOCUS control, the internal Astigmatism adjustment must be re-set; see the Calibration section of this manual.

Graticule

The graticule of the 7403N 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 1.22 centimeter square. In addition, each major division is divided into five minor divisions. The vertical gain and horizontal timing of the plug-in units 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. 2-3 shows the graticule of the 7403N and defines the various measurement lines. The terminology defined here will be used in all discussions involving graticule measurements. Notice the 0%, 10, 90, and 100 markings on the left side of the graticule. These markings are provided to facilitate risetime measurements.

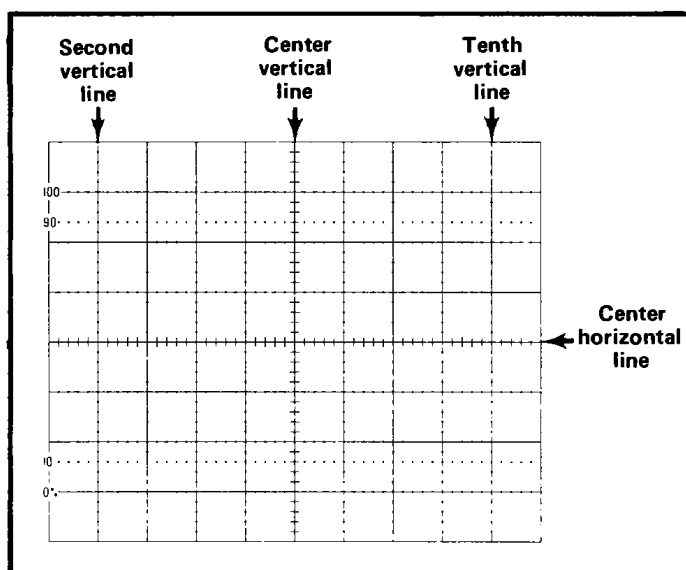


Fig. 2-3. Definition of measurement lines on 7403N graticule.

Light Filter

The tinted filter provided with the 7403N 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, loosen the two screws on the right side of the bezel and remove the bezel. Remove the tinted filter; leave the clear plastic faceplate protector installed and replace the bezel. The 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 7403N. 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 and the tinted filter. The filter can be ordered by Tektronix Part No. 378-0696-00.

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 and released, the display is compressed within the graticule area. Press in the BEAM FINDER switch to return to a normal display. To locate and reposition an overscanned display, use the following procedure;

1. Press and release the BEAM FINDER switch.
2. 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. Press the BEAM FINDER switch in; the display should remain within the viewing area.

Display Photography

A permanent record of the CRT display can be obtained with an oscilloscope camera system. The instruction manuals for the Tektronix Oscilloscope Cameras include complete instructions for obtaining waveform photographs. The following specific information applies to the 7403N.

The CRT bezel of the 7403N provides integral mounting for a Tektronix Oscilloscope Camera. The three pins located on the left side of the CRT bezel connect power to compatible camera systems. It also receives control signals from Tektronix automatic cameras to allow camera-controlled single-shot photography (see camera manual for further information).

Vertical Mode

Left and Right Mode. When the LEFT or RIGHT button of the VERT 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 VERT MODE switch produces a display which alternates between the plug-in units in the left vertical and right vertical compartments with each sweep of 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 TRIG SOURCE switch allows selection of the triggering for an alternate display. When this 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 unit which is not providing a trigger signal will appear unstable on the CRT.

Chopped Mode. The CHOP position of the VERT 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 lower 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 TRIG SOURCE switch. When the TRIG SOURCE switch is set to VERT MODE, the internal trigger signals from the vertical plug-in units 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 VERT 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-in compartments of the 7403N is greater than 20:1 at 50 megahertz. The rejection ratio increases to 100:1 at DC.

The overall deflection factor 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 amplitude of the signal applied to one of the plug-in units 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 applied to that plug-in unit should not exceed 4 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 VERT MODE switch.
4. For similar response from each channel, set the plug-in units for the same input coupling.

Trigger Source

The TRIG SOURCE switch allows selection of the internal trigger signal 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 VERT MODE switch is changed, or as the display is electronically switched between the LEFT VERT and RIGHT VERT plug-in units in the ALT position of the VERT MODE switch. It also provides a usable trigger signal in the ADD 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 VERT 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 unit. The internal trigger signal is obtained from the selected vertical compartment, whether the plug-in unit 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 7403N 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 TRIG SOURCE switches 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. The advantages of using the internal trigger system to provide the X signal are that the attenuator switch of the amplifier unit providing the horizontal signal determines the horizontal deflection factor to allow full-range operation and the plug-in units do not have to be moved between compartments when X-Y operation is desired.

Another method of obtaining an X-Y display is to install an amplifier plug-in unit in one of the horizontal plug-in

compartments (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.

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 upon the setting of the INTENSITY control. A two-volt peak-to-peak signal will completely blank the display even at maximum intensity levels. Lower amplitude signals can be used to only 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. Useful input frequency range is DC to 10 megahertz (input voltage derating necessary above two megahertz). The maximum input voltage should be limited to 10 volts (DC plus peak AC). When the EXT Z AXIS input is not in use, replace the BNC cap.

Time markers applied to the Ext Z Axis input connector provide a direct time reference on the display. With uncalibrated horizontal sweep or external horizontal 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.

Raster Display

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 7403N 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 VERT 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 EXT Z AXIS input to provide intensity modulation of the display. This type of raster display could be used to provide a television-type display. Complete information on operation using the Z-axis feature is given under Intensity Modulation.

To provide a stable raster display, both time-base units must be correctly triggered. Internal triggering is not provided for the time-base units when they are in the vertical compartments; external triggering must be used. Also, blanking is not provided from the time-base units when they are installed 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 7403N.

Calibrator

General. The internal calibrator of the 7403N provides a convenient signal source for checking basic vertical gain and 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 voltage of 40 millivolts, 0.4 volt, and 4 volts at the three front-panel pin-jack connectors into high-impedance loads. Output resistance is approximately 50 ohms at the 40 mV and 0.4 V pin jacks and approximately 450 ohms at the 4 V pin jack.

Current. A 40-milliampere, one-kilohertz output current is provided when the optional current-loop accessory (Tektronix Part No. 012-0259-00) is connected between the 4 V pin-jack and ground. This output can be used to check and calibrate current-measuring probe systems.

Waveshape. The square-wave output signal of the calibrator can be used as a reference waveshape 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.

Applications

The 7403N Oscilloscope and its associated plug-in units provide a very flexible measurement system. The capa-

bilities of the overall system depend mainly upon the plug-in units that are chosen for use with this instrument. Specific applications for the individual plug-in units are described in the plug-in 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 with this instrument.

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, "Scope Waveform Analysis", Howard W. Sams & Co. Inc., The Bobbs-Merrill Company Inc., Indianapolis, 1963.

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.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

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 7403N 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 within each major circuit and the relationship of the external controls and connectors 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 relationship.

BLOCK DIAGRAM

General

The following discussion is provided to aid in understanding the overall concept of the 7403N before the individual circuits are discussed in detail. A basic block diagram of the 7403N 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 located at the rear of the 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 is displayed. The selected vertical signal is then amplified by the Vertical Amplifier circuit to bring it to the level necessary to drive the vertical deflection plates of the CRT.

Horizontal signals for display on the CRT are connected to the Horizontal Amplifier circuit from the horizontal plug-in compartment. The Horizontal Amplifier circuit amplifies this signal to provide the horizontal deflection for the CRT.

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. The Calibrator circuit produces a square-wave output signal with accurate amplitude which can be used to check the calibration of this instrument and the compensation of probes.

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 7403N control settings. The CRT circuit produces the voltages and contains the controls necessary for operation of the cathode-ray tube. It also contains the Z-Axis Amplifier which provides the drive signal to control the intensity level of the CRT display.

The power necessary for the operation of this instrument is produced by the Low-Voltage Power Supply circuit. These voltages are connected to all circuits within the instrument.

CIRCUIT OPERATION

General

This section provides a detailed description of the electrical operation and relationship of the circuits in the 7403N. 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 (also see books under Logic Fundamentals):

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

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

Horizontal Amplifier Circuits, Tektronix Part No. 062-1144-00.

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

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

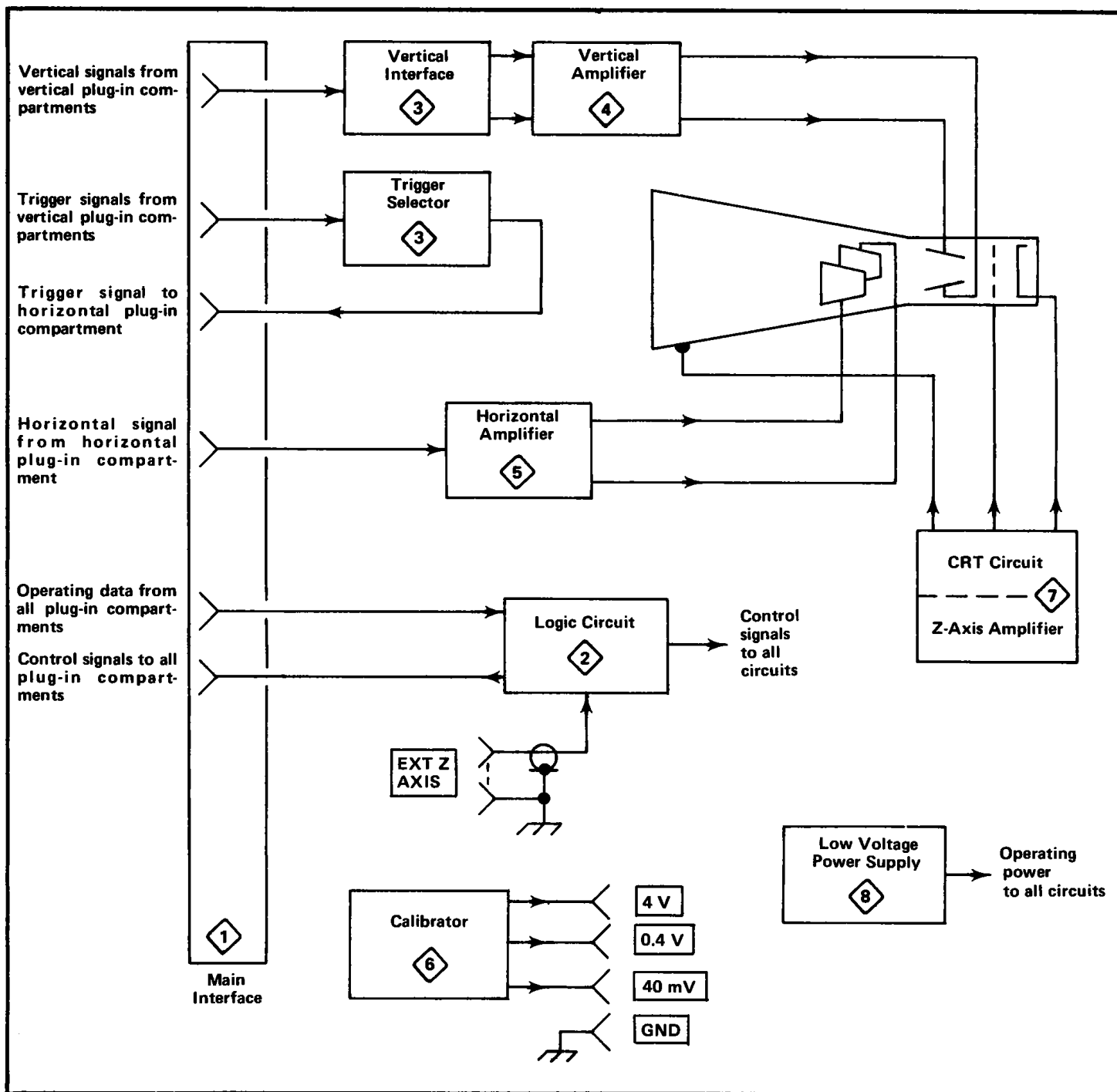


Fig. 3-1. Basic block diagram of 7403N Oscilloscope.

Sweep Generator Circuits, Tektronix Part No. 062-1098-01.

Vertical Amplifier Circuits, Tektronix Part No. 062-1145-00.

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

Lloyd P. Hunter (Ed.), "Handbook of Semiconductor Electronics", second edition, McGraw-Hill, New York, 1962.

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 circuit. The block diagrams also show the inputs and outputs for each circuit and the relationship of the external controls and connectors 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 Operation", 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, Chapters 9-11, 1965.

Symbols

The operation of circuits within the 7403N 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 this standard will be described in the circuit description for the applicable device.

NOTE

Logic symbols used on the diagrams depict the logic function and may differ from the manufacturer's data.

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 step. Thus:

$$HI = 1$$

$$LO = 0$$

Wherever possible, the input and output lines are named to indicate the functions that they perform when at the HI (true) state. For example, the line labeled, "Display B Command" means that the B Time-Base 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 function of non-digital devices will be described individually using operating waveforms or other techniques to illustrate their function.

MAIN INTERFACE

General

Diagram 1 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 and in the associated plug-in units. These output signals automatically determine the correct instrument operation in relation to the plug-in installed and/or selected, plug-in control settings, and the 7403N control settings. A schematic of this circuit is shown on diagram 2 at the rear of this manual.

Logic 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 circuit, 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 within this circuit are given in the circuit description which follows.

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 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 this 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.

TABLE 3-1

Basic Logic Reference

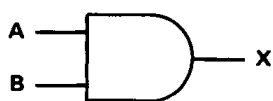
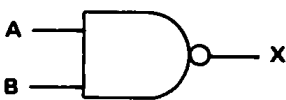
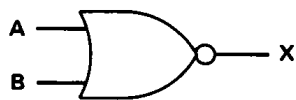
Device	Symbol	Description	Input/Output Table																		
AND gate		A device with two or more inputs and one output. The output of the AND gate is HI if and only if all of the inputs are at the HI state.	<table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><th>A</th><th>B</th><th>X</th>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

TABLE 3-1 (cont.)
Basic Logic Reference

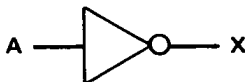
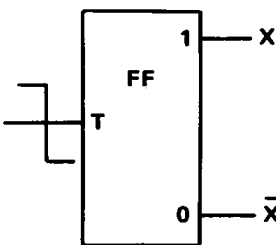
Device	Symbol	Description	Input/Output Table																				
Inverter		A device with one input and one output. The output state is always opposite to the input state.	<table><tr><th>Input</th><th>Output</th></tr><tr><td>A</td><td>X</td></tr><tr><td>LO</td><td>HI</td></tr><tr><td>HI</td><td>LO</td></tr></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:	<table><tr><th colspan="3">Input / Output</th></tr><tr><th>A</th><th>B</th><th>X</th></tr><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></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																					
	AND gate with LO-state indicator at the A input. The output of this gate is HI if and only if the A input is LO and the B input is HI.																						
	OR gate with LO-state indicator at the A input: The output of this gate is HI if either the A input is LO or the B input is HI.	<table><tr><th colspan="3">Input / Output</th></tr><tr><th>A</th><th>B</th><th>X</th></tr><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></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.																					
Triggered (toggle) Flip-Flop		A bistable device with one input and two outputs (either or both outputs may be used). When triggered, the outputs change from one stable state to the other stable state with each 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.	<table><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>X̄</th></tr><tr><td>X</td><td>X̄</td><td>X</td><td>X̄</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></table>	Input		Output		Condition before trigger pulse	Condition after trigger pulse	X	X̄	X	X̄	X	X̄	LO	HI	HI	LO	HI	LO	LO	HI
Input		Output																					
Condition before trigger pulse	Condition after trigger pulse	X	X̄																				
X	X̄	X	X̄																				
LO	HI	HI	LO																				
HI	LO	LO	HI																				

TABLE 3-1 (cont.)
Basic Logic Reference

Device	Symbol	Description	Input/Output Table																																				
Set-Clear (J-K) Flip-Flop		A bistable device with two inputs and two outputs (either or both outputs may be used). The outputs change state in response to the states at the inputs. The outputs are complementary (i.e., when one output is HI the other is LO).	<table><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><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></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																																					
D (data) Type Flip-Flop		A bistable device with two inputs and two outputs (either or both outputs may be used). When triggered the state of the "1" output changes to the state at the data (D) input 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.	<table><tr><th colspan="2">Input</th><th colspan="2">Output</th></tr><tr><th>A</th><th>X</th><th>$\bar{X}$</th><th></th></tr><tr><td>LO</td><td>LO</td><td>HI</td><td></td></tr><tr><td>HI</td><td>HI</td><td>LO</td><td></td></tr></table> Output conditions shown after trigger pulse	Input		Output		A	X	$\bar{X}$		LO	LO	HI		HI	HI	LO																					
Input		Output																																					
A	X	$\bar{X}$																																					
LO	LO	HI																																					
HI	HI	LO																																					
Triggered Set-Clear (J-K) Flip-Flop		A bistable device with three or more inputs and two outputs (either or both outputs may be used). When triggered, the outputs change state 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.	<table><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><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></table> Output conditions shown after trigger pulse	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																																					
Flip-flop with direct inputs (may be applied to all triggered flip-flops)		For devices with direct-set (S_D) or direct-clear (C_D) inputs, the indicated state at either of these inputs over-rides all other inputs (including trigger) to set the outputs to the states shown in the input/output table.	<table><tr><th colspan="4">Input</th><th colspan="2">Output</th></tr><tr><th>A</th><th>B</th><th>C</th><th>D</th><th>X</th><th>$\bar{X}$</th></tr><tr><td>1</td><td>1</td><td>LO</td><td>LO</td><td colspan="2">No change¹</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></table> Φ = Has no effect in this case ¹ Output state determined by conditions at triggered inputs	Input				Output		A	B	C	D	X	$\bar{X}$	1	1	LO	LO	No change ¹		Φ	Φ	LO	HI	LO	HI	Φ	Φ	HI	LO	HI	LO	Φ	Φ	HI	HI	Undefined	
Input				Output																																			
A	B	C	D	X	$\bar{X}$																																		
1	1	LO	LO	No change ¹																																			
Φ	Φ	LO	HI	LO	HI																																		
Φ	Φ	HI	LO	HI	LO																																		
Φ	Φ	HI	HI	Undefined																																			

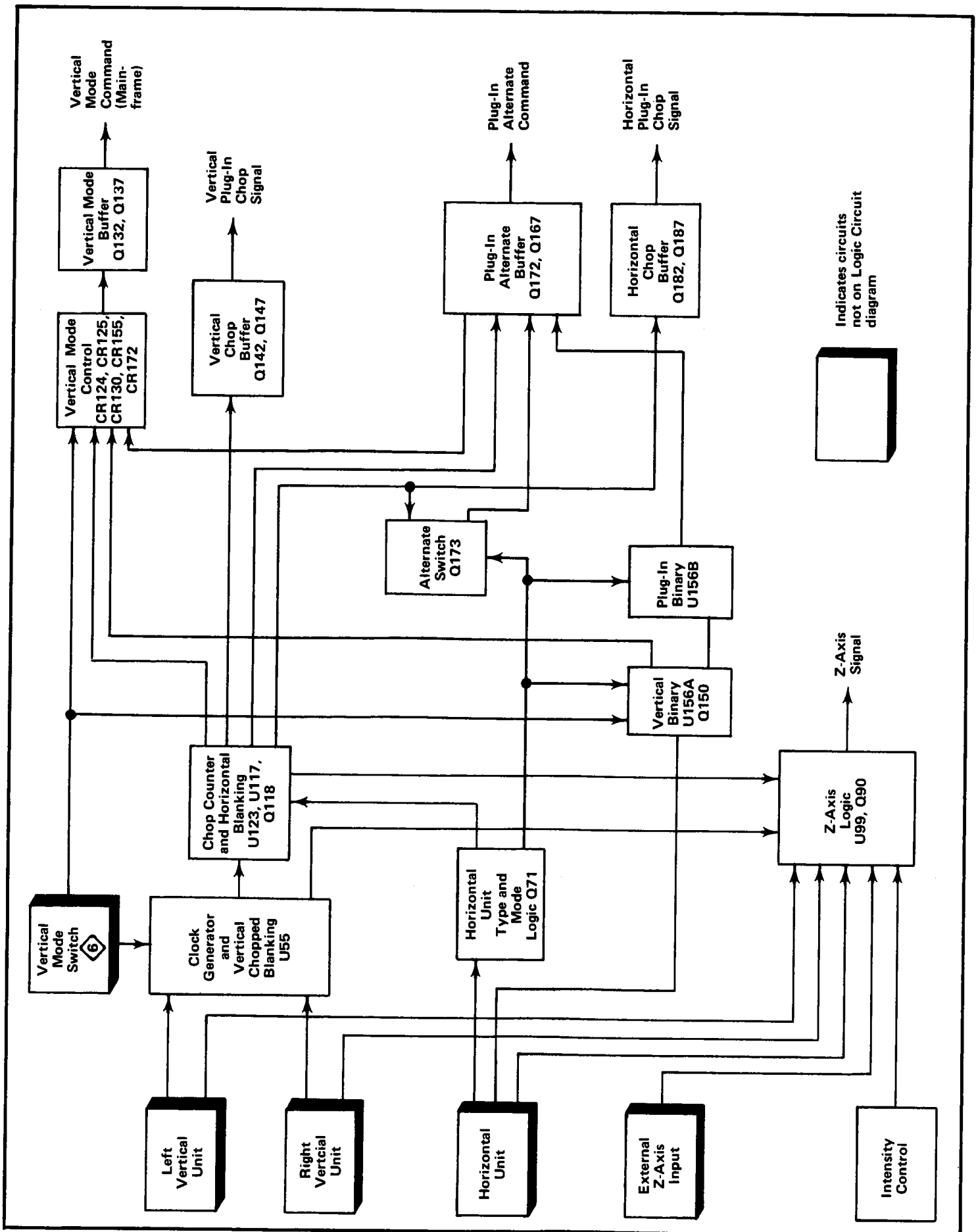


Fig. 3-2. Block diagram of Logic Circuit.

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, an external signal from the rear panel EXT Z AXIS input connector, or signals from the plug-in compartments. The Vertical Chopped Blanking from U55 and Horizontal Chopped Blanking from U117B are applied to this stage to blank the CRT display during vertical and/or horizontal trace switching. The Intensity Limit input from the horizontal

plug-in compartment provides protection for the CRT phosphor at slow sweep rates.

The Z-Axis Logic stage consists of dual-transistor Q90 and integrated circuit U99, which is a five-transistor array. A simplified schematic of the Z-Axis Logic stage is shown in Fig. 3-3. Only the components essential to operation of this stage are shown in this simplified schematic.

Transistor U99C is connected in the common-base configuration to provide the output for this stage. The

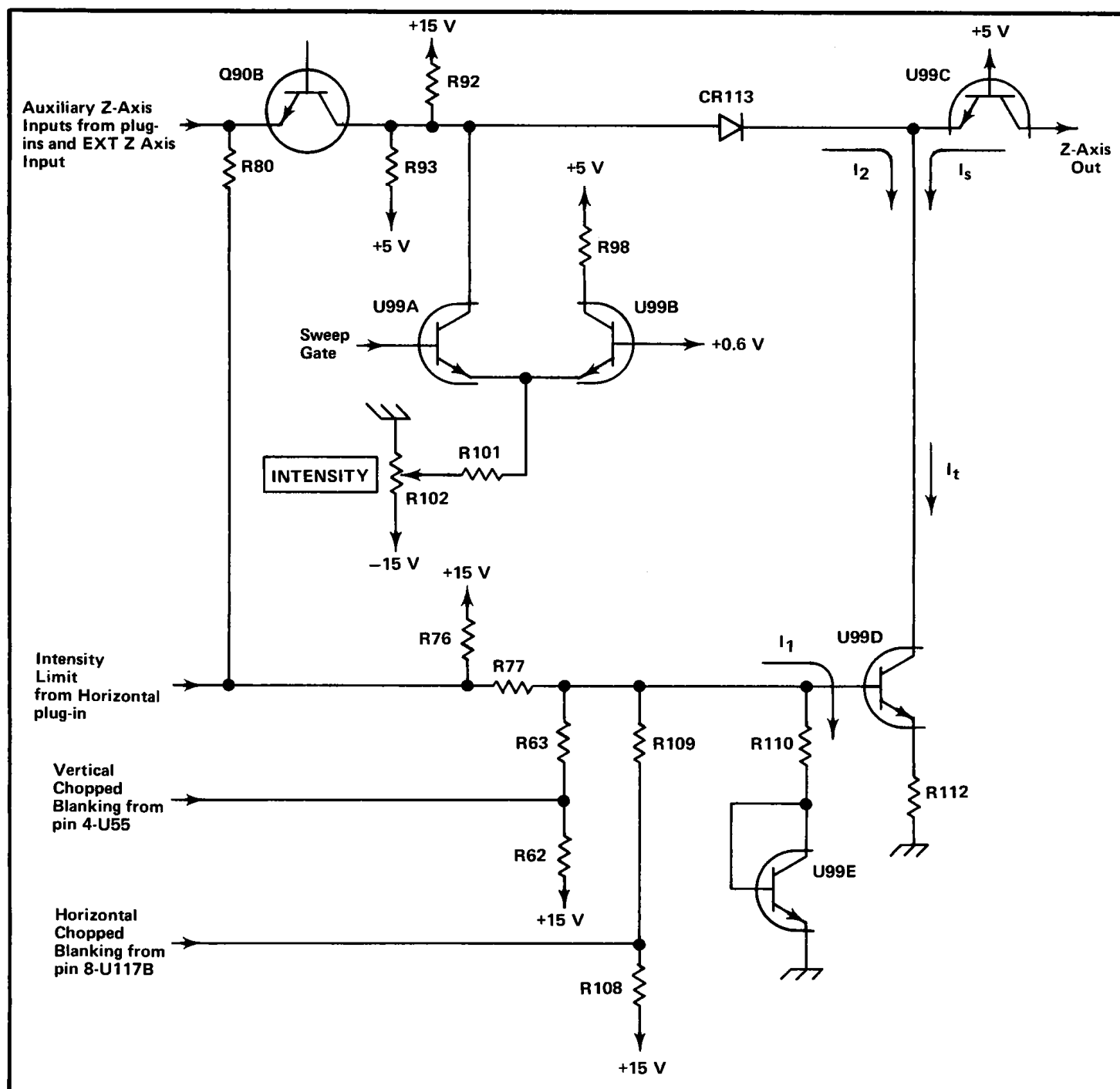


Fig. 3-3. Simplified schematic of Z-Axis Logic stage.

collector load for U99C is provided by the Z-Axis Amplifier in the CRT Circuit. Transistors U99D and U99E provide a current-limiting action for this stage. The collector current of U99D, represented by I_t , is the maximum amount of current that can flow in the circuit. The amount of this current is determined by the relationship between the Intensity Limit, Vertical Chopped Blanking, and Horizontal Chopped Blanking inputs. When all of these inputs are HI the collector current of U99D, I_t , is maximum. This maximum level of I_t is determined by current I_1 in the base circuit of U99D established by networks R76-R77, R62-R63, and R108-R109 into R110 and the collector of U99E. During either Vertical Chopped Blanking or Horizontal Chopped Blanking, the respective input level goes LO. This shunts the current I_1 from the base of U99D so the collector current of U99D, I_t , drops to minimum to blank the CRT display during vertical or horizontal trace switching.

The Intensity Limit function limits the output current of this stage to protect the CRT phosphor whenever the time-base unit is set to a slow sweep rate. For conditions that do not require limiting, quiescent current is added to I_1 from the +15-volt supply through R76-R77. When the time-base unit is set to a sweep rate which requires intensity limiting, the Intensity Limit input goes to ground level in the plug-in unit. This reduces the level of I_1 at the base of U99D and therefore reduces I_t and the output current to

reduce the intensity of the display. At the same time, the ground level from the Intensity Limit input is connected to the emitter of Q90B through R80. This connection limits the maximum level to which the INTENSITY control can be set to aid in obtaining intensity limiting at slow sweep rates.

The collector current of U99D is made up of two currents; I_s and I_2 . Under quiescent conditions (no trace, CRT blanked), the level of I_2 is determined by divider R92 and R93. When the Sweep Gate level is LO (no sweep in progress), I_2 is at its maximum level so that I_s is minimum to provide minimum intensity of the display ($I_s + I_2$ are always equal to I_t). During sweep time, the Sweep Gate level at the base of U99A goes HI. Now, the current through U99A as established by INTENSITY control R102 determines the output current. As the INTENSITY control is turned toward maximum, the level of I_2 decreases. This allows I_s to increase to produce a brighter display. The Auxiliary Z-Axis Inputs from the plug-in compartments and the intensity modulating signal from the EXT Z-AXIS input connector are connected to the emitter of Q90B. These signals modulate the level of I_2 to, in turn, modulate the intensity of the display.

Clock Generator

One half of integrated circuit U55 along with the external components shown in Fig. 3-4A make up the Clock

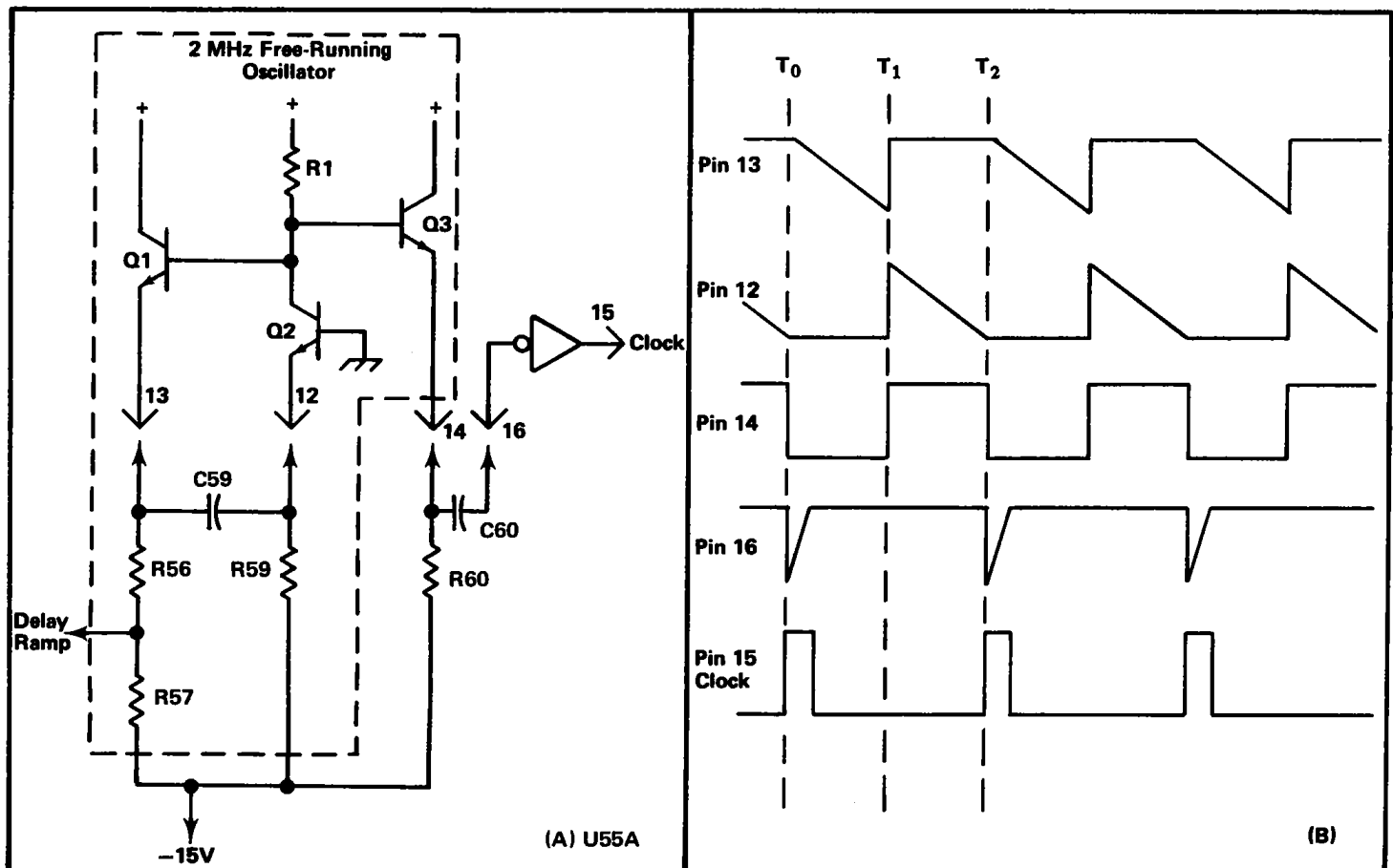


Fig. 3-4. (A) Diagram of Clock Generator stage, (B) Idealized waveforms from Clock Generator stage.

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 mainframe 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. Then, Q1 is forward biased and its emitter rapidly rises positive. 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 (see time T_1 on waveforms).

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. 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). 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.

Vertical Chopped Blanking

The Vertical Chopped Blanking stage is made up of the remaining half of integrated circuit U55. This stage deter-

mines 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) VERT 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 VERT 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 trace switching. Fig. 3-5A identifies the functions of the pins of U55B.

1. CHOP VERTICAL MODE

When the VERT 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—VERT MODE switch set to CHOP.

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

Pin 10 LO—Delay Ramp more negative than about 0 volts.

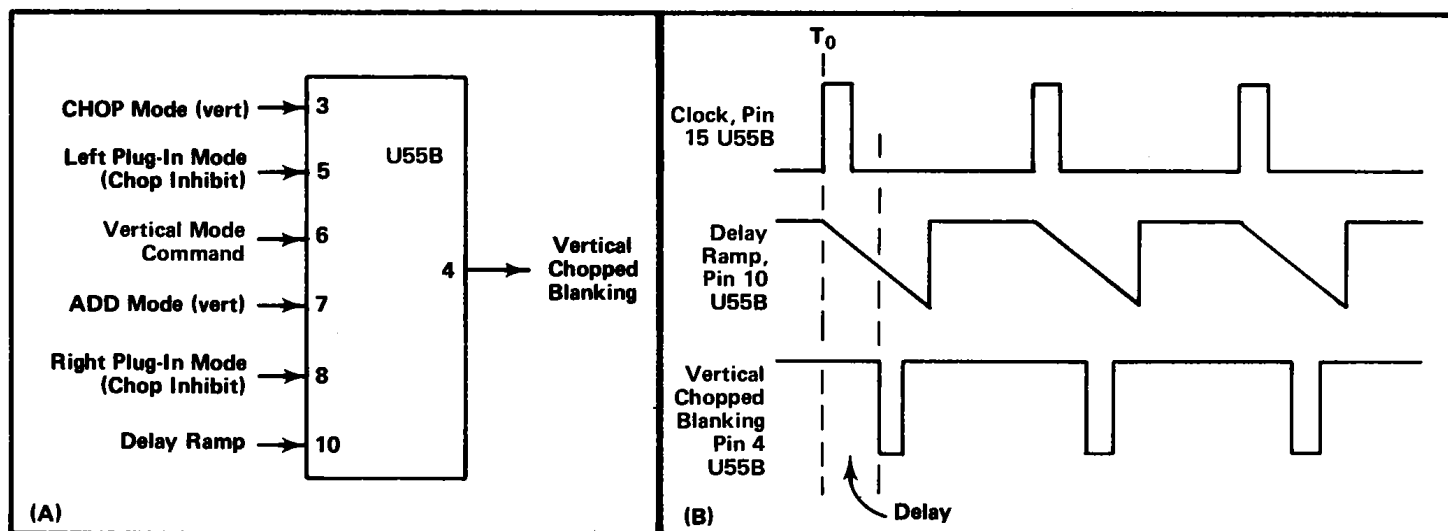


Fig. 3-5. (A) Input and output pins for Vertical Chopped Blanking stage, (B) Idealized waveform for Vertical Chopped Blanking stage.

2. LEFT VERTICAL UNIT SET FOR CHOPPED OPERATION

If the Left Vertical unit is set for chopped operation, the setting of the VERT MODE switch determines whether the Vertical Chopped Blanking pulses are available. If the VERT MODE switch is set to the CHOP position, conditions are as described in No. 1 above. Operation in the ADD position of the VERT MODE switch is given later. For the LEFT position of the VERT 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—VERT 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—VERT MODE switch set to any position except ADD.

Pin 10 LO—Delay Ramp more negative than about 0 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 VERT MODE switch is set to ALT, Vertical Chopped Blanking pulses are produced only 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 previously for the left vertical

unit except that Vertical Chopped Blanking pulses are produced when the VERT 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—VERT MODE switch set to any position except CHOP.

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

Pin 7 LO—VERT 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 0 volts.

4. ADD VERTICAL MODE

When the VERT 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 traces of the vertical units. The input conditions are:

Pin 3 LO—VERT 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—VERT 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 0 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.

Horizontal Unit Type and Mode Logic

The Horizontal Unit Type and Mode Logic stage supplies control levels to indicate the type and operating mode of

the plug-in unit installed in the horizontal compartment. Inputs to this stage from the horizontal plug-in unit are the X-Compensation Inhibit command and the Horizontal Plug-In Mode. The outputs are the Sweep Command and Horizontal Chopped command. A simplified schematic of this stage is shown in Fig. 3-7A.

The Sweep Command signal is derived directly from the X-Compensation Inhibit command from the plug-in unit. This level is HI for sweep units and LO for non-sweep units (also LO for sweep units operated in the amplifier mode). The Sweep Command signal is connected to the Alternate Switch, Vertical Binary, and Plug-In Binary stages to

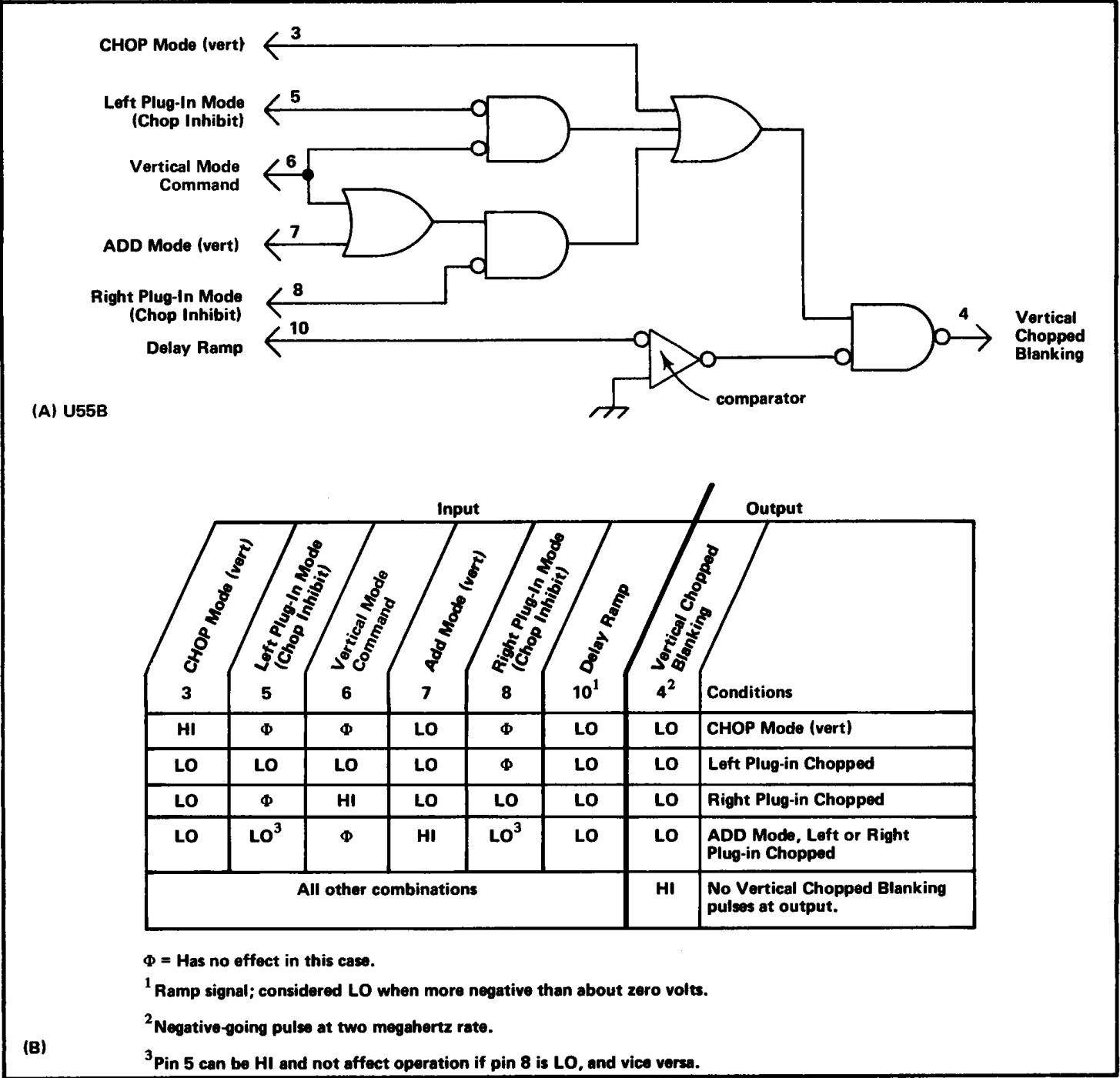
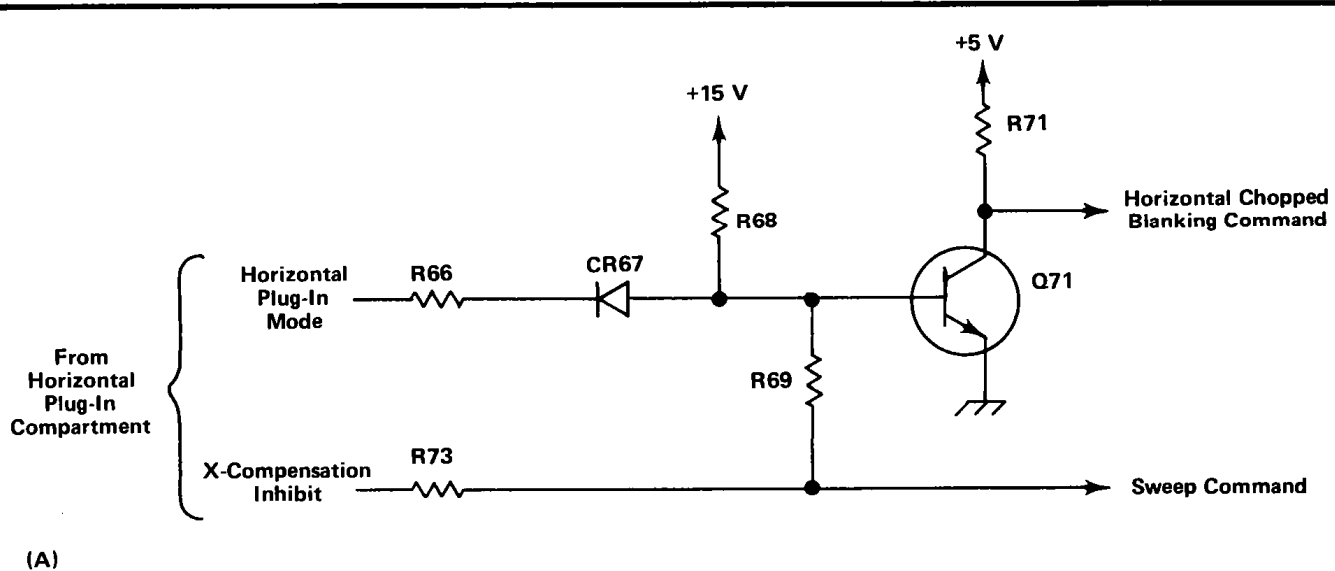


Fig. 3-6. (A) Logic diagram for Vertical Chopped Blanking stage, (B) Table of input/output combinations for Vertical Chopped Blanking stage.

indicate the operating mode of the horizontal unit. See the discussion for these individual stages for more information.

The Horizontal Chopped Command from the collector of Q71 is connected to the Chop Counter stage to alter the counting rate (see Chop Counter discussion). The Horizontal Chopped Command is derived from the level of the Horizontal Plug-In Mode input in conjunction with the Sweep Command. An input/output table for this stage is shown in Fig. 3-7B. The Horizontal Plug-In Mode signal is supplied by dual-trace units, and varies between about 0

and +5 volts depending upon the mode. 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 this input line open, and a level of about +5 volts is established on the line by resistors R64-R65 (see complete diagram). Therefore, the stage operates as for CH 1. Diode CR67 is reverse biased and Q71 conducts. Its collector goes LO to indicate that a single-channel unit is installed in the horizontal compartment. A LO input level (+1 V or less) forward biases CR67 and turns Q71 off. The collector level of Q71 goes HI, generating the Horizontal Chopped Command.



(B)

Input		Output		
X-Compensation Inhibit	Horizontal Plug-in Mode	Collector Q71	Mode	Horizontal Unit Type
HI	Φ	LO	Sweep	Time-Base Unit
LO	HI	LO	CH 1	Dual-Trace Amplifier Unit
LO	LO ¹	HI	ALT	
LO	HI	LO	ADD	
LO	LO	HI	CHOP	
LO	HI	LO	CH 2	

Φ = Has no effect in this case

¹ +1 volt or less

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

Chop Counter

The Chop Counter stage produces the Vertical Mainframe Chop Signal, the Vertical Plug-In Chop Signal, the Horizontal Plug-In Chop Signal, and the Horizontal Chopped Blanking signal. The Clock pulse produced by the Clock Generator stage provides the timing signal for this stage. A logic diagram of the Chop Counter stage, identifying the inputs and outputs, is shown in Fig. 3-8.

The Chop Counter stage consists of integrated circuits U117 and U123, and transistor Q118. U117 and U123 are dual D-type flip-flops with direct-set, direct-clear inputs (see Table 3-1 for operation of D-type flip-flop). Transistor Q118 operates as a three input AND gate. Its output is HI only 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

Chopped Command input. The following discussion describes the operation of this stage for both conditions of the Horizontal Chopped Command.

CONDITION 1

Horizontal Chopped Command—LO

This is the normal operating condition of the Chop Counter stage. For more information on the Horizontal Chopped Command, see the discussion on the Horizontal Unit Type and Mode Logic stage.

The LO level established at the direct-clear (C) input of U117B by the Horizontal Chopped Command, overrides all other inputs to U117B. This sets the "1" output to its LO level and the "0" output goes HI. The HI level at the "0" output of U117B is connected to the direct-set (S) inputs of U123A and U123B. As a result, U123A and U123B operate as triggered flip-flops or divide-by-two counters.

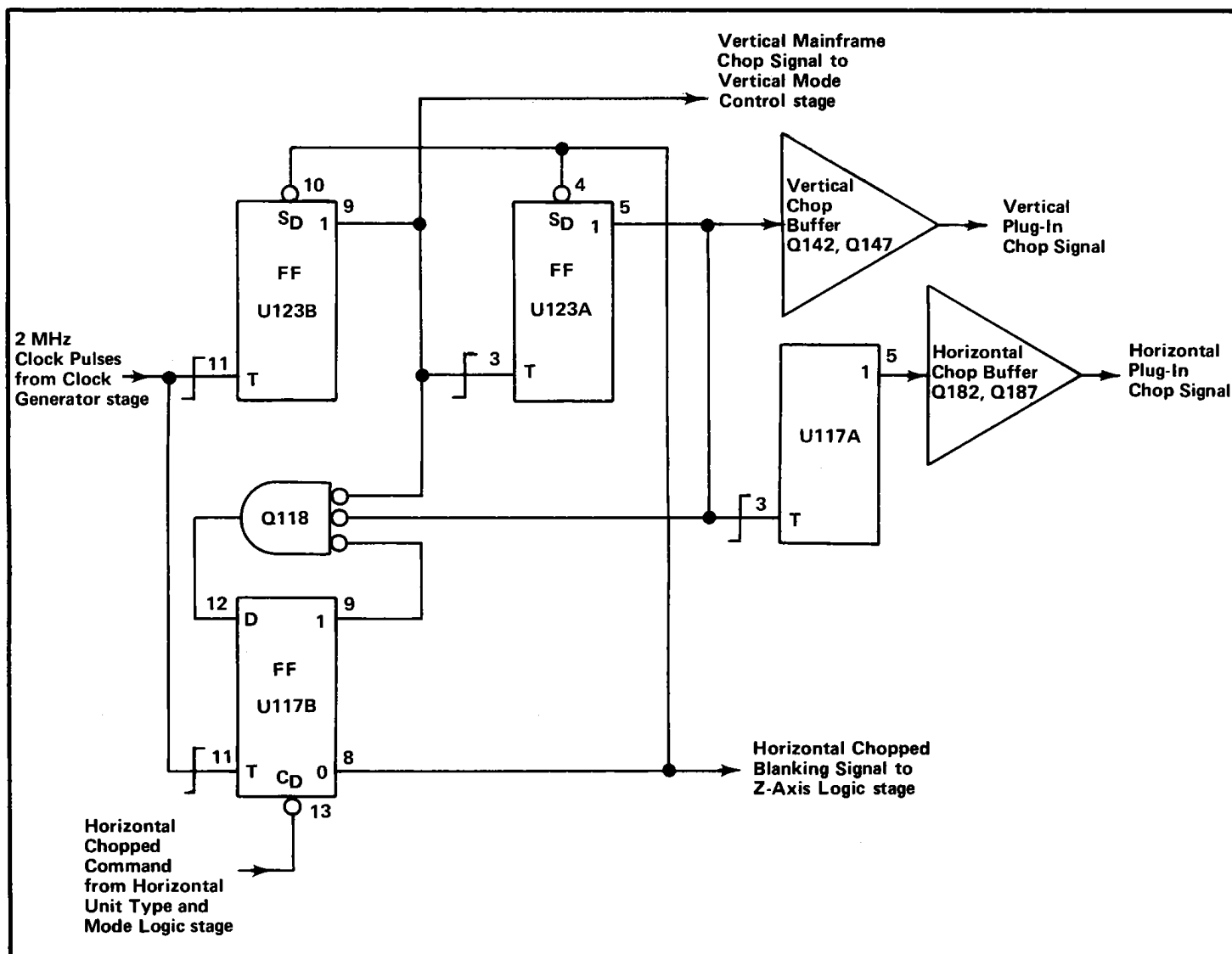


Fig. 3-8. Detailed logic diagram of Chop Counter stage.

The two-megahertz clock pulses from the Clock Generator stage are connected to the trigger (T) input of U123B. Under this condition, U123B changes output states with each positive-going Clock pulse, and the signal at its "1" output is a square wave which switches between the HI and LO levels at a one-megahertz rate. This signal is connected to the Vertical Mode Control stage to provide the Vertical Mainframe Chop Signal. It is also connected to the trigger input of U123A. U123A also changes output states with each positive-going pulse at its trigger input to produce a 500 kilohertz square wave at its "1" output. The output from U123A provides the Vertical Plug-In Chop Signal to the Vertical Plug-In Chop Buffer stage. It is also connected to the trigger input of U117A to result in a 250-kilohertz Horizontal Plug-In Chop Signal at the "1" output. Idealized waveforms showing the timing relationship between the input and output signals for this stage when operating in condition 1 are shown in Fig. 3-9.

Even though the conditions are correct during condition 1 to enable Q118, it has no effect on the operation of this circuit, since the LO level at the direct-clear input of U117B effectively disables the data (D) and trigger (T) inputs of U117B.

CONDITION 2

Horizontal Chopped Command—HI

This is the state of the Horizontal Chopped Command when a dual-trace unit in the HORIZ compartment is operated in a dual-trace mode.

In this condition, the direct-clear input of U117B is HI, which enables it to transfer the level at the data (D) input to the "1" output upon the arrival of each Clock pulse at

its trigger input. The collector level of Q118 establishes the level at the D Input of U117B. This level is LO unless all three inputs to the AND gate Q118 are LO. With the data input of U117B at its LO level, the next Clock pulse at its trigger input sets the "1" output LO and the "0" output HI. This is the condition shown at time T_0 in Fig. 3-10. At this time, the HI level at the direct-set inputs of U123A and U123B enables U123A and U123B so they operate in a normal manner for the next two Clock pulses. At time T_1 , the "1" outputs of all three counters are at their LO level. This activates AND gate Q118 and its output goes HI. This HI level is connected to the D input of U117B and the next Clock pulse at time T_2 produces a HI output level at the "1" output of U117B. At the same time, the "0" output of U117B goes LO to set the "1" outputs of U123A and U123B to their HI level. This level is also connected to the Z-Axis Logic stage through CR108 to provide the Horizontal Chopped Blanking signal to blank the CRT during horizontal trace switching. Since the "1" outputs of all three counters have gone HI, Q118 is now disabled and its output goes LO.

The Clock pulse at time T_3 has no effect on U123B, since its direct-set input is still held LO. However, this Clock pulse triggers U117B to transfer the LO at its data input to the "1" output. The "0" output of U117B goes HI to enable U123A and U123B. The conditions in the circuit are now the same as they were at time T_0 so a new cycle will begin at T_4 .

Vertical Mode Control

The Vertical Mode Control stage is made up of discrete components CR124-CR125, CR126, 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

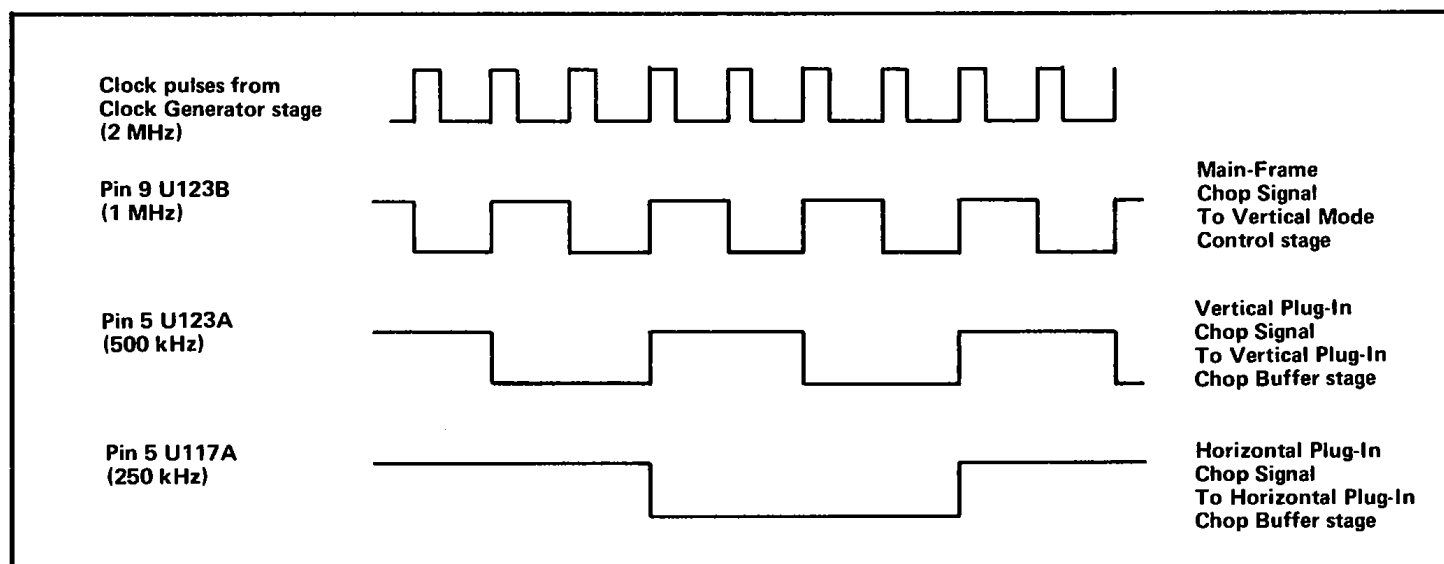


Fig. 3-9. Idealized input and output waveforms for Chop Counter stage when operating in condition 1.

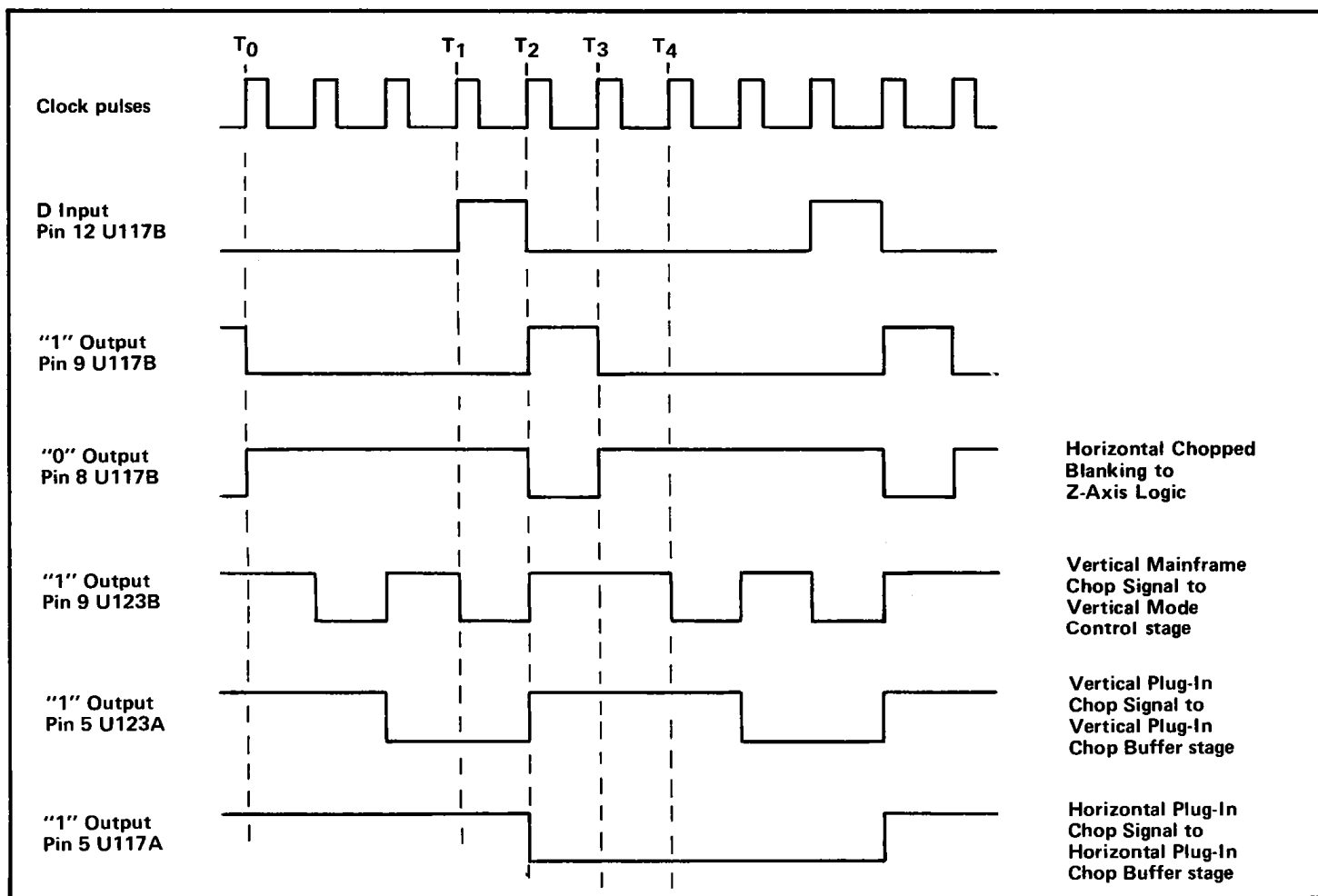


Fig. 3-10. Idealized input and output waveforms for Chop Counter stage when operating in condition 2.

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.

The VERT MODE switch located on diagram 6 provides control levels for 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 VERT MODE switch is as follows:

Right. When the VERT MODE switch is set to RIGHT, a HI level is connected to the Buffer Amplifier through R126 and CR126. The LO level at the anodes of diodes CR125 and CR130 holds them reverse biased. The resultant Vertical Mode Command output from the Buffer Amplifier is a HI level to indicate that the right vertical unit is to be displayed.

Chop. In the CHOP position of the VERT MODE switch, a HI level is applied to the anodes of diodes

CR124-CR125 through R125. Both diodes are forward biased so the Vertical Chop Signal from pin 9 of U123B can pass to the emitter of Q132. This signal switches between the HI and LO levels at a one-megahertz rate and it produces a corresponding Vertical Mode Command output at the collector of Q137. When this output is HI, the right vertical unit is displayed and when it switches to LO, the left vertical unit is displayed.

Alt. In the ALT mode, the VERT MODE switch applies a HI level to the anodes of diodes CR130-CR155-CR172 through R130. These diodes are forward biased so the Display Right Command from pin 5 of U156A can pass to the emitter of Q132 to determine the Vertical Mode Command level. The Display Right Command switches between its HI and LO levels at a rate determined by the Vertical Binary stage. In special circumstances where the plug-in unit installed in the horizontal compartment does not produce a sweep, Q173 provides an alternate switching signal (see Alternate Switch for details).

Add and Left. The control levels in the ADD and LEFT positions of the VERT MODE switch are not connected to this stage. However, since only the line corresponding to

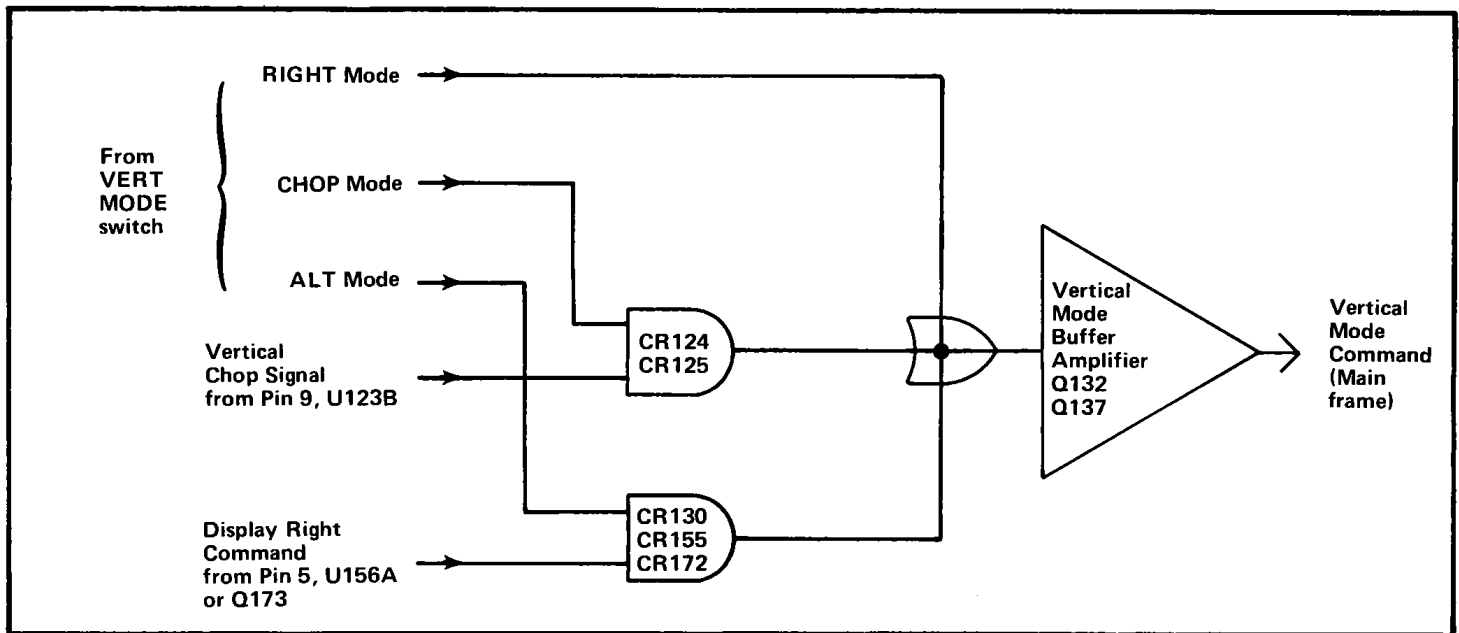


Fig. 3-11. Logic diagram of Vertical Mode Control and Vertical Mode Buffer Amplifier stages.

the selected vertical mode can be HI, the RIGHT, CHOP, and ALT lines must remain at their LO level when either LEFT or ADD are selected. Therefore, the emitter of Q132 remains LO to produce a LO Vertical Mode Control output level. Final control of LEFT or ADD mode is made by the Vertical Interface circuit.

A logic diagram of the Vertical Mode Control stage is shown in Fig. 3-11. The discrete components which make

up each logic function are identified. The gate connected to the input of the Buffer Amplifier is a phantom-OR gate. A phantom-OR gate performs the OR logic function merely by interconnection of the two signals.

Vertical Binary

The Vertical Binary stage consists of integrated circuit U156A and transistor Q150. U156A is a D-type flip-flop with direct-set and direct-clear inputs (see Table 3-1 for operating details). The connection between the "0" output and the data (D) input enables this flip-flop to operate in the triggered mode. A logic diagram of the Vertical Binary stage is shown in Fig. 3-12.

The Vertical Binary stage operates in one of three conditions, depending on the levels of the applied control signals. These conditions are:

CONDITON 1—ALT mode with sweep

Input levels:

ALT Command—HI

Sweep Command—HI

Holdoff—Pulse which switches from LO to HI level at end of each sweep.

In this condition, the HI level at the emitter of Q150 disables it so its collector remains HI. As a result, Q150 has no effect upon operation of the stage and the direct-clear input of U156A remains HI. The direct-set input of U156A is also HI, so it does not affect the operation of U156A

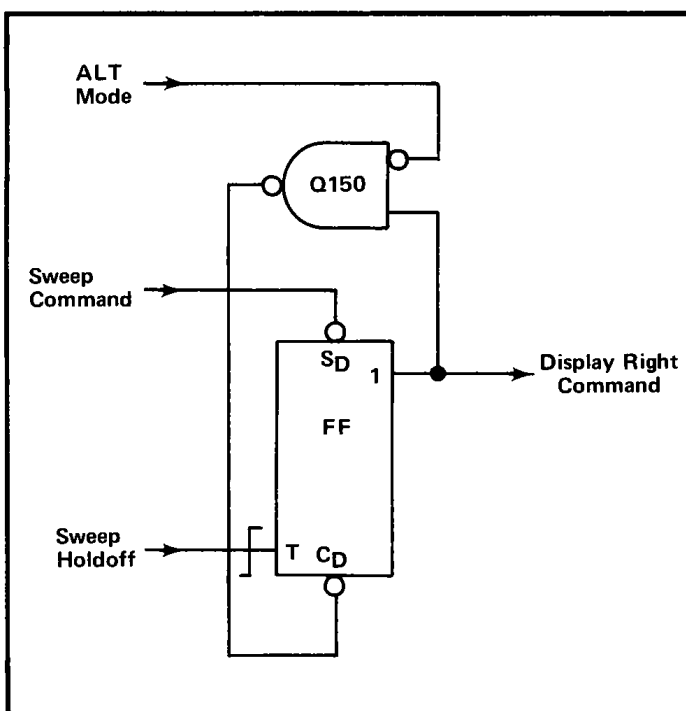


Fig. 3-12. Logic diagram of Vertical Binary stage.

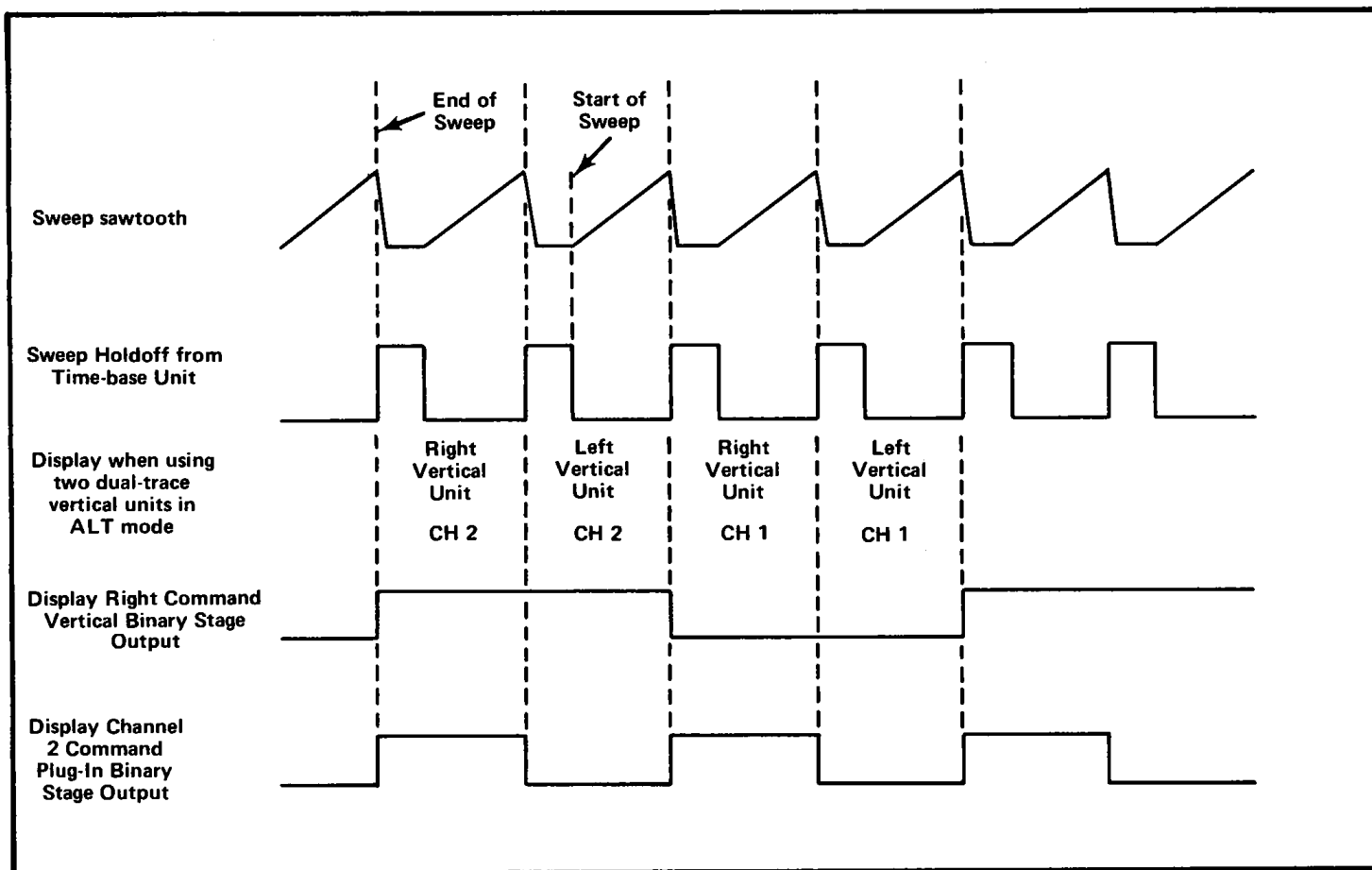


Fig. 3-13. Idealized waveforms showing relationship between input and output waveforms for Vertical Binary and Plug-In Binary stages when operating in condition 1.

either. Therefore, U156A operates as a basic triggered flip-flop which changes output states with each positive-going Sweep Holdoff pulse at the trigger (T) input. The Sweep Holdoff pulse goes positive at the end of each sweep. The signal at the "1" output of U156A switches between the HI and LO level at one-half the rate of the Sweep Holdoff signal from the horizontal plug-in unit. Fig. 3-13 shows the time relationship between the input and output signals for this stage, and gives the resultant display with each signal combination.

CONDITION 2—Any mode except ALT with sweep

Input levels:

ALT MODE—LO

Sweep Command—HI

Holdoff-Pulse which changes from LO to HI at end of each sweep.

For this condition the Sweep Command level remains HI so U156A still operates as a triggered flip-flop. However, the emitter of Q150 is pulled LO by the ALT Mode command from the VERT MODE switch. This enables

Q150, but it does not change output state unless the level at the "1" output of U156A is HI. Quiescently, the output of Q150 is LO. Therefore, when the positive-going Sweep Hold-off pulse is received at the end of the sweep, the "1" output of U156A goes HI. This activates Q150 and its output goes LO to provide a direct-clear reset to U156A. This resets the "1" output of U156A to its LO level, and Q150 is again disabled so its output returns to the HI level. The stage is now ready for the next positive-going trigger pulse. The action is the same with each trigger pulse, so the signal at the output of this stage is at the same repetition rate as the Sweep Holdoff input. Therefore, this stage is now operating as a divide-by-one counter rather than a divide-by-two counter as in condition 1. The output under this condition is used only by the Plug-In Binary stage.

CONDITION 3—No sweep

Input levels:

ALT Mode—Has no effect in this condition.

Sweep Command—LO

Sweep Holdoff—LO

When the Sweep Command is LO, CR157 is forward biased to apply a LO level to the direct-set input of U156A.

This disables the Vertical Binary stage. However, a special Display Right Command is available with the right set of conditions; see Alternate Switch for details.

Plug-In Binary

The Plug-In Binary stage consists of U156B, which is connected as a triggered flip-flop with direct-set input. The trigger input for this stage is the Display Right Command from the Vertical Binary stage. In both conditions of the Vertical Binary stage where a sweep is present (sweep Command HI), this stage operates as a divide-by-two counter. When the VERT MODE switch is set to ALT, the repetition rate of the Display Channel 2 Command output of this stage is one-fourth of the Sweep Holdoff input (see waveforms in Fig. 3-13). For any position of the VERT MODE switch except ALT, the repetition rate of the output signal from this stage is one-half of the Sweep Holdoff input.

When the Sweep Command goes LO to indicate that a sweep is not being produced, a LO level is connected to the direct-set input of U156B. This disables the Plug-In Binary stage. A logic diagram of the Plug-In Binary stage is shown in Fig. 3-14.

Alternate Switch

When the Sweep Command level is HI (time-base unit installed in horizontal compartment operating in time-base mode), Q173 is reverse biased and has no effect on operation of this circuit. When this level goes LO (time-base unit

operated in amplifier mode or vertical unit in horizontal compartment), Q173 is forward biased. Now, the current through Q173 is determined by the Horizontal Plug-In Chop Signal from U117A. Therefore, the Horizontal Plug-In Chop Signal provides the Plug-In Alternate Command through CR173 and the Plug-In Alternate Buffer. In the ALT position of the VERT MODE switch, this signal is also coupled to the Vertical Mode Control stage through CR172. This configuration provides usable operation in the ALT mode when a sweep is not being generated, since both the Vertical Binary and the Plug-In Binary stages are disabled under this condition.

Output Buffers

The output switching commands from the Logic circuit are provided through buffer stages Q142-Q137, Q142-Q147, Q162-Q167, and Q182-Q187. Each of these stages includes a common-base input transistor to provide a low-impedance load for the associated driving stages. The output transistor is connected as an emitter-follower to provide isolation between the Logic circuit and other circuits within this instrument or the plug-in units.

TRIGGER SELECTOR

General

The Trigger Selector circuit determines the trigger signal which is connected to the time-base unit as controlled by the TRIG SOURCE switch. Fig. 3-15 shows a detailed block diagram of the Trigger Selector circuit, along with a simplified diagram of all the circuitry involved in selection

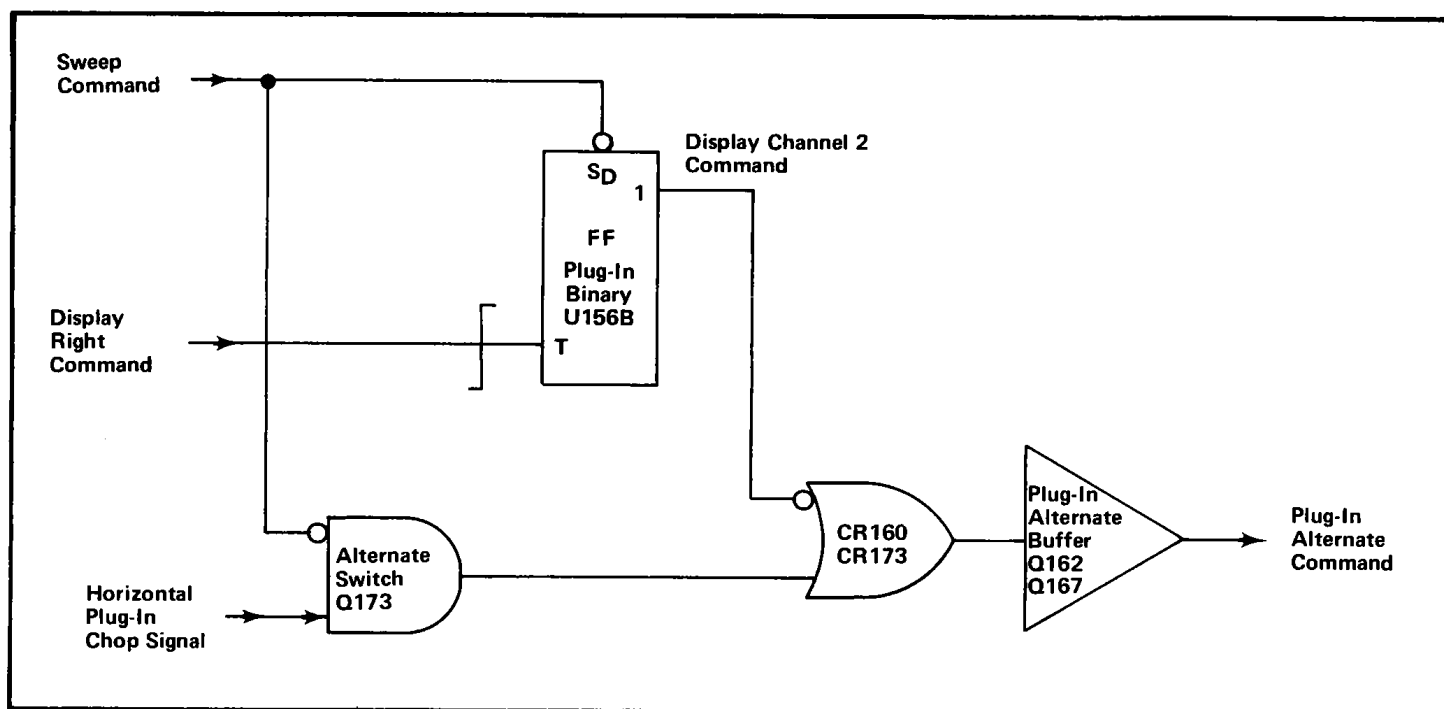


Fig. 3-14. Logic diagram of Plug-In Binary, Alternate Switch and Plug-In Alternate Buffer stages.

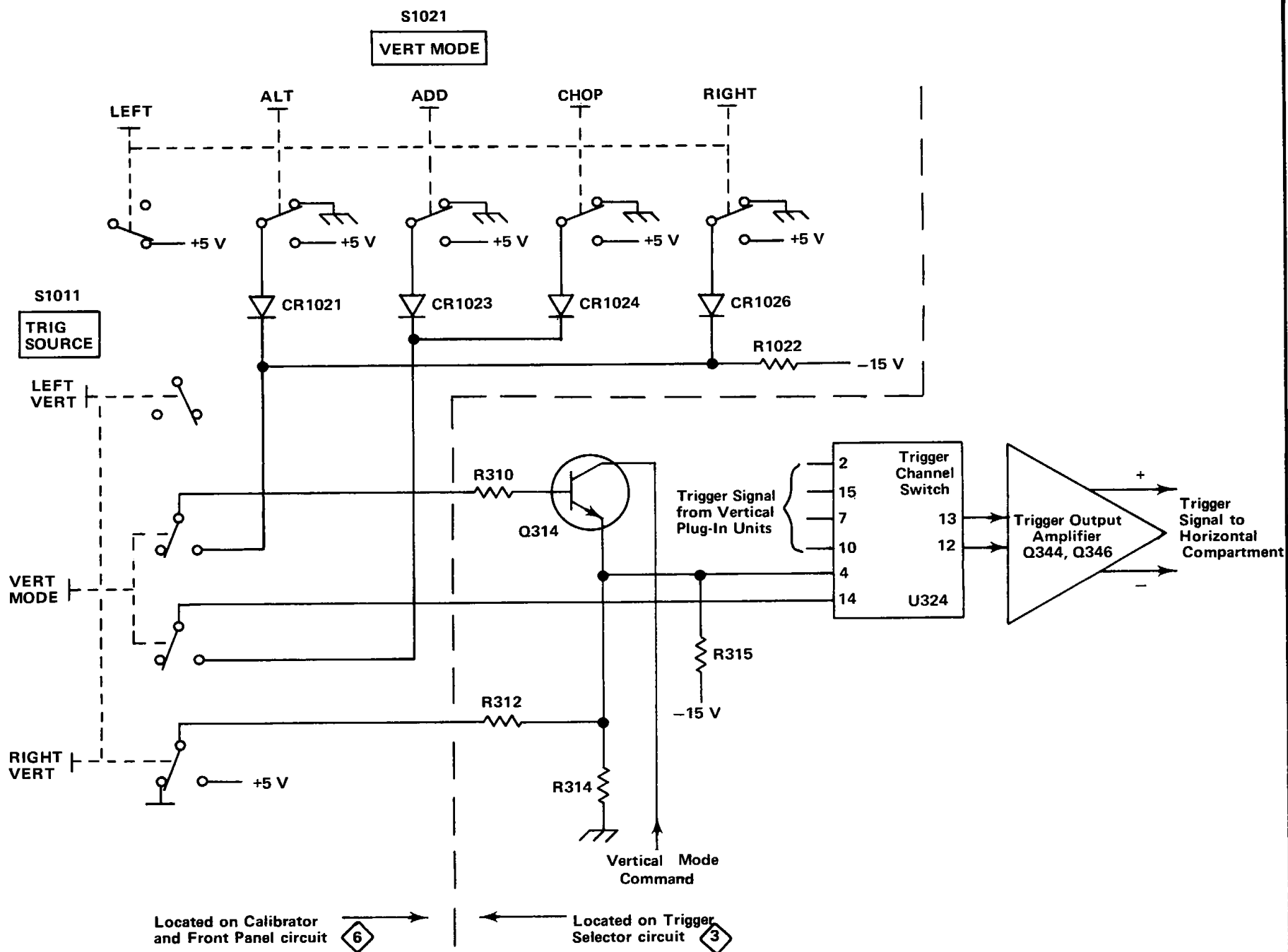


Fig. 3-15. Detailed block diagram of Trigger Selector circuit along with simplified diagram of trigger source selection circuitry.

of the trigger source. A schematic of the Trigger Selector circuit is shown on diagram 3 at the rear of this manual. Also, see diagram 6 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. 3-15 determines the operation of the Trigger Channel Switch stage. TRIG SOURCE switch S1011 controls Trigger Channel Switch U324 through Q314. When the TRIG SOURCE switch is set to the VERT MODE position, the setting of the VERT 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 TRIG SOURCE switch.

VERT MODE. In the VERT MODE position of the TRIG SOURCE switch, the setting of the VERT MODE switch determines the operation of the Trigger Channel Switch stage. In the LEFT position of the VERT 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. 3-16).

When the VERT 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 its 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 section 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 VERT 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.

LEFT VERT. When the LEFT VERT trigger source is selected, the VERT 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 TRIG 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 horizontal compartment as controlled by the Trigger Mode and ADD signals from the trigger selection circuitry. Refer to diagram 3 during the following discussion.

Resistors R317-R319 establish the input resistance and provide a load for the trigger signal from the right vertical plug-in unit. Resistors R20-R24, located on the Main Interface circuit, provide the input resistance and load for the left vertical plug-in unit. R321-R323-R324 and R326-R327-R328 establish the operating level of the Trigger

VERT MODE switch positions		TRIG SOURCE switch positions	
		VERT MODE	RIGHT VERT
↓	LEFT	LO (Left Vertical)	↑
	ALT	Switches from LO to HI, and vice versa, at end of each sweep (both; follows display)	↑
	ADD	LO at pin 4 of U324. HI at pin 14 ¹ (both; added algebraically)	LO (Left Vertical)
	CHOP		HI (Right Vertical)
	RIGHT	HI (Right Vertical)	↓

¹ Pin 14 LO for all other conditions.

Fig. 3-16. Input levels at pin 4 of U324 (source of triggering signal is shown in parenthesis).

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. 3-17. U324 provides a high impedance differential input for the trigger signal from the left vertical unit at pins 2 and 15, and 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 TRIG SOURCE or the VERT MODE switches are changed.

When the level at pin 4 is LO (see Trigger Mode and ADD Signals discussion and Fig. 3-17), 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 VERT 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 it 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 TRIG SOURCE switch is set to VERT MODE and the VERT MODE switch is set to either ADD or CHOP.

Input		Output
Trigger Mode Signal	Trigger ADD	Trigger Output Signal
4	14	12, 13
LO	LO	Left trigger signal
HI	LO	Right trigger signal
LO	HI	Both (added algebraically)

Fig. 3-17. Input/output table for Trigger Channel Switch stage.

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 horizontal unit (via the Main Interface circuit). The horizontal 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 at their collectors increases. This stage prevents this change from affecting the Trigger Channel Switch 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 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. Fig. 3-18 shows a detailed block diagram of the Vertical Interface circuit. A schematic of this circuit is shown on diagram 3 at the rear of this manual.

Vertical Channel Switch

The Vertical Channel Switch stage 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.

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. 3-19. 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 R223-R238. The sum of the DC output currents at pins 12 and 13 is always equal to the sum of the DC input currents at pins 1, 8, 9, and 16 in all modes. This provides a constant DC bias to the following stage as the VERT MODE switch is changed.

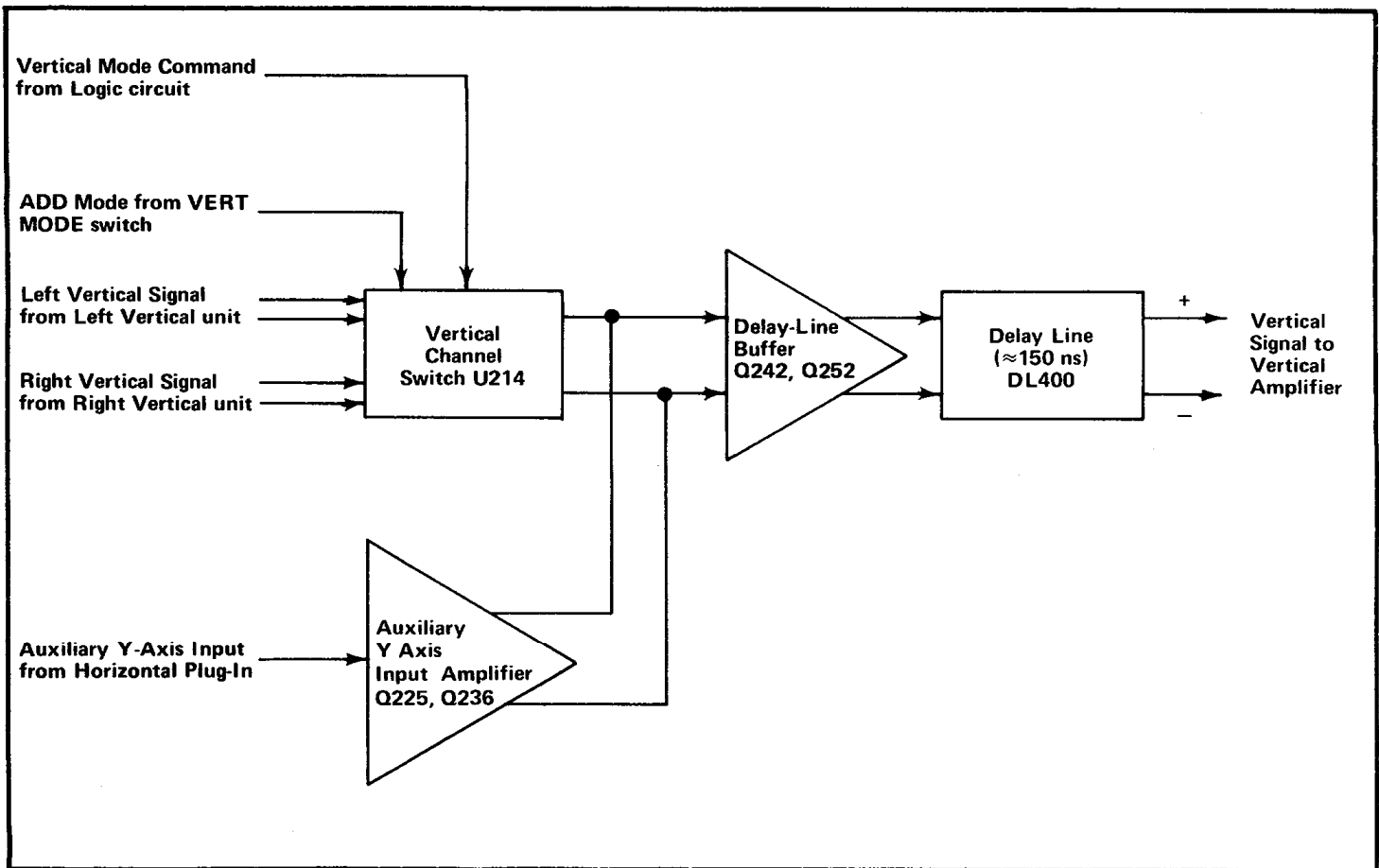


Fig. 3-18. Vertical Interface detailed block diagram.

When the VERT 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 VERT 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.

When the VERT 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.

Auxiliary Y-Axis Input Amplifier

The Auxiliary Y-Axis Input Amplifier accepts an input from horizontal plug-in units having compatible features. Normally, this input is a positioning voltage to offset the display. The single-ended signal connected to the input of this stage is converted to a push-pull signal at the collectors of Q225 and Q236. This signal is connected to the Delay-Line Buffer stage along with the output from the Vertical Channel Switch.

Input		Output
Vertical Mode Command	ADD Mode (Vert)	Output signal
4	14	12, 13
LO	LO	Left vertical signal
HI	LO	Right vertical signal
LO	HI	Both (added algebraically)

Fig. 3-19. Input/output table for Vertical Channel Switch.

Delay-Line Buffer

The output of the Vertical Channel Switch stage, along with any signal from the Auxiliary Y-Axis Input Amplifier, is connected to the emitters of Q242-Q252. These transistors are connected as common-base amplifiers to provide a low-impedance current-summing point. The signal at the collectors of Q242-Q252 is connected to Delay Line DL400. Resistors R260-R262 provide reverse termination for the Delay Line.

Delay Line

Delay Line DL400 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 final amplification for the vertical signal before it is applied to the vertical

deflection plates of the CRT. This circuit includes an input from the BEAM FINDER switch to compress an over-scanned display within the viewing area of the CRT. Fig. 3-20 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.

Input Amplifier

The Input Amplifier stage Q420-Q424, Q435-Q440, and R452-R462 provides a low input impedance for the Vertical Amplifier circuit to permit accurate delay-line termination. C401-R401, C403-R403, 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. Vertical Centering adjustment R427 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. The RC network between the emitters of Q420 and Q424 provides frequency compensation for this stage. C405-R405 in this network are adjustable to provide optimum response. The signal at the collectors of Q420-Q424 is connected to the bases of Q435-Q440. These transistors are connected as common-emitter amplifiers to provide amplification for the vertical deflection signal. Feedback is provided from the collectors of Q435-Q440 to the bases of Q420-Q424 through C430-R430, C415-R415, C433-R433, and C417-R417 to provide gain stabilization for this stage. Emitter followers

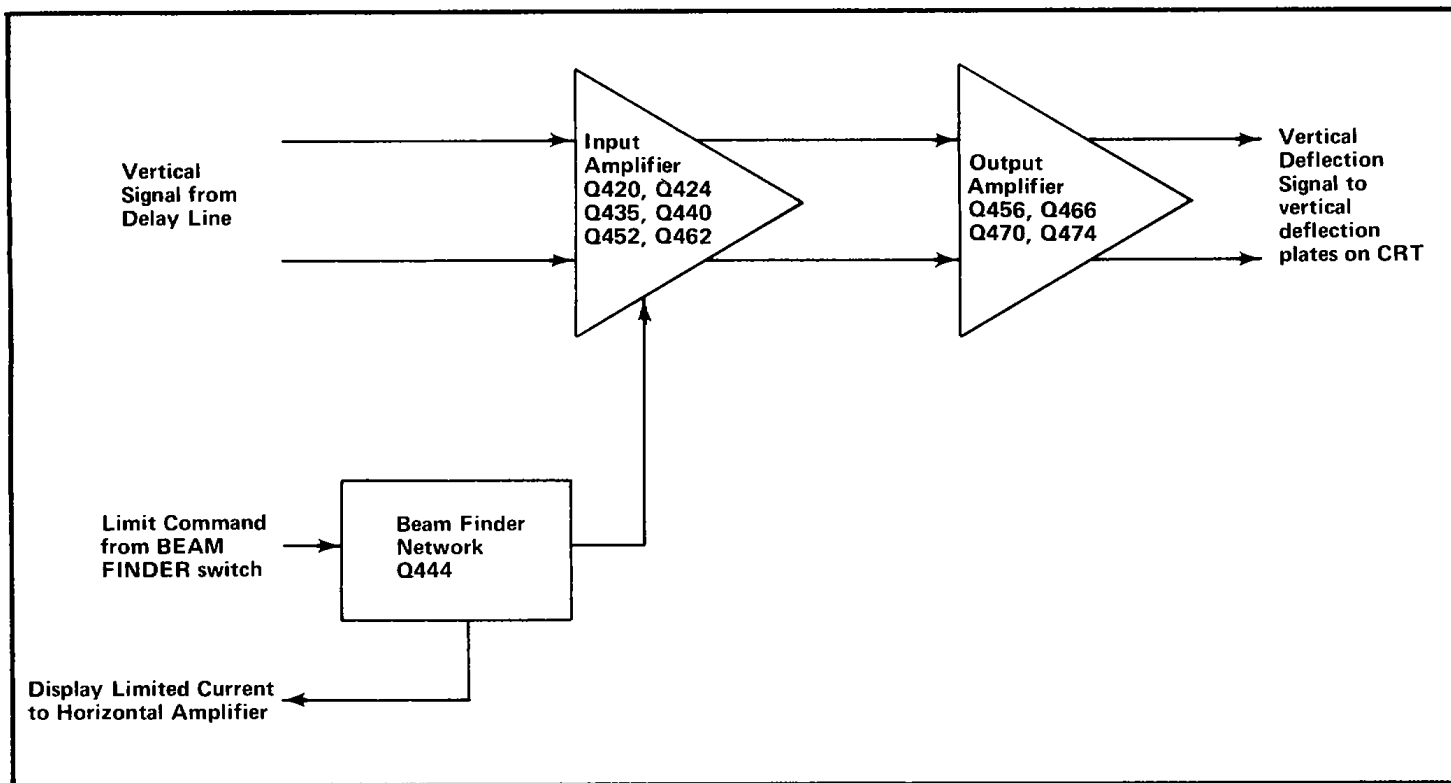


Fig. 3-20. Vertical Amplifier detailed block diagram.

Q452-Q462 provide isolation between the Input Amplifier and Output Amplifier stages.

Beam Finder Network

The Beam Finder Network consisting of transistor Q444 and associated components provides a means of locating a display which overscans the graticule area. Under normal operation, -15 volts is connected to the emitters of Q435-Q440 from the BEAM FINDER switch (see diagram 7) through CR442 and also through R438. When the BEAM FINDER switch is pressed, the -15 volts through CR442 is interrupted, so the emitter current for Q435-Q440 must be supplied through R438 and R437. R438 limits the amount of current available to Q435-Q440 to limit the dynamic range of these transistors and compress the display vertically within the graticule area. At the same time, base current is supplied to Q444 through CR442 and R443. This transistor is forward biased to supply DC current to the Output Amplifier through CR445-R447-R449 and emitter followers Q452-Q462. This keeps the Output Amplifier stage operating at about the same DC potentials regardless of the condition of the BEAM FINDER switch. The collector level of Q444 is also connected to the Horizontal Amplifier circuit to produce a similar effect in this circuit.

Output Amplifier

The signals from Q452-Q462 are connected to the bases of Q456-Q466 in the Output Amplifier through R451-R461. Q456-Q466 and Q470-Q474 provide the final amplification for the vertical signal before it is applied to the vertical deflection plates of the CRT. Vertical Gain adjustment R458 sets the resistance between the emitters of Q456-Q466 to set the overall gain of the vertical deflection system. Variable capacitor C459 provides further high-frequency compensation for this circuit. The output signal at the collectors of Q470-Q474 provides the vertical deflection signal for the CRT. LR networks LR475 and LR483 prevent oscillation of the output transistors.

HORIZONTAL AMPLIFIER

General

The Horizontal Amplifier circuit amplifies the push-pull horizontal deflection signals from the plug-in unit in the horizontal compartment and connects it to the horizontal deflection plates of the CRT. Fig. 3-21 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.

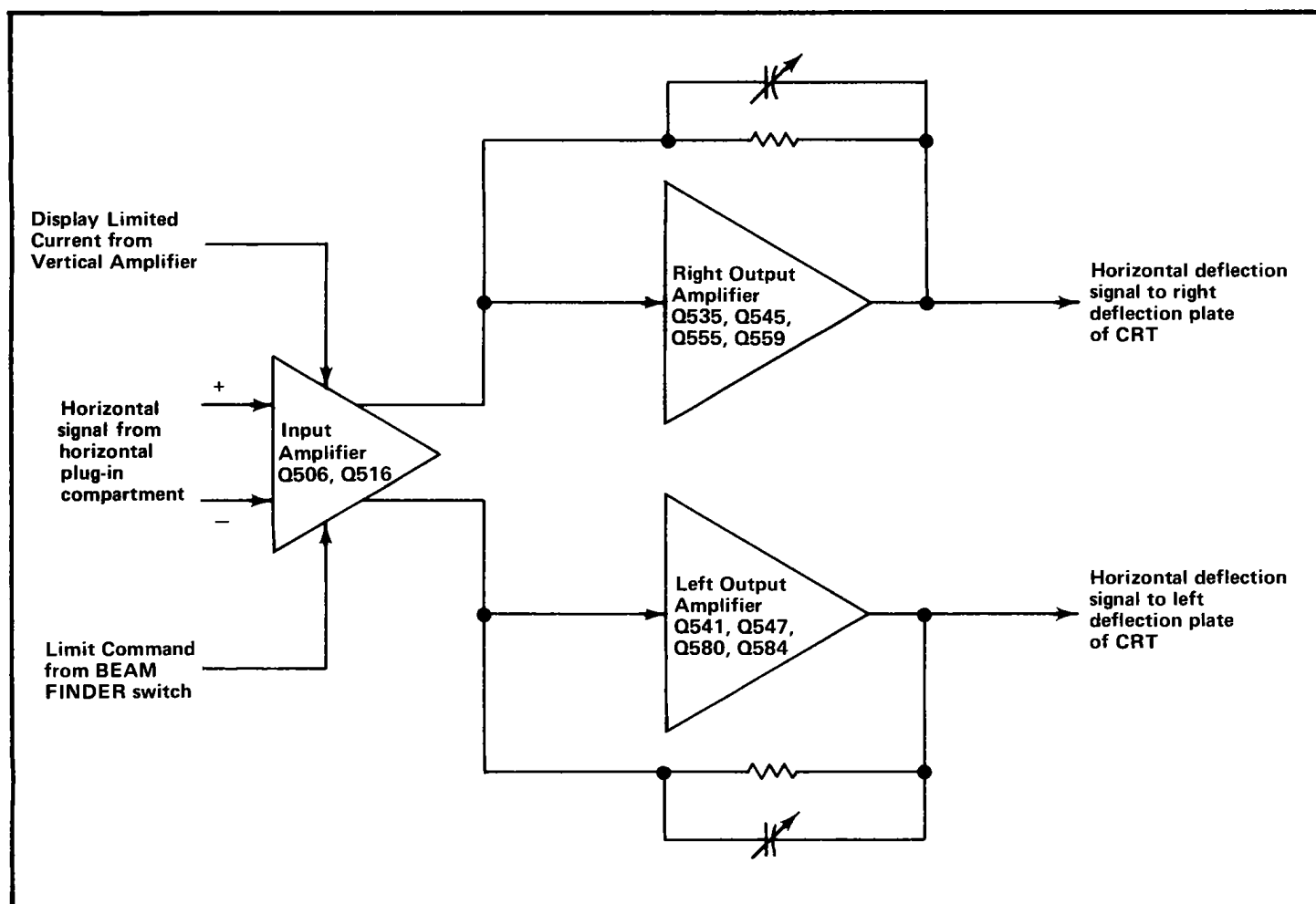


Fig. 3-21. Horizontal Amplifier detailed block diagram.

Input Amplifier

The horizontal signal from the plug-in unit in the horizontal compartment is connected to the bases of Q506 and Q516. Resistors R501 and R503 establish the input resistance of this stage and provide a load for the signal output of the plug-in unit. Resistors R508-R509-R510-R512-R513-R514 provide degeneration between the emitters of Q506 and Q516. Horizontal Gain adjustment R509 determines the amount of emitter degeneration to control the signal gain of this stage, thereby setting the overall gain of the Horizontal Amplifier circuit. Horizontal Centering adjustment R513 balances the quiescent current through Q506 and Q516 to produce a centered trace on the CRT with no horizontal deflection signal applied.

For normal operation, -15 volts is connected to the variable arm of the Horizontal Centering adjustment from the BEAM FINDER switch. When the BEAM FINDER switch is actuated, this voltage is interrupted to limit the emitter current of Q506-Q516. At the same time, DC current is added to the circuit through CR522-CR526 from the Vertical Amplifier. This added current maintains about the same DC currents through the output stages in both positions of the BEAM FINDER switch.

The signal at the collectors of Q506-Q516 is connected to the Left and Right Output Amplifiers through the limiting network CR519-CR520-CR528-CR533. These diodes limit the input to the Left and Right Output Amplifier stages so they always operate within their dynamic range and are not over-driven by excessive current from the Input Amplifier stage. Since the output signal from the Input Amplifier stage is a current signal, very little voltage change occurs across the limiting network. With horizontal deflection signals which produce an on-screen display, CR528 and CR533 remain forward biased and CR519-CR520 are reverse biased. Under this condition, CR519-R519 provide frequency compensation for the stage. However, if high-amplitude horizontal deflection signals are applied to this circuit as a result of sweep magnification or high-amplitude external horizontal signals, either CR528 or CR533 is reverse biased, depending on the polarity of the over-drive signal. This results in a sufficient voltage change at the anode of either CR519 or CR520 to forward bias it. The shunt diodes provide a current path for the signal current to limit the current change at the bases of Q535-Q541 during the over-drive condition.

Right Output Amplifier

Transistors Q535, Q545, Q555, and Q559 are connected as a current-driven feedback amplifier. The input current is converted to a voltage output signal to drive the right horizontal deflection plate of the CRT. The signal at the collector of Q535 is connected to the emitters of output transistors Q555-Q559 through emitter follower Q545 and parallel paths. High-frequency signals are connected to the

emitter of Q555 through RC network C550-R550. Low-frequency signals are connected to the emitter of Q559 through R553. The output transistors Q555 and Q559 are connected in the complementary configuration to provide less resistive loading at the output. The output signal at the collectors of Q555-Q559 is connected to the right deflection plate of the CRT through R567.

Negative feedback is provided from the collectors of Q555-Q559 to the base of Q535 through feedback network C561-C562-C564-R561-R562-R564-R565. Variable capacitor C562 adjusts the transient response of the feedback network to provide good linearity at fast sweep rates.

Left Output Amplifier

Basic operation of the Left Output Amplifier stage is the same as just described for the Right Output Amplifier. C587 provides linearity adjustment for the Left Output Amplifier at fast sweep rates. The output signal at the collectors of Q580-Q584 is connected to the left deflection plate of the CRT through R591.

CALIBRATOR AND FRONT PANEL

General

The Calibrator and Front Panel circuit provides output voltage to the front-panel Calibrator pin-jacks and includes the front-panel switches and controls. Fig. 3-22 shows a detailed block diagram of the Calibrator portion of this circuit. A schematic of this circuit is shown on diagram 6 at the rear of this manual.

Mode Switch Logic

The VERT MODE switch determines the operating mode of the Vertical Interface circuit. The levels established by this switch are also used in various other circuits throughout this instrument. This switch is designed so it is self-cancelling (i.e., only one button can be pressed at a time). Specific operation of this switch is described in connection with the circuits that it controls.

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

Calibrator

General. The Calibrator circuit provides accurate voltage output at the front-panel Calibrator pin-jacks. Repetition rate of the output signal is about one kilohertz.

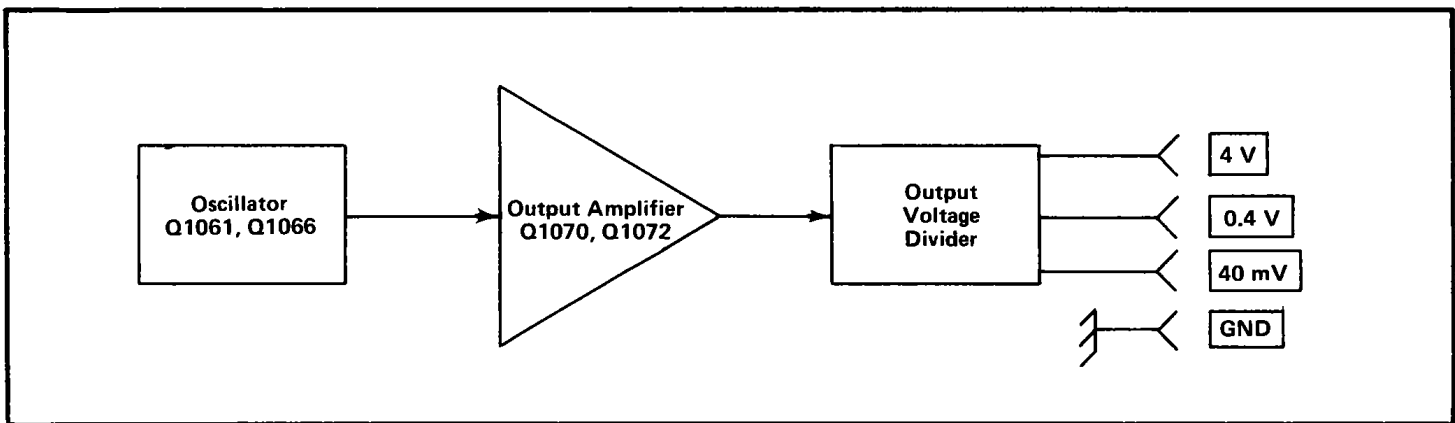


Fig. 3-22. Calibrator detailed block diagram.

Oscillator. Q1061 and Q1066 are connected as a square-wave oscillator to determine the repetition rate of the Calibrator circuit. Oscillation occurs as follows: Assume that Q1061 is conducting and Q1066 is off. The collector current of Q1061 through R1061 produces a voltage level which holds the base of Q1066 low. This keeps Q1066 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, C1064 begins to charge toward -15 volts through R1069. The emitter of Q1066 goes negative also as C1064 charges, until it reaches a level about 0.6 volt more negative than the level at its base. Then, Q1066 is forward biased and its emitter rapidly rises positive. Since C1064 cannot change its charge instantaneously, the sudden change in voltage at the emitter of Q1066 pulls the emitter of Q1061 positive also, to reverse bias it. The current through Q1066 produces a voltage drop at its collector to produce the negative portion of the square wave.

Now, conditions are reversed. Since Q1061 is reverse biased, there is no current through it. Therefore, C1064 can begin to discharge through R1063. The emitter level of Q1061 follows the discharge of C1064 until it reaches about -0.6 volt. Then, Q1061 is forward biased and its collector drops negative to reverse bias Q1066. This interrupts the current through Q1066, and its collector goes positive again to complete the square wave. Once again, C1064 begins to charge through R1069 to start the second cycle. The signal produced at the collector of Q1066 has a repetition rate of about one kilohertz.

The repetition rate of the Oscillator stage can be changed by BEAM FINDER switch S1030. When this switch is pressed and released, the Oscillator is disabled and the collector of Q1066 rises positive. This produces a positive DC voltage output to the front-panel Calibrator pin-jacks.

Output Amplifier. Transistors Q1070 and Q1072 are connected as a comparator with the reference level at the

base of Q1072 determined by the network R1073-R1074-R1076-R1077. The 4 Volts adjustment R1077 is set to provide accurate output voltage at the 4 V Calibrator pin-jack J1080.

The output of the Oscillator stage is connected to the base of Q1070. This signal controls the conduction of comparator Q1070-Q1072. When the base of Q1070 is high, it is off and Q1072 is conducting. This produces a positive output voltage at the Calibrator pin-jacks. When the level at the base of Q1070 is switched low, Q1070 conducts and Q1072 is reverse biased. Now, the voltage level at the Calibrator pin-jacks drops to zero.

Output Voltage Divider. The collector current of Q1072 in the Output Amplifier stage is applied across the voltage divider made up of resistors R1079 through R1085. This divider is designed to provide a low output resistance in the 40 mV and 0.4 V positions while providing accurate output voltages. The output resistance at the 4 V pin-jack is about 450 ohms and at the 0.4 V and 40 mV pin-jacks is about 50 ohms.

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. 3-23 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.

Z-Axis Amplifier

The Z-Axis signal from the Logic Circuit is applied to the bases of both Q607 and Q621 through C604-R604. These transistors are complementary to provide best response to both positive-going and negative-going Z-axis

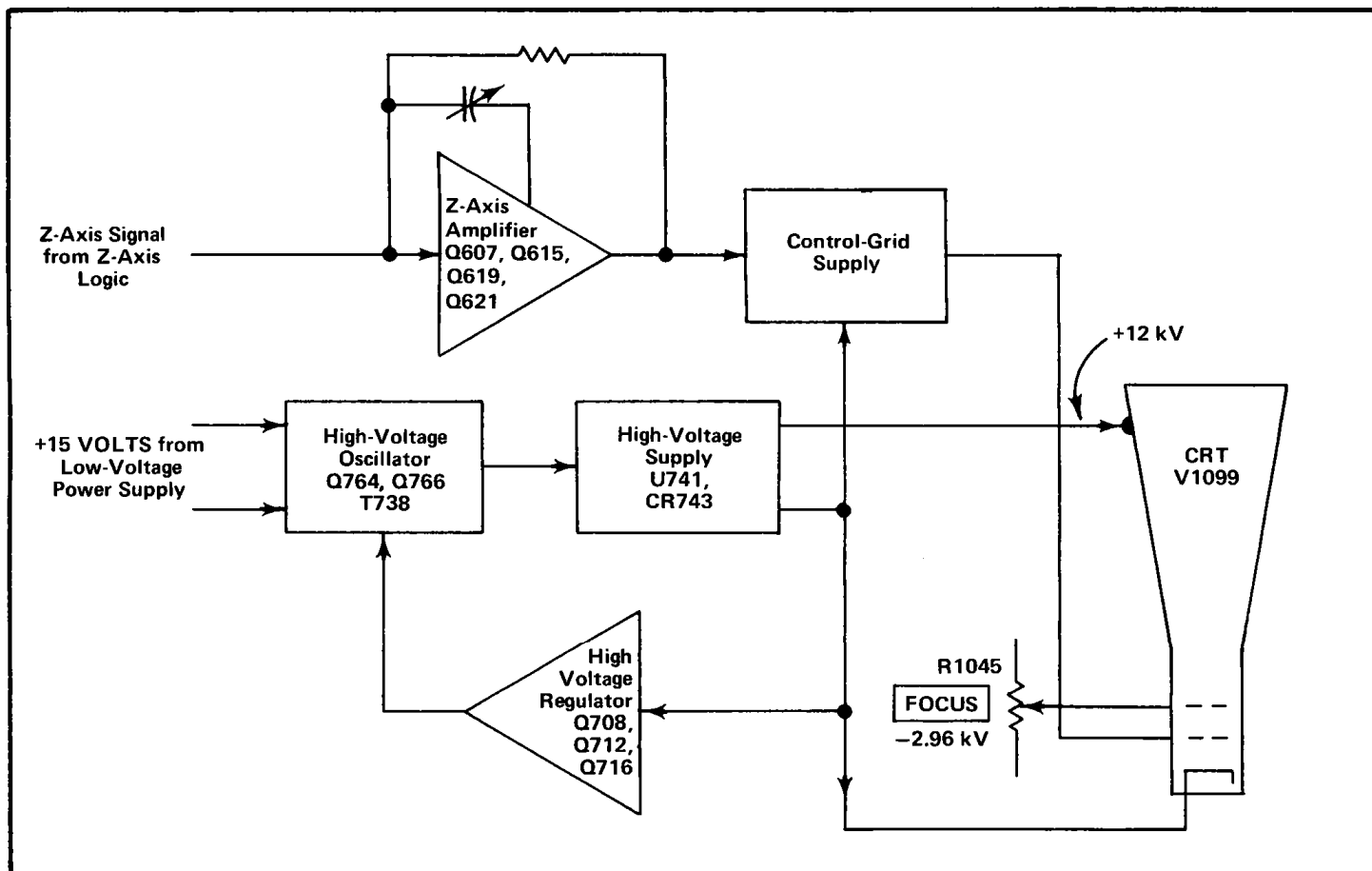


Fig. 3-23. CRT Circuit detailed block diagram.

signals. The output transistors Q615 and Q619 are also complementary transistors connected in the collector-coupled configuration. The amplified signal at the collector of Q621 is connected to the emitter of Q619. These transistors maintain the low-frequency response of the input signal and provide a fast falling edge on the output signal. Only the fast-changing portions of the amplified signal at the collector of Q607 are coupled to the emitter of Q615 through C613 and R613. Q607 and Q615 provide a fast rising edge on the output signal. The signal at the collectors of Q615-Q619 is connected to the Control-Grid Supply through R625. The Z-Axis Amplifier is frequency stabilized by feedback from the output to the input through C622-R622-R623. C622 is adjustable to provide 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.

High-Voltage Oscillator

Power for operation of the high-voltage supply is provided from the +15-Volt Supply. At the time of turn-on, CR716 disconnects the negative side of the supply voltage from the collector of Q716. This allows the starting base bias current for the High-Voltage Oscillator to be supplied from the +5-Volt Supply through R716, Q716, and the base feedback windings of T738 while the emitter potential

of Q764-Q766 is established by the negative side of the +15-Volt Supply. As the output of the high-voltage supply increases to its required output level, the collector of Q716 goes negative until CR716 is forward biased. Then, the collector level of Q716 is clamped about 0.6 volt more negative than the negative side of the +15-Volt Supply. 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 provide a regulated high-voltage output.

Q764-Q766 and the associated circuitry comprise an oscillator to drive high-voltage transformer T738. When the instrument is turned on, assume that Q764 comes into conduction first. The collector current of Q764 produces a corresponding current increase in the base-feedback winding of T738 to further increase the bias on Q764. At the same time, the voltage developed across the base-feedback winding connected to Q766 holds Q766 reverse biased.

As long as the collector current of Q764 continues to increase, voltage is induced into the base-feedback windings of T738 which holds Q764 forward biased and Q766

reverse biased. However, when the collector current of Q764 stabilizes, the magnetic field built up in T738 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 the High-Voltage Regulator, Q766 conducts and the amplified current at its collector adds to the current flowing through T738 to the collapsing field. Then, as the current through T738 stabilizes again, the magnetic field around it once more begins to collapse. This reverses the conditions to start another cycle.

The signal produced across the primary of T738 is a sine wave at a frequency of 35 to 45 kilohertz. The amplitude of the oscillations in the primary of T738 is controlled by the High-Voltage Regulator to set the total accelerating potential for the CRT. Filter network C722-L722 decouples high peak operating current from the +15-Volt Supply.

High-Voltage Regulator

A sample of the secondary voltage from T738 is connected to the High-Voltage Regulator stage through divider R700-R702A-R702B. Q708 and Q712 are connected as an error amplifier to sense any change in the voltage level at the base of Q708. The -15-Volt Supply, connected to the emitter of Q708 through R709, provides the reference level for this stage. The output voltage is set by the fixed values of the components in this circuit.

Regulation occurs as follows: If the output voltage at the -2960 V test point starts to go positive (less negative), a sample of this positive-going change is connected to the base of Q708 through R702B and R706. Both Q708 and Q712 are forward biased by this positive change, which in turn increases the conduction of Q716. This results in a greater bias current delivered to the bases of Q764-Q766 through Q716. Now, the bases of both Q764 and Q766 are biased closer to their conduction level so 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 T738 to produce a more negative level at the -2960 V 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 T738 also determines the output level of the positive High-Voltage Supply and the Control-Grid Supply, the total high-voltage output is regulated by sampling the output of the negative High-Voltage Supply.

High-Voltage Supplies

High-voltage transformer T738 has two output windings. One winding provides filament voltage for the cathode-ray tube. The other winding provides the negative and positive accelerating potential for the CRT and the bias voltage for

the control grid. All of these voltages 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 voltage quadrupler U741. The applied voltage to the input of U741 from the secondary of T738 is about three kilovolts. This results in an output voltage of about +12 kilovolts at the CRT anode. The negative accelerating potential for the CRT cathode is also obtained from this same secondary winding. Half-wave rectifier CR743 provides an output voltage of about -2.96 kilovolts which is connected to the CRT cathode through R745. The cathode and filament are connected together through R765 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 to maintain a regulated high-voltage output.

The network consisting of diodes CR750-CR752-CR756-CR757 provides the negative voltage for the control grid of the CRT. Output level of this supply is set by CRT Grid Bias adjustment R759. Approximately 300 volts peak-to-peak voltage from the secondary of T738 is connected to the Control-Grid Supply through C748 and R748. Diodes CR756 and CR757 clip this signal to determine the operating level at the control grid. CR756 limits the negative excursion of the signal; quiescently when the CRT is blanked, the anode of CR756 is set at about +15 volts by the Z-Axis Amplifier stage. The positive clipping level at the cathode of CR757 is set by CRT Grid Bias adjustment. R759 is adjusted to bias the control grid of the CRT just enough negative so the trace is blanked between sweeps. Under normal conditions, this biases the control grid about 80 volts more negative than the cathode.

The negative level at the CRT cathode is connected to the cathode of CR752. This level is held constant by the High-Voltage Regulator as described previously. The clipped voltage developed by diodes CR756 and CR757 is super-imposed on this negative voltage to result in a level at the anode of CR750 which is more negative than the CRT cathode level. C750 and R754 act as a filter to provide a constant voltage output level. The unblanking gate level developed by the Z-Axis Amplifier stage is applied to the anode of CR756 through R625. The fast rising and falling portions of this signal are coupled directly to the output through C750. The overall effect of the unblanking gate is to reduce the negative clipping level of CR756, thereby reducing the negative voltage added to the cathode potential to reduce the difference in voltage between the control grid and cathode of the CRT. This allows the cathode current of the CRT to pass to the anode so the display can be viewed.

CRT Control Circuits

Focus of the CRT display is determined by FOCUS control R1045. This control is part of divider

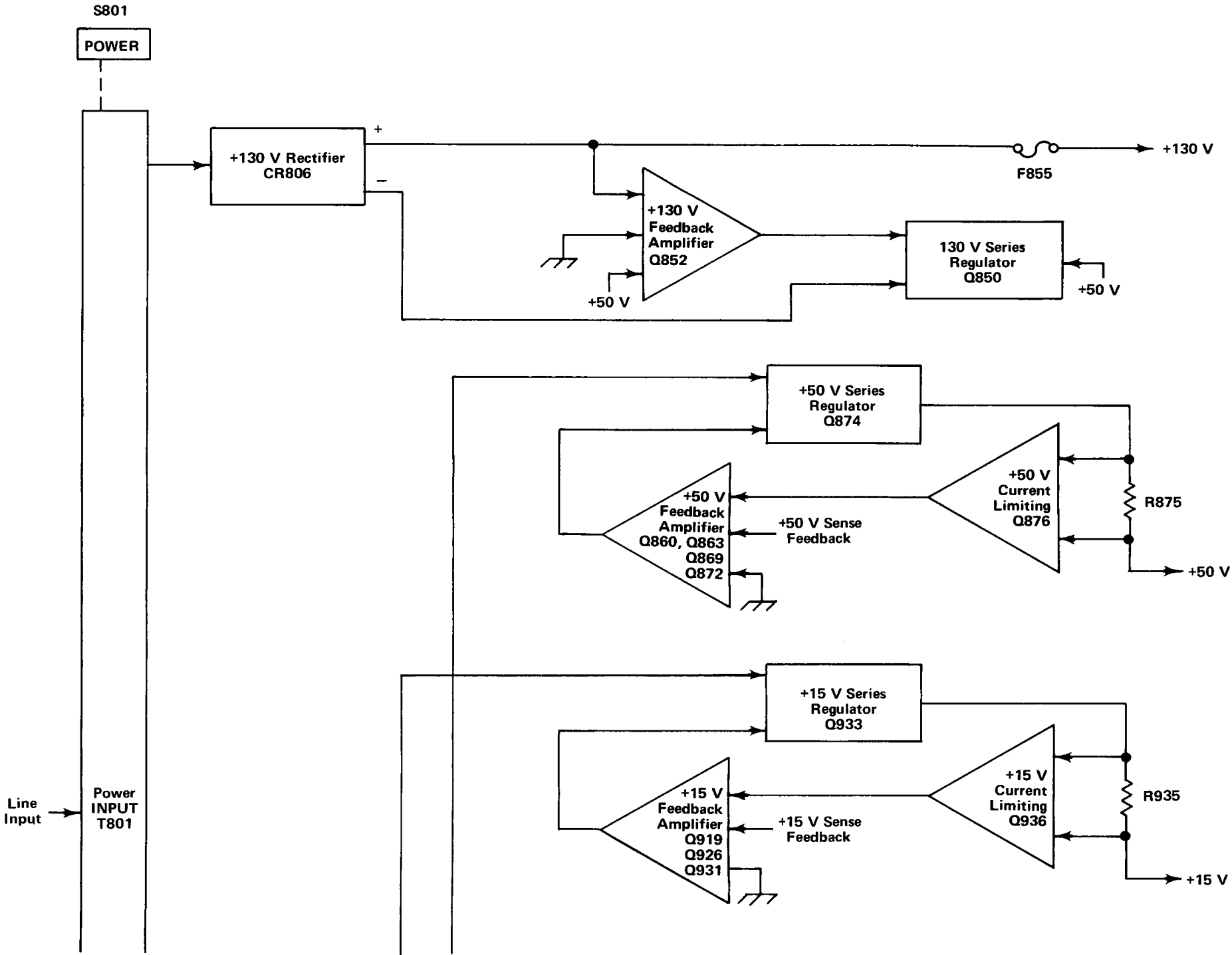


Fig. 3-24. Low-Voltage Power Supply detailed block diagram.

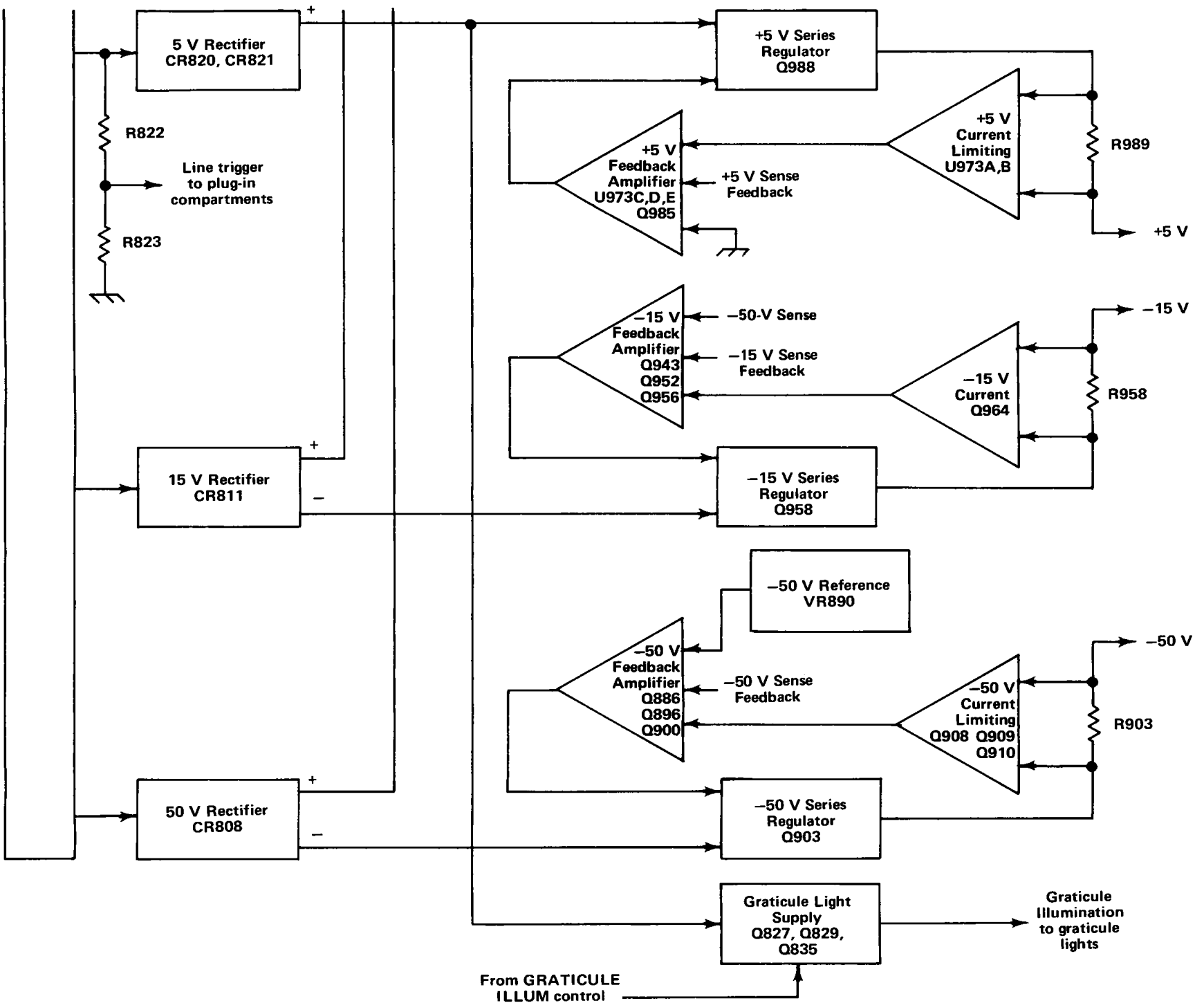


Fig. 3-24, (cont).

R702C-R1045-R761 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 Astigmatism adjustment R636, which is used in conjunction with the FOCUS control to obtain a well-defined display, varies the positive level on the astigmatism grid. Geometry adjustment R630 varies the positive level on the horizontal deflection-plate shield 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 R633 controls the current through L1098, which affects the CRT beam after vertical deflection, but before horizontal deflection. Therefore, it affects only the vertical (Y) components of the display. Beam Rotation adjustment R1040 (located on Calibrator and Front Panel diagram) controls the current through L1099 and affects both the vertical and horizontal rotation of the display.

LOW-VOLTAGE POWER SUPPLY

General

The Low-Voltage Power Supply circuit provides the operating power for this instrument from six regulated supplies. Electronic regulation is used to provide stable, low-ripple output voltages. Each supply contains a short-protection circuit to prevent instrument damage if a supply is inadvertently over-loaded or shorted to ground. Fig. 3-24 shows a detailed block diagram of the Low-Voltage Power Supply circuit. A schematic of this circuit is shown on diagram 8 at the rear of this manual.

Power Input

Power is applied to the primary of transformer T801 through line fuse F1000, thermal cutout S1000, and POWER switch S1001. The Voltage-Selector Jumper, P1001, connects the two halves of the primary of T801 in parallel for 110-volt (nominal) operation. Voltage-Selector Jumper P1002 connects the two halves of the primary in series for 220-volt (nominal) operation. The line fuse, F1000, must be changed to provide the correct protection for 220-volt nominal operation.

Each half of the primary of T801 has taps above and below the 110-volt (220-volt) nominal point. When the Voltage-Selector Jumper is moved from LOW to MED to HI, more turns are effectively added to the primary winding and the turns ratio is decreased to compensate for the increased primary voltage. This configuration extends the regulating range of the 7403N.

Thermal cutout S1000 provides thermal protection for this instrument. If the internal temperature of the instru-

ment exceeds a safe operating level, S1000 opens to interrupt the applied power. When the temperature returns to a safe level, S1000 automatically closes to re-apply the power.

—50-Volt Supply

The following discussion includes the description of the 50 V 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, their operation is most easily understood when discussed as a unit.

The 50 V Rectifier assembly CR808 rectifies the output at the secondary of T801 to provide the unregulated voltage source for both the —50- and +50-volt supplies. CR808 is connected as a bridge rectifier and its output is filtered by C808-C809. Transistors Q886, Q896, Q900 operate as a feedback-stabilized regulator circuit to maintain a constant —50-volt output level. Q886 is connected as a differential amplifier to compare the feedback voltage at the base of Q886B against the reference voltage at the base of Q886A. The error output at the collector of Q886B reflects the difference, if any, between these two inputs. The change in error-output level at the collector of Q886B is always opposite in direction to the change in the feedback input at the base of Q886B (out of phase).

Zener diode VR890 sets a reference level of about —9 volts at the base of Q886A. A feedback sample of the output voltage from this supply is connected to the base of Q886B through divider R880-R881-R882. R881 in this divider is adjustable to set the output level of this supply. Notice that the feed-back voltage to this divider is obtained from a line labeled —50 V Sense. Fig. 3-25 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 Sense feedback 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 V Sense line is small and constant, 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 an increase in load, or a decrease in input voltage (as a result of line voltage changes or ripple), the voltage across divider R880-R881-R882 decreases also. This results in a more

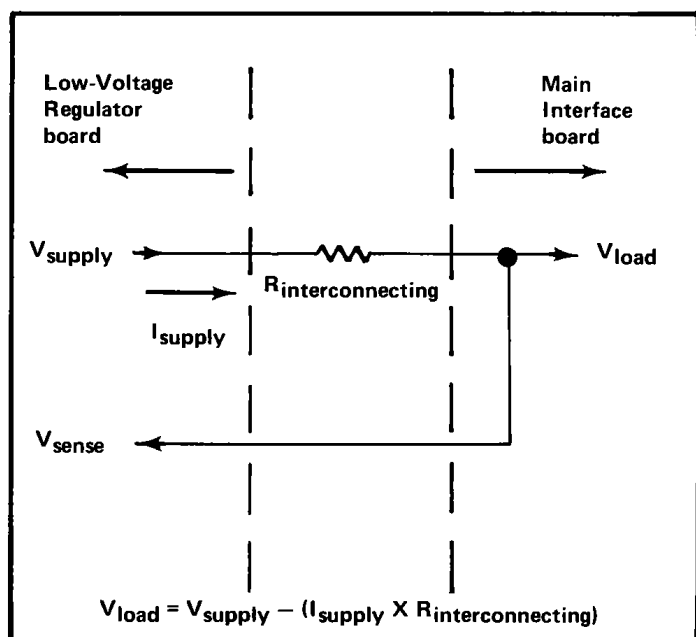


Fig. 3-25. Schematic illustrating voltage drop between power supply output and load due to resistance of interconnecting wire.

positive feedback level at the base of Q886B than that established by the -50 V Reference stage at the base of Q886A. Since the transistor with the more positive base controls the conduction of the differential amplifier, the output current at the collector of Q886B increases. This increase in output from Q886B allows more current to flow through Q896 and Q900 to result in increased conduction of -50 V Series Regulator Q903. The load current increases and the output voltage of this supply also increases (more negative). As a result, the feedback voltage from the -50 V Sense line increases and the base of Q886B returns to the same level as the base of Q886A. Similarly, if the output level of this supply increases (more negative), the output current of Q886B decreases. The feedback through Q896 and Q900 reduces the conduction of the -50 V Series Regulator to decrease the output voltage of this supply.

-50 Volts adjustment R881 determines the divider ratio to the base of Q886B and thereby determines the feedback voltage. This adjustment sets the output level of the supply in the following manner: If R881 is adjusted so the voltage at its variable arm goes less negative (closer to ground), this appears as an error signal at the base of Q886B. In the same manner as described previously, this positive-going change at the feedback input of the differential amplifier increases the conduction of the -50 V Series Regulator to produce more current to the load, and thereby increases the output voltage of this supply. This places more voltage across divider R880-R881-R882 and the divider action returns the base of Q886B to about -9 volts. Notice that the feedback action of this supply forces a change in the output level which always returns the base of Q886B to the same level as the base of Q886A. In this manner, the output level of the -50 -Volt Supply can be set to exactly -50 volts by correct adjustment of R881.

The -50 V Current Limiting stage Q908-Q909-Q910 protects the -50 -Volt Supply if excess current is demanded from this supply. All of the output current from the -50 -Volt Supply flows through R903. Transistor Q908 senses the voltage at the collector of the -50 -V Series Regulator Q903 and compares it against the -50 V output level at the base of Q909 which is obtained from the other side of R903. Under normal operation, Q908 is held in conduction and Q909 is off. However, 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 R903 increases until the base of Q908 goes more negative than the level at the base of Q909. Then Q909 takes over conduction of the comparator. The collector current of Q909 increases the voltage drop across R896 to reduce the conduction of Q896 in the -50 V Feedback Amplifier and limit the conduction of Q903. Q910 is connected as a constant-current source for Q908-Q909.

-15 -Volt 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 R945-R946 between ground and the -50 V Sense voltage. The divider ratio of R945-R946 sets a level of -15 volts at the base of Q943A. The level on the -50 V Sense line is held stable by the -50 -Volt Supply as described previously. The -15 V Sense voltage is connected to the base of Q943B through R940. Any change at the output of the -15 -Volt Supply appears at the base of Q943B as an error signal. The output voltage is regulated in the same manner as described for the -50 -Volt Supply.

$+5$ -Volt Supply

Basic operation of the $+5$ -Volt Supply is the same as described for the previous supplies. The $+5$ V Current Limiting and $+5$ V Feedback Amplifier (except for Q985) is made up of five-transistor array U973. Notice that both U973C and Q985 in the $+5$ V Feedback Amplifier are connected as emitter followers, since inversion is not necessary in the feedback path for positive output voltages. Reference voltage for the $+5$ V Feedback Amplifier stage is established by divider R970-R971 between the $+5$ V Sense and -50 V Sense feedback voltages. This divider establishes a quiescent level of about 0 volts at the base of U973E.

$+15$ -Volt Supply

The $+15$ -Volt Supply operates in the same manner as described for the previous supplies. The unregulated $+15$ -Volt Supply provides the source voltage for the High-Voltage Oscillator stage in the CRT Circuit through fuse F814 and P870.

+50-Volt Supply

Operation of the +50-Volt Supply is the same as described for the previous supplies. The unregulated +50 volts from 50 V Rectifier CR808 is used to provide a positive starting voltage for the –50-Volt Supply.

+130-Volt Supply

The +130 V Rectifier CR806 provides the rectified voltage for the +130-Volt Supply. However, this secondary winding of T801 does not supply the full potential necessary to obtain the +130-volt output level. To provide the required output level, the +50-Volt Supply is connected in series with this supply through Q850. Basic regulation of the output voltage is provided by +130 V Feedback Amplifier Q852, and +130 V Series Regulator Q850.

The output voltage of this supply is connected across divider R855-R856. This divider provides a quiescent level of about +50 volts at the base of Q852. The reference level for this supply is provided by the +50-Volt Supply connected to the emitter of Q852. If the output of this supply changes, this change is sensed by Q852 and an amplified error signal is connected to the base of Q850. This error signal changes the conduction of the +130 V Series Regulator Q850 to correct the output error. Fuse F855 protects this supply if the output is shorted. How-

ever, since the response time of F855 is slow to a shorted condition, VR851 provides additional current to the base of Q850 to protect Q852 from damage. Diode CR852 limits the reverse bias on Q852 to about 0.6 volt when F855 is blown.

Graticule Light Supply

Power for the graticule lights is supplied by the Graticule Light Supply (see diagram 8). Rectified voltage for this supply is provided by 5 V Rectifier CR820-CR821. Q835 operates as a series regulator transistor. Emitter follower Q829 determines the conduction of this series regulator as controlled by front panel GRATICULE ILLUM Control R1095. Current-limiting to protect this supply is provided by Q827. Under normal operation, divider R830-R831-R833 sets the base of Q827 below its conduction level. However, if excess current is demanded from this supply, the voltage drop across R837-R838 increases until Q827 comes into conduction. The collector of Q827 then limits the conduction of this supply to limit its output current.

Divider R822-R823 provides a sample of the line voltage in the secondary of T801 to the plug-in unit. This provides a line-frequency reference to the plug-in units for internal triggering at line frequency or for other applications.

SECTION 4

MAINTENANCE

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

Introduction

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance, or troubleshooting of the 7403N.

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 7403N are held in place by spring-action of the panels themselves. To remove the panels, push the panels toward the top of the instrument until the bottom of the panel is clear of the slot along the bottom rail of the instrument. Then, pull the panel out at the bottom and lift away from the instrument. The bottom panel is held in place with eight screws. 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 this instrument or EMI interference to the display due to other equipment.

Power-Unit Removal

The power unit can be slid out of the back of the 7403N to gain access to the Logic and Rectifier circuit boards and for power-unit maintenance. To remove the power unit, use the following procedure:

1. Remove the side panels.
2. Remove the six screws which secure the power unit to the sides of the instrument.
3. Slide the power unit out of the rear of the instrument until it can be set down on the work surface (guide the 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.

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 7403N is subjected determines the frequency of maintenance. A convenient time to perform preventive maintenance is preceding recalibration of the instrument.

Cleaning

General. The 7403N should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides an electrical conduction path which 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 7403N can be removed with a soft cloth or small brush. The 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.

Maintenance—7403N

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 No. 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 this 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 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 lead, should receive special attention. Excessive dirt in these areas may cause high-voltage arcing and result in improper instrument operation.

Lubrication

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 Part No. 003-0342-01.

Visual Inspection

The 7403N should be inspected occasionally for such defects as broken connections, improperly seated semiconductors, damaged or improperly installed circuit boards, and heat-damaged parts. The corrective procedure for most

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

Semiconductor Checks

Periodic checks of the semiconductors in the 7403N 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.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting of the 7403N. 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 foldout pages in the Diagrams section. The component number and electrical value of each component in this instrument are shown on these diagrams. Each main circuit is assigned a series of component numbers. Table 4-1 lists the main circuits in the 7403N 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.

Circuit Boards. Fig. 4-1 shows the location of the circuit boards within this instrument along with the assembly numbers. The assembly numbers are also used on the diagrams and in the parts list to aid in locating the circuit boards. Pictures of these circuit boards are shown in Figs. 7-1 through 7-13. These pictures are located in the

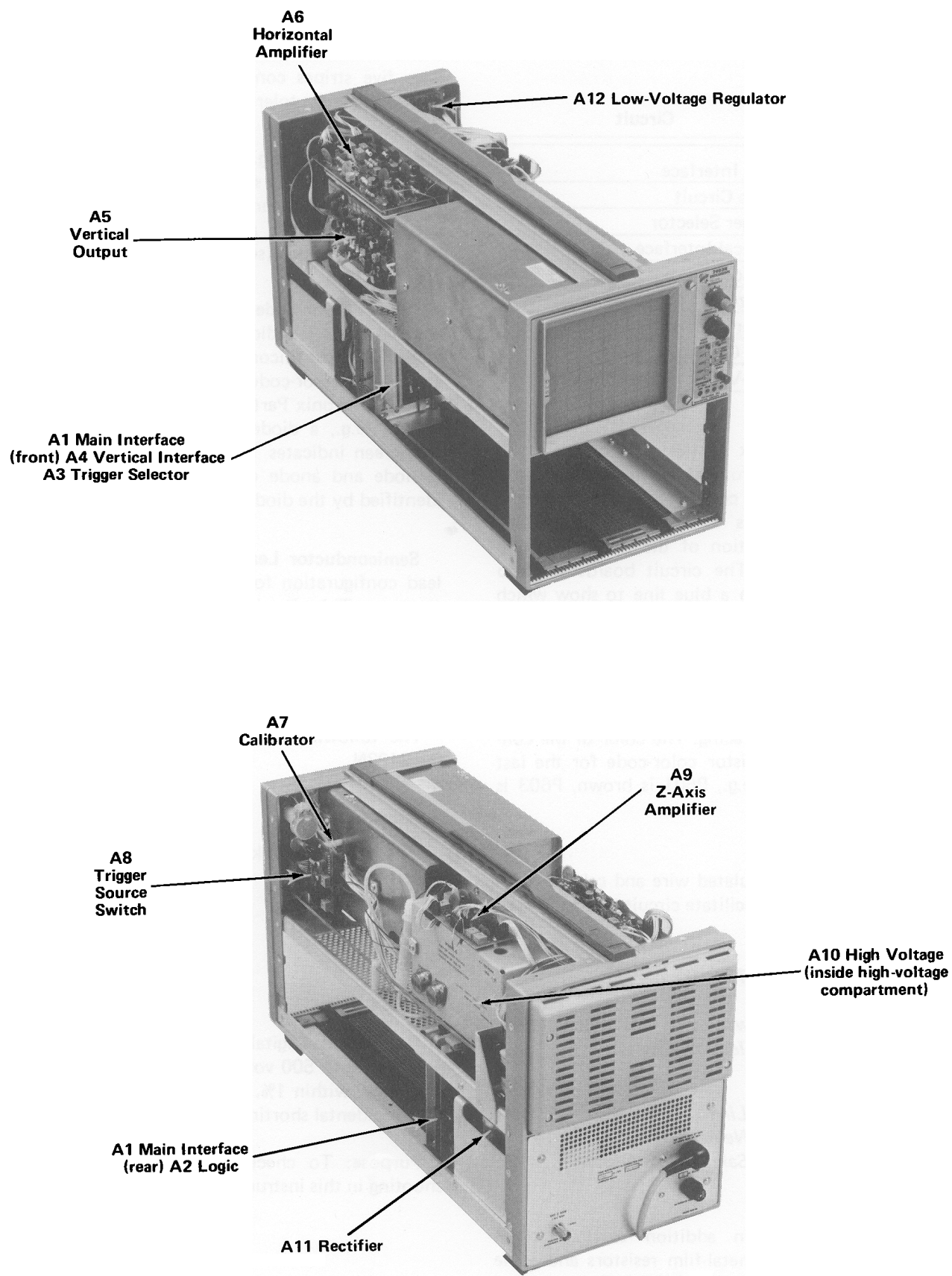


Fig. 4-1. Location of circuit boards in the 7403N.

TABLE 4-1

Component Numbers

Component numbers on diagrams	Diagram numbers	Circuit
1-49	1	Main Interface
50-199	2	Logic Circuit
300-399	3	Trigger Selector
200-299	3	Vertical Interface
400-499	4	Vertical Amplifier
500-599	5	Horizontal Amplifier
1000-1099	6	Calibrator and Front Panel
600-799	7	CRT Circuit
800-999	8	Low-Voltage Power Supply

Diagrams section on the back of the page opposite the circuit diagram, to aid the cross-referencing between the diagrams and the circuit-board components. Each electrical component on the boards is identified by its circuit number. The color and location of the interconnecting connectors are also shown. The circuit boards are also outlined on the diagrams with a blue line to show which portions of the circuit are located on a circuit board.

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 7403N is color-coded to facilitate circuit tracing.

NOTE

Color code of the AC power cord is as follows (in accordance with National Electrical Code):

<i>Black</i>	<i>Line</i>
<i>White</i>	<i>Neutral</i>
<i>Green</i>	<i>Safety earth (ground)</i>

Resistor Color-Code. In addition to the brown composition resistors, some metal-film resistors and some wire-wound resistors are used in the 7403N. The resistance values of wire-wound resistors are usually printed on the body of the component. The resistance values of composition resistors and metal-film resistors are color-coded on the components with EIA color-code (some metal-film resistors may have the value printed on the

body). The color-code is read starting with the stripe nearest the end of the resistor. Composition resistors have four stripes which consist of two significant figures, a multiplier, and a tolerance value (see Fig. 4-2). 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 on the side of the component body. The white ceramic capacitors used in the 7403N are color-coded in picofarads using a modified EIA code (see Fig. 4-2).

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 No. 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. 4-3 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 7403N.

1. Transistor Tester

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

Purpose: To test the semiconductors used in this instrument.

2. Multimeters

Description: Digital voltmeter, 10 megohm input impedance and 0 to 500 volts range; ohmmeter, 0 to 2 megohms. Accuracy, within 1%. 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/volts 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.

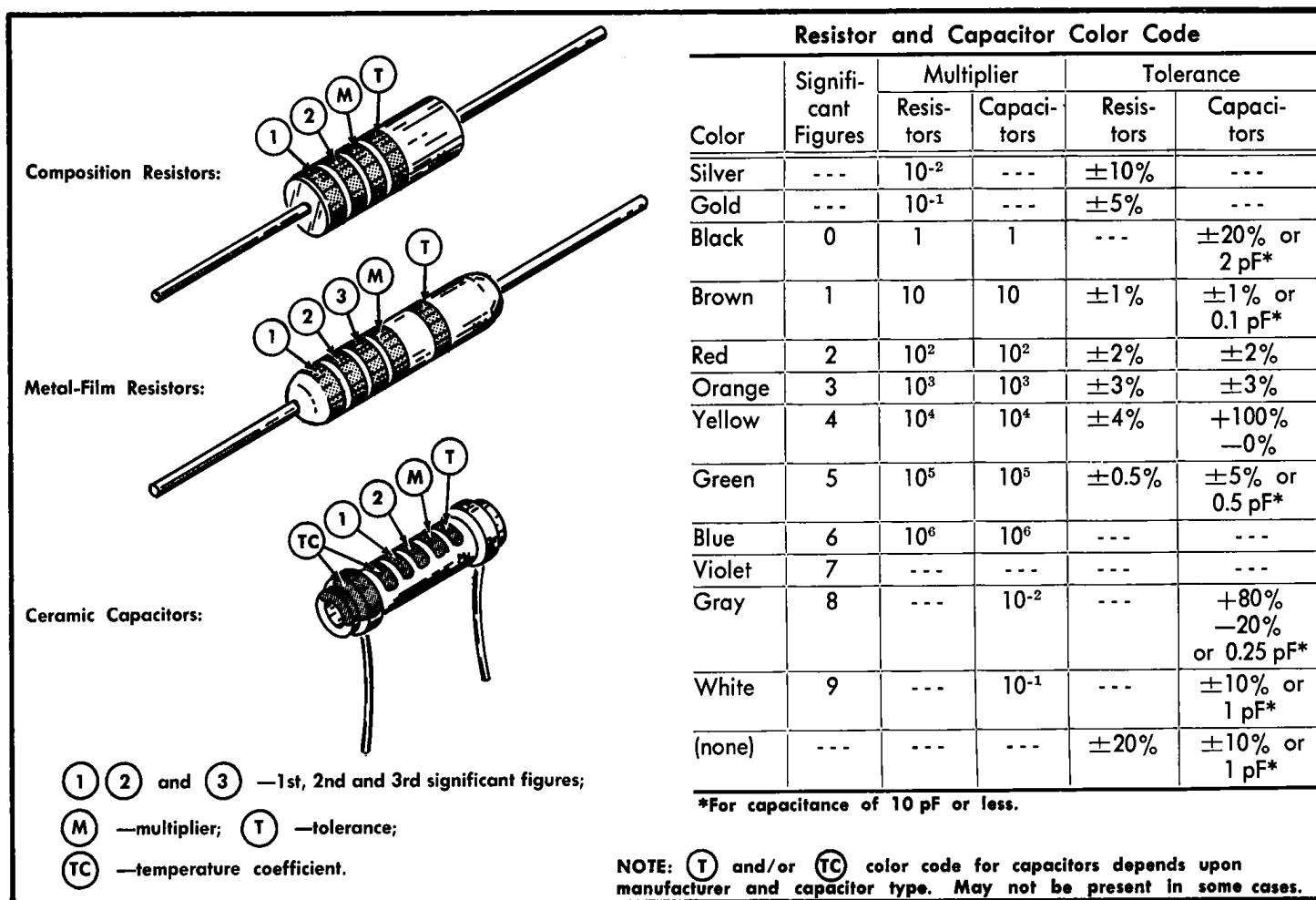


Fig. 4-2. Color code for resistors and ceramic capacitors.

3. Test Oscilloscope

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

Purpose: To check operating waveforms in this instrument.

Troubleshooting Techniques

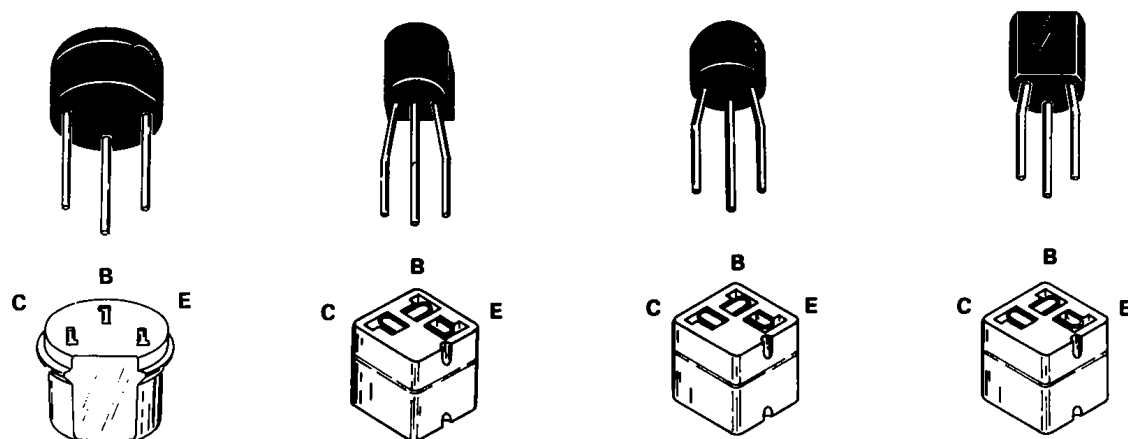
This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks assure proper connection, operation, and calibration. If the trouble is not located by these checks, the remaining steps aid in locating 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.

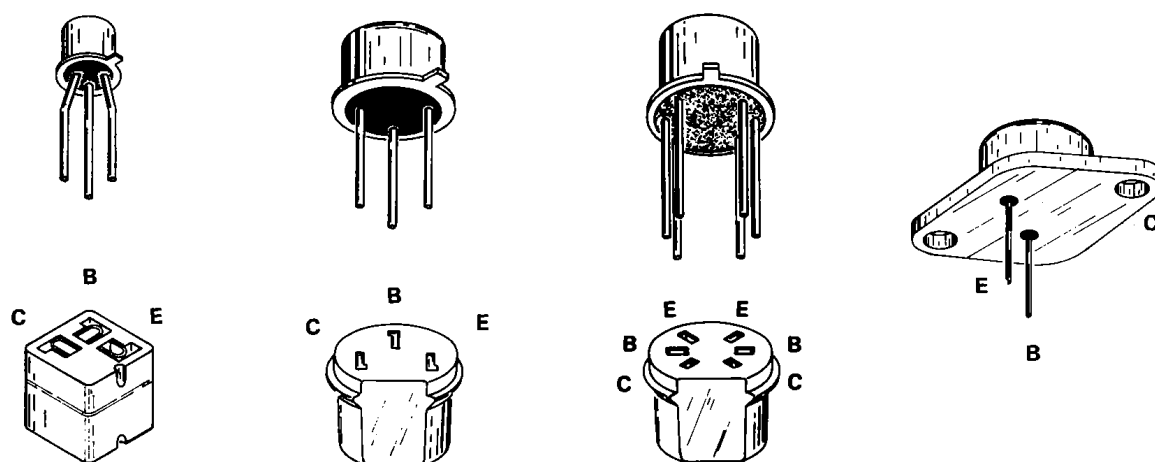
2. Check Associated Equipment. Before proceeding with troubleshooting of the 7403N, check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source. The associated 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 7403N 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.

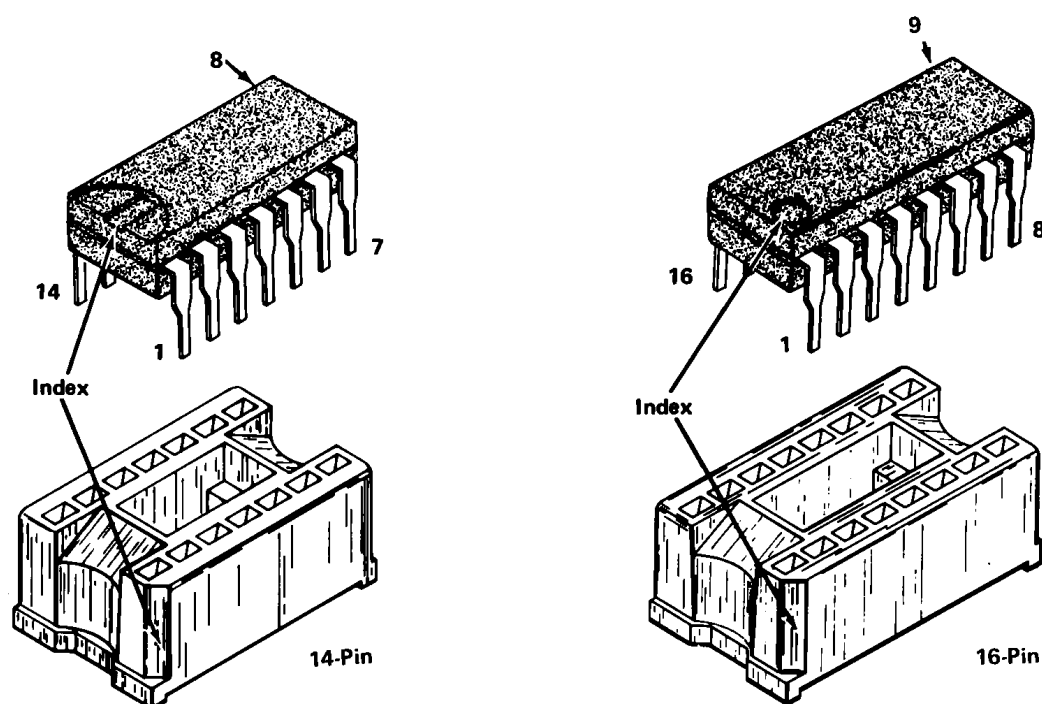
4. Check Instrument Calibration. Check the calibration of this instrument, or the affected circuit if the trouble appears in one circuit. The apparent trouble may only be a result of misadjustment, or may be corrected by calibration. Complete calibration instructions are given in the Calibration section.



Plastic-Cased Transistors



Metal-Cased Transistors



Integrated Circuits

Fig. 4-3. Electrode configuration for semiconductors used in this instrument.

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. Typical voltages and waveforms are given on the schematics in the Diagrams section.

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 4-2 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 4-2

Power Supply Tolerance and Ripple

Power Supply	Test Point	Output Voltage Tolerance	Maximum ripple (peak-to-peak)
–50 Volt	TP-50 (back of Main Interface board)	±0.1 volt	5 mV
–15 Volt	P750-Pin 7	±0.3 volt	2 mV
+5 Volt	P750-Pin 5	±0.15 volt	2 mV
+15 Volt	P750-Pin 4	±0.3 volt	2 mV
+50 Volt	P750-Pin 3	±0.6 volt	5 mV
+130 Volt	P750-Pin 2	±5.2 volts	300 mV

Fig. 4-4 provides a guide for locating a defective circuit. This chart does not include checks for all possible defects; use steps 6 and 7 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.

If incorrect operation of the power supplies is suspected, connect the 7403N to a variable autotransformer. Then, check for correct regulation with a DC voltmeter (0.1 % accuracy) and correct ripple with a test oscilloscope while varying the autotransformer throughout the regulating range of this instrument.

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 7403N. 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.

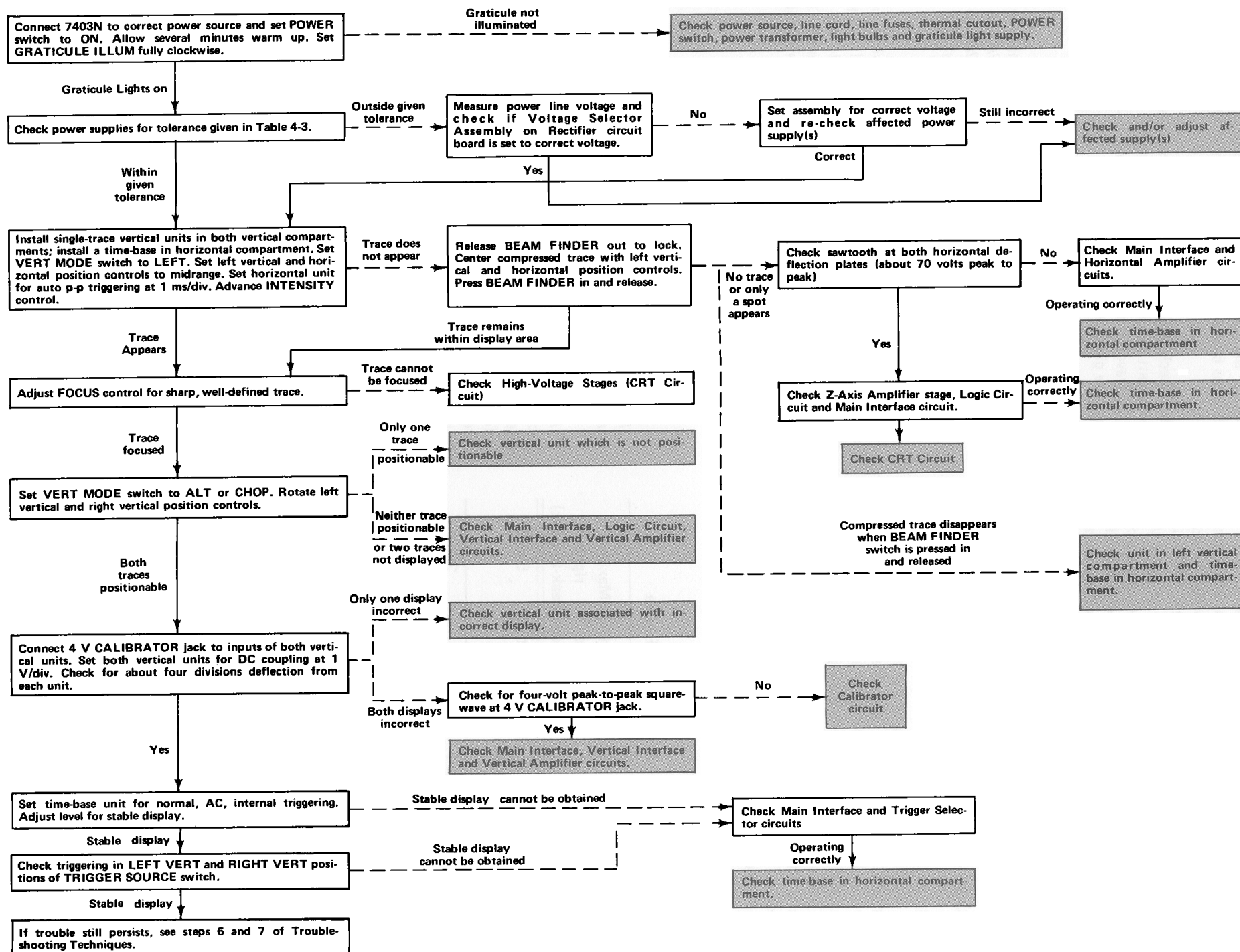
A good check of transistor operation is actual performance under operating conditions. A transistor can most effectively be checked by substituting a new component for it (or one which has been checked previously). However, be sure that circuit conditions are not such that a replacement transistor might 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 operation 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 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

CIRCUIT ISOLATION TROUBLESHOOTING CHART



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 diodes under test.

C. RESISTORS.

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

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 7403N can be obtained through your

local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance in the 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 7403N. 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. 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.

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. General soldering techniques which apply to maintenance of any precision electronic equipment should be used when working on this instrument. Use only 60/40 rosin-core electronic-grade solder. The choice of soldering iron is determined by the repair to be made. When soldering on circuit boards, use a 35- to 40-watt pencil-type soldering iron with a 1/8-inch wide,

wedge-shaped tip. Keep the tip properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the wiring from the base material. Avoid excessive heat; apply only enough heat to remove the component or to make a good solder joint. Also, apply only enough solder to make a firm solder joint; do not apply too much solder.

For metal terminals (e.g., switch terminals, potentiometers, etc.) a higher wattage-rating soldering iron may be required. Match the soldering iron to the work being done. For example, if the component is connected to the chassis or other large heat-radiating surface, it will require a 75-watt or larger soldering iron. The pencil-type soldering iron used on the circuit board can be used for soldering to switch terminals, potentiometers, or metal terminals mounted in plastic holders.

After soldering is completed, clean the area around the solder connection with a flux-remover solvent. Be careful not to remove any information printed in the area.

Component Replacement

WARNING

Disconnect the instrument from the power source before replacing components.

General. The exploded-view drawings associated with the Mechanical Parts List (located at rear of manual) 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, the entire assembly including all soldered-on components, can be replaced. Part numbers are given in the Mechanical Parts List for either the completely wired (670-_____-__) or the unwired board (388-_____-__).

NOTE

Even though unwired boards are available without components, use of the completely wired replacement board is recommended due to the large number of components mounted on most of the boards.

Most of the circuit boards in this instrument are mounted on the chassis; pin connectors are used for interconnection with other circuits. Use the following procedure to remove the chassis-mounted circuit boards (removal instructions for the exceptions will be given later).

A. CHASSIS-MOUNTED BOARDS.

1. Disconnect any pin connectors on the board or connected to other portions of the instrument. Note the order of these connectors so they can be correctly replaced.

2. Remove the securing screws.

3. Remove the board.

4. To replace the 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 the circuit board illustrations in the Diagrams section.

B. TRIGGER SELECTOR AND VERTICAL INTERFACE CIRCUIT BOARD REPLACEMENT.

The Trigger Selector and Vertical Interface circuit boards plug onto the front of the Main Interface circuit board. Use the following procedure to replace either board.

1. Remove the securing screws.

2. Pull out on the edges of the board until the board clears the interconnecting terminals. Hold the board parallel to the Main Interface board until the board is free, so as not to bend the interconnecting terminals.

3. To replace the circuit board, position it so the interconnecting pins and sockets mate properly.

4. Gently press the circuit board against the mounting surface. Be sure that all the interconnecting pins and sockets mate properly.

5. Replace the securing screws.

C. LOGIC CIRCUIT BOARD REPLACEMENT.

1. Slide out the power unit as described previously.

2. Disengage the plastic snaps which secure the sides of the board.

3. Pull out on the edges of the board until the board clears the interconnecting terminals. Hold the board parallel to the Main Interface board until the board is free, so as not to bend the interconnecting terminals.

4. To replace the Logic board, position it so the guide holes in the board mate with the guide posts. Check that all the interconnecting pins and sockets mate properly.

5. Gently press the board against the Main Interface board until the plastic snaps secure the board.

D. MAIN INTERFACE CIRCUIT BOARD REPLACEMENT.

1. Slide out the power unit as described previously.
2. Remove all of the plug-on circuit boards from the Main Interface 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 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 (total of nine screws). Also remove the hexagonal posts which secure the ground straps to the Main Interface board.
5. Remove the Main Interface board assembly from the rear of 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 the circuit board illustration in the Diagrams section.

E. LOW-VOLTAGE REGULATOR CIRCUIT BOARD REPLACEMENT.

1. Remove the four screws which secure the heat radiator to the rear frame of the instrument.
2. Slide the heat radiator out of the rear of the instrument and disconnect the pin connectors. Remove the heat radiator from the instrument.
3. Remove the four screws which secure the plastic protective cover to the heat radiator.
4. Remove the power transistors from the back of the heat radiator. Note the location of each power transistor.
5. To replace the Low-Voltage Regulator board, reverse the order of removal.

NOTE

After replacing the power transistors, check that the transistor cases are not shorted to the heat radiator before applying power.

F. RECTIFIER BOARD REPLACEMENT.

To replace the Rectifier board, proceed as follows:

1. Slide out the power unit as described previously.
2. Disconnect the pin connectors from the board.

3. Disconnect the wires soldered to the top of the board.

4. Unsolder all of the power transformer wires connected to the top of the board. Use a vacuum-type desoldering tool to remove the solder from the hole in the circuit board.

5. Remove the screws holding each corner of the board to the chassis.

6. To replace the Rectifier board, reverse the order of removal. Be sure that all of the transformer wires are properly placed before resoldering. Match the arrows on the multi-pin connectors to the arrows on the board. Correct location of the pin connectors and the wire color code is shown in the circuit board illustration in the Diagrams section.

G. CALIBRATOR BOARD REPLACEMENT.

To replace the Calibrator circuit board, proceed as follows:

1. Disconnect the cable connected to the TRIG SOURCE switch circuit board from the Calibrator board (note the wire color-code so they can be correctly replaced). Use a vacuum-type desoldering tool to remove the excess solder.

2. Remove the BEAM FINDER switch actuator from the rear of the BEAM FINDER pushbutton shaft assembly. Use a 0.050-inch hex-key wrench to loosen the set screw. Remove the knob and shaft through the front of the instrument.

3. Remove the knobs from the INTENSITY, FOCUS, and GRATICULE ILLUM controls with a 1/16-inch hex-key wrench.

4. Disengage the POWER switch actuating rod from the switch. Remove the rod through the front of the instrument.

5. Remove the securing nut which holds the GRATICULE ILLUM control to the front panel.

6. Remove the front panel from the instrument.

7. Remove the screw holding the Calibrator board to the support on the CRT shield.

8. Remove the two screws holding the VERT MODE switch to the front sub-panel.

9. Pull the Calibrator board out far enough to allow the multi-pin connectors and wire leads to be disconnected from the Calibrator board (note the wire color code).

10. Remove the board.

11. To replace the circuit board, reverse the removal procedure. Match the arrows on the multi-pin connectors to the arrows on the circuit board.

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.

CAUTION

POWER switch must be turned off before removing or replacing semiconductors

Replacement semiconductors should be of the original type or a direct replacement. Fig. 4-3 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-cased 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.

WARNING

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 this may damage the pins.

Access to Power Transistors. The power transistors associated with the Low-Voltage Power Supply are mounted on the heat radiator at the rear of the instrument. To gain access to these transistors, remove the screws which secure the plastic protective cover 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, refer to the procedure for removal of the Low-Voltage Regulator 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 and/or wire leads are used in the 7403N to interconnect the circuit boards. When the interconnection is made at a circuit board, 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 circuit-board 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.

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.

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:

A. REMOVAL

1. Remove the heat radiator/Low-Voltage Regulator circuit board assembly as described previously.
2. Remove the CRT base socket from the rear of the CRT.
3. Loosen the two 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.
4. Disconnect the deflection-plate connectors. Be careful not to bend these pins.
5. Disconnect the CRT anode plug from the jack located on the front of the high-voltage compartment. Ground this lead to the chassis to dissipate any stored charge.
6. Remove the two screws securing the CRT bezel to the front panel. Remove the plastic faceplate protector and light filter.
7. 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.
2. Clean the CRT faceplate, plastic faceplate protector, and the light filter with denatured alcohol.
3. Re-install the CRT bezel, faceplate protector, and light filter. Firmly tighten the two screws.
4. Push forward on the CRT base to be certain that the CRT is as far forward as possible. Then tighten the two screws beside the CRT base until the springs on the screws are fully compressed.

5. Replace the CRT base socket.
6. Reconnect the CRT anode plug.
7. Re-install the heat radiator/Low-Voltage Regulator circuit board assembly.
8. Carefully reconnect the deflection-plate connectors. After each connector is installed, lightly pull on its lead to be sure that it will remain in its socket.
9. Check the calibration of the complete instrument. Calibration procedure is given in Section 5.

Switch Replacement. The pushbutton switches used in the 7403N are not repairable and should be replaced as a unit if defective.

Graticule-Bulb Replacement. To remove a graticule bulb, first remove the two screws securing the CRT bezel to the front panel. Remove the plastic light shield and retaining spring. Now, firmly grasp the defective bulb and pull straight out. Push the replacement bulb straight into the socket as far as it will go. Replace the retaining spring, light shield, and CRT bezel.

Power Transformer Replacement. Replace the power transformer only with a direct replacement transformer. 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. 7-11 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. Remove the heat radiator/Low-Voltage Regulator assembly 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 Z-Axis Amplifier board.

5. Remove the screw on the bottom of the high-voltage compartment and the two screws located at the top.

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 or Z-Axis Amplifier circuit boards. Disconnect the multi-pin connectors on the High-Voltage board.

7. Using an insulated shorting strap, discharge the exposed connections to chassis ground.

8. Remove the two power transistors and the four screws which secure the High-Voltage board to the high-voltage compartment. Now, all of the circuitry in the high-voltage box can be reached for maintenance or replacement except those in the encapsulated assembly.

9. To replace the encapsulated assembly, remove the four screws located on the bottom of the High-Voltage circuit board (remove board to reach screws).

10. To replace the high-voltage compartment, reverse the above procedure. Be careful not to pinch any of the interconnecting wires when re-attaching the high-voltage compartment to the chassis.

Fuse Replacement. Table 4-3 gives the rating, location, and function of the fuses used in this instrument.

TABLE 4-3

Fuse Ratings

Circuit Number	Rating	Location	Function
F1000	2 A Slow	Rear panel	110-volt line
F1000	1 A Slow	Rectifier board	220-volt line
F814	2 A Fast	Rectifier board	High voltage
F855	0.15 A Fast	Low-Voltage Regulator board	+130 volts

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 7403N is to be shipped for long distances by commercial means of transportation, it is recommended that it be repackaged in the original manner for maximum protection. The original shipping carton can be saved and used for this purpose. The repackaging illustration in the Mechanical Parts List shows how to repackage the 7403N and gives the part number for the packaging components.

New shipping cartons can be obtained from Tektronix, Inc. Contact your local Tektronix Field Office or representative.

NOTE

The package 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.

NOTES

SECTION 5

CALIBRATION

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

Calibration Interval

To assure instrument accuracy, check the calibration of the 7403N 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.

Tektronix Field Service

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

Using This Procedure

General. This section provides several features to facilitate checking or adjusting the 7403N. These are:

Index. To aid in locating a step in the Performance Check or Adjustment procedure, an index is given preceding Part I—Performance Check and Part II—Adjustment procedure.

Performance Check. The performance of this instrument can be checked without removing the covers or making internal adjustments by performing only Part I—Performance Check. This procedure checks the instrument against the tolerances listed in the Performance Requirement column of Section 1. In addition, a cross-reference is provided to the step in Part II—Adjustment which will return the instrument to correct calibration. In most cases, the adjustment step can be performed without changing control settings or equipment connections.

Adjustment Procedure. To return this instrument to correct calibration with the minimum number of steps, perform only Part II—Adjustment. The Adjustment procedure gives the recommended calibration procedure for all circuits in this instrument. For functional checks, see Part I—Performance Check.

Partial Procedure. A partial check or adjustment is often desirable after replacing components, or to touch up the adjustment of a portion of the instrument between major recalibrations. To check or adjust only part of the instru-

ment, set the controls as given under Preliminary Control Settings and start with the nearest Equipment Required list preceding the desired portion. 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 re-adjustment is necessary, also check the calibration of any steps listed in the INTERACTION—part of the step.

Complete Performance Check/Adjustment. To completely check and adjust all parts of this instrument, perform both Parts I and II. Start the complete procedure by adjusting the power supply as given in the Adjustment procedure. Then perform the Adjustment procedure for a portion of the instrument (e.g., Vertical System Adjustment) and follow this with the Performance Check for the same portion (e.g., Vertical System Check). This method will assure that the instrument is both correctly adjusted and performing within all given tolerances.

IMPORTANT NOTE

All waveforms shown in this section were taken with a Tektronix Oscilloscope Camera System, unless noted otherwise.

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories, or its equivalent, is required for complete calibration of the 7403N. Specifications given for the test equipment are the minimum necessary for accurate calibration. Therefore, the specifications of any test equipment used must meet or exceed the listed specifications. All test equipment is assumed to be correctly calibrated and operating within the listed specification. 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.

Special Calibration Fixtures

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

Calibration Equipment Alternatives

All of the listed test equipment is required to completely check and adjust this instrument. If only a Performance Check procedure or an Adjustment procedure is performed, not all of the listed test equipment is required. The Test Equipment list indicates whether each item is used in the Performance Check procedure, the Adjustment procedure, or both. The Performance Check and Adjustment procedures have been written using the first item of equipment given as an example of applicable equipment. When other equipment is substituted, control settings or calibration setup may need to be altered slightly to meet the requirements of the substitute equipment. If the exact item of test equipment given as an example in the Test Equipment list is not available, first check the Specifications column carefully to see if any other equipment is available which might suffice. Then check the Usage column to see what this item of test equipment is used for. If used for a check or adjustment which is of little or no importance to your measurement requirements, the item and corresponding step(s) can be deleted.

The following procedure is written to completely check and adjust the 7403N to the Performance Requirements given in Section 1 and to allow interchanging 7000-series plug-in units between 7000-series mainframes without the need to re-calibrate the instruments each time. If the

applications for which you will use the 7403N do not require the full available performance from the 7403N/Plug-in combination, this procedure and the required equipment list can be shortened accordingly. For example, the basic measurement capabilities of this instrument can be verified by checking vertical deflection accuracy, vertical square-wave response, and basic horizontal timing with 7000-series real-time plug-in units and an accurate square-wave signal. Also, if the 7403N/plug-in combination is to be used as a fixed system without the need to interchange plug-in units, all tests can be made by substituting vertical plug-in units and applicable test signals for the 067-0587-00 mainframe standardizer calibration fixture.

Preliminary Control Settings

Set the 7403N controls as follows:

INTENSITY	Midrange
FOCUS	Adjust for well-defined display
BEAM FINDER	Pressed in
GRATICULE ILLUM	As desired
VERT MODE	LEFT
TRIG SOURCE	VERT MODE
POWER	Pulled out

TEST EQUIPMENT

Description	Minimum Specifications	Usage	Performance Check	Adjustment	Examples of Applicable Test Equipment
1. Precision DC voltmeter	Range, zero to 150 volts; accuracy, within 0.2%.	Calibrator output accuracy check and adjustment. Low-voltage power supply adjustment.	X	X	a. Tektronix 7D13 Digital Multimeter (test oscilloscope must have Readout System). b. Fluke Model 825A Differential DC Voltmeter.
2. DC voltmeter (VOM)	Range, zero to 4000 volts; accuracy, checked to within 1% at -2960 volts.	High-voltage power supply check. Z-axis DC levels adjustment.		X	a. Triplet Model 630-NA. b. Simpson Model 262.
3. Time-mark generator	Marker outputs, 10 nanoseconds to 0.1 second; marker accuracy, within 0.1%. Trigger output, one millisecond.	CRT geometry check and adjustment. Horizontal timing check and adjustment.	X	X	a. Tektronix 2901 Time-Mark Generator. b. Tektronix 184 Time-Mark Generator.

Description	Minimum Specifications	TEST EQUIPMENT		Performance Check	Adjustment	Examples of Applicable Test Equipment
		Usage				
4. Medium-frequency constant-amplitude signal generator	Frequency, 50 to 70 megahertz; reference frequency, 50 kilohertz; output amplitude, variable from five millivolts to five volts peak to peak into 50 ohms; amplitude accuracy, constant within 3% of reference as output frequency changes.	External Z-axis operation check. Vertical bandwidth check. Vertical amplifier isolation check. Horizontal bandwidth check.	X			a. Tektronix 191 Constant Amplitude Signal Generator. b. General Radio 1215-C with 1263-C Amplitude Regulating Power Supply.
5. Low-frequency signal generator	Frequency, 35 kilohertz; output amplitude, variable from 50 to 100 millivolts.	X-Y phase shift check.	X			a. General Radio 1310-B Oscillator.
6. Test-oscilloscope system (dual-trace)	Bandwidth, DC to 50 megahertz; minimum deflection factor, 10 millivolts/division; accuracy, within 3%.	Horizontal limit centering adjustment.		X		a. Tektronix 7503 or 7504 Oscilloscope with two 7A15 or 7A16 Amplifier and 7B50 or 7B52 Time-Base plug-in units, and two P6053 Probes. b. Tektronix 453A Oscilloscope with two P6054 Probes.
7. Vertical plug-in unit (two identical units required)	Tektronix 7A-series. 50-megahertz bandwidth required for complete procedure as written.	Used throughout procedure to provide vertical input to 7403N under calibration. Identical units required only for X-Y phase shift check.	X	X		a. Tektronix 7A15 Amplifier (may be shared with 7000-series test oscilloscope). b. Any 7A-series plug-in unit (tolerances in some steps may be limited if low-frequency units used).
8. Time base plug-in unit	Tektronix 7B-series.	Used throughout procedure to provide sweep.	X	X		a. Tektronix 7B53N or 7B52 Time Base. b. Any 7B-series plug-in unit.
9. Mainframe standardizer calibration fixture	Produces gain-check and pulse-response waveforms.	Used throughout procedure to standardize instrument so plug-in units can be interchanged without complete recalibration.	X	X		a. Tektronix Calibration Fixture 067-0587-00. b. Calibrated 7000-series plug-in units with suitable signal sources may be substituted if lower performance is acceptable.

Description	Minimum Specifications	TEST EQUIPMENT Usage	Performance Check	Adjustment	Examples of Applicable Test Equipment
10. 10X passive probe	Compatible with 7B-series external trigger input.	Chopped mode operation check (adjustment procedure).		X	a. Tektronix P6053 or P6054 Probe (may be shared with test oscilloscope).
11. T connector	Connectors, BNC.	External Z-axis operation check.	X		a. Tektronix Part No. 103-0030-00.
12. Termination	Impedance, 50 ohms; accuracy, $\pm 2\%$; connectors, BNC.	Horizontal timing check and adjustment. X-Y phase shift check.	X	X	a. Tektronix Part No. 011-0049-01.
13. Dual-input coupler	Connectors, BNC.	Added operation check. X-Y phase shift check.	X		a. Tektronix Calibration Fixture 067-0525-00.
14. Cable (two required)	Impedance, 50 ohms; type, RF-58/U; length, 18 and 42 inches; connectors, BNC.	Used throughout procedure for signal interconnection.	X	X	a. Tektronix Part No. 012-0076-00 (18-inch). Tektronix Part No. 012-0057-01 (42-inch).
15. GR in-line termination	Impedance, 50 ohms; accuracy, $\pm 2\%$; connectors, GR874 input with BNC male output.	External Z-axis operation check. Vertical bandwidth check. Vertical amplifier isolation check. Horizontal bandwidth check.	X		a. Tektronix Part No. 017-0083-00.
16. Cable	Impedance, 50 ohms; type RG-213/U; electrical length, five nanoseconds; connectors, GR874.	External Z-axis operation check. Vertical bandwidth check. Vertical amplifier isolation check. Horizontal bandwidth check.	X		a. Tektronix Part No. 017-0502-00.
17. BNC to pin-jack cable	Adapts pin jacks to BNC male connector.	Added operation check. Trigger source operation check. Astigmatism adjustment.	X	X	a. Tektronix Part No. 175-1178-00 (one supplied as standard accessory).
18. Screwdriver	Three-inch shaft, 3/32-inch bit.	Used throughout adjustment procedure to adjust variable resistors.		X	a. Xcelite R-3323.
19. Low-capacitance screwdriver	1 1/2-inch shaft.	Used throughout adjustment procedure to adjust variable capacitors.		X	a. Tektronix Part No. 003-0000-00.

PART I—PERFORMANCE CHECK

Introduction

The following procedure checks the performance of the 7403N without removing the covers or making internal adjustments. All tolerances given in this procedure are based on Section 1 of this manual.

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Calibrator Check

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Preliminary Procedure for Performance Check

NOTE

The performance of this instrument can be checked at any temperature within the 0°C to +50°C range unless stated otherwise.

1. Connect the 7403N 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.

DISPLAY and Z-AXIS CHECK**Equipment Required**

- | | |
|-------------------------------|----------------------------------|
| 1. 7B53N plug-in unit | 5. Five-nanosecond GR cable |
| 2. 7A15 plug-in unit | 6. 50-ohm GR in-line termination |
| 3. Medium-frequency generator | 7. BNC T connector |
| 4. 42-inch 50-ohm BNC cable | |

1. Check External Z-Axis Operation

a. Install the 7A15 in the left vertical compartment and the 7B53N in the horizontal compartment.

b. Connect the output of the medium-frequency constant-amplitude signal generator to the input of the 7A15 through the five-nanosecond GR cable, 50-ohm GR in-line termination, and the BNC T connector.

c. Set the 7A15 for a deflection factor of one volt/division.

d. Set the 7B53N for auto, internal triggering at a calibrated sweep rate of 10 microseconds/division.

e. Set the medium-frequency generator for a two-division display at its reference frequency (50 kilohertz).

f. Remove the cover from the EXT Z AXIS connector on the rear panel.

g. Connect the output of the BNC T connector to the EXT Z AXIS connector with the 42-inch 50-ohm BNC cable.

h. CHECK—Top portion of displayed waveform blanked out.

i. Disconnect the cable and replace the cover on the EXT Z AXIS connector.

2. Check Beam Finder

a. Set the 7A15 deflection factor to 20 millivolts/division. Notice that the display exceeds the viewing area.

b. Press and release the BEAM FINDER switch.

c. CHECK—Display compressed within graticule area.

d. Increase the 7A15 deflection factor until the compressed display is reduced in amplitude.

e. Press the BEAM FINDER switch in.

f. CHECK—Display remains within graticule area.

g. Disconnect all test equipment and remove the plug-in units.

VERTICAL SYSTEM CHECK

Equipment Required

- | | |
|--|----------------------------------|
| 1. Mainframe standardizer calibration fixture. | 5. Five-nanosecond GR cable |
| 2. 7B53N plug-in unit | 6. 50-ohm GR in-line termination |
| 3. Medium-frequency generator | 7. BNC to pin-jack cable |
| 4. 7A15 plug-in unit (two) | 8. Dual-input coupler |

Control Settings

Set the controls as given under Preliminary Control Settings.

3. Check Vertical Output Amplifier Gain

- a. Install the mainframe standardizer calibration fixture in the left vertical compartment and the 7B53N in the horizontal compartment.
- b. Set the calibration fixture Test switch to Vert or Horiz Gain with the Rep Rate switch set to 250 kHz.
- c. Set the 7B53N for auto, internal triggering at a sweep rate of 0.5 millisecond/division.
- d. Position the display so the first and seventh traces are near the top and bottom horizontal lines of the graticule.
- e. Note the exact deflection between the second and sixth traces for step 3h.
- f. Remove the calibration fixture from the left vertical compartment and install it in the right vertical compartment.
- g. Set the VERT MODE switch to RIGHT.
- h. CHECK—Deflection between the second and sixth traces should be the same as step 3e $\pm 1\%$.
- i. ADJUSTMENT—See step 12 of Adjustment procedure.

4. Check Vertical Linearity

- a. Set the mainframe standardizer calibration fixture Test switch to Vert or Horiz + Step Resp with the Rep Rate switch set to 2.5 kHz.
- b. Set the calibration fixture Amplitude control so the display is exactly two divisions in amplitude; adjust the calibration fixture Position control to keep the display centered on the graticule while setting the amplitude.
- c. CHECK—Position the two divisions of deflection vertically and check for not more than 0.1 division of compression or expansion anywhere within the graticule area.

5. Check Vertical Amplifier Bandwidth

- a. Connect the medium-frequency constant-amplitude signal generator to the CW In connector of the mainframe standardizer calibration fixture with the five-nanosecond GR cable and the 50-ohm GR in-line termination.
- b. Set the Test switch of the calibration fixture to Vert or Horiz Freq Resp.
- c. Set the 7B53N for a sweep rate of 0.2 microsecond/division.
- d. Set the medium-frequency generator for eight divisions of deflection, centered on the graticule, at a reference frequency of 50 kilohertz.
- e. Without changing the output amplitude, increase the output frequency of the medium-frequency generator until the display is reduced to 5.6 divisions (-3 dB point).

f. **CHECK**—Output frequency must be 67 megahertz or higher (65 megahertz if checked outside the +20°C to +30°C temperature range). Actual frequency (right vertical), megahertz.

g. Remove the calibration fixture from the right vertical compartment and install it in the left vertical compartment (leave signal connected).

h. Set the VERT MODE switch to LEFT.

i. Repeat parts d through f. Actual frequency (left vertical), megahertz.

j. **ADJUSTMENT**—See step 13 of Adjustment procedure.

k. Disconnect all test equipment (leave plug-in units installed).

6. Check Vertical Amplifier Isolation

a. Remove the mainframe standardizer calibration fixture from the left vertical compartment and install the 7A15 in this compartment.

b. Set the 7A15 for a deflection factor of 0.1 volt/division.

c. Connect the output of the medium-frequency generator to the input of the 7A15 with the five-nanosecond GR cable and the 50-ohm GR in-line termination.

d. Set the medium-frequency generator for eight divisions of deflection at 50 megahertz.

e. Set the VERT MODE switch to RIGHT.

f. **CHECK**—CRT display for not more than 0.1 division of 50 megahertz signal (channel isolation at least 100:1).

g. Remove the 7A15 from the left vertical compartment and install it in the right vertical compartment (leave signal connected).

h. Set the medium-frequency generator for eight divisions of deflection at 50 megahertz.

i. Set the VERT MODE switch to LEFT.

j. **CHECK**—CRT display for not more than 0.1 division of 50 megahertz signal.

k. Disconnect all test equipment.

7. Check Added Operation

a. Install the other 7A15 in the left vertical compartment.

b. Set both 7A15 units for a deflection factor of 0.2 volt/division.

c. Connect the 0.4 V Calibrator pin-jack to the inputs of the 7A15 units with the BNC to pin-jack cable and dual-input coupler.

d. Set the 7B53N for auto, internal triggering at a sweep rate of 0.5 millisecond/division.

e. Note the vertical deflection and center the display with the left 7A15 Position control.

f. Set the VERT MODE switch to RIGHT.

g. Note the vertical deflection and center the display with the right 7A15 Position control.

h. Set the VERT MODE switch to ADD.

i. **CHECK**—CRT display; vertical deflection should approximately equal the algebraic sum of the deflection noted in parts e and g of this step.

j. Disconnect the BNC to pin-jack cable and dual-input coupler.

8. Check Alternate Operation

a. Set the VERT MODE switch to ALT.

b. Position the traces about two divisions apart.

c. Turn the 7B53N Time/Division switch throughout its range.

d. **CHECK**—Trace alternation between the left and right 7A15 units at all sweep rates. At faster sweep rates, alternation will not be apparent; instead display appears as two traces on the screen.

e. Remove the plug-in units.

HORIZONTAL SYSTEM CHECK

Equipment Required

- | | |
|---|-----------------------------------|
| 1. 7B53N plug-in unit | 7. 42-inch 50-ohm BNC cable |
| 2. 7A15 plug-in unit (two) | 8. 50-ohm BNC termination |
| 3. Time-mark generator | 9. Dual-input coupler |
| 4. Mainframe standardizer calibration fixture | 10. Five-nanosecond GR cable |
| 5. Low-frequency generator | 11. 50-ohm GR in-line termination |
| 6. Medium-frequency generator | 12. Three-inch screwdriver |

Control Settings

Set the controls as given under Preliminary Control Settings.

9. Check Horizontal Linearity

a. Install the 7B53N in the left vertical compartment and the mainframe standardizer calibration fixture in the horizontal compartment.

b. Set the Test switch on the calibration fixture to Vert or Horiz + Step Resp with the Rep Rate switch set to 2.5 kHz.

c. Set the 7B53N for auto, internal triggering at a sweep rate of 0.5 millisecond/division.

d. Set the calibration fixture Amplitude control so the display is exactly two divisions in amplitude horizontally; adjust the calibration fixture Position control to keep the display centered on the graticule while setting the amplitude.

e. CHECK—Position the two divisions of deflection horizontally and check for not more than 0.1 division of compression or expansion anywhere within the graticule area.

f. Remove the plug-in units.

10. Check High-Frequency Timing

a. Install the 7A15 in the left vertical compartment and the 7B53N in the horizontal compartment.

b. Connect the time-mark generator to the input of the 7A15 with the 42-inch 50-ohm BNC cable and the 50-ohm BNC termination.

c. Set the time-mark generator for one-millisecond markers. Set the deflection factor of the 7A15 so the markers are at least two divisions in amplitude.

d. Set the 7B53N for auto, internal triggering at a sweep rate of one millisecond/division.

e. Set the 7B53N Swp Cal adjustment for exactly one marker each major graticule division.

f. Set the time-mark generator for 10-nanosecond markers.

g. Set the 7B53N for a sweep rate of 0.05 microsecond/division with the X10 magnifier on; set the deflection factor of the 7A15 so the markers are about two divisions in amplitude.

h. CHECK—CRT display for one marker each two divisions over the center eight divisions.

i. ADJUSTMENT—See step 18 of Adjustment procedure.

j. Disconnect all test equipment and remove the plug-in units.

11. Check X-Y Phase Shift

a. Install the 7A15 plug-in units in the left vertical and horizontal compartments.

b. Set both 7A15 units for a deflection factor of 10 millivolts/division with DC input coupling.

c. Connect the low-frequency signal generator to the inputs of the 7A15 plug-in units with the 42-inch 50-ohm BNC cable, 50-ohm BNC termination, and dual-input coupler.

d. Set the low-frequency generator for eight divisions of vertical and horizontal deflection at an output frequency of 35 kilohertz.

e. CHECK—CRT lissajous display for an opening at the center vertical line of 0.28 division or less (indicates 2° or less phase shift; see Fig. 5-1).

f. Disconnect all test equipment (leave plug-in units installed).

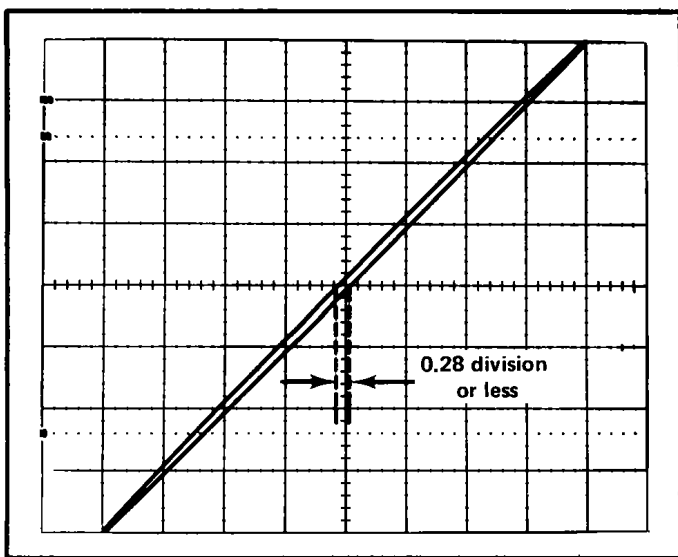


Fig. 5-1. Typical CRT display when checking X-Y phase shift.

12. Check Horizontal Bandwidth

a. Install the 7B53N in the right vertical compartment.

b. Set the VERT MODE switch to RIGHT.

c. Set the 7B53N for auto triggering at a sweep rate of one millisecond/division (display will free run).

d. Connect the medium-frequency generator to the input of the 7A15 in the horizontal compartment with the five-nanosecond GR cable and the 50-ohm GR in-line termination.

e. Set the medium-frequency generator for 8 divisions of horizontal deflection at its reference frequency (50 kilohertz).

f. Without changing the output amplitude, increase the output frequency of the generator until the display is reduced to 5.6 divisions horizontally (-3 dB point).

g. CHECK—Output frequency must be two megahertz or higher. Actual frequency, megahertz.

h. Disconnect all test equipment and remove the plug-in units.

TRIGGERING CHECK

Equipment Required

- | | |
|---|--------------------------|
| 1. Mainframe standardizer calibration fixture | 3. 7A15 plug-in unit |
| 2. 7B53N plug-in unit | 4. BNC to pin-jack cable |

Control Settings

Set the controls as given under Preliminary Control Settings.

13. Check Trigger Source Operation

a. Install the mainframe standardizer calibration fixture in the right vertical compartment and the 7A15 in the left vertical compartment.

b. Install the 7B53N in the horizontal compartment.

c. Set the 7B53N for auto, internal triggering at a sweep rate of 0.5 millisecond/division.

d. Set the 7A15 for a deflection factor of 0.2 volt/division.

e. Connect the 0.4 V Calibrator pin-jack to the input of the 7A15 with the BNC to pin-jack cable.

f. Position the Calibrator waveform display in the upper half of the graticule area with the 7A15 Position control.

g. Set the VERT MODE switch to RIGHT.

h. Set the calibration fixture Test switch to Vert or Horiz +Step Resp, Rep Rate switch to 250 Hz, and adjust the Amplitude control for a two-division display. Position the display in the lower half of the graticule area.

i. Set the VERT MODE switch to ALT.

j. CHECK—CRT display; both square-wave displays are stable.

k. Set the TRIG SOURCE switch to LEFT VERT.

l. CHECK—CRT display; Calibrator display only is stable.

m. Set the TRIG SOURCE switch to RIGHT VERT.

n. CHECK—CRT display; calibration fixture display only is stable.

o. Disconnect the BNC to pin-jack cable and remove the plug-in units.

CALIBRATOR CHECK

Equipment Required

1. Precision DC voltmeter

Control Settings

Set the controls as given under Preliminary Control Settings.

14. Check Calibrator Output Voltage

- a. Press and release the BEAM FINDER switch.
 - b. Connect the precision DC voltmeter between the 40 mV Calibrator pin-jack and chassis ground.
 - c. CHECK—Meter reading; 40 millivolts ± 0.4 millivolt (within 0.8 millivolt if this measurement is made outside the $+15^{\circ}\text{C}$ to $+35^{\circ}\text{C}$ range).
 - d. Connect the precision DC voltmeter between the 0.4 V Calibrator pin-jack and chassis ground.
 - e. CHECK—Meter reading; 0.4 volt ± 0.004 volt (within 0.008 volt if this measurement is made outside the $+15^{\circ}\text{C}$ to $+35^{\circ}\text{C}$ range).
 - f. Connect the precision DC voltmeter between the 4 V Calibrator pin-jack and chassis ground.
 - g. CHECK—Meter reading; 4 volts ± 0.04 volt (within 0.08 volt if outside the $+15^{\circ}\text{C}$ to $+35^{\circ}\text{C}$ range).
 - h. ADJUSTMENT—See step 4 of Adjustment procedure.
 - i. Press the BEAM FINDER switch in.
 - j. Disconnect all test equipment.
- This completes the Performance Check procedure for the 7403N. If the instrument has met all tolerances given in this procedure, it is correctly calibrated and within the required specifications.

PART II-ADJUSTMENT

7403N, Serial No. _____

Calibration Date _____

Calibrated by _____

13. Adjust Vertical High-Frequency Compensation (C405, R405, C413, C459) Page 5-19

14. Check Vertical Chopped Mode Operation Page 5-20

Introduction

The following procedure returns the 7403N to correct calibration. All limits and tolerances given in this procedure are calibration guides, and should not be interpreted as instrument specifications except as listed in the Performance Requirement column of Section 1. The actual operation of the instrument may exceed the given limits or tolerances if the instrument meets the Performance Requirements as checked in Part I—Performance Check of this section.

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Power Supply and Calibrator Adjustment

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| 2. Check Remaining Power-Supply Voltages | Page 5-14 |
| 3. Check High-Voltage Power Supply | Page 5-15 |
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Display and Z-Axis Adjustment

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| 5. Adjust Z-Axis DC Levels (R759) | Page 5-16 |
| 6. Adjust Astigmatism (R636) | Page 5-16 |
| 7. Adjust Z-Axis Compensation (C622) | Page 5-17 |
| 8. Adjust Trace Rotation (R1040) | Page 5-17 |
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Vertical System Adjustment

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| 11. Adjust Vertical Centering (R427) | Page 5-19 |
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Horizontal System Adjustment

- | | |
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| 15. Adjust Horizontal Amplifier Gain and Low-Frequency Linearity (R509) | Page 5-21 |
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| 18. Adjust High-Frequency Timing (C562, C587) | Page 5-22 |

Preliminary Procedure for Adjustment

NOTE

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

1. Remove the side and bottom covers from the 7403N.

2. Connect the 7403N to a power source which meets the voltage and frequency requirements of this instrument. The applied voltage should be near the center of the voltage range marked on the rear panel (see Section 2 for information on converting this instrument from one operating voltage to another).

NOTE

If correct line voltage is not available, use a variable autotransformer to provide the correct input voltage.

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

NOTE

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

POWER SUPPLY and CALIBRATOR ADJUSTMENT

Equipment Required

- | | |
|--|---------------------------|
| 1. Precision DC voltmeter

2. DC voltmeter (VOM) | 3. Three-inch screwdriver |
|--|---------------------------|

Control Settings

Set the controls as given under Preliminary Control Settings.

1. Adjust —50-Volt Power Supply

- a. Set the INTENSITY control fully counterclockwise.
- b. Connect the precision DC voltmeter between TP—50 (see Fig. 5-2A) and chassis ground.
- c. CHECK—Meter reading; —50 volts ± 0.1 volt.
- d. ADJUST— —50 Volts adjustment R881 (see Fig. 5-2B) for a meter reading of exactly —50 volts.
- e. INTERACTION—Change in setting of R881 may also affect operation of all circuits within the 7403N.

2. Check Remaining Power-Supply Voltages

a. CHECK—Table 5-1 lists the low-voltage power supplies in this instrument. Check each supply with the precision DC voltmeter for output voltage within the given tolerance (connect meter ground lead to chassis ground). Power supply test points are shown in Fig. 5-2A.

- b. Disconnect the precision DC voltmeter.

NOTE

Ripple and regulation of the individual power supplies can be checked using the procedure given under Troubleshooting Techniques in Section 4.

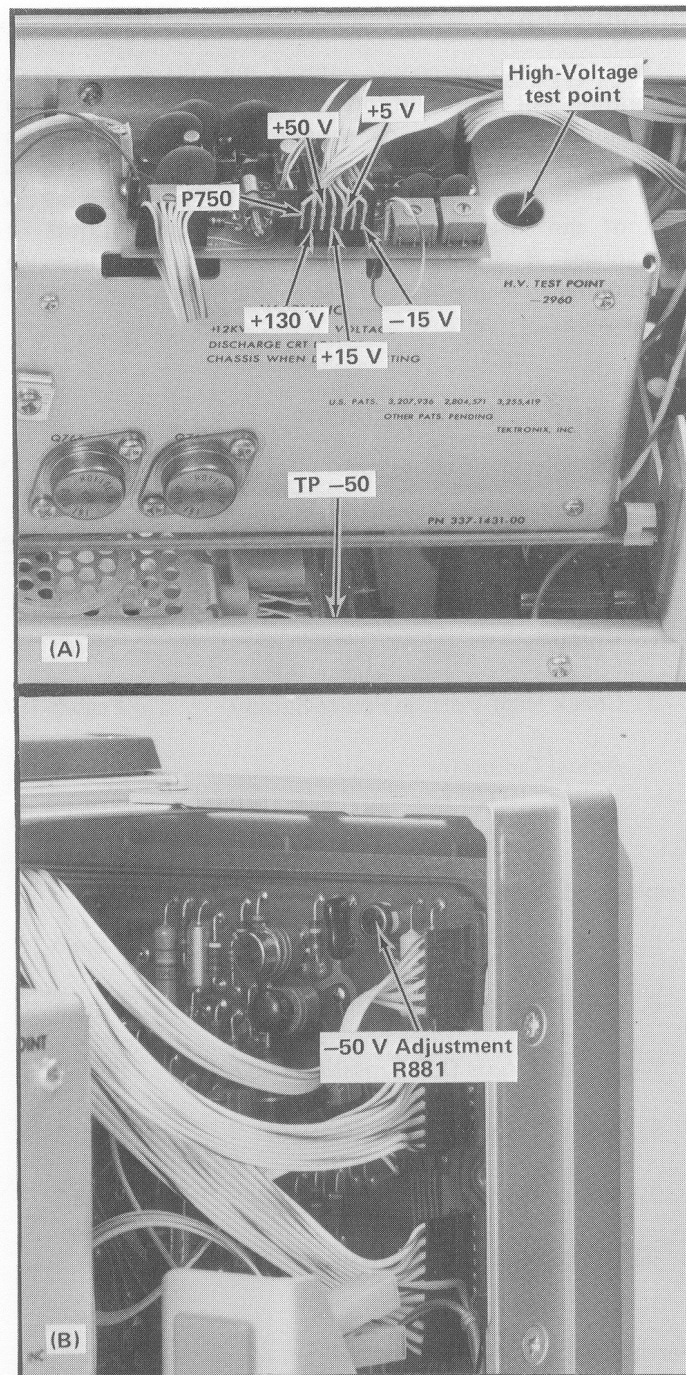


Fig. 5-2. (A) Locations of power supply and High-Voltage test points; (B) Location of —50 V adjustment R881.

TABLE 5-1

Power Supply Tolerance

Power Supply	Test Point	Output Voltage Tolerance
–50 Volt	TP-50	± 0.1 volt
–15 Volt	Pin 7 P750	± 0.3 volt
+5 Volt	Pin 5 P750	± 0.15 volt
+15 Volt	Pin 4 P750	± 0.3 volt
+50 Volt	Pin 3 P750	± 0.6 volt
+130 Volt	Pin 2 P750	± 5.2 volts

3. Check High-Voltage Power Supply

a. Connect the DC voltmeter (VOM) (set to measure at least 3000 volts) between the high-voltage test point (see Fig. 5-2A) and chassis ground.

b. CHECK—Meter reading; -2960 volts ± 89 volts.

4. Adjust Calibrator Output Voltage

a. Press and release the BEAM FINDER switch.

b. Connect the precision DC voltmeter between the 4 V and GND pin jacks.

c. CHECK—Meter reading; 4 volts ± 0.04 volt.

d. ADJUST—4 Volts adjustment R1077 (see Fig. 5-3) for a meter reading of exactly 4 volts.

e. Disconnect all test equipment.

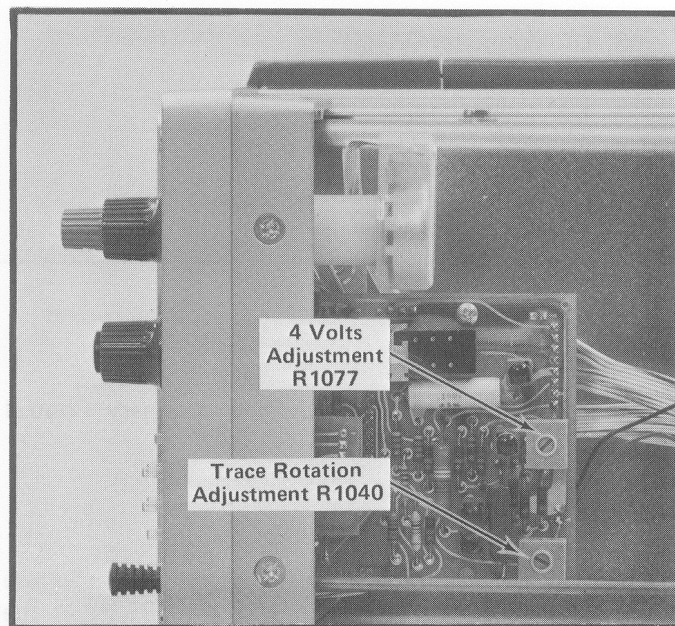


Fig. 5-3. Locations of adjustments on Calibrator circuit board.

DISPLAY AND Z-AXIS ADJUSTMENT

Equipment Required

- | | |
|---|---------------------------------|
| 1. Mainframe standardizer calibration fixture | 7. BNC to pin-jack cable |
| 2. 7B53N plug-in unit | 8. 18-inch 50-ohm BNC cable |
| 3. DC Voltmeter (VOM) | 9. 42-inch 50-ohm BNC cable |
| 4. 7A15 plug-in unit | 10. Three-inch screwdriver |
| 5. 10X passive probe | 11. Low-capacitance screwdriver |
| 6. Time-mark generator | |

Control Settings

Set the controls as given under Preliminary Control Settings.

5. Adjust Z-Axis DC Levels

a. Install the mainframe standardizer calibration fixture in the left vertical compartment and the 7B53N in the horizontal compartment.

b. Set the INTENSITY control fully counterclockwise.

c. Set the 7B53N for the amplifier mode.

d. Connect the DC voltmeter (VOM) between the Z Axis test point (see Fig. 5-4) and chassis ground. Note the voltmeter reading.

e. Adjust the INTENSITY control for a meter reading four volts more positive than the reading in part d.

f. ADJUST—CRT Grid Bias adjustment R759 (see Fig. 5-4) so the dot on the CRT screen is just extinguished.

g. Set the 7B53N for a sweep rate of 0.1 second/division in the time-base mode.

h. With the trace de-focused and positioned vertically off screen (set calibration fixture to Vert or Horiz Freq Resp for sufficient range to position display off screen), set the INTENSITY control fully clockwise.

i. CHECK—Meter reading should be +50 volts ± 2 volts. Disregard the momentary negative meter deflection during sweep holdoff.

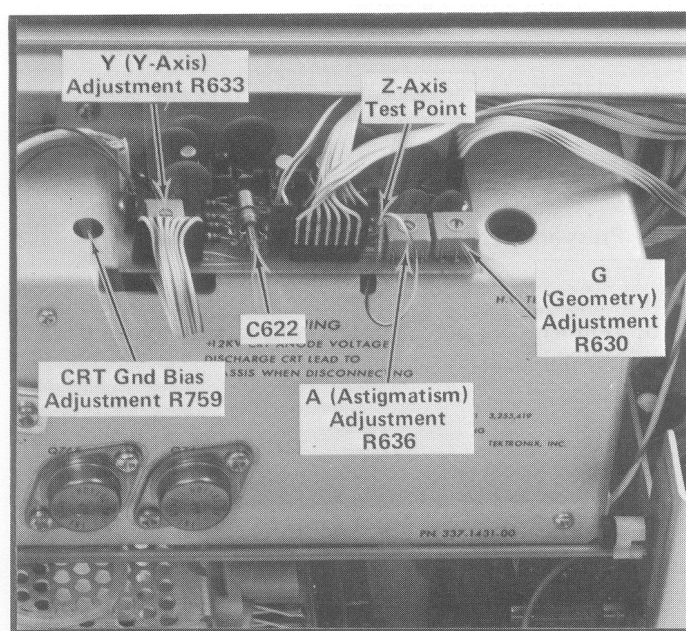


Fig. 5-4. Locations of Display and Z-Axis Adjustments and test point.

j. Set the 7B53N for a sweep rate of 50 milliseconds/division.

k. CHECK—Meter reading should be +78 volts ± 3 volts.

l. Disconnect the voltmeter and reduce the INTENSITY setting to a normal viewing level.

6. Adjust Astigmatism

a. Set the 7B53N for auto, internal triggering at a sweep rate of one millisecond/division.

b. Set the mainframe standardizer calibration fixture Test switch to Vert or Horiz Aux In.

c. Connect the 4 V Calibrator pin-jack to the Aux In connector of the calibration fixture with the BNC to pin-jack cable.

d. Set the calibration fixture Position control for a centered display, and the Amplitude control for about two divisions of vertical deflection.

e. CHECK—CRT display is well defined.

f. ADJUST—FOCUS control and A (Astigmatism) adjustment R636 (see Fig. 5-4) to obtain best display definition.

g. Disconnect the cable.

7. Adjust Z-Axis Compensation

a. Install the 7A15 in the right vertical compartment.

b. Set the VERT MODE switch to RIGHT.

c. Connect the 10X probe to the input of the 7A15. Check the probe compensation.

d. Set the 7B53N for a sweep rate of one microsecond/division with the X10 magnifier on.

e. Connect the probe tip to the Z-Axis test point (see Fig. 5-4).

f. Set the 7A15 for a vertical deflection factor of one volt/division (10 volts/division at probe tip).

g. Adjust the INTENSITY control for three divisions of vertical deflection on the CRT. Position the display so the leading edge of the waveform is displayed.

h. CHECK—CRT display for optimum square leading corner.

i. ADJUST—C622 (see Fig. 5-4) for optimum square leading corner (use low-capacitance screwdriver to adjust variable capacitor).

j. Disconnect the probe.

8. Adjust Trace Rotation

a. Set the INTENSITY control to midrange.

b. Move the trace to the center horizontal line with the 7A15 position control.

c. CHECK—Trace aligns with the center horizontal line within 0.1 division.

d. ADJUST—Trace Rotation adjustment R1040 (see Fig. 5-3) to align the trace with the center horizontal line.

9. Adjust Y-Axis Alignment

a. Inter-change the 7B53N and 7A15 plug-in units.

b. Move the trace to the center vertical line with the 7A15 position control.

c. CHECK—Trace aligns with the center vertical line within 0.1 division.

d. ADJUST—Y (Y-Axis) adjustment R633 (see Fig. 5-4) to align the trace with the center vertical line.

10. Adjust Geometry

a. Remove the 7A15 and install the 7B53N in the horizontal compartment.

b. Set the VERT MODE switch to LEFT.

c. Connect the marker output of the time-mark generator to the Aux In connector of the calibration fixture with an 18-inch 50-ohm BNC cable.

d. Connect the trigger output of the time-mark generator to the external trigger input connector of the 7B53N with a 42-inch 50-ohm BNC cable.

e. Set the time-mark generator for one-millisecond markers and one-millisecond triggers.

f. Set the calibration fixture Test switch to Vert or Horiz Aux In and the Amplitude Step or Aux control fully clockwise.

Adjustment—7403N

g. Set the 7B53N for auto triggering from the external source at a sweep rate of 0.5 millisecond/division (magnifier off).

h. Set the 7B53N variable time/division control to obtain exactly one marker for each major graticule division.

i. Set the time-mark generator for both one- and 0.1-millisecond markers.

j. Position the baseline of the markers as far toward the bottom of the graticule as possible with the calibration fixture Position control.

k. CHECK—Vertical bowing and tilt of the marker display is less than 0.1 division (each 0.1-millisecond marker represents 0.1 division).

l. ADJUST—G (Geometry) adjustment R630 (see Fig. 5-4) for minimum bowing of time markers. Adjustment may have to be compromised to obtain less than 0.1 division bowing and tilt everywhere within the graticule area.

m. Disconnect all test equipment and remove the plug-in units.

VERTICAL SYSTEM ADJUSTMENT

Equipment Required

- | | |
|---|--------------------------------|
| 1. Mainframe standardizer calibration fixture | 4. Three-inch screwdriver |
| 2. 7B53N plug-in unit | 5. Low-capacitance screwdriver |
| 3. 10X probe | |

Control Settings

Set the controls as given under Preliminary Control Settings.

11. Adjust Vertical Centering

- a. Install the 7B53N in the horizontal compartment.
- b. Set the 7B53N for auto, internal triggering at a sweep rate of one millisecond/division.
- c. CHECK—The trace should be within 0.3 division of the graticule center line.
- d. ADJUST—Vertical Centering adjustment R427 (see Fig. 5-5) to position the trace to the center horizontal line.

12. Adjust Vertical Gain

- a. Install the mainframe standardizer calibration fixture in the left vertical compartment.

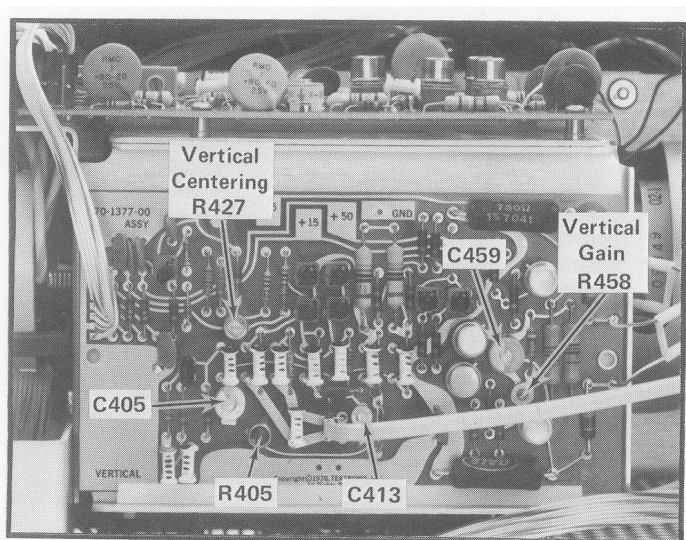


Fig. 5-5. Locations of Vertical System Adjustments.

- b. Set the calibration fixture Test switch to Vert or Horiz Gain with the Rep Rate switch set to 250 kHz.

- c. Position the display so the first and seventh traces are near the top and bottom lines of the graticule.

- d. CHECK—Deflection between the second and sixth traces should be six divisions ± 0.06 division.

- e. ADJUST—Vertical Gain adjustment R458 (see Fig. 5-5) for exactly six divisions of deflection between the second and sixth traces.

13. Adjust Vertical High-Frequency Compensation

- a. Set the calibration fixture Test switch to Vert or Horiz +Step Resp, Rep Rate switch to 250 kHz, and adjust the Amplitude control for a six-division display.

- b. Set the 7B53N for a calibrated sweep rate of five nanoseconds/division (use X10 magnifier). Set the triggering level control and position control for a stable display, centered on the graticule.

- c. CHECK—Check for optimum square corner and flat top on displayed pulse with aberrations not to exceed $+0.1$ or -0.1 division with total peak-to-peak aberrations not to exceed 0.1 division.

- d. ADJUST—High-frequency compensation as given in Table 5-2 for optimum square leading corner and flat top with minimum aberrations within limits given in part c. Location of adjustments is shown in Fig. 5-5. Use the low-capacitance screwdriver to adjust the variable capacitors. Repeat the complete adjustment procedure several times to obtain optimum adjustment.

TABLE 5-2

High-Frequency Compensation

Adjustment	Primary Area Of Pulse Affected	Best Sweep Rate
C405	First 50 nanoseconds	50 nanoseconds/division
R405	First 20 nanoseconds	20 nanoseconds/division
C413	First 30 nanoseconds	20 nanoseconds/division
C459	First 5 nanoseconds	20 nanoseconds/division
Vertical deflection plate lead dress	First 30 nanoseconds	20 nanoseconds/division

e. Remove the calibration fixture from the left vertical compartment and install it in the right vertical compartment.

f. Set the VERT MODE switch to RIGHT.

g. CHECK—Optimum square leading corner and flat top on the displayed pulse with aberrations not to exceed +0.1 or -0.1 division, with total peak-to-peak aberrations not to exceed 0.1 division.

h. ADJUST—If necessary, compromise the adjustment of C405, R405, C413, and C459 for best response from both the left and right vertical compartments.

i. To verify correct high-frequency compensation, perform the bandwidth check as given in step 5 of the Performance Check.

14. Check Vertical Chopped Mode Operation

a. Connect the 10X probe to the external trigger input of the 7B53N.

b. Connect the probe tip to TP115 (see Fig. 5-6).

c. Set the calibration fixture Test switch to Aux In and move the trace several divisions above the center line with the Position control.

d. Set the VERT MODE switch to CHOP.

e. Set the 7B53N for auto, external triggering at a sweep rate of 0.2 microsecond/division.

f. CHECK—CRT display for chopped waveform display with duration of the time segment from each channel, including the blanked portion, between two and three divisions. Also, check that the unblanked (visible) portion of the time segment from each channel consists of at least 75% of the duration of the total channel segment.

g. Disconnect the probe and remove all plug-in units.

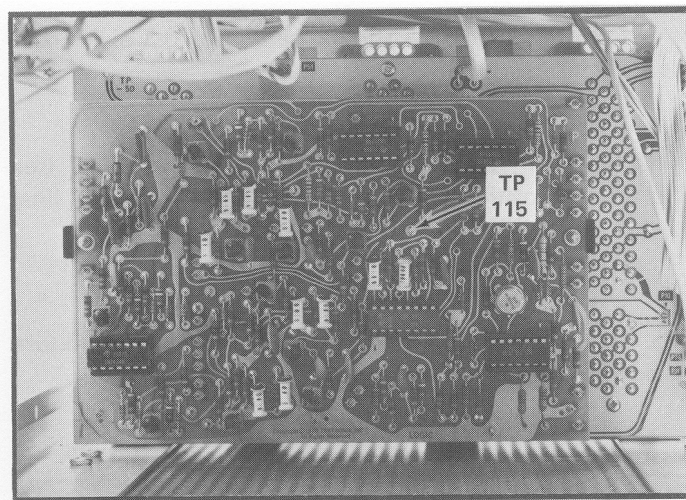


Fig. 5-6. Location of TP115 on Logic circuit board (shown with power-unit removed).

HORIZONTAL SYSTEM ADJUSTMENT

Equipment Required

1. 7B53N plug-in unit
2. 7A15 plug-in unit
3. Mainframe standardizer calibration fixture
4. Test-oscilloscope system with two 10X probes
5. Time-mark generator
6. 42-inch 50-ohm BNC cable
7. 50-ohm BNC termination
8. Three-inch screwdriver
9. Low-capacitance screwdriver

Control Settings

Set the controls as given under Preliminary Control Settings.

15. Adjust Horizontal Amplifier Gain and Low-Frequency Linearity

a. Install the mainframe standardizer calibration fixture in the horizontal compartment and the 7B53N in the left vertical compartment.

b. Set the Test switch on the calibration fixture to Vert or Horiz Gain.

c. Set the 7B53N for auto, internal triggering at a sweep rate of one millisecond/division.

d. Position the display so the first and ninth traces are near the far left and right vertical lines of the graticule.

e. CHECK—Deflection between the second and eighth traces is eight divisions ± 0.08 division.

f. ADJUST—Horizontal Gain adjustment R509 (see Fig. 5-7) for exactly eight divisions of deflection between the second and eighth traces.

g. CHECK—With gain set exactly, all nine vertical traces align with their respective graticule lines within 0.05 division.

h. INTERACTION—If R509 is adjusted, check steps 17 and 18.

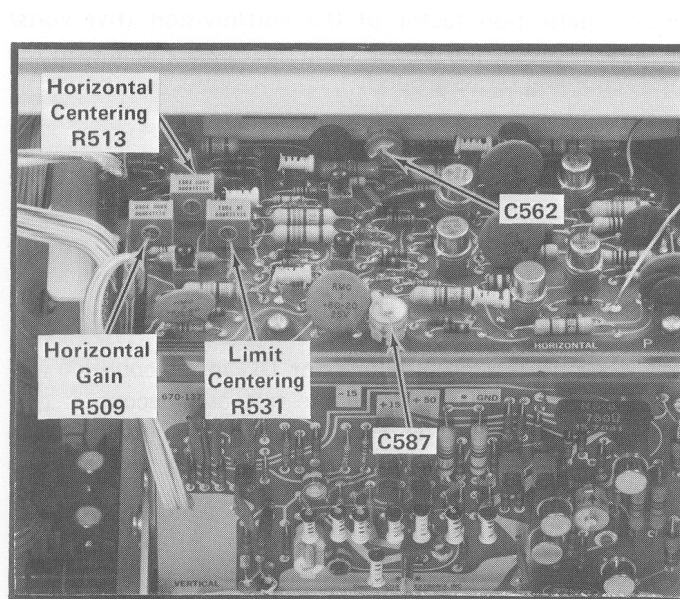


Fig. 5-7. Locations of Horizontal System Adjustments.

16. Adjust Horizontal Amplifier Centering

a. Set the test switch on the calibration fixture to Triggering Gain.

b. CHECK—Vertical trace produced by 7B53N should align with the vertical center line of the graticule within 0.3 division.

c. ADJUST—Horizontal Centering adjustment R513 (see Fig. 5-7) to position the trace to the vertical center line.

d. INTERACTION—If R513 is adjusted, re-check steps 15 and 17.

17. Adjust Horizontal Amplifier Limit Centering

a. Remove the mainframe standardizer calibration fixture and install the 7B53N in the horizontal compartment.

b. Set the 7B53N for auto, internal triggering at a sweep rate of one millisecond/division with the magnifier on.

c. Connect 10X probes to both inputs of the test oscilloscope. Connect the probe tips to the horizontal deflection plate connectors of the 7403N (be sure probes are compensated).

d. Set both channels of the test oscilloscope for a vertical deflection factor of 0.5 volt/division (five volts/division at probe tip) in the chop dual-trace mode with the input coupling set to ground.

e. Position the ground-reference traces displayed on the test oscilloscope to the center horizontal line of the graticule. Do not change the test-oscilloscope position controls after establishing this ground reference.

f. Set the test oscilloscope for DC input coupling and set the triggering controls so the test oscilloscope is triggered from the signal on channel 1 only. Set the triggering controls for a stable display at a sweep rate of two milliseconds/division.

g. CHECK—The base line of both displayed waveforms should be at the same DC level within 0.2 division (see Fig. 5-8).

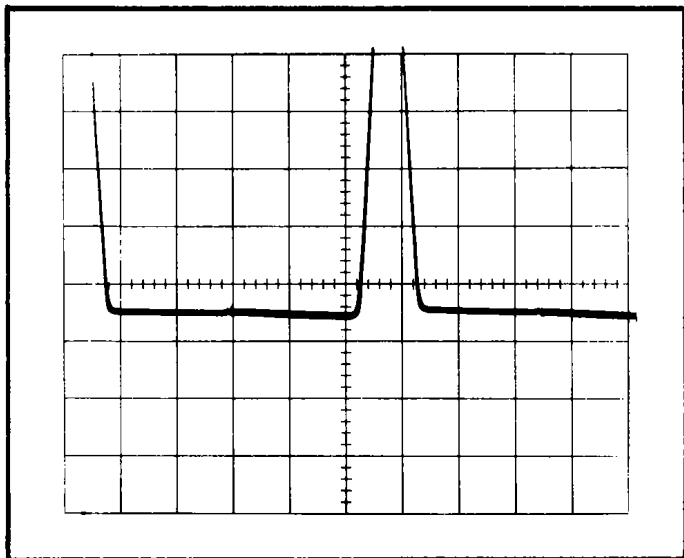


Fig. 5-8. Test oscilloscope waveforms when Horizontal Amplifier Limiting Centering is properly adjusted.

h. ADJUST—Limit Centering adjustment R531 (see Fig. 5-7) to match the DC levels of both waveforms.

i. INTERACTION—If R531 is adjusted, re-check steps 15 and 16.

j. Disconnect all test equipment.

18. Adjust High Frequency Timing

a. Install the 7A15 in the left vertical compartment.

b. Connect the time-mark generator to the input connector of the 7A15 with the 42-inch 50-ohm BNC cable and the 50-ohm BNC termination.

c. Set the time-mark generator for one-millisecond markers. Set the deflection factor of the 7A15 so the markers are at least two divisions in amplitude.

d. Set the 7B53N for auto, internal triggering at a sweep rate of one millisecond/division.

e. Position the first marker to the left vertical line of the graticule.

f. Set the 7B53N Swp Cal adjustment for one marker each major graticule division between the second and tenth lines.

g. Set the time-mark generator for 10-nanosecond markers.

h. Set the 7B53N for a sweep rate of 0.05 microsecond/division with the X10 magnifier on; set the deflection factor of the 7A15 so the markers are about two divisions in amplitude.

i. CHECK—CRT display for one marker each two divisions over the center eight divisions.

j. ADJUST—C562 and C587 (see Fig. 5-7) for one marker each two divisions over the center eight divisions (use low-capacitance screwdriver).

This completes the calibration/checkout procedure for the 7403N. Disconnect all test equipment and replace the side panels. 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 the Performance Requirement column of Section 1.

PARTS LIST ABBREVIATIONS

BHB	binding head brass	int	internal
BHS	binding head steel	lg	length or long
cap.	capacitor	met.	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

CHASSIS

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Description
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Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C741A¹
C741B¹
C741C¹
C741D¹

Semiconductor Device, Diodes

CR741A¹
CR741B¹
CR741C¹
CR741D¹

Delay Line

DL400	*119-0288-00	B010100	B010399	Delay line assembly
DL400	*119-0288-01	B010400		Delay line assembly

Bulbs

DS1090	150-0047-00	Incandescent, #CN8-398, 200 mA
DS1091	150-0047-00	Incandescent, #CN8-398, 200 mA
DS1092	150-0047-00	Incandescent, #CN8-398, 200 mA

Fuse

F1000	159-0023-00	2A	3AG	Slo-Blo
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Connector

J1050	131-0955-00	BNC, receptacle, electrical
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¹Furnished as a unit with HV Multiplier.

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
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Inductors

L1098	*108-0605-00			Y axis alignment
L1099	*108-0647-00			Trace rotator

Transistors

Q764	*151-0140-00	Silicon	NPN	TO-3	Selected from 2N3055
Q766	*151-0140-00	Silicon	NPN	TO-3	Selected from 2N3055
Q850	*151-0337-00	Silicon	NPN	TO-3	Selected from 2N3055
Q874	*151-0336-00	Silicon	NPN	TO-3	Selected from 2N3055
Q903	*151-0336-00	Silicon	NPN	TO-3	Selected from 2N3055
Q933	*151-0337-00	Silicon	NPN	TO-3	Selected from 2N3055
Q958	*151-0337-00	Silicon	NPN	TO-3	Selected from 2N3055
Q988	*151-0337-00	Silicon	NPN	TO-3	Selected from 2N3055

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R102 ¹	311-0945-00	5 k Ω , Var			
R741A ²					
R1045 ³	311-0945-00	5 M Ω , Var			
R1086	308-0679-00	0.51 Ω	2 W	WW	5%
R1095	311-1144-00	5 k Ω , Var			

Switches

Wired or Unwired

S1000	260-0907-00	Thermostatic	Open 280°F	Close 168°F
S1001	260-1222-00	Push-pull		POWER

Transformers

T738	*120-0709-00	HV Transformer
T801	*120-0708-00	LV Transformer

¹Furnished as a unit with R1045.

²Furnished as a unit with HV Multiplier.

³Furnished as a unit with R102.

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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HV Multiplier

U741	152-0495-00			HV Multiplier
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Electron Tube

V1099	*154-0640-00			CRT Standard Phosphor
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A1 MAIN INTERFACE Circuit Board Assembly***670-1372-00****Complete Board****Capacitors**Tolerance $\pm 20\%$ unless otherwise indicated.

C1	290-0271-00	9 μ F	Elect.	125 V	+20%—15%
C3	290-0302-00	100 μ F	Elect.	20 V	10%
C5	290-0302-00	100 μ F	Elect.	20 V	10%
C7	290-0302-00	100 μ F	Elect.	20 V	10%
C9	290-0271-00	9 μ F	Elect.	125 V	+20%—15%
C16	283-0068-00	0.01 μ F	Cer	500 V	
C18	283-0068-00	0.01 μ F	Cer	500 V	
C44	283-0068-00	0.01 μ F	Cer	500 V	
C47	281-0638-00	240 pF	Cer	500 V	5%

Semiconductor Device, Diodes

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

Connectors

J1	131-0767-00	Receptacle, electrical, 76 pin
J2	131-0767-02	Receptacle, electrical, 76 pin
J3	131-0767-02	Receptacle, electrical, 76 pin

A1 MAIN INTERFACE 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.						
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	315-0561-00		560 Ω	$\frac{1}{4}$ W		5%
R23	315-0561-00		560 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%
R33	315-0682-00		6.8 k Ω	$\frac{1}{4}$ W		5%
R42	315-0105-00		1 M Ω	$\frac{1}{4}$ W		5%
R44	315-0334-00		330 k	$\frac{1}{4}$ 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%

A2 LOGIC Circuit Board Assembly***670-1370-00****Complete Board****Capacitors**Tolerance $\pm 20\%$ unless otherwise indicated.

C55	283-0003-00	0.01 μ F	Cer	150 V	
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	5%
C73	283-0003-00	0.01 μ F	Cer	150 V	
C75	283-0000-00	0.001 μ F	Cer	500 V	
C89	283-0003-00	0.01 μ F	Cer	150 V	
C135	281-0503-00	8 pF	Cer	500 V	± 0.5 pF
C136	281-0547-00	2.7 pF	Cer	500 V	10%
C137	283-0000-00	0.001 μ F	Cer	500 V	
C145	281-0503-00	8 pF	Cer	500 V	± 0.5 pF
C146	281-0547-00	2.7 pF	Cer	500 V	10%
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	± 0.5 pF
C166	281-0547-00	2.7 pF	Cer	500 V	10%
C185	281-0503-00	8 pF	Cer	500 V	± 0.5 pF
C186	281-0547-00	2.7 pF	Cer	500 V	10%
C187	283-0000-00	0.001 μ F	Cer	500 V	
C193	283-0026-00	0.2 μ F	Cer	25 V	

A2 LOGIC Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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Capacitors (cont)

C195	283-0026-00		0.2 μ F	Cer 25 V
C196	283-0003-00		0.01 μ F	Cer 150 V
C198	283-0026-00		0.2 μ F	Cer 25 V

Semiconductor Device, Diodes

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
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

Inductors

LR193	*108-0604-00	3.2 μ H (wound on a 7.5 Ω , 1/4 W, 5% resistor)
LR195	*108-0604-00	3.2 μ H (wound on a 7.5 Ω , 1/4 W, 5% resistor)
LR197	*108-0604-00	3.2 μ H (wound on a 7.5 Ω , 1/4 W, 5% resistor)
LR198	*108-0604-00	3.2 μ H (wound on a 7.5 Ω , 1/4 W, 5% resistor)

Transistors

Q71	151-0223-00	Silicon	NPN	TO-18	2N4275
Q90A,B	151-0232-00	Silicon	NPN	TO-78	Dual
Q118	151-0223-00	Silicon	NPN	TO-18	2N4275
Q132	*151-0199-00	Silicon	PNP	TO-92	Replaceable by MOT MPS 3640
Q137	151-0223-00	Silicon	NPN	TO-18	2N4275

A2 LOGIC Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description	
Transistors (cont)				
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

ResistorsResistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R50	315-0223-00	22 k Ω	$\frac{1}{4}$ W	Prec	5%
R51	321-0193-00	1 k Ω	$\frac{1}{8}$ W		1%
R53	315-0223-00	22 k Ω	$\frac{1}{4}$ W	Prec	5%
R54	321-0193-00	1 k Ω	$\frac{1}{8}$ W		1%
R55	315-0470-00	47 Ω	$\frac{1}{4}$ W		5%
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	Prec	5%
R63	315-0102-00	1 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		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%
R69	315-0154-00	150 k Ω	$\frac{1}{4}$ W		5%
R71	315-0103-00	10 k Ω	$\frac{1}{4}$ W		5%
R73	315-0510-00	51 Ω	$\frac{1}{4}$ W		5%
R74	315-0510-00	51 Ω	$\frac{1}{4}$ W	Prec	5%
R76	315-0222-00	2.2 k Ω	$\frac{1}{4}$ W		5%
R77	315-0392-00	3.9 k Ω	$\frac{1}{4}$ W		5%
R78	321-0258-00	4.75 k Ω	$\frac{1}{8}$ W		1%
R80	315-0392-00	3.9 k Ω	$\frac{1}{4}$ W		5%

A2 LOGIC Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description	
Resistors (cont)				
R82	315-0510-00	51 Ω	$\frac{1}{4}$ W	5%
R83	315-0510-00	51 Ω	$\frac{1}{4}$ W	5%
R84	315-0510-00	51 Ω	$\frac{1}{4}$ W	5%
R85	315-0471-00	470 Ω	$\frac{1}{4}$ W	5%
R86	315-0100-00	10 Ω	$\frac{1}{4}$ W	5%
R88	321-0230-00	2.43 k Ω	$\frac{1}{8}$ W	Prec 1%
R89	315-0910-00	91 Ω	$\frac{1}{4}$ W	5%
R90	315-0362-00	3.6 k Ω	$\frac{1}{4}$ W	5%
R92	321-0202-00	1.24 k Ω	$\frac{1}{8}$ W	Prec 1%
R93	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R95	315-0751-00	750 Ω	$\frac{1}{4}$ W	5%
R96	315-0241-00	240 Ω	$\frac{1}{4}$ W	5%
R98	315-0511-00	510 Ω	$\frac{1}{4}$ W	5%
R99	315-0221-00	220 Ω	$\frac{1}{4}$ W	5%
R101	315-0302-00	3 k Ω	$\frac{1}{4}$ W	5%
R108	321-0237-00	2.87 k Ω	$\frac{1}{8}$ W	Prec 1%
R109	315-0471-00	470 Ω	$\frac{1}{4}$ W	5%
R110	321-0097-00	100 Ω	$\frac{1}{8}$ W	Prec 1%
R112	321-0097-00	100 Ω	$\frac{1}{8}$ W	Prec 1%
R115	315-0512-00	5.1 Ω	$\frac{1}{4}$ W	5%
R116	315-0510-00	51 Ω	$\frac{1}{4}$ W	5%
R118	315-0472-00	4.7 k Ω	$\frac{1}{4}$ W	5%
R120	315-0472-00	4.7 k Ω	$\frac{1}{4}$ W	5%
R121	315-0472-00	4.7 k Ω	$\frac{1}{4}$ W	5%
R122	315-0472-00	4.7 k Ω	$\frac{1}{4}$ W	5%
R123	315-0103-00	10 k Ω	$\frac{1}{4}$ W	5%
R124	315-0511-00	510 Ω	$\frac{1}{4}$ W	5%
R125	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R126	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R128	315-0510-00	51 Ω	$\frac{1}{4}$ W	5%
R129	315-0223-00	22 k Ω	$\frac{1}{4}$ W	5%
R130	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R132	315-0222-00	2.2 k Ω	$\frac{1}{4}$ W	5%
R133	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R134	315-0821-00	820 Ω	$\frac{1}{4}$ W	5%
R135	315-0123-00	12 k Ω	$\frac{1}{4}$ W	5%
R136	315-0681-00	680 Ω	$\frac{1}{4}$ W	5%
R137	315-0221-00	220 Ω	$\frac{1}{4}$ W	5%
R138	315-0472-00	4.7 k Ω	$\frac{1}{4}$ W	5%
R140	315-0391-00	390 Ω	$\frac{1}{4}$ W	5%

A2 LOGIC Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Resistors (cont)			
R141	315-0122-00	1.2 k Ω	$\frac{1}{4}$ W 5%
R142	315-0222-00	2.2 k Ω	$\frac{1}{4}$ W 5%
R143	315-0102-00	1 k Ω	$\frac{1}{4}$ W 5%
R144	315-0821-00	820 Ω	$\frac{1}{4}$ W 5%
R145	315-0123-00	12 k Ω	$\frac{1}{4}$ W 5%
R146	315-0681-00	680 Ω	$\frac{1}{4}$ W 5%
R147	315-0181-00	180 Ω	$\frac{1}{4}$ W 5%
R148	315-0472-00	4.7 k Ω	$\frac{1}{4}$ W 5%
R149	315-0100-00	10 Ω	$\frac{1}{4}$ W 5%
R150	315-0103-00	10 k Ω	$\frac{1}{4}$ W 5%
R152	315-0101-00	100 Ω	$\frac{1}{4}$ W 5%
R154	315-0223-00	22 k Ω	$\frac{1}{4}$ W 5%
R155	315-0391-00	390 Ω	$\frac{1}{4}$ W 5%
R157	315-0103-00	10 k Ω	$\frac{1}{4}$ W 5%
R158	315-0203-00	20 k Ω	$\frac{1}{4}$ W 5%
R159	315-0510-00	51 Ω	$\frac{1}{4}$ W 5%
R160	315-0391-00	390 Ω	$\frac{1}{4}$ W 5%
R161	315-0122-00	1.2 k Ω	$\frac{1}{4}$ W 5%
R162	315-0222-00	2.2 k Ω	$\frac{1}{4}$ W 5%
R163	315-0102-00	1 k Ω	$\frac{1}{4}$ W 5%
R164	315-0821-00	820 Ω	$\frac{1}{4}$ W 5%
R165	315-0123-00	12 k Ω	$\frac{1}{4}$ W 5%
R166	315-0681-00	680 Ω	$\frac{1}{4}$ W 5%
R168	315-0472-00	4.7 k Ω	$\frac{1}{4}$ W 5%
R170	315-0472-00	4.7 k Ω	$\frac{1}{4}$ W 5%
R174	315-0121-00	120 Ω	$\frac{1}{4}$ W 5%
R180	315-0391-00	390 Ω	$\frac{1}{4}$ W 5%
R181	315-0122-00	1.2 k Ω	$\frac{1}{4}$ W 5%
R182	315-0222-00	2.2 k Ω	$\frac{1}{4}$ W 5%
R183	315-0102-00	1 k Ω	$\frac{1}{4}$ W 5%
R184	315-0821-00	820 Ω	$\frac{1}{4}$ W 5%
R185	315-0123-00	12 k Ω	$\frac{1}{4}$ W 5%
R186	315-0681-00	680 Ω	$\frac{1}{4}$ W 5%
R188	315-0472-00	4.7 k Ω	$\frac{1}{4}$ W 5%
R189	315-0100-00	10 Ω	$\frac{1}{4}$ W 5%

Integrated Circuits

U55	*155-0011-00	Monolithic
U99	156-0048-00	Linear, replaceable by RCA CA3046
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

A3 TRIGGER SELECTOR Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No.		Description
		Eff	Disc	

670-1371-00*Complete Board****Capacitors**Tolerance $\pm 20\%$ unless otherwise indicated.

C301	283-0003-00	0.01 μ F	Cer	150 V	
C305	283-0004-00	0.02 μ F	Cer	150 V	
C322	281-0572-00	6.8 pF	Cer	500 V	± 0.5 pF
C329	281-0572-00	6.8 pF	Cer	500 V	± 0.5 pF
C342	283-0000-00	0.001 μ F	Cer	500 V	
C343	281-0509-00	15 pF	Cer	500 V	10%
C348	283-0000-00	0.001 μ F	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
Q344	151-0221-00	Silicon	PNP	TO-18	2N4258
Q346	151-0221-00	Silicon	PNP	TO-18	2N4258

ResistorsResistors 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%

A3 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	321-0052-00	34 Ω	1/8 W	Prec		1%
R335	321-0052-00	34 Ω	1/8 W	Prec		1%
R340	321-0214-00	1.65 kΩ	1/8 W	Prec		1%
R341	315-0680-00	68 Ω	1/4 W			5%
R342	315-0331-00	330 Ω	1/4 W			5%
R343	315-0330-00	33 Ω	1/4 W			5%
R344	321-0040-00	25.5 Ω	1/8 W	Prec		1%
R345	315-0561-00	560 Ω	1/4 W			5%
R346	321-0040-00	25.5 Ω	1/8 W	Prec		1%
R348	315-0331-00	330 Ω	1/4 W			5%
R349	315-0680-00	68 Ω	1/4 W			5%
R350	321-0214-00	1.65 kΩ	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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A4 VERTICAL INTERFACE Circuit Board Assembly

*670-1373-00	B010100	B010399	Complete Board
*670-1373-01	B010400	B029999	Complete Board
*670-1373-02	B030000		Complete Board

CapacitorsTolerance $\pm 20\%$ unless otherwise indicated.

C207	281-0538-00	1 pF	Cer	500 V	
C208	281-0528-00	82 pF	Cer	500 V	10%
C215	281-0589-00	170 pF	Cer	500 V	5%
C217	281-0537-00	0.68 pF	Cer	500 V	
C220	283-0177-00	1 μ F	Cer	25 V	+80%—20%
C227	281-0503-00	8 pF	Cer	500 V	± 0.5 pF
C260	283-0000-00	XB010400	Cer	500 V	

Transistors

Q225	151-0190-00	Silicon	NPN	TO-92	2N3904
Q236	151-0190-00	Silicon	NPN	TO-92	2N3904
Q242	151-0221-00	Silicon	PNP	TO-18	2N4258
Q252	151-0221-00	Silicon	PNP	TO-18	2N4258

A4 VERTICAL INTERFACE Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description		
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	315-0393-00		39 k Ω	$\frac{1}{4}$ W		5%
R209	321-0741-02		40.9 Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{2}\%$
R211	322-0197-00		1.10 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	315-0393-00		39 k Ω	$\frac{1}{4}$ W		5%
R216	321-0741-02		40.9 Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{2}\%$
R218	322-0197-00		1.10 k Ω	$\frac{1}{4}$ W	Prec	1%
R219	321-0741-02		40.9 Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{2}\%$
R223	315-0330-00		33 Ω	$\frac{1}{4}$ W		5%
R225	315-0911-00		910 Ω	$\frac{1}{4}$ W		5%
R226	321-0069-00		51.1 Ω	$\frac{1}{8}$ W	Prec	1%
R228	321-0060-00		41.2 Ω	$\frac{1}{8}$ W	Prec	1%
R230	321-0236-00		2.8 k Ω	$\frac{1}{8}$ W	Prec	1%
R232	321-0060-00		41.2 Ω	$\frac{1}{8}$ W	Prec	1%
R234	321-0069-00		51.1 Ω	$\frac{1}{8}$ W	Prec	1%
R236	315-0911-00		910 Ω	$\frac{1}{4}$ W		5%
R238	315-0330-00		33 Ω	$\frac{1}{4}$ W		5%
R240	323-0149-00		348 Ω	$\frac{1}{2}$ W	Prec	1%
R244	315-0101-00		100 Ω	$\frac{1}{4}$ W		5%
R246	315-0331-00		330 Ω	$\frac{1}{4}$ W		5%
R250	323-0149-00		348 Ω	$\frac{1}{2}$ W	Prec	1%
R254	315-0101-00		100 Ω	$\frac{1}{4}$ W		5%
R260	321-0098-00	B010100	102 Ω	$\frac{1}{8}$ W	Prec	1%
R260	321-0069-00	B010400	51.1 Ω	$\frac{1}{8}$ W	Prec	1%
R262	321-0069-00	XB010400	51.1 Ω	$\frac{1}{8}$ W	Prec	1%

Integrated Circuit

U214	*155-0022-00	Monolithic
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A5 VERTICAL OUTPUT Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
	*670-1377-00	B010100	B029999	Complete Board
	*670-1377-01	B030000		Complete Board

CapacitorsTolerance $\pm 20\%$ unless otherwise indicated.

C400	281-0604-00	2.2 pF	Cer	500 V	± 0.25 pF
C401	281-0504-00	10 pF	Cer	500 V	10%
C403	281-0504-00	10 pF	Cer	500 V	10%
C405	281-0153-00	1.7-11 pF, Var	Air	250 V	
C406	281-0509-00	15 pF	Cer	500 V	10%
C407	281-0524-00	150 pF	Cer	500 V	
C408	283-0116-00	820 pF	Cer	500 V	5%
C409	283-0600-00	43 pF	Mica	500 V	5%
C411	281-0509-00	15 pF	Cer	500 V	10%
C413	281-0151-00	1-3 μ F, Var	Cer	100 V	
C415	281-0659-00	4.3 pF	Cer	500 V	± 0.25 pF
C417	281-0659-00	4.3 pF	Cer	500 V	± 0.25 pF
C430	281-0658-00	6.2 pF	Cer	500 V	± 0.25 pF
C433	281-0658-00	6.2 pF	Cer	500 V	± 0.25 pF
C442	283-0003-00	0.01 μ F	Cer	150 V	
C445	283-0000-00	0.001 μ F	Cer	500 V	
C459	281-0160-00	7-25 pF, Var	Cer	350 V	
C479	283-0003-00	0.01 μ F	Cer	150 V	
C490	283-0003-00	0.01 μ F	Cer	150 V	
C492	283-0003-00	0.01 μ F	Cer	150 V	
C494	283-0003-00	0.01 μ F	Cer	150 V	

Semiconductor Device, Diodes

CR442	*152-0185-00	Silicon	Replaceable by 1N4152
CR445	*152-0185-00	Silicon	Replaceable by 1N4152

Inductors

L430	276-0528-00	XB030000	Core, ferramic suppressor
L433	276-0528-00	XB030000	Core, ferramic suppressor
LR475	*108-0209-00		0.75 μ H (wound on a 470 Ω , $\frac{1}{2}$ W, 10% resistor)
LR483	*108-0209-00		0.75 μ H (wound on a 470 Ω , $\frac{1}{2}$ W, 10% resistor)

Transistors

Q420	151-0221-00	Silicon	PNP	TO-18	2N4258
Q424	151-0221-00	Silicon	PNP	TO-18	2N4258
Q435	*151-0269-00	Silicon	NPN	TO-106	Selected from SE 3005
Q440	*151-0269-00	Silicon	NPN	TO-106	Selected from SE 3005
Q444	151-0190-00	Silicon	NPN	TO-92	2N3904

A5 VERTICAL OUTPUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description		
Transistors (cont)					
Q452	*151-0269-00	Silicon	NPN	TO-106	Selected from SE 3005
Q456	*151-0160-00	Silicon	NPN	TO-5	Selected from 2N3137
Q462	*151-0269-00	Silicon	NPN	TO-106	Selected from SE 3005
Q466	*151-0160-00	Silicon	NPN	TO-5	Selected from 2N3137
Q470	*151-0211-00	Silicon	NPN	TO-5	Selected from 2N3866
Q474	*151-0211-00	Silicon	NPN	TO-5	Selected from 2N3866

ResistorsResistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R401	321-0068-00		49.9 Ω	$\frac{1}{8}$ W	Prec	1%
R403	321-0068-00		49.9 Ω	$\frac{1}{8}$ W	Prec	1%
R405	311-0978-00		250 Ω , Var			
R407	315-0103-00		10 k Ω	$\frac{1}{4}$ W		5%
R408	315-0473-00		47 k Ω	$\frac{1}{4}$ W		5%
R409	315-0562-00	B010100	5.6 k Ω	$\frac{1}{4}$ W		5%
R409	315-0512-00	B030000	5.1 k Ω	$\frac{1}{4}$ W		5%
R411	315-0202-00		2 k Ω	$\frac{1}{4}$ W		5%
R413	315-0201-00		200 Ω	$\frac{1}{4}$ W		5%
R415	321-0126-00		200 Ω	$\frac{1}{8}$ W	Prec	1%
R417	321-0126-00		200 Ω	$\frac{1}{8}$ W	Prec	1%
R422	315-0331-00		330 Ω	$\frac{1}{4}$ W		5%
R426	321-0193-00		1 k Ω	$\frac{1}{8}$ W	Prec	1%
R427	311-0634-00		500 Ω , Var			
R428	321-0193-00		1 k Ω	$\frac{1}{8}$ W	Prec	1%
R430	321-0126-00		200 Ω	$\frac{1}{8}$ W	Prec	1%
R433	321-0126-00		200 Ω	$\frac{1}{8}$ W	Prec	1%
R437	321-0109-00		133 Ω	$\frac{1}{8}$ W	Prec	1%
R438	315-0152-00		1.5 k Ω	$\frac{1}{4}$ W		5%
R443	315-0822-00		8.2 k Ω	$\frac{1}{4}$ W		5%
R447	323-0181-00		750 Ω	$\frac{1}{2}$ W	Prec	1%
R449	323-0181-00		750 Ω	$\frac{1}{2}$ W	Prec	1%
R450	315-0272-00		2.7 k Ω	$\frac{1}{4}$ W		5%
R451	315-0560-00		56 Ω	$\frac{1}{4}$ W		5%
R453	315-0560-00		56 Ω	$\frac{1}{4}$ W		5%
R454	315-0471-00		470 Ω	$\frac{1}{4}$ W		5%
R455	315-0222-00		2.2 k Ω	$\frac{1}{4}$ W		5%
R457	323-0155-00		402 Ω	$\frac{1}{2}$ W	Prec	1%
R458	311-0643-00		50 Ω , Var			
R460	315-0272-00		2.7 k Ω	$\frac{1}{4}$ W		5%
R461	315-0560-00		56 Ω	$\frac{1}{4}$ W		5%

A5 VERTICAL OUTPUT Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description			
Resistors (cont)						
R463	315-0560-00	56 Ω	1/4 W			5%
R465	315-0222-00	2.2 kΩ	1/4 W			5%
R467	323-0155-00	402 Ω	1/2 W	Prec		1%
R468	321-0075-00	59 Ω	1/8 W	Prec		1%
R470	315-0100-00	10 Ω	1/4 W			5%
R472	315-0121-00	120 Ω	1/4 W			5%
R474	315-0100-00	10 Ω	1/4 W			5%
R477	308-0676-00	750 Ω	5 W	WW		1%
R479	307-0106-00	4.7 Ω	1/4 W			5%
R481	308-0676-00	750 Ω	5 W	WW		1%
R490	307-0103-00	2.7 Ω	1/4 W			5%
R492	307-0103-00	2.7 Ω	1/4 W			5%
R494	307-0103-00	2.7 Ω	1/4 W			5%

A6 HORIZONTAL AMPLIFIER Circuit Board Assembly***670-1378-00****Complete Board****Capacitors**Tolerance $\pm 20\%$ unless otherwise indicated.

C513	283-0002-00	0.01 μ F	Cer	500 V	
C519	281-0564-00	24 pF	Cer	500 V	5%
C546	283-0002-00	0.01 μ F	Cer	500 V	
C550	283-0083-00	0.0047 μ F	Cer	500 V	5%
C561	281-0504-00	10 pF	Cer	500 V	10%
C562	281-0097-00	9-35 pF, Var	Cer		
C564	281-0526-00	1.5 pF	Cer	500 V	± 0.5 pF
C569	283-0002-00	0.01 μ F	Cer	500 V	
C573	283-0002-00	0.01 μ F	Cer	500 V	
C575	283-0083-00	0.0047 μ F	Cer	500 V	5%
C586	281-0504-00	10 pF	Cer	500 V	10%
C587	281-0092-00	9-35 pF, Var	Cer		
C588	281-0526-00	1.5 pF	Cer	500 V	± 0.5 pF
C593	283-0002-00	0.01 μ F	Cer	500 V	
C595	283-0081-00	0.1 μ F	Cer	25 V	+80%—20%
C596	283-0081-00	0.1 μ F	Cer	25 V	+80%—20%
C597	283-0081-00	0.1 μ F	Cer	25 V	+80%—20%
C599	283-0081-00	0.1 μ F	Cer	25 V	+80%—20%

A6 HORIZONTAL AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description			
Semiconductor Device, Diodes						
CR519	*152-0322-00	Silicon	Tek Spec			
CR520	*152-0322-00	Silicon	Tek Spec			
CR522	*152-0153-00	Silicon	Tek Spec			
CR526	*152-0153-00	Silicon	Tek Spec			
CR528	*152-0153-00	Silicon	Tek Spec			
CR533	*152-0153-00	Silicon	Tek Spec			
CR538	*152-0185-00	Silicon	Replaceable by 1N4152			
CR539	*152-0185-00	Silicon	Replaceable by 1N4152			
CR543	*152-0153-00	Silicon	Tek Spec			
Transistors						
Q506	151-0223-00	Silicon	NPN	TO-18	2N4275	
Q516	151-0223-00	Silicon	NPN	TO-18	2N4275	
Q535	151-0220-00	Silicon	PNP	TO-18	2N4122	
Q541	151-0220-00	Silicon	PNP	TO-18	2N4122	
Q545	*151-0103-00	Silicon	NPN	TO-5	Replaceable by 2N2219	
Q547	*151-0103-00	Silicon	NPN	TO-5	Replaceable by 2N2219	
Q555	*151-0270-00	Silicon	PNP	TO-5	Tek Spec	
Q559	*151-0274-00	Silicon	NPN	TO-5	Selected from 2N3501	
Q580	*151-0270-00	Silicon	PNP	TO-5	Tek Spec	
Q584	*151-0274-00	Silicon	NPN	TO-5	Selected from 2N3501	
Resistors						
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.						
R501	321-0069-00	51.1 Ω	$\frac{1}{8}$ W	Prec		1%
R502	315-0100-00	10 Ω	$\frac{1}{4}$ W			5%
R503	321-0069-00	51.1 Ω	$\frac{1}{8}$ W	Prec		1%
R505	323-0187-00	866 Ω	$\frac{1}{2}$ W	Prec		1%
R506	315-0151-00	150 Ω	$\frac{1}{4}$ W			5%
R508	321-0148-00	340 Ω	$\frac{1}{8}$ W	Prec		1%
R509	311-1139-00	500 Ω , Var				
R510	321-0157-00	422 Ω	$\frac{1}{8}$ W	Prec		1%
R512	323-0190-00	931 Ω	$\frac{1}{2}$ W	Prec		1%
R513	311-1140-00	100 Ω , Var				
R514	323-0190-00	931 Ω	$\frac{1}{2}$ W	Prec		1%
R516	315-0151-00	150 Ω	$\frac{1}{4}$ W			5%
R517	323-0187-00	866 Ω	$\frac{1}{2}$ W	Prec		1%
R519	315-0122-00	1.2 k Ω	$\frac{1}{4}$ W			5%
R522	323-0206-00	1.37 k Ω	$\frac{1}{2}$ W	Prec		1%
R524	315-0473-00	47 k Ω	$\frac{1}{4}$ W			5%
R526	323-0206-00	1.37 k Ω	$\frac{1}{2}$ W	Prec		1%
R528	321-0320-00	21 k Ω	$\frac{1}{8}$ W	Prec		1%
R529	321-0269-00	6.19 k Ω	$\frac{1}{8}$ W	Prec		1%
R531	311-1138-00	1 k Ω , Var				

A6 HORIZONTAL AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description			
Resistors (cont)						
R532	321-0269-00	6.19 kΩ	1/8 W	Prec		1%
R533	321-0320-00	21 kΩ	1/8 W	Prec		1%
R535	321-0225-00	2.15 kΩ	1/8 W	Prec		1%
R537	315-0300-00	30 Ω	1/4 W			5%
R538	321-0193-00	1 kΩ	1/8 W	Prec		1%
R539	315-0300-00	30 Ω	1/4 W			5%
R541	321-0225-00	2.15 kΩ	1/8 W	Prec		1%
R543	315-0102-00	1 kΩ	1/4 W			5%
R546	303-0470-00	47 Ω	1 W			5%
R550	315-0470-00	47 Ω	1/4 W			5%
R551	301-0393-00	39 kΩ	1/2 W			5%
R553	323-0066-00	47.5 Ω	1/2 W	Prec		1%
R555	323-0231-00	2.49 kΩ	1/2 W	Prec		1%
R556	315-0100-00	10 Ω	1/4 W			5%
R558	315-0100-00	10 Ω	1/4 W			5%
R559	323-0097-00	100 Ω	1/2 W	Prec		1%
R561	321-0189-00	9.09 Ω	1/8 W	Prec		1%
R562	315-0751-00	750 Ω	1/4 W			5%
R564	323-0287-00	9.53 kΩ	1/2 W	Prec		1%
R565	323-0287-00	9.53 kΩ	1/2 W	Prec		1%
R567	315-0101-00	100 Ω	1/4 W			5%
R569	321-0251-00	4.02 kΩ	1/8 W	Prec		1%
R570	321-0830-03	2.41 kΩ	1/8 W	Prec		1/4 %
R572	321-0273-00	6.81 kΩ	1/8 W	Prec		1%
R573	323-0352-00	45.3 kΩ	1/2 W	Prec		1%
R575	315-0470-00	47 Ω	1/4 W			5%
R576	301-0393-00	39 kΩ	1/2 W			5%
R578	323-0066-00	47.5 Ω	1/2 W	Prec		1%
R580	323-0231-00	2.49 kΩ	1/2 W	Prec		1%
R581	315-0100-00	10 Ω	1/4 W			5%
R583	315-0100-00	10 Ω	1/4 W			5%
R584	323-0097-00	100 Ω	1/2 W	Prec		1%
R586	321-0189-00	909 Ω	1/8 W	Prec		1%
R587	315-0751-00	750 Ω	1/4 W			5%
R588	323-0287-00	9.53 kΩ	1/2 W	Prec		1%
R589	323-0287-00	9.53 kΩ	1/2 W	Prec		1%
R591	315-0101-00	100 Ω	1/4 W			5%
R593	315-0100-00	10 Ω	1/4 W			5%
R595	307-0106-00	4.7 Ω	1/4 W			5%
R597	315-0100-00	10 Ω	1/4 W			5%
R599	307-0103-00	2.7 Ω	1/4 W			5%

A7 CALIBRATOR Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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670-1379-00*Complete Board****Capacitors**Tolerance $\pm 20\%$ unless otherwise indicated.

C1064	285-0703-00	0.1 μ F	PTM	100 V	5%
C1079	283-0513-00	220 pF	Mica	500 V	5%

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		

Transistors

Q1061	151-0224-00	Silicon	NPN	TO-18	2N3692
Q1066	151-0224-00	Silicon	NPN	TO-18	2N3692
Q1070	151-0220-00	Silicon	PNP	TO-18	2N4122
Q1072	151-0220-00	Silicon	PNP	TO-18	2N4122

ResistorsResistors 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%
R1040	311-1141-00	2.5 k Ω , Var			
R1061	315-0223-00	22 k Ω	$\frac{1}{4}$ W		5%
R1062	315-0362-00	3.6 k Ω	$\frac{1}{4}$ W		5%
R1063	315-0433-00	43 k Ω	$\frac{1}{4}$ W		5%
R1066	315-0183-00	18 k Ω	$\frac{1}{4}$ W		5%
R1067	315-0513-00	51 k Ω	$\frac{1}{4}$ W		5%
R1069	315-0433-00	43 k Ω	$\frac{1}{4}$ W		5%
R1071	323-0260-00	4.99 k Ω	$\frac{1}{2}$ W	Prec	1%
R1073	315-0222-00	2.2 k Ω	$\frac{1}{4}$ W		5%
R1074	315-0102-00	1 k Ω	$\frac{1}{4}$ W		5%
R1076	315-0752-00	7.5 k Ω	$\frac{1}{4}$ W		5%
R1077	311-1137-00	5 k Ω , Var			
R1079	315-0203-00	20 k Ω	$\frac{1}{4}$ W		5%
R1081	321-0812-07	455 Ω	$\frac{1}{8}$ W	Prec	1/10%
R1082	321-0825-03	50.8 k Ω	$\frac{1}{8}$ W	Prec	$\frac{1}{4}\%$
R1084	321-0816-07	5 k Ω	$\frac{1}{8}$ W	Prec	1/10%
R1085	321-1068-07	50.5 Ω	$\frac{1}{8}$ W	Prec	1/10%

A7 CALIBRATOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Description
Switches				
	Wired or Unwired			
S1021 ¹	*670-1379-00		Pushbutton	VERT MODE
S1030	260-1132-00		Push-push	BEAM FINDER

A8 TRIGGER SOURCE SWITCH Circuit Board Assembly

*670-1375-00 Complete Board

Switch

	Wired or Unwired			
S1011 ¹	*670-1375-00		Pushbutton	TRIG SOURCE

A9 Z AXIS AMPLIFIER Circuit Board Assembly

*670-1383-00 B010100 B029999 Complete Board
 *670-1383-01 B030000 Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C604	283-0092-00	0.03 μ F	Cer	200 V	+80%—20%
C611	283-0092-00	0.03 μ F	Cer	200 V	+80%—20%
C613	283-0092-00	0.03 μ F	Cer	200 V	+80%—20%
C617	283-0092-00	0.03 μ F	Cer	200 V	+80%—20%
C619	283-0092-00	0.03 μ F	Cer	200 V	+80%—20%
C622	281-0053-00	0.35-1.37 pF, Var	Cer		
C630	283-0003-00	0.01 μ F	Cer	150 V	
C636	283-0003-00	0.01 μ F	Cer	150 V	
C639	283-0092-00	0.03 μ F	Cer	200 V	+80%—20%

Transistors

Q607	151-0188-00	Silicon	PNP	TO-92	2N3906
Q615	*151-0270-00	Silicon	PNP	TO-5	Tek Spec
Q619	151-0292-00	Silicon	NPN	TO-92	TIS100
Q621	151-0223-00	Silicon	NPN	TO-18	2N4275

¹See Mechanical Parts List for replacement parts.

A9 Z AXIS AMPLIFIER 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.					
R602	315-0124-00			120 k Ω	5%
R604	315-0103-00			10 k Ω	5%
R605	315-0103-00			10 k Ω	5%
R609	315-0102-00			1 k Ω	5%
R611	315-0102-00			1 k Ω	5%
R613	315-0100-00			10 Ω	5%
R615	315-0472-00			4.7 k Ω	5%
R617	315-0562-00			5.6 k Ω	5%
R618	303-0203-00			20 k Ω	5%
R620	315-0103-00			10 k Ω	5%
R622	315-0682-00	B010100	B029999	6.8 k Ω	5%
R622	315-0472-00	B030000		4.7 k Ω	5%
R623	323-0312-00			17.4 k Ω	1%
R625	315-0121-00			120 Ω	5%
R630	311-1148-00			100 k Ω , Var	
R633	311-1141-00			2.5 k Ω , Var	
R636	311-1148-00			100 k Ω , Var	
R638	315-0432-00			4.3 k Ω	5%
R639	315-0512-00			5.1 k Ω	5%

A10 HIGH VOLTAGE Circuit Board Assembly***670-1380-00****Complete Board****Capacitors**Tolerance $\pm 20\%$ unless otherwise indicated.

C700	290-0410-00	15 μ F	Elect.	100 V	+50%—10%
C702	283-0021-00	0.001 μ F	Cer	5000 V	
C704	283-0189-00	0.1 μ F	Cer	400 V	
C705	283-0198-00	0.22 μ F	Cer	50 V	
C711	283-0078-00	0.001 μ F	Cer	500 V	
C720	285-0629-00	0.047 μ F	PTM	300 V	
C722	290-0312-00	47 μ F	Elect.	35 V	10%
C743	283-0082-00	0.01 μ F	Cer	4000 V	+80%—20%
C745	283-0082-00	0.01 μ F	Cer	4000 V	+80%—20%
C746	283-0082-00	0.01 μ F	Cer	4000 V	+80%—20%
C748	281-0512-00	27 pF	Cer	500 V	10%
C750	283-0082-00	0.01 μ F	Cer	4000 V	+80%—20%
C752	283-0021-00	0.001 μ F	Cer	5000 V	
C757	290-0305-01	3 μ F	Elect.	150 V	10%
C760	283-0021-00	0.001 μ F	Cer	5000 V	

A10 HIGH VOLTAGE Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description			
Semiconductor Device, Diodes						
CR700	*152-0061-00	Silicon	Tek Spec			
CR716	*152-0185-00	Silicon	Replaceable by 1N4152			
CR743	152-0409-00	Silicon	High voltage 10 kV			
CR750	*152-0061-00	Silicon	Tek Spec			
CR752	*152-0061-00	Silicon	Tek Spec			
CR756	*152-0061-00	Silicon	Tek Spec			
CR757	*152-0061-00	Silicon	Tek Spec			
Inductor						
L722	*108-0646-00	80 μ H				
Transistors						
Q708	*151-0126-00	Silicon	NPN	TO-18	Replaceable by 2N2484	
Q712	151-0188-00	Silicon	PNP	TO-92	2N3906	
Q716	151-0136-00	Silicon	NPN	TO-5	2N3053	
Resistors						
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.						
R700	315-0434-00	430 k Ω	$\frac{1}{4}$ W	5%		
R702A } R702B } R702C }	*307-0283-00	650 k Ω 29.45 k Ω 19 M Ω	Thick film			
R705	315-0302-00	3 k Ω	$\frac{1}{4}$ W	5%		
R706	315-0473-00	47 k Ω	$\frac{1}{4}$ W	5%		
R708	315-0395-00	3.9 M Ω	$\frac{1}{4}$ W	5%		
R709	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%		
R713	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%		
R714	315-0104-00	100 k Ω	$\frac{1}{4}$ W	5%		
R716	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%		
R745	301-0203-00	20 k Ω	$\frac{1}{2}$ W	5%		
R748	301-0165-00	1.6 M Ω	$\frac{1}{2}$ W	5%		
R754	301-0915-00	9.1 M Ω	$\frac{1}{2}$ W	5%		
R758	315-0513-00	51 k Ω	$\frac{1}{4}$ W	5%		
R759	311-1134-00	50 k Ω , Var				
R761	325-0073-00	3.57 M Ω	1 W	Prec	1%	
R763	301-0104-00	100 k Ω	$\frac{1}{2}$ W	5%		
R765	315-0473-00	47 k Ω	$\frac{1}{4}$ W	5%		

A11 RECTIFIER Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
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670-1382-00*Complete Board****Capacitors**Tolerance $\pm 20\%$ unless otherwise indicated.

C806	290-0468-00	250 μF	Elect.	150 V	+75%—10%
C808	290-0507-00	1800 μF	Elect.	75 V	+75%—10%
C809	290-0507-00	1800 μF	Elect.	75 V	+75%—10%
C810	285-0555-00	0.1 μF	MT	100 V	
C811	290-0506-00	9600 μF	Elect.	25 V	+100%—10%
C813	290-0506-00	9600 μF	Elect.	25 V	+100%—10%
C814	290-0506-00	9600 μF	Elect.	25 V	+100%—10%
C820	285-0555-00	0.1 μF	MT	100 V	
C821	290-0508-00	18,000 μF	Elect.	15 V	+100%—10%
C823	283-0004-00	0.02 μF	Cer	150 V	

Semiconductor Device, Diodes

CR806	152-0488-00	Silicon	Rectifier Bridge 200 V, 1.5 A		
CR808	152-0488-00	Silicon	Rectifier Bridge 200 V, 1.5 A		
CR811	152-0406-00	Silicon	Rectifier assembly, full wave bridge, 3 A, 250 V		
CR820	152-0423-00	Silicon	Rectifier 300 V, 3 A		
CR821	152-0423-00	Silicon	Rectifier 300 V, 3 A		

Fuses

F814	159-0021-00	2 A	3AG	Fast-Blo
F1001	159-0019-00	1 A	3AG	Slo-Blo

Transistors

Q827	151-0223-00	Silicon	NPN	TO-92	2N4275
Q829	151-0223-00	Silicon	NPN	TO-92	2N4275
Q835	151-0334-00	Silicon	NPN	Plastic	MJE 520

ResistorsResistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R805	315-0100-00	10 Ω	$\frac{1}{4}$ W	5%
R822	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R823	315-0151-00	150 Ω	$\frac{1}{4}$ W	5%
R824	315-0470-00	47 Ω	$\frac{1}{4}$ W	5%
R826	315-0302-00	3 k Ω	$\frac{1}{4}$ W	5%

A11 RECTIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Resistors (cont)					
R827	315-0472-00		4.7 k Ω	1/4 W	5%
R830	315-0911-00		910 Ω	1/4 W	5%
R831	315-0392-00		3.9 k Ω	1/4 W	5%
R833	315-0683-00		68 k Ω	1/4 W	5%
R837	307-0054-00		3.6 Ω	1/2 W	5%
R838	307-0054-00		3.6 Ω	1/2 W	5%

A12 LOW-VOLTAGE REGULATOR Circuit Board Assembly

*670-1376-00	B010100	B029999	Complete Board
*670-1376-02	B030000		Complete Board

CapacitorsTolerance $\pm 20\%$ unless otherwise indicated.

C858	283-0078-00			0.001 μ F	Cer	500 V	
C866	283-0077-00	B010100	B010329	330 pF	Cer	500 V	5%
C866	283-0078-00	B010330		0.001 μ F	Cer	500 V	
C880	283-0638-00			130 pF	Mica	100 V	1%
C889	290-0415-00			5.6 μ F	Elect.	35 V	10%
C923	281-0591-00			5600 pF	Cer	200 V	
C950	283-0078-00	B010100	B029999	0.001 μ F	Cer	500 V	
C950	283-0083-00	B010330		0.0047 μ F	Cer	500 V	
C979	281-0591-00			5600 pF	Cer	200 V	
C985	283-0083-00			0.0047 μ F	Cer	500 V	5%

Semiconductor Device, Diodes

CR852	*152-0185-00		Silicon	Replaceable by 1N4152
CR861	*152-0185-00		Silicon	Replaceable by 1N4152
CR867	*152-0061-00		Silicon	Tek Spec
CR868	*152-0061-00		Silicon	Tek Spec
CR875	152-0066-00		Silicon	1N3194
CR883	*152-0185-00		Silicon	Replaceable by 1N4152
CR885	*152-0185-00		Silicon	Replaceable by 1N4152
CR888	*152-0185-00		Silicon	Replaceable by 1N4152
CR891	*152-0185-00		Silicon	Replaceable by 1N4152
CR894	*152-0185-00		Silicon	Replaceable by 1N4152
CR896	*152-0185-00		Silicon	Replaceable by 1N4152
CR903	152-0066-00		Silicon	1N3194
CR920	*152-0185-00		Silicon	Replaceable by 1N4152
CR924	*152-0061-00		Silicon	Tek Spec
CR925	*152-0061-00		Silicon	Tek Spec

A12 LOW-VOLTAGE REGULATOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Semiconductor Device, Diodes (cont)						
CR935	152-0066-00			Silicon	1N3194	
CR941	*152-0185-00			Silicon	Replaceable by 1N4152	
CR950	*152-0185-00			Silicon	Replaceable by 1N4152	
CR951	*152-0185-00			Silicon	Replaceable by 1N4152	
CR952	*152-0185-00			Silicon	Replaceable by 1N4152	
CR958	152-0066-00			Silicon	1N3194	
CR961	*152-0185-00			Silicon	Replaceable by 1N4152	
CR980	*152-0185-00			Silicon	Replaceable by 1N4152	
CR981	*152-0185-00			Silicon	Replaceable by 1N4152	
CR989	152-0066-00			Silicon	1N3194	
VR851	152-0283-00			Zener	1N976B 400 mW, 43 V, 5%	
VR890	152-0124-00			Zener	1N938A 500 mW, 9.1 V, 5% TC	
Fuse						
F855	159-0083-00			0.15 A	250 V	Fast-Blo
Transistors						
Q852	151-0276-00			Silicon	PNP	TO-92 2N5087
Q860	151-0292-00	B010100	B010329	Silicon	NPN	TO-92 TIS100
Q860	151-0347-00	B010330		Silicon	NPN	TO-92 2N5551
Q863	151-0292-00	B010100	B010329	Silicon	NPN	TO-92 TIS100
Q863	151-0347-00	B010330		Silicon	NPN	TO-92 2N5551
Q869	151-0292-00	B010100	B010329	Silicon	NPN	TO-92 TIS100
Q869	151-0347-00	B010330		Silicon	NPN	TO-92 2N5551
Q872	151-0279-00			Silicon	NPN	TO-39 SE 7056
Q876	151-0232-00			Silicon	NPN	TO-78 Dual
Q886	151-0232-00			Silicon	NPN	TO-78 Dual
Q896	*151-0228-00			Silicon	PNP	TO-5 Tek Spec
Q900	151-0292-00	B010100	B010329	Silicon	NPN	TO-92 TIS100
Q900	151-0347-00	B010330		Silicon	NPN	TO-92 2N5551
Q908	151-0292-00			Silicon	NPN	TO-92 TIS100
Q909	151-0292-00			Silicon	NPN	TO-92 TIS100
Q910	151-0292-00			Silicon	NPN	TO-92 TIS100
Q919	151-0232-00			Silicon	NPN	TO-78 Dual
Q926	151-0292-00	B010100	B010329	Silicon	NPN	TO-92 TIS100
Q926	151-0347-00	B010330		Silicon	NPN	TO-92 2N5551
Q931	151-0260-00			Silicon	NPN	TO-39 2N5189
Q936	151-0232-00			Silicon	NPN	TO-78 Dual
Q943	151-0232-00			Silicon	NPN	TO-78 Dual
Q952	*151-0134-00			Silicon	PNP	TO-5 Replaceable by 2N2905
Q956	151-0260-00			Silicon	NPN	TO-39 2N5189
Q964	151-0232-00			Silicon	NPN	TO-78 Dual
Q985	151-0136-00			Silicon	NPN	TO-5 2N3053

A12 LOW-VOLTAGE REGULATOR 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.				
R853	315-0473-00	47 k Ω	$\frac{1}{4}$ W	5%
R855	323-0309-00	16.2 k Ω	$\frac{1}{2}$ W	Prec 1%
R856	323-0289-00	10 k Ω	$\frac{1}{2}$ W	Prec 1%
R858	321-0924-07	40 k Ω	$\frac{1}{8}$ W	Prec 1/10%
R859	321-0924-07	40 k Ω	$\frac{1}{8}$ W	Prec 1/10%
R860	315-0684-00	680 k Ω	$\frac{1}{4}$ W	5%
R862	315-0204-00	200 k Ω	$\frac{1}{4}$ W	5%
R864	315-0203-00	20 k Ω	$\frac{1}{4}$ W	5%
R866	315-0332-00	3.3 k Ω	$\frac{1}{4}$ W	5%
R867	315-0824-00	820 k Ω	$\frac{1}{4}$ W	5%
R870	315-0122-00	1.2 k Ω	$\frac{1}{4}$ W	5%
R872	315-0151-00	150 Ω	$\frac{1}{4}$ W	5%
R875	308-0677-00	1 Ω	2 W	WW 5%
R876	315-0204-00	200 k Ω	$\frac{1}{4}$ W	5%
R877	315-0511-00	510 Ω	$\frac{1}{4}$ W	5%
R878	315-0244-00	240 k Ω	$\frac{1}{4}$ W	5%
R879	315-0124-00	120 k Ω	$\frac{1}{4}$ W	5%
R880	323-0272-00	6.65 k Ω	$\frac{1}{2}$ W	Prec 1%
R881	311-0978-00	250 Ω , Var	$\frac{1}{2}$ W	Prec 1%
R882	323-0206-00	1.37 k Ω	$\frac{1}{2}$ W	Prec 1%
R883	321-0223-00	2.05 k Ω	$\frac{1}{8}$ W	Prec 1%
R884	323-0306-00	15 k Ω	$\frac{1}{2}$ W	Prec 1%
R886	315-0224-00	220 k Ω	$\frac{1}{4}$ W	5%
R889	315-0911-00	910 Ω	$\frac{1}{4}$ W	5%
R890	323-0264-00	5.49 k Ω	$\frac{1}{2}$ W	Prec 1%
R891	315-0473-00	47 k Ω	$\frac{1}{4}$ W	5%
R892	315-0682-00	6.8 k Ω	$\frac{1}{4}$ W	5%
R894	315-0245-00	2.4 M Ω	$\frac{1}{4}$ W	5%
R896	301-0363-00	36 k Ω	$\frac{1}{2}$ W	5%
R898	315-0122-00	1.2 k Ω	$\frac{1}{4}$ W	5%
R901	315-0151-00	150 Ω	$\frac{1}{4}$ W	5%
R903	308-0677-00	1 Ω	2 W	WW 5%
R904	308-0679-00	0.51 Ω	2 W	WW 5%
R906	315-0304-00	300 k Ω	$\frac{1}{4}$ W	5%
R907	315-0124-00	120 k Ω	$\frac{1}{4}$ W	5%
R908	315-0431-00	430 Ω	$\frac{1}{4}$ W	5%
R910	315-0681-00	680 Ω	$\frac{1}{4}$ W	5%
R911	315-0563-00	56 k Ω	$\frac{1}{4}$ W	5%
R912	315-0152-00	1.5 k Ω	$\frac{1}{4}$ W	5%
R915	321-1296-07	12 k Ω	$\frac{1}{8}$ W	Prec 1/10%

A12 LOW-VOLTAGE REGULATOR Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Description		
Resistors (cont)						
R916	321-0924-07			40 kΩ	1/8 W	Prec 1/10%
R918	301-0683-00			68 kΩ	1/2 W	5%
R921	315-0912-00			9.1 kΩ	1/4 W	5%
R922	315-0623-00			62 kΩ	1/4 W	5%
R923	315-0512-00			5.1 kΩ	1/4 W	5%
R924	315-0623-00			62 kΩ	1/4 W	5%
R927	315-0472-00			4.7 kΩ	1/4 W	5%
R932	315-0182-00			1.8 kΩ	1/4 W	5%
R935	308-0678-00			0.1 Ω	2 W	WW 5%
R936	301-0273-00			27 kΩ	1/2 W	5%
R937	315-0361-00			360 Ω	1/4 W	5%
R938	315-0333-00			33 kΩ	1/4 W	5%
R939	315-0184-00			180 kΩ	1/4 W	5%
R940	315-0822-00			8.2 kΩ	1/4 W	5%
R942	315-0154-00			150 kΩ	1/4 W	5%
R945	321-0332-07			28 kΩ	1/8 W	Prec 1/10%
R946	321-1296-07			12 kΩ	1/8 W	Prec 1/10%
R948	315-0914-00			910 kΩ	1/4 W	5%
R950	315-0681-00			680 Ω	1/4 W	5%
R952	301-0363-00	B010100	B010449	36 kΩ	1/2 W	5%
R952	301-0303-00	B010450		30 kΩ	1/2 W	5%
R954	315-0472-00			4.7 kΩ	1/4 W	5%
R956	307-0103-00			2.7 Ω	1/4 W	5%
R957	315-0151-00			150 Ω	1/4 W	5%
R958	308-0678-00			0.1 Ω	2 W	WW 5%
R959	308-0680-00			0.045 Ω	3 W	WW
R961	315-0221-00			220 Ω	1/4 W	5%
R963	315-0103-00			10 kΩ	1/4 W	5%
R966	315-0243-00			24 kΩ	1/4 W	5%
R967	315-0364-00			360 kΩ	1/4 W	5%
R970	321-0926-07			4 kΩ	1/8 W	Prec 1/10%
R971	321-0924-07			40 kΩ	1/8 W	Prec 1/10%
R973	315-0104-00			100 kΩ	1/4 W	5%
R975	315-0362-00			3.6 kΩ	1/4 W	5%
R977	315-0184-00			180 kΩ	1/4 W	5%
R979	315-0822-00			8.2 kΩ	1/4 W	5%
R980	315-0164-00			160 kΩ	1/4 W	5%
R983	315-0472-00			4.7 kΩ	1/4 W	5%
R985	304-0470-00			47 Ω	1 W	
R986	315-0122-00			1.2 kΩ	1/4 W	5%
R989	308-0678-00			0.1 Ω	2 W	WW 5%
R991	315-0913-00			91 kΩ	1/4 W	5%
R993	315-0241-00			240 Ω	1/4 W	5%
R994	315-0124-00			120 kΩ	1/4 W	5%
R995	315-0103-00			10 kΩ	1/4 W	5%

Integrated Circuit

U973	156-0068-00	5 xstr array, replaceable by RCA CA3046				
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SECTION 7

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

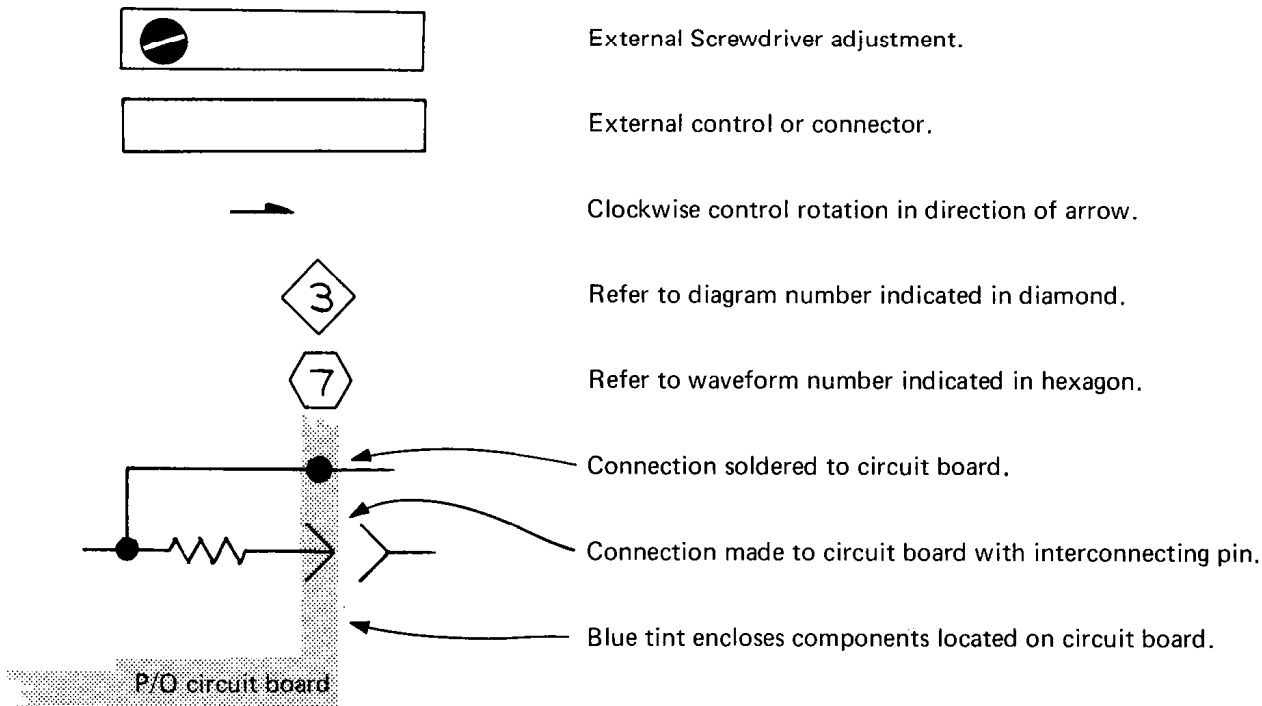
Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
 Values less than one are in microfarads (μ F).
 Resistors = Ohms (Ω)

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:



The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)	LR	Inductor/resistor combination
AT	Attenuator, fixed or variable	M	Meter
B	Motor	Q	Transistor or silicon-controlled rectifier
BT	Battery	P	Connector, movable portion
C	Capacitor, fixed or variable	R	Resistor, fixed or variable
CR	Diode, signal or rectifier	RT	Thermistor
DL	Delay line	S	Switch
DS	Indicating device (lamp)	T	Transformer
F	Fuse	TP	Test point
FL	Filter	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
H	Heat dissipating device (heat sink, heat radiator, etc.)	V	Electron tube
HR	Heater	VR	Voltage regulator (zener diode, etc.)
J	Connector, stationary portion	Y	Crystal
K	Relay		
L	Inductor, fixed or variable		

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 50 MHz
Deflection factor (with probe)	50 millivolts to 50 volts/division
Input impedance	10 megohm, 9.5 picofarads
Probe ground	7403N chassis ground
Trigger source	External from Calibrator 0.4 V jack to indicate true time relationship between signals
Recommended type (as used for wave- forms on diagrams)	Tektronix 7503 with 7A15 and 7B52 plug-in units, P6053 Probe

Voltmeter

Type	Non-loading digital multimeter
Input impedance	10 megohms
Range	0 to 1000 volts
Reference voltage	7403N chassis ground
Recommended type (as used for voltages on diagrams)	Tektronix 7D13 Digital Multimeter (test oscilloscope must have Readout System)

7403N Conditions

Line Voltage	110 volts
Signal applied	No signal applied for voltage measurements. Apply 0.4 volts of 1 kHz calibrator sig- nal from 7403N to INPUT of 7A15 for waveforms only.
Connectors	No connections for voltage measurements. For wave- forms Calibrator signal is applied to external trigger input of test scope. Also see Signal applied above.
Trace position	Centered
Control settings	As follows except as noted otherwise on individual diagrams.

7403N

INTENSITY	Counterclockwise
FOCUS	Midrange
BEAM FINDER	In
GRATICULE ILLUM	Counterclockwise
VERT MODE	LEFT
TRIG SOURCE	VERT MODE

Left and Right Vertical Plug-Ins (7A15)

Position	Centered
Polarity	+UP
Input Coupling	Gnd
Volts/Div	.1
Variable	Cal

Horizontal 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:

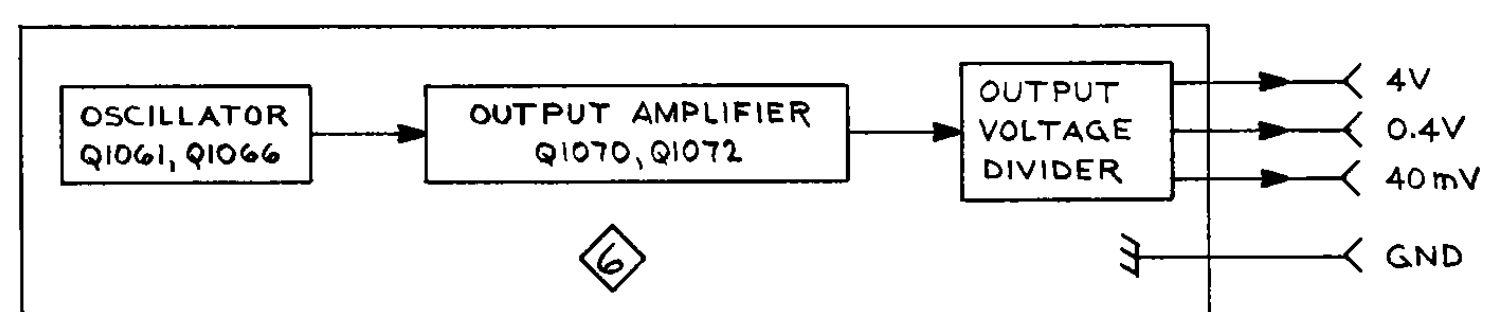
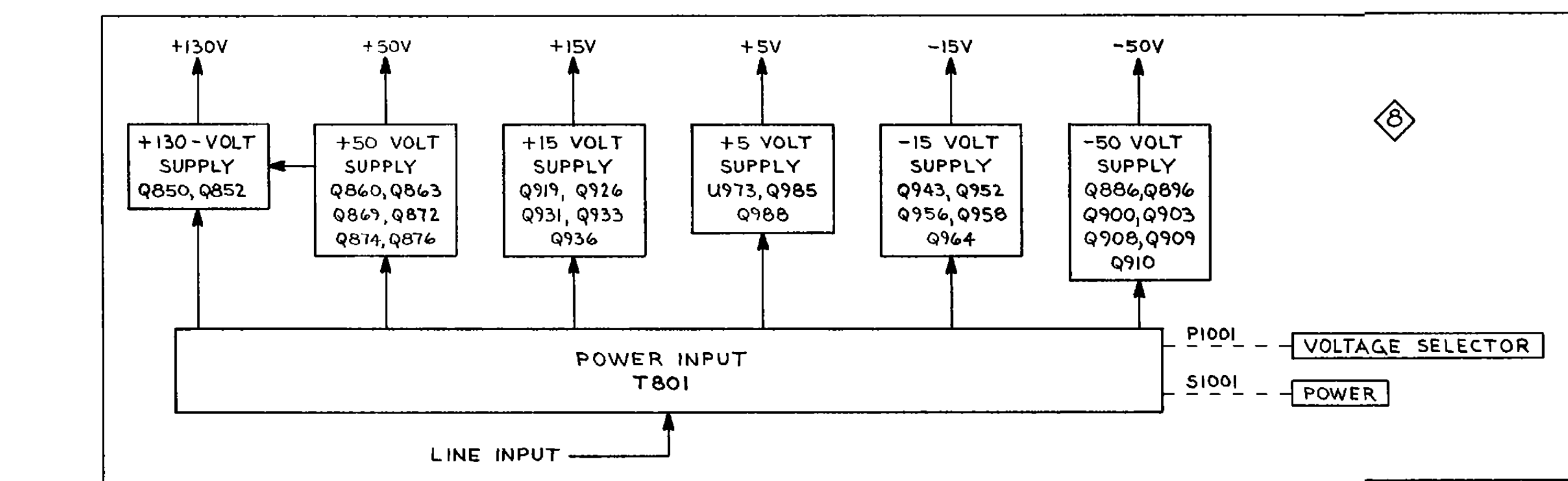
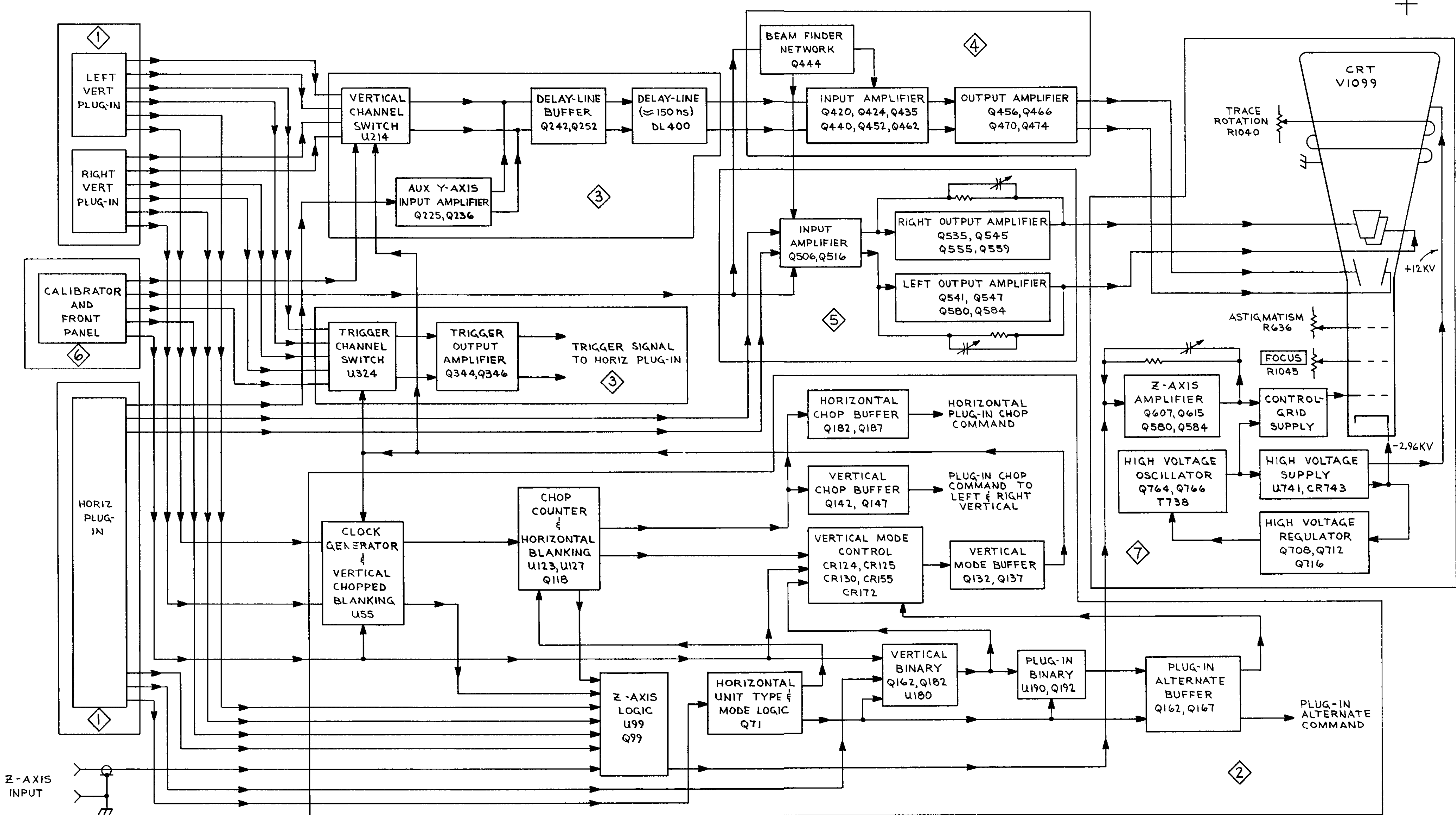
Left Vertical 7A15

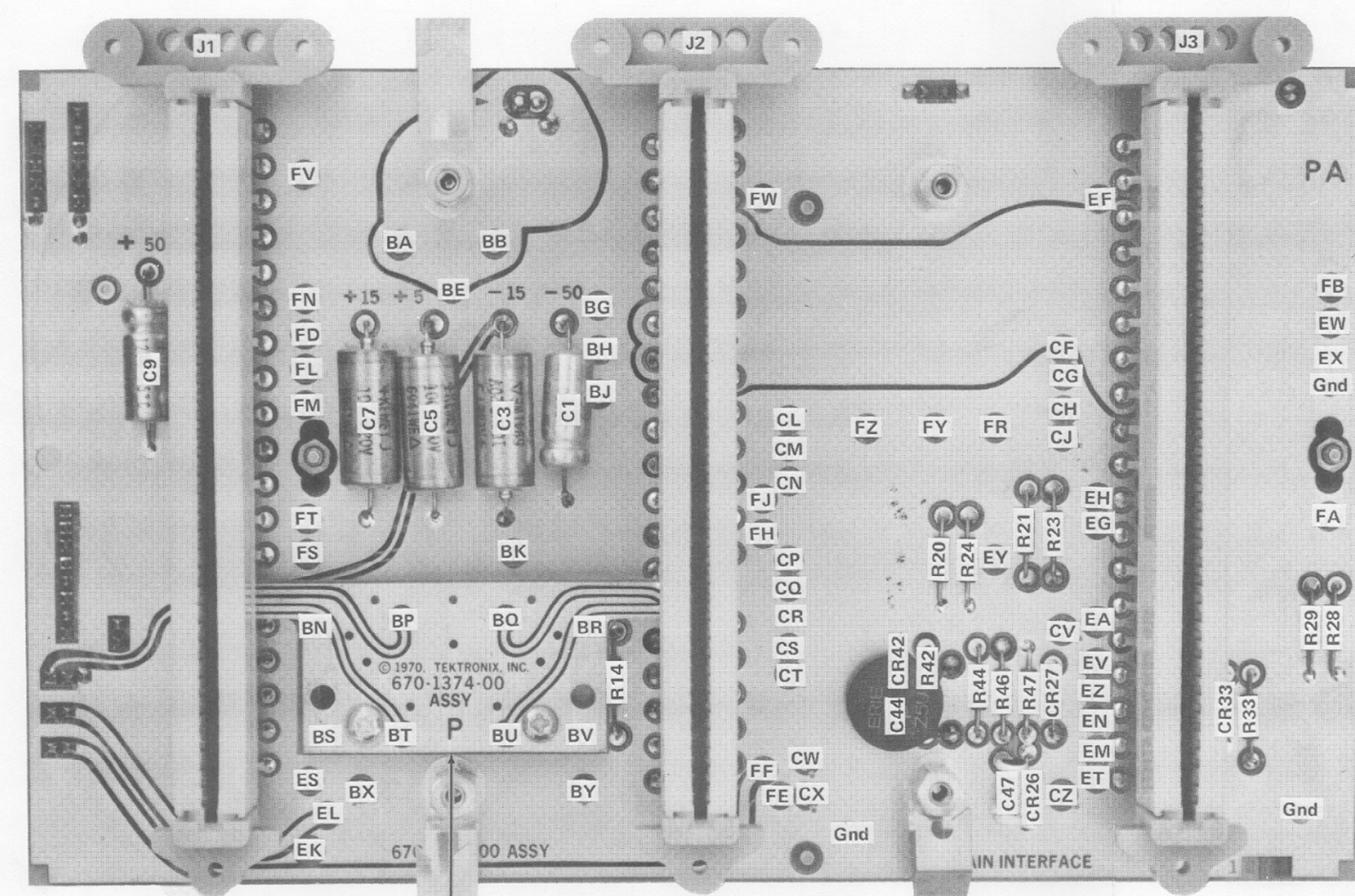
Input Coupling	DC
Position	Vertically center display
Apply 0.4 volts of 1 kHz calibrator to the INPUT connector	

All voltages given on the diagrams are in volts. Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System. 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 different component tolerances, internal calibration, or front-panel control settings.

NOTE

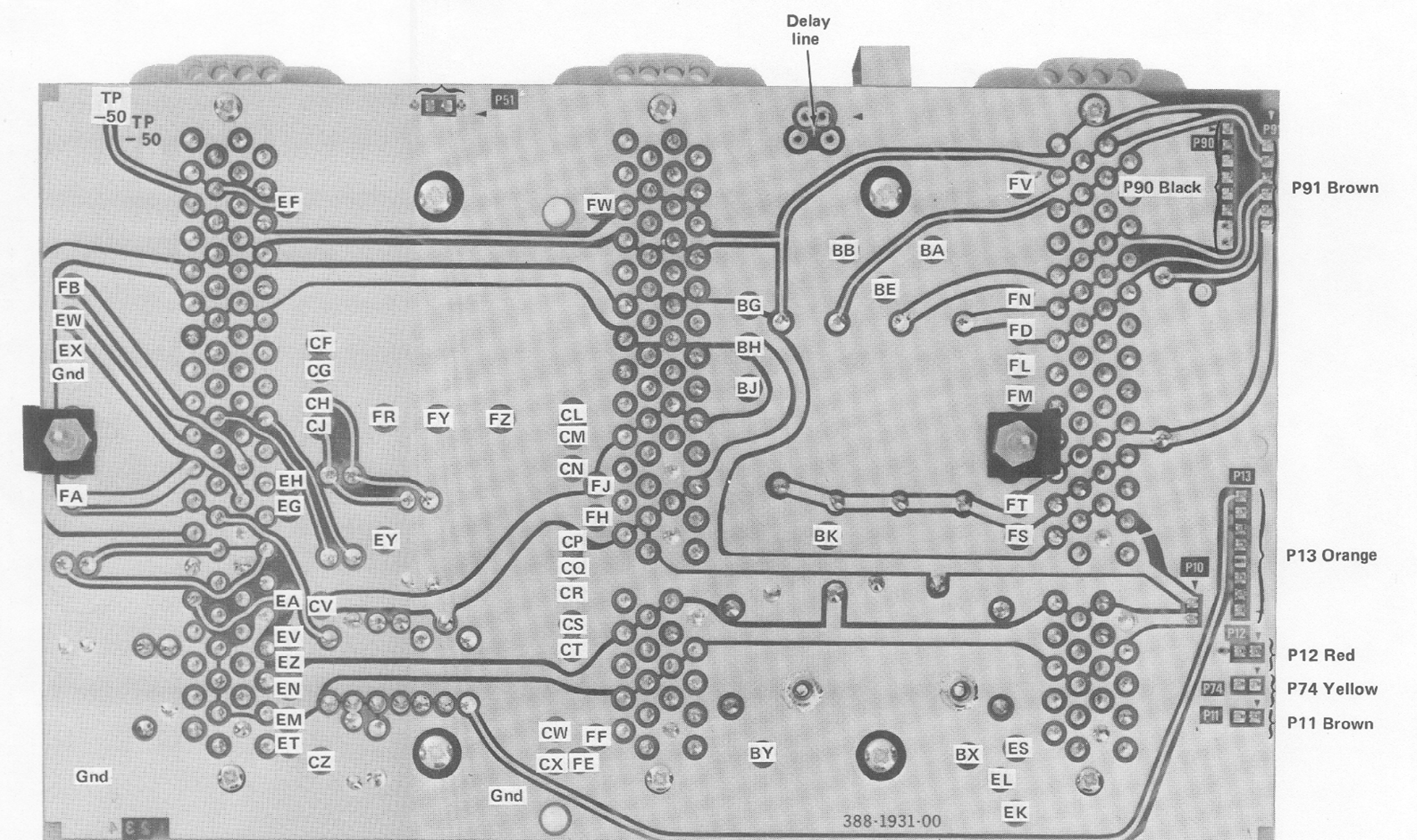
The spring tension of the pin sockets insures a good connection between the circuit board and the pin. This spring tension can be destroyed by using the pin sockets as a connection point for spring-loaded probe tips, alligator clips, etc.





R12, C18, C16
Located below
Vertical Interconnect
circuit board

Fig. 7-1. Main Interface circuit board (front).



P90 Black
P91 Brown
P13 Orange
P12 Red
P74 Yellow
P11 Brown

Fig. 7-2. Main Interface circuit board (rear).

MAIN INTERFACE

INTER PLUG-IN SIGNAL

INTER PLUG-IN COMMON

+AUX TRIG IN
 -AUX TRIG IN
 + TRIGGER IN
 - TRIGGER IN
 + 50V DC
 - 50V DC
 +15V DC
 -15V DC
 AUX Z AXIS
 AUX Z AXIS COMMON
 MAIN FRAME MODE
 AUX Y AXIS

SINGLE SWP RESET
LIGHTS COMMON

+ TRIGGER OUT
- TRIGGER OUT
CHASSIS GND
CHASSIS GND
SIGNAL (+)
SIGNAL (-)

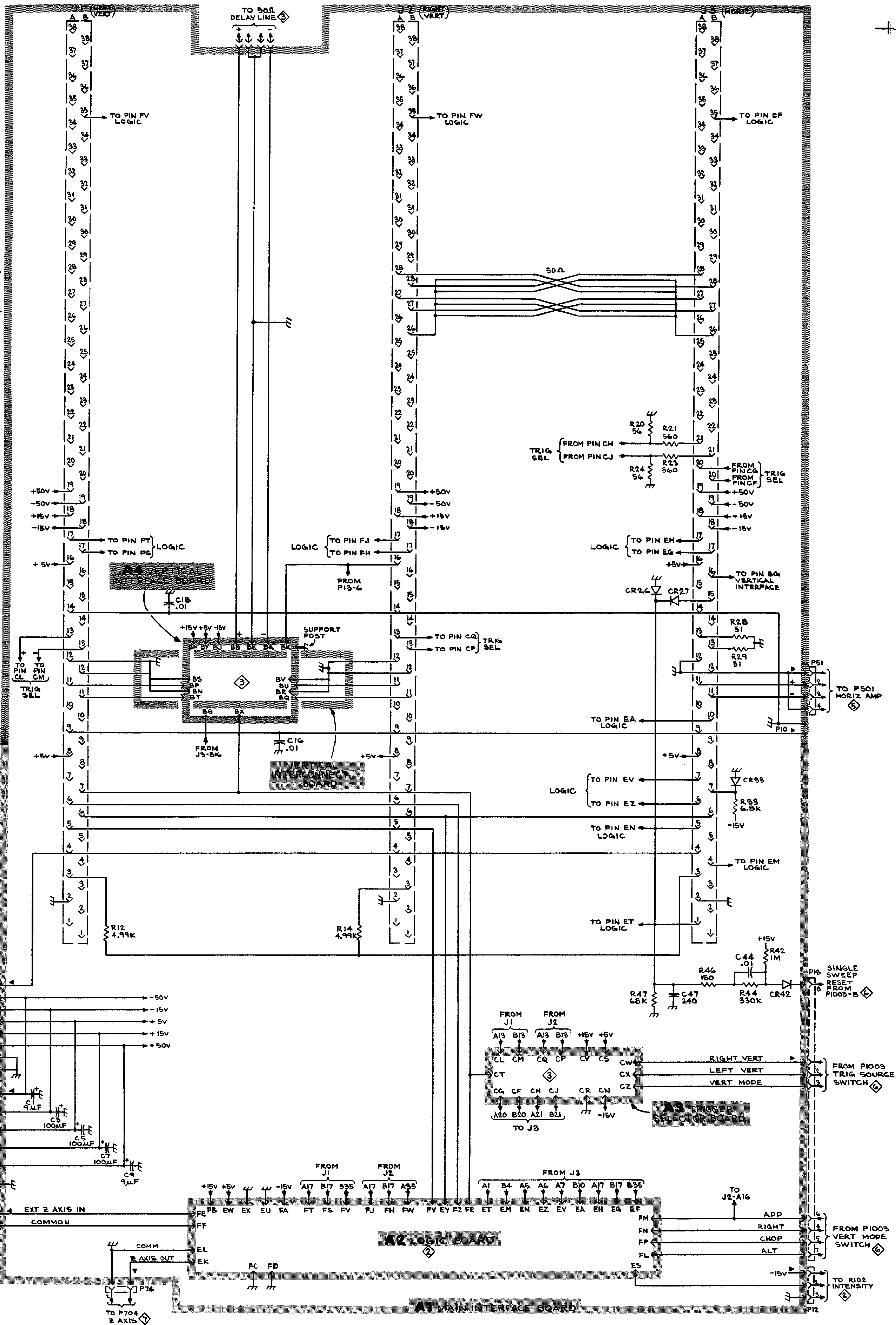
X-COMP INHIBIT
+5V LIGHTS

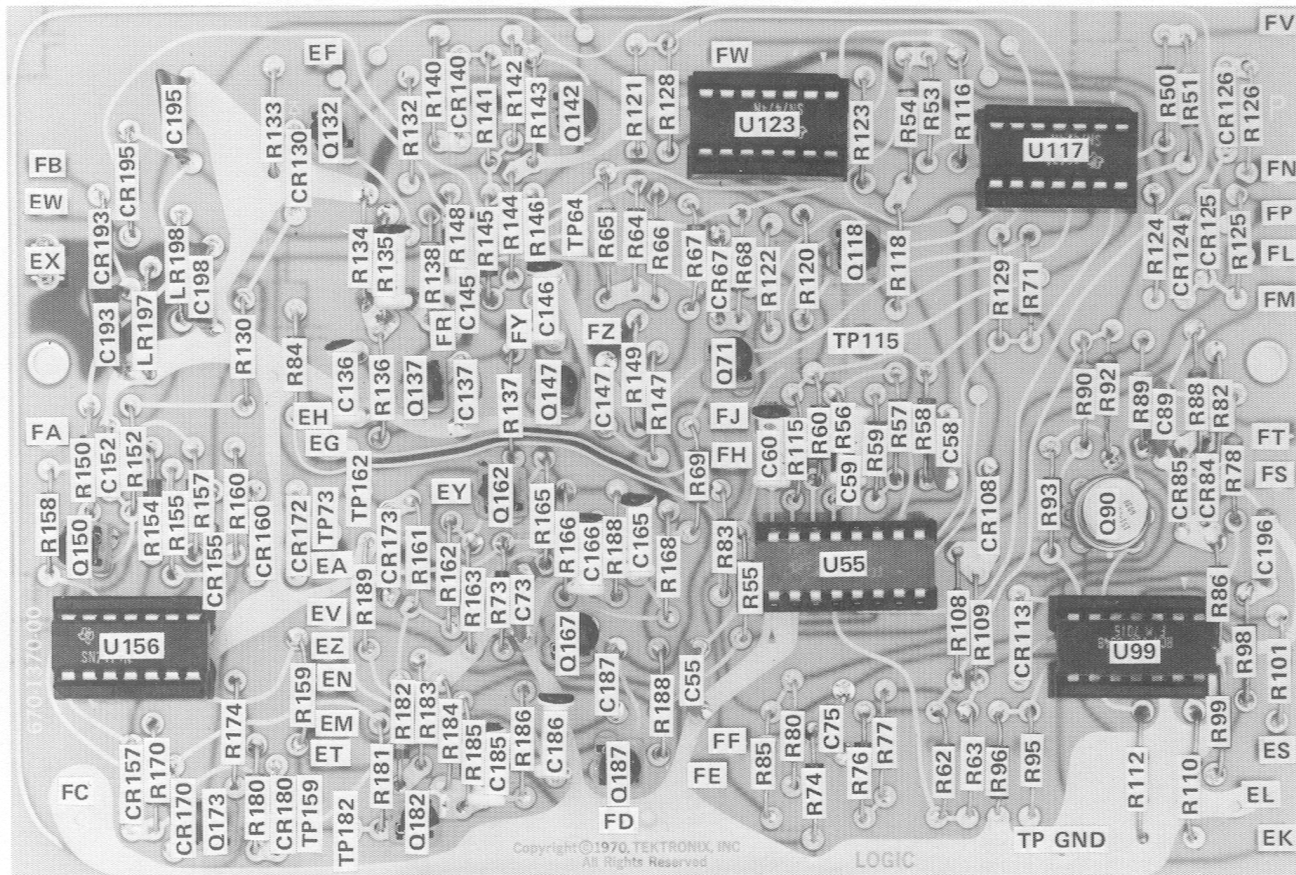
+ 5V DC

INTENSITY LIMIT
VERT MODE COMMAND
CHOP COMMON
ALT DRIVE
CHOP DRIVE

LINE TRIGGER
HOLDOFF
SWEEP
SWEEP
GATE COMMON

SWEEP GATE



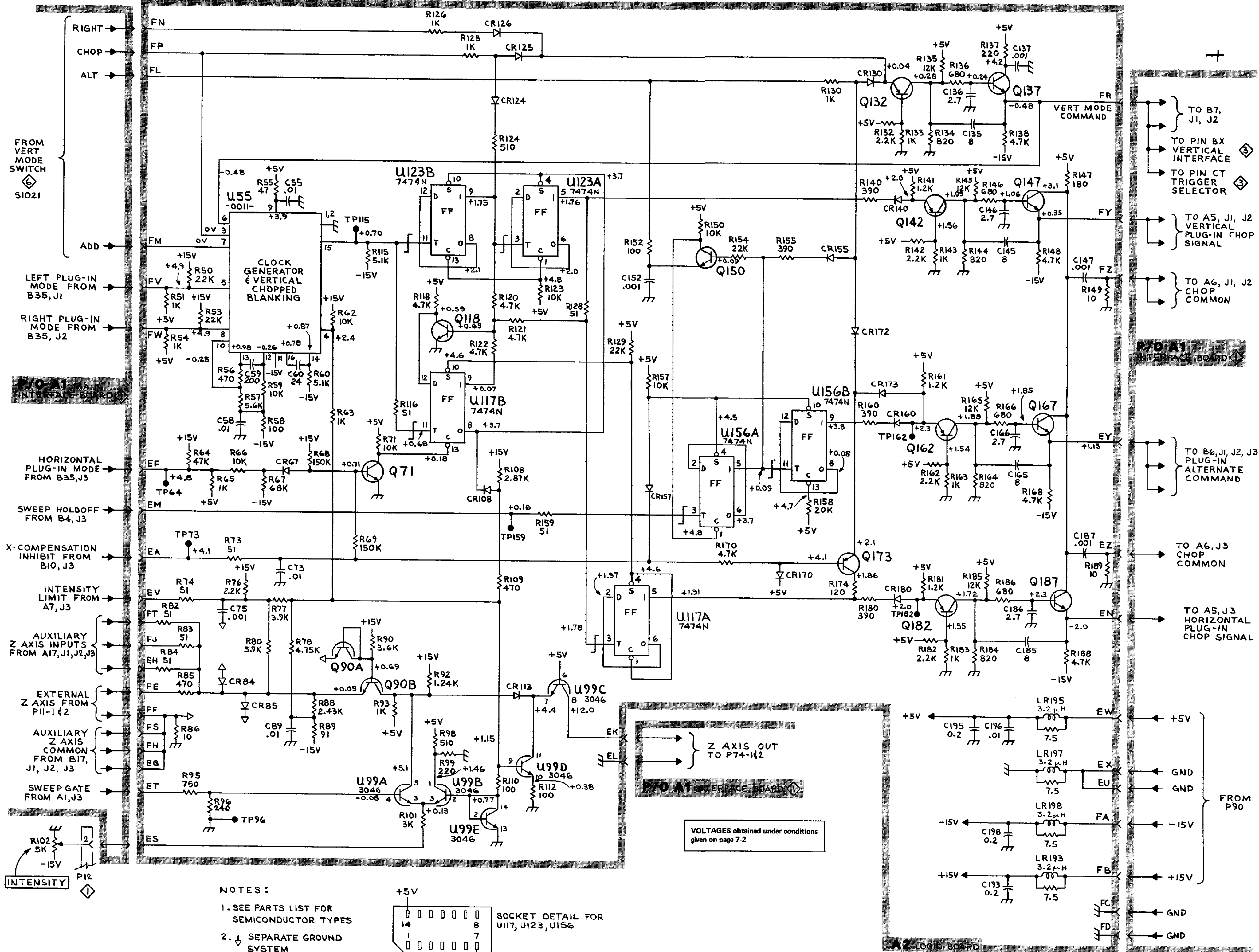


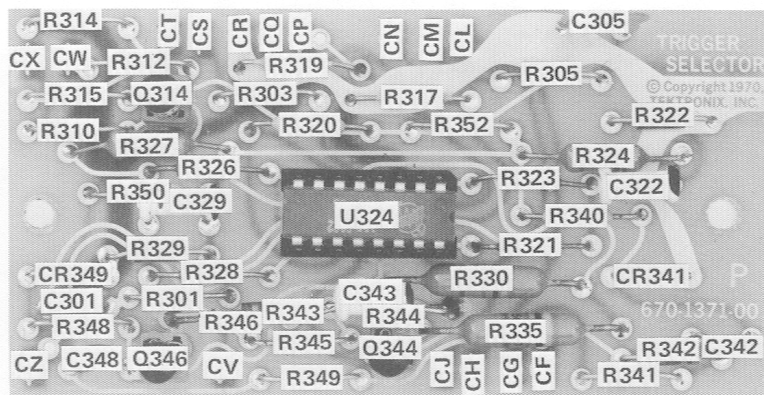
A2



Fig. 7-3. Logic circuit board.

Ⓐ



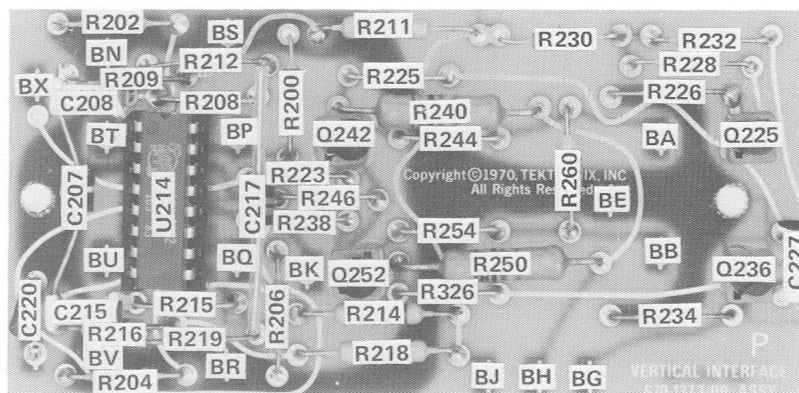


A3



Fig. 7-4. Trigger Selector circuit board.

(A)

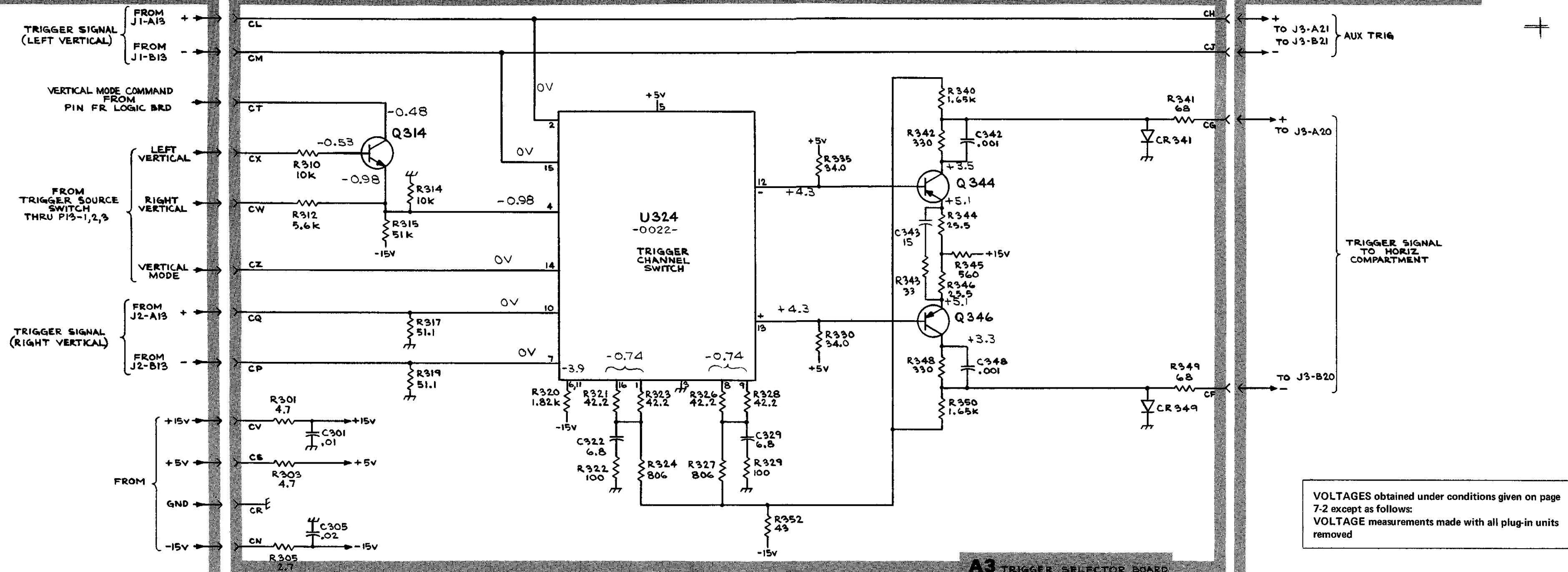


A4

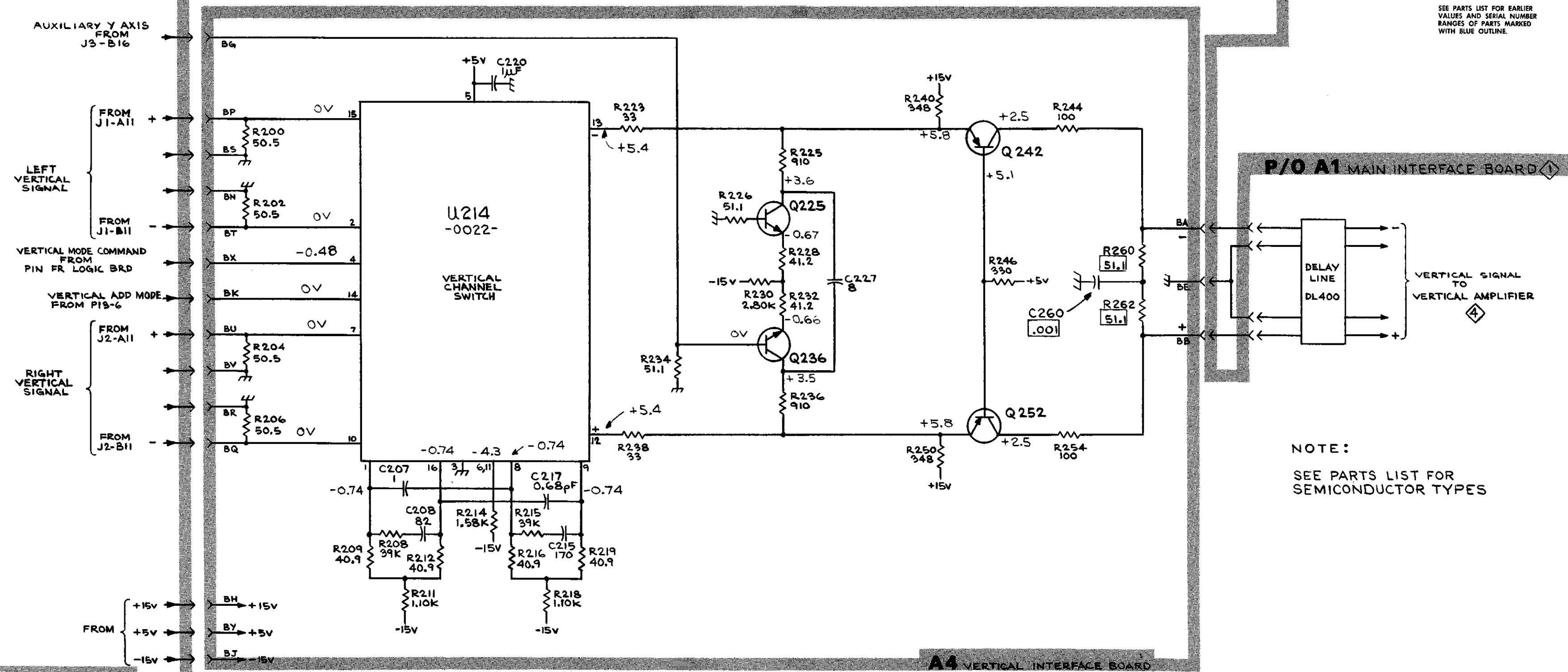


Fig. 7-5. Vertical Interface circuit board.

(A)



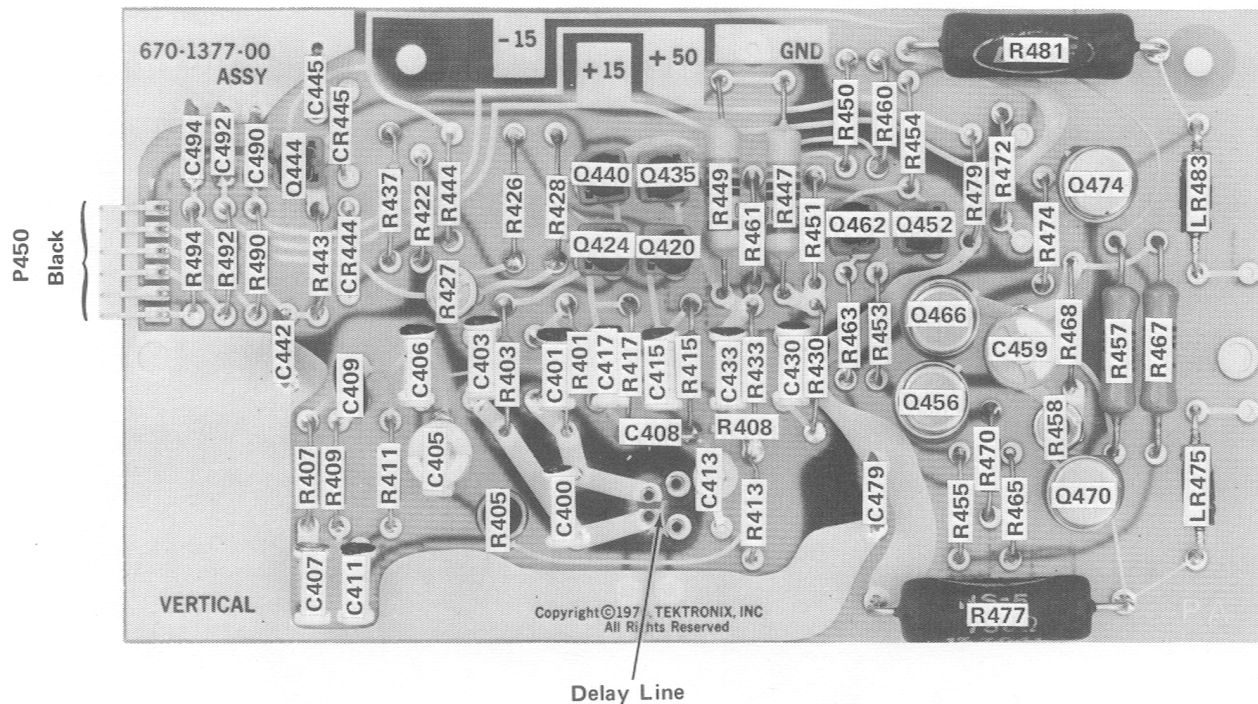
A3 TRIGGER SELECTOR BOARD



P/O A1 MAIN INTERFACE BOARD

A4 VERTICAL INTERFACE BOARD

7403N

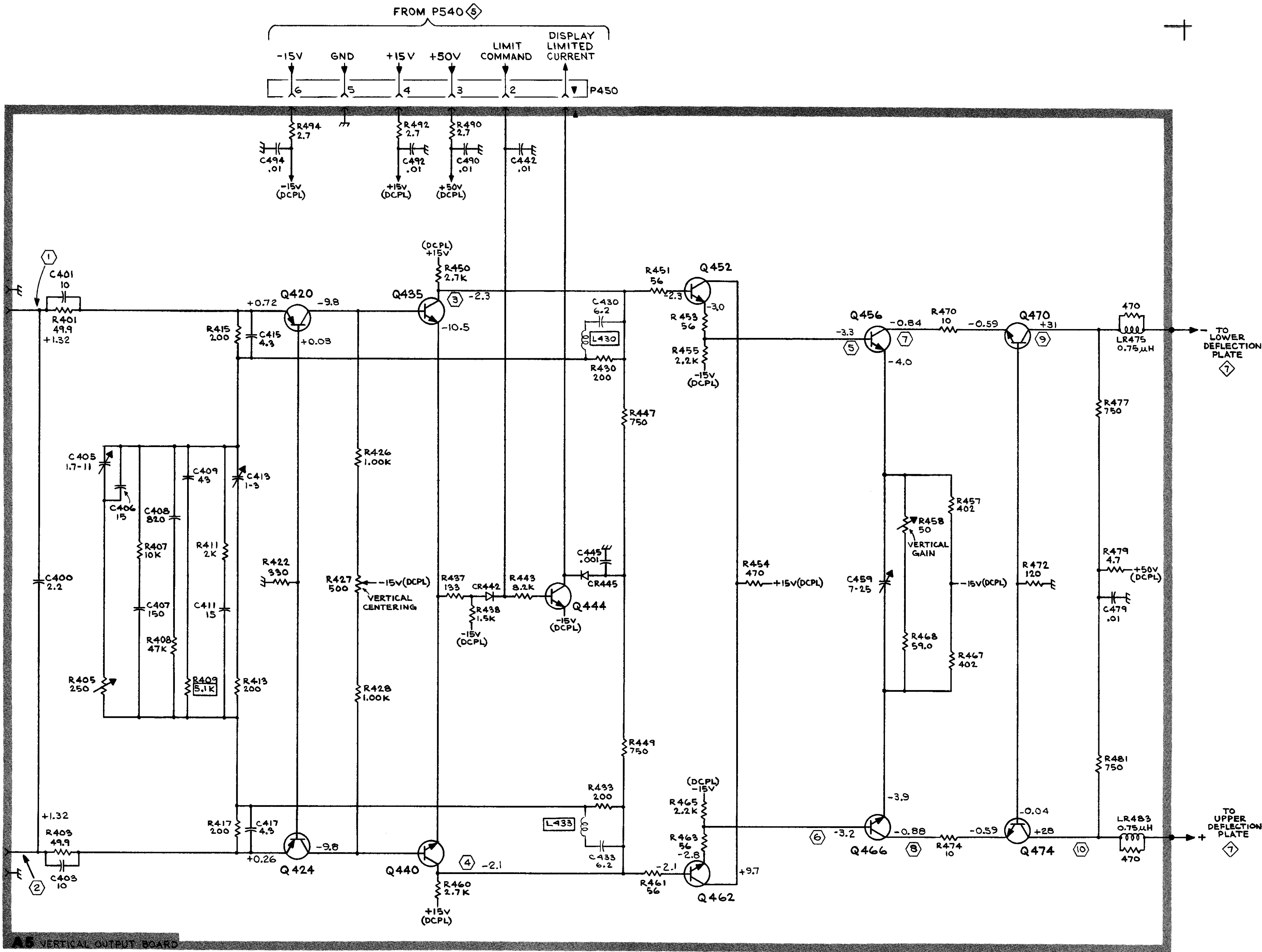
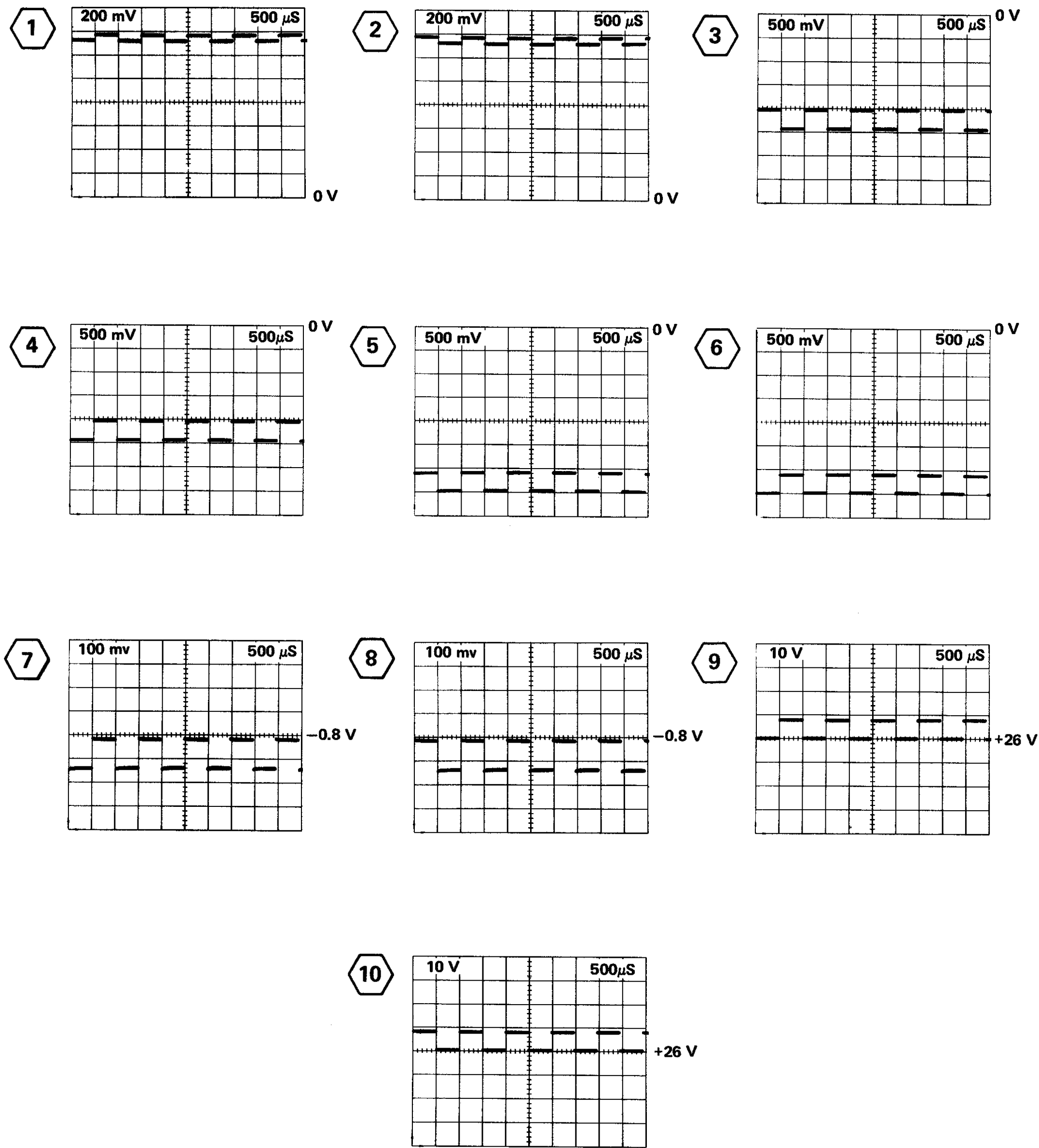


A5



Fig. 7-6. Vertical Output circuit board.

(A)

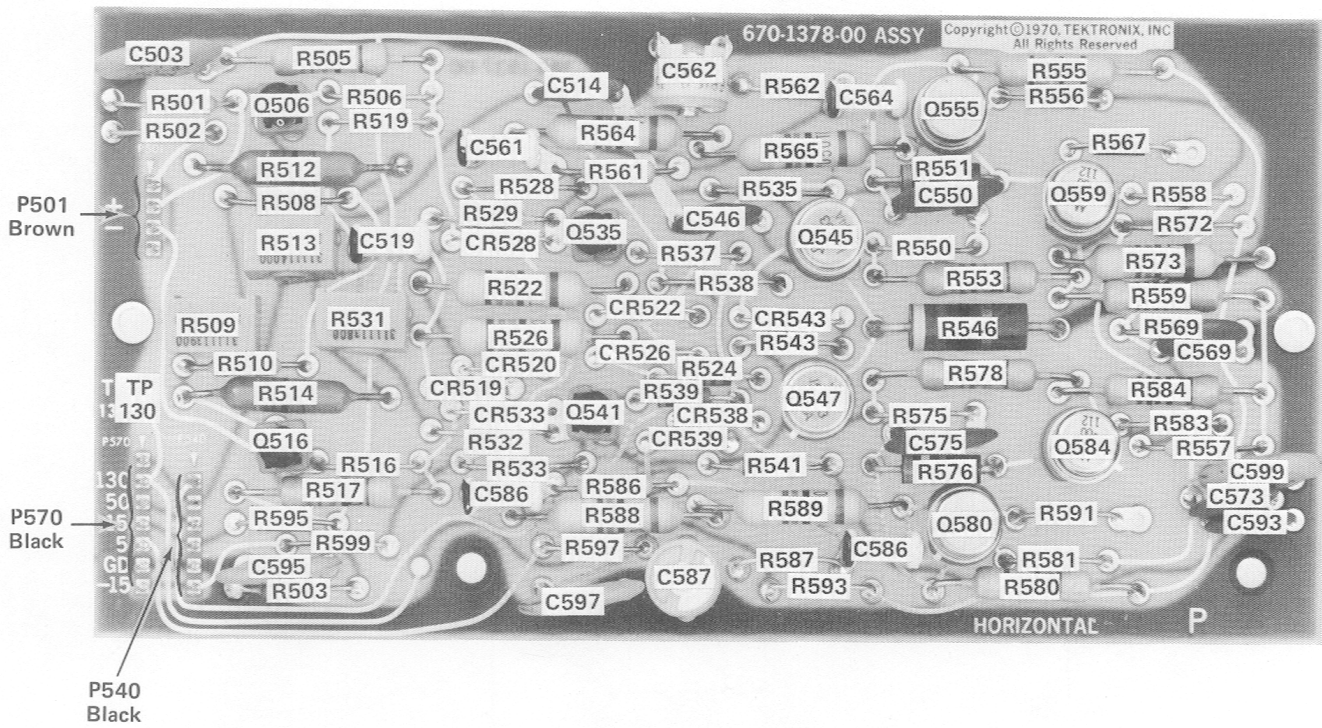


NOTE:
SEE PARTS LIST FOR
SEMICONDUCTOR TYPES

SEE PARTS LIST FOR EXACT
VALUES AND SERIAL NUMBER
RANGES OF PARTS MARKED
WITH BLUE OUTLINE.

VOLTAGES and WAVEFORMS obtained under conditions
given on page 7-2.

7403N

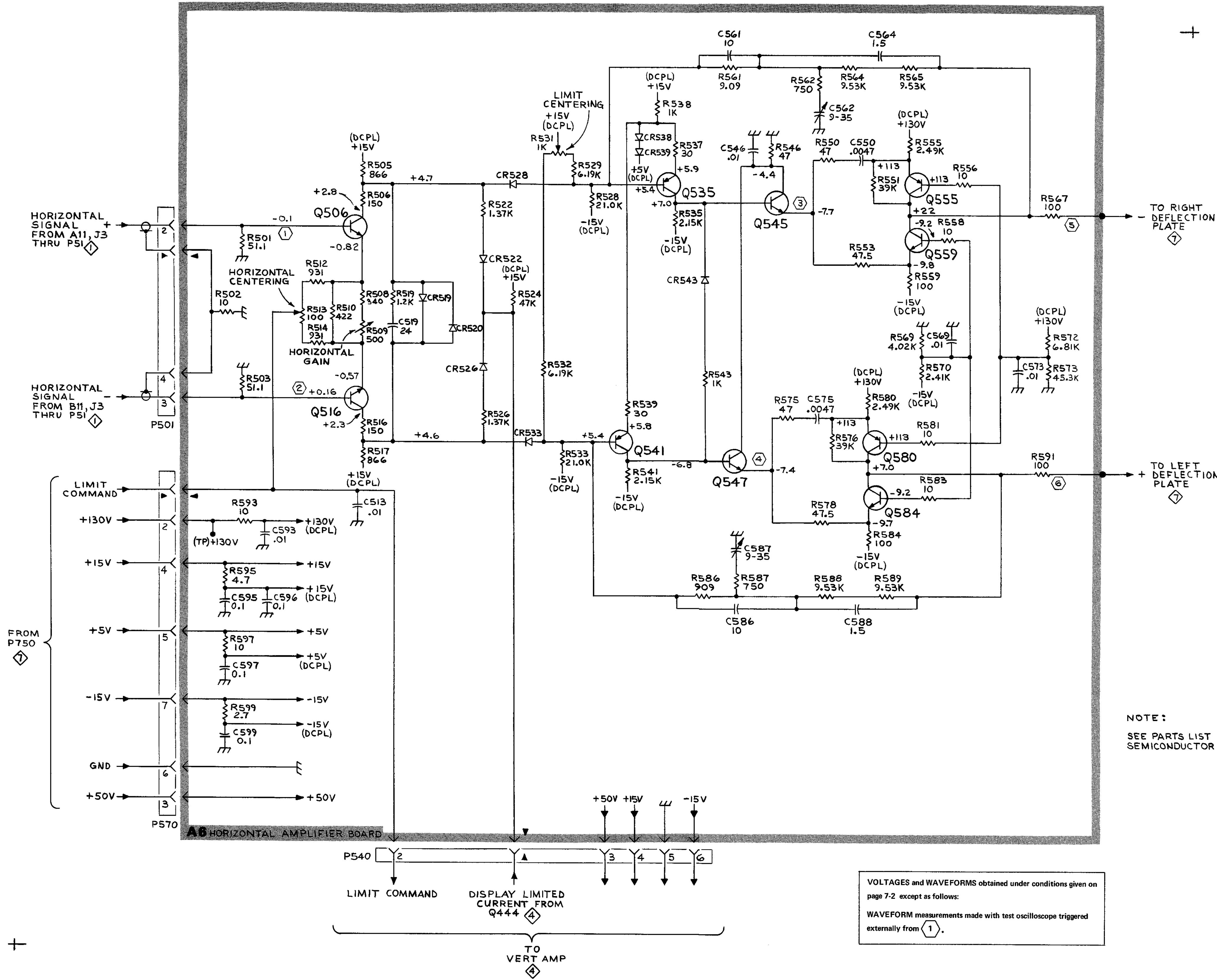
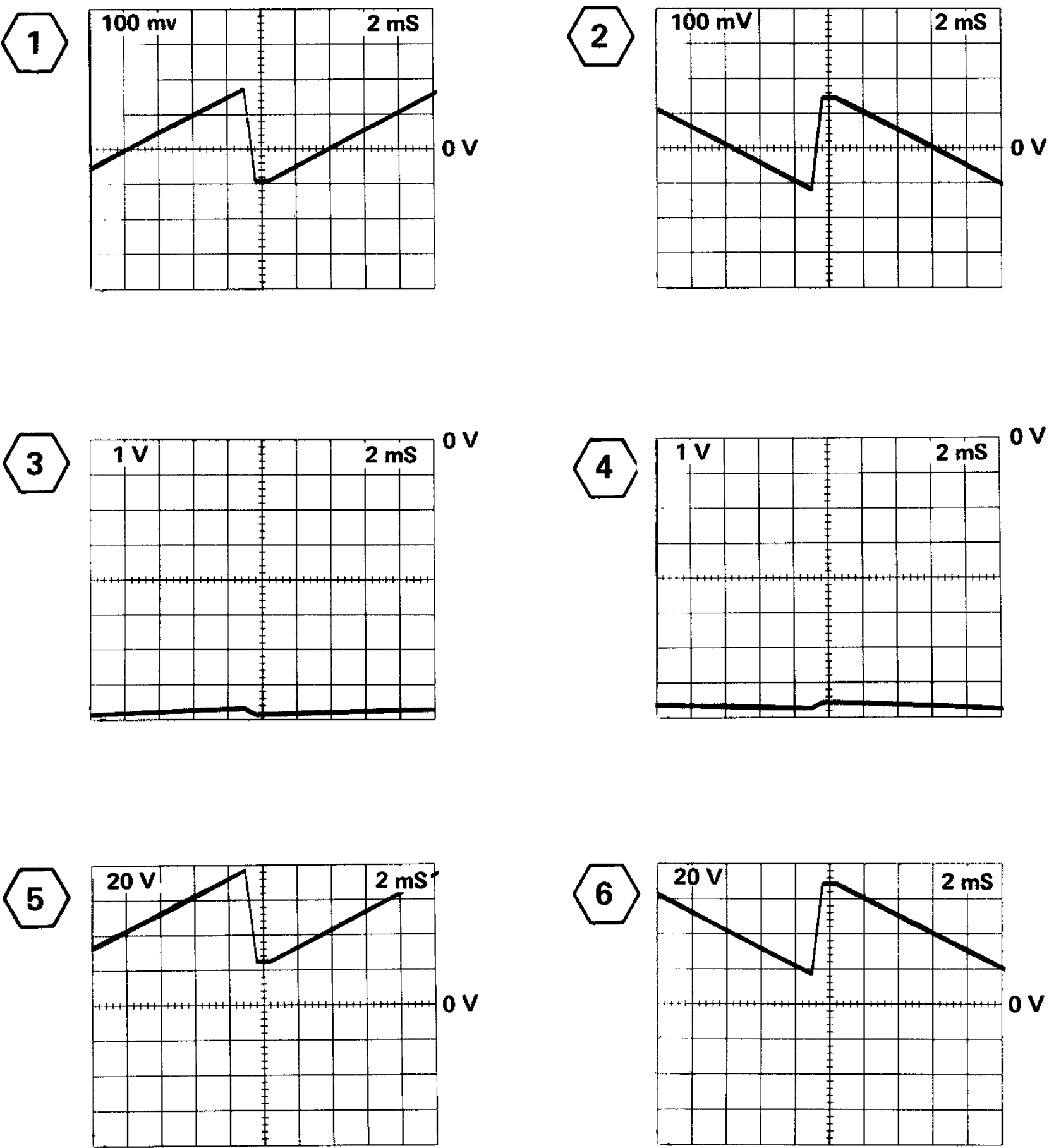


A6



Fig. 7-7. Horizontal Amplifier Circuit board.

(A)



VOLTAGES and WAVEFORMS obtained under conditions given on page 7-2 except as follows:
WAVEFORM measurements made with test oscilloscope triggered externally from 1.

A7

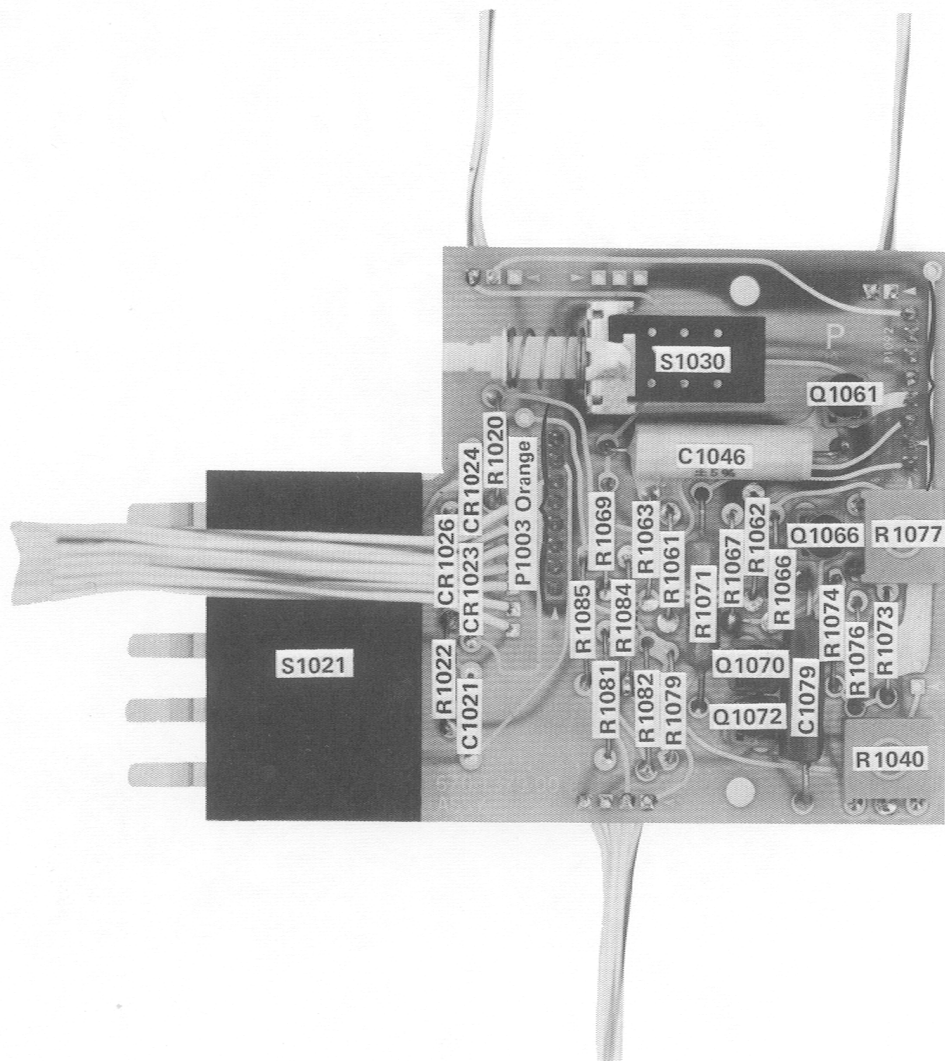


Fig. 7-8. Calibrator circuit board.

A8

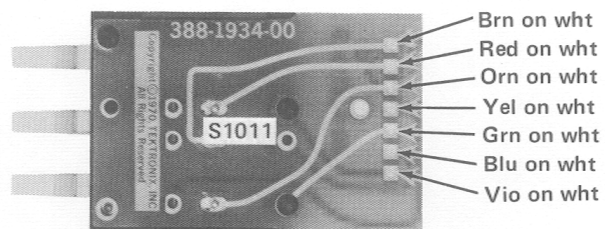
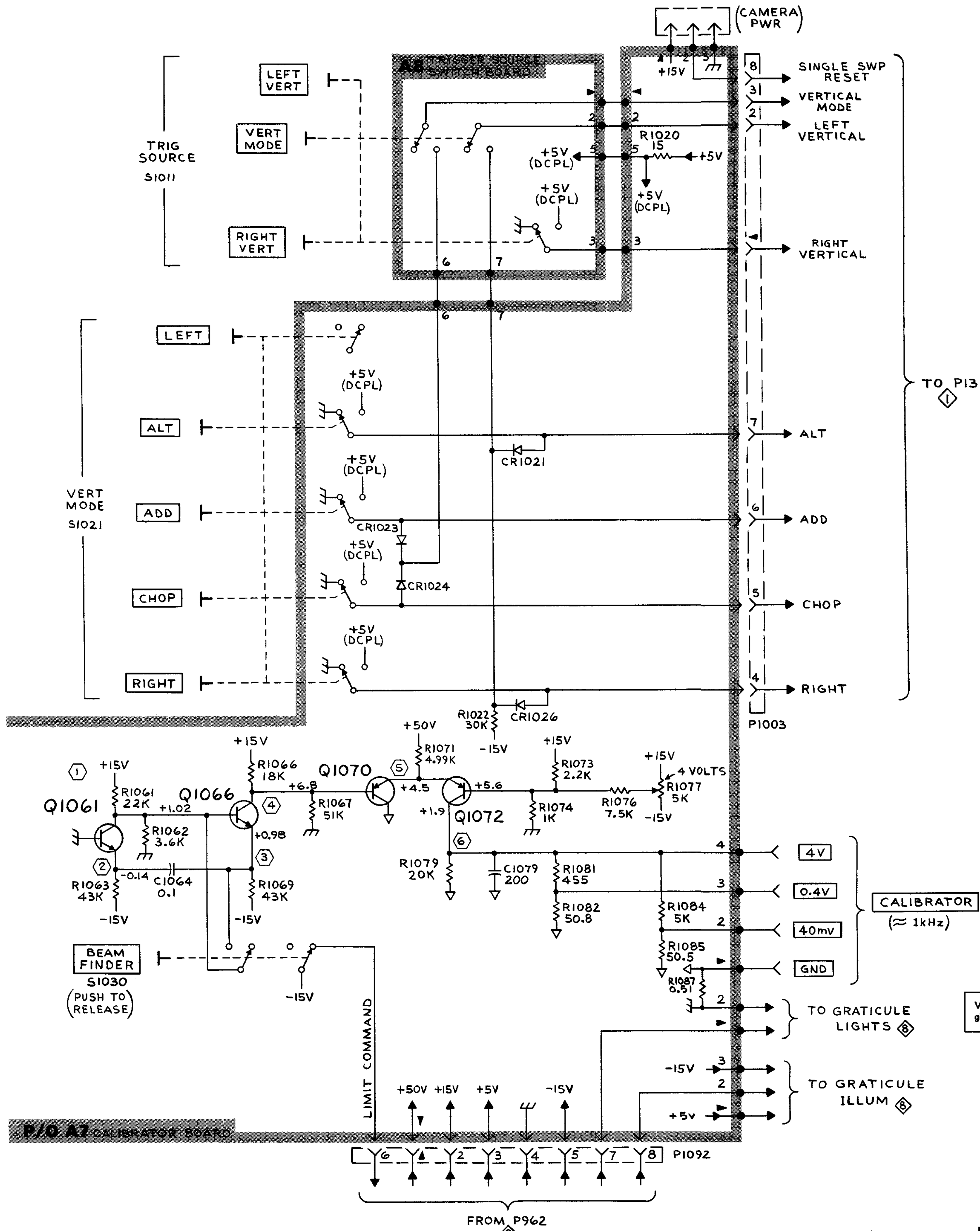
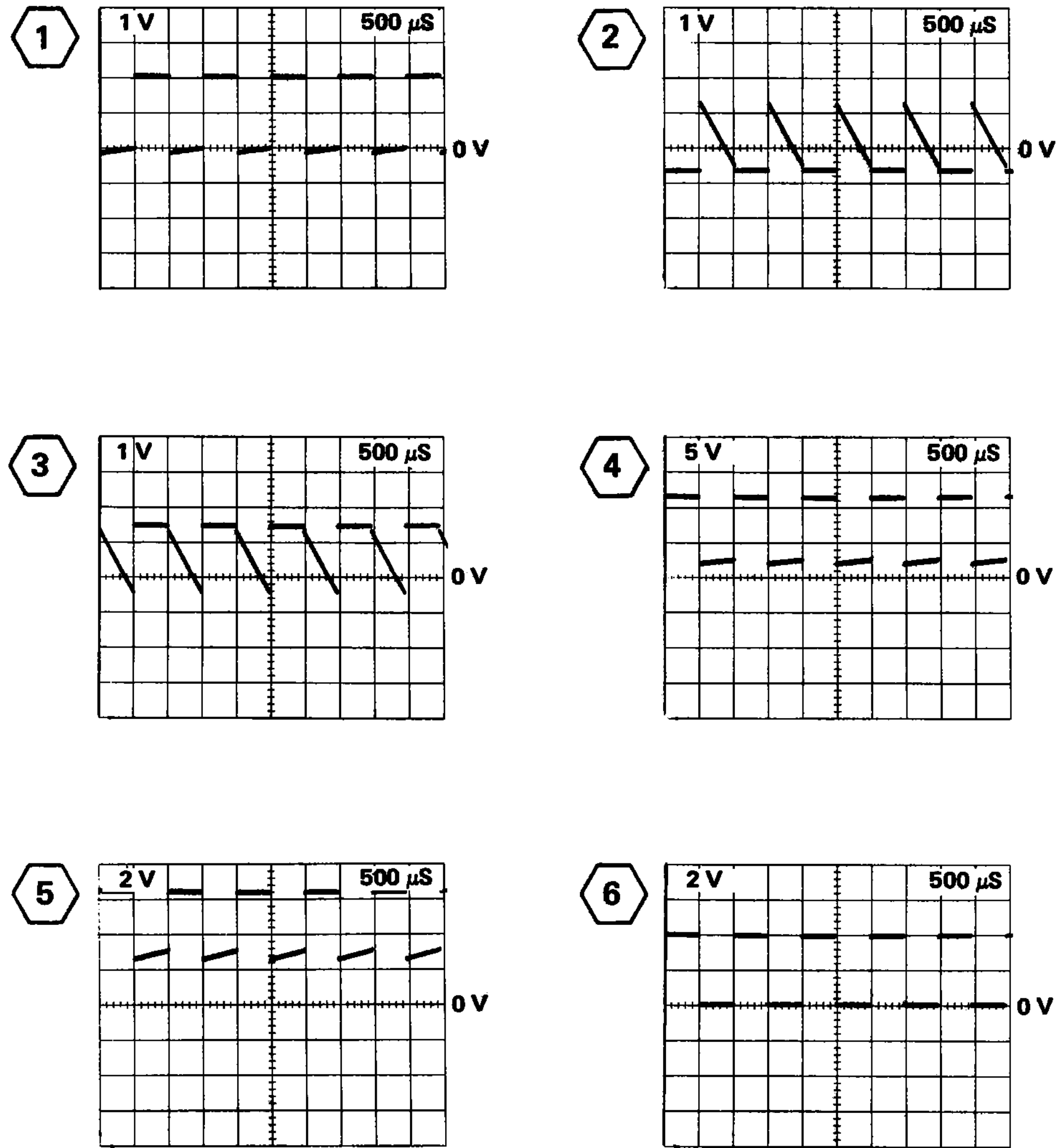
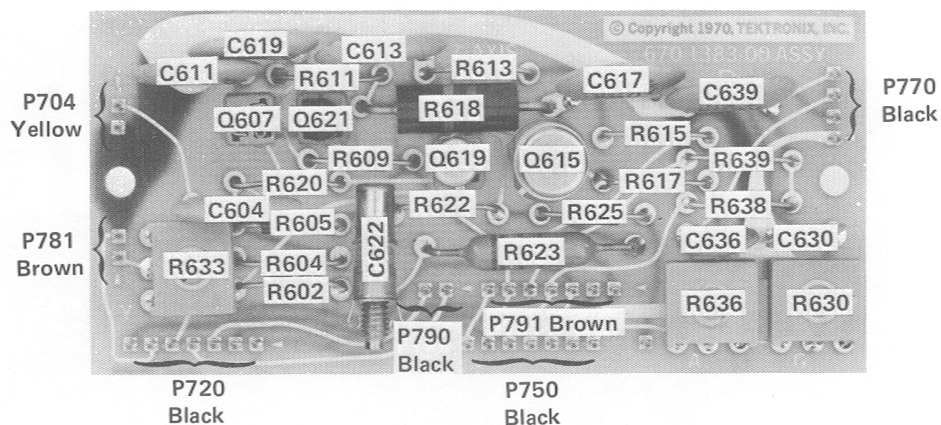


Fig. 7-9. Trigger Source Switch circuit board.



- NOTES:
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
 2. ∇ SEPARATE GROUND SYSTEM

VOLTAGES and WAVEFORMS obtained under conditions given on page 7-2.

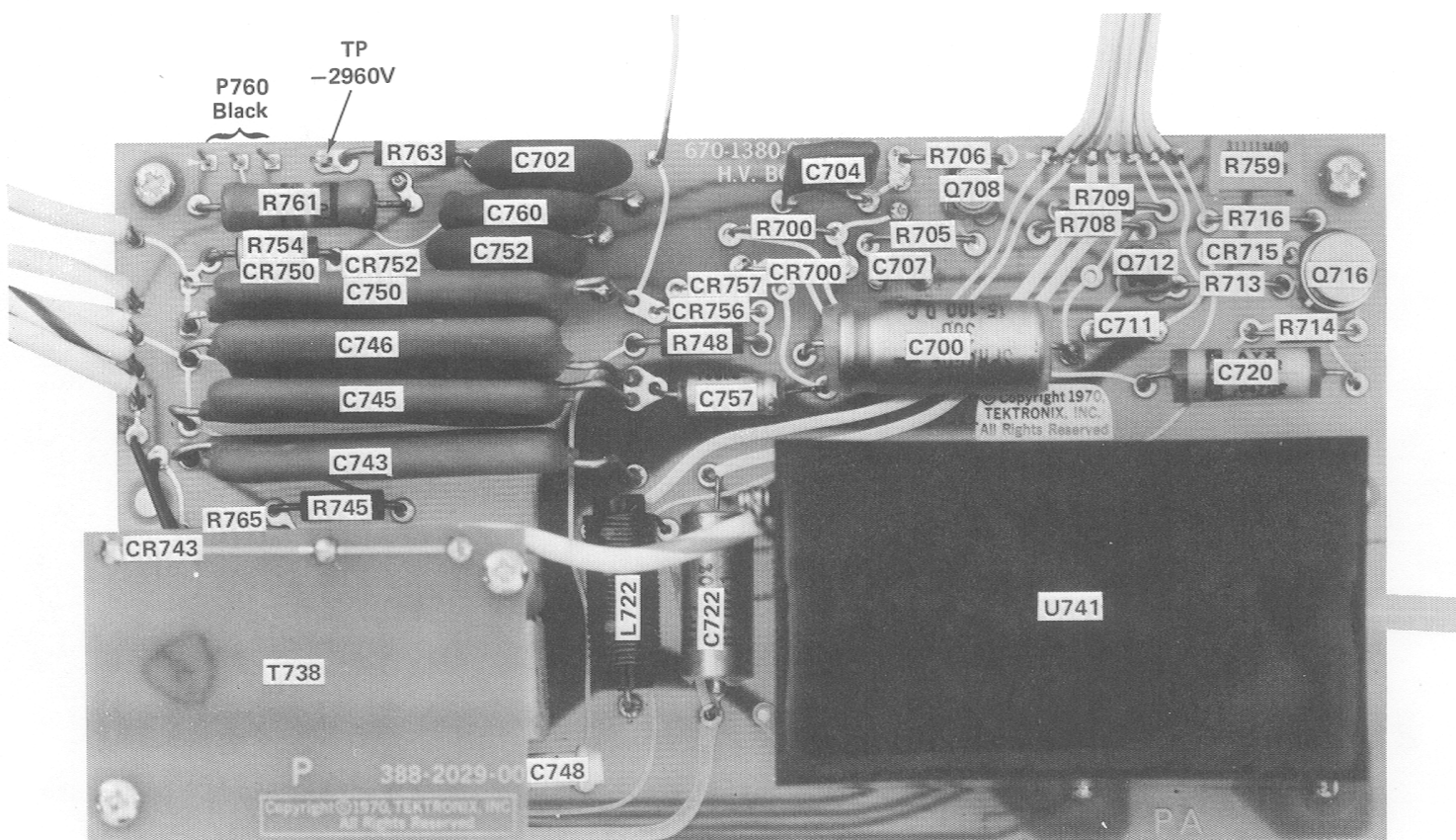


A9



Fig. 7-10. Z-Axis Amplifier circuit board.

(A)

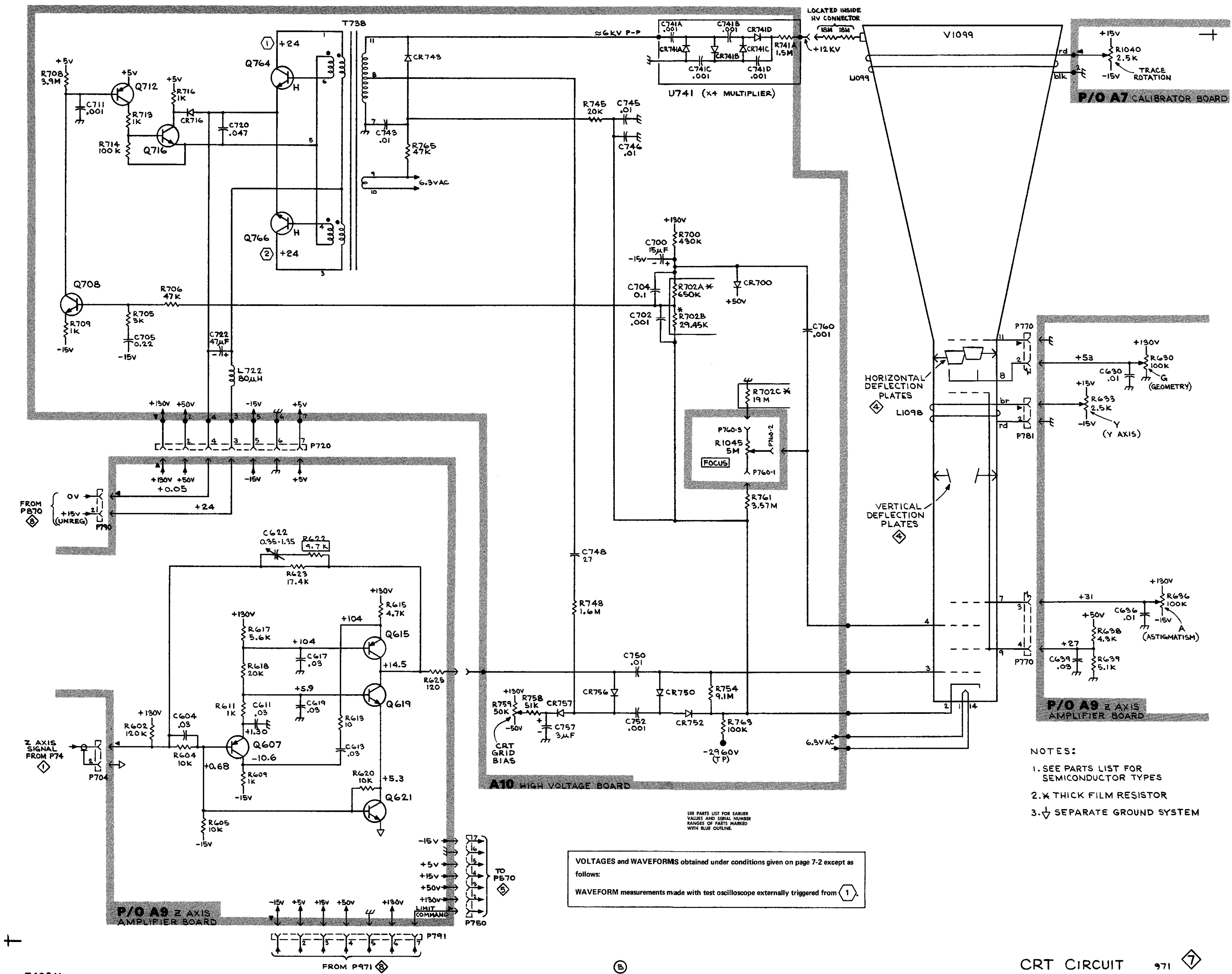
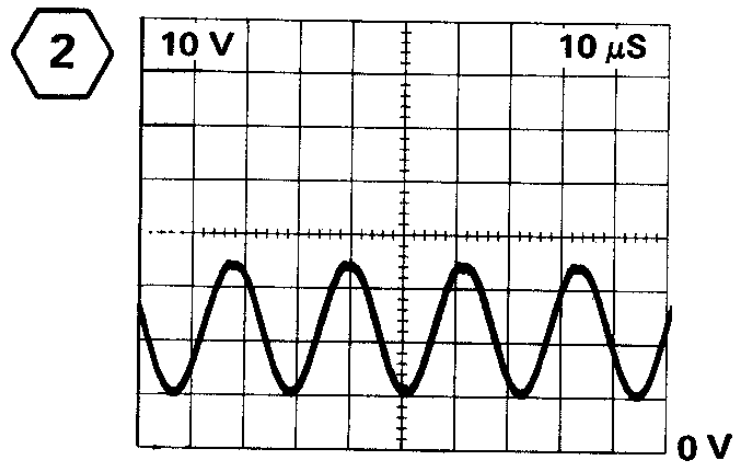


NOTE: Q730, Q734, R702, R758 mounted on rear of board.

A10

Fig. 7-11. High Voltage circuit board.

(A)



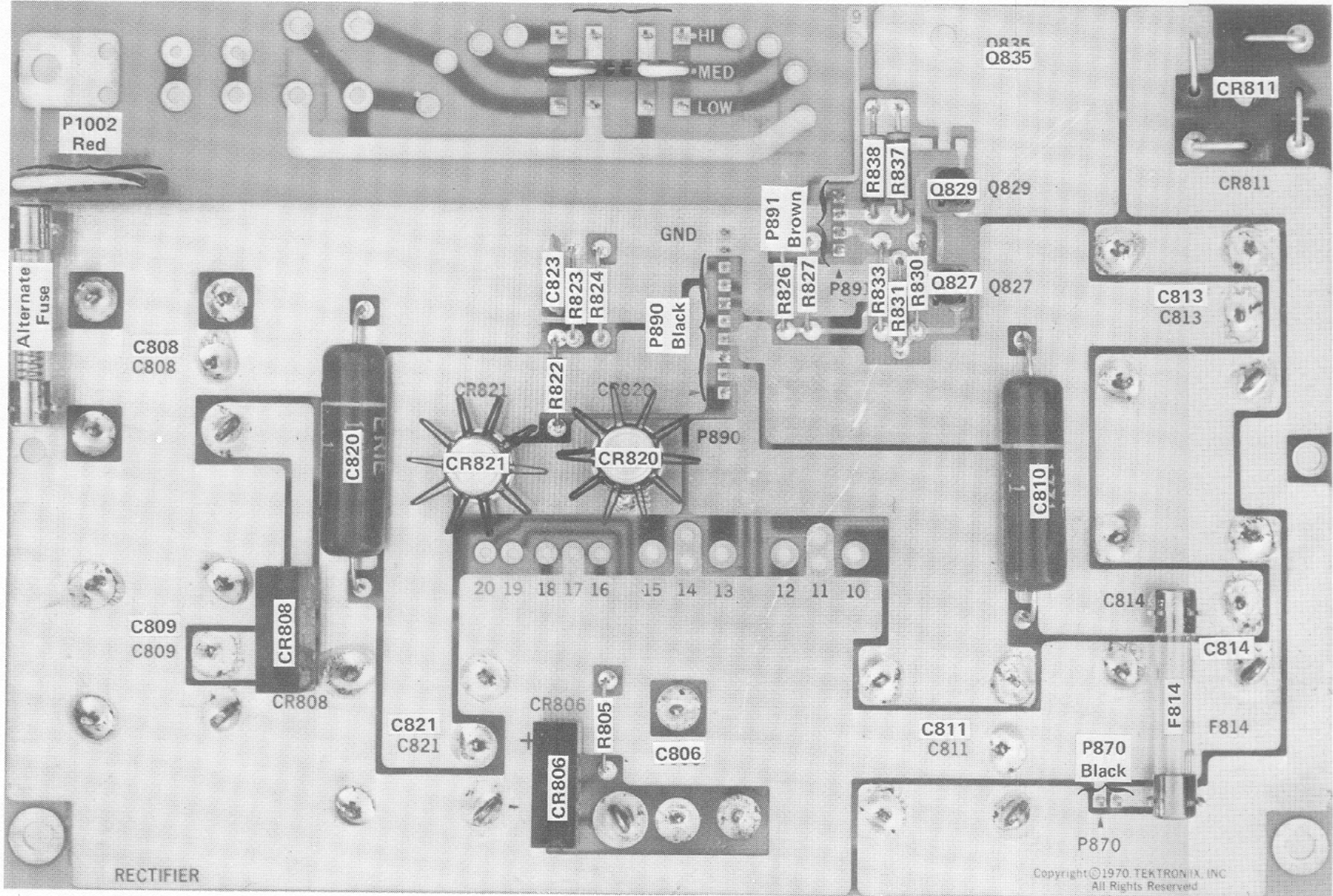


Fig. 7-12. Rectifier circuit board.

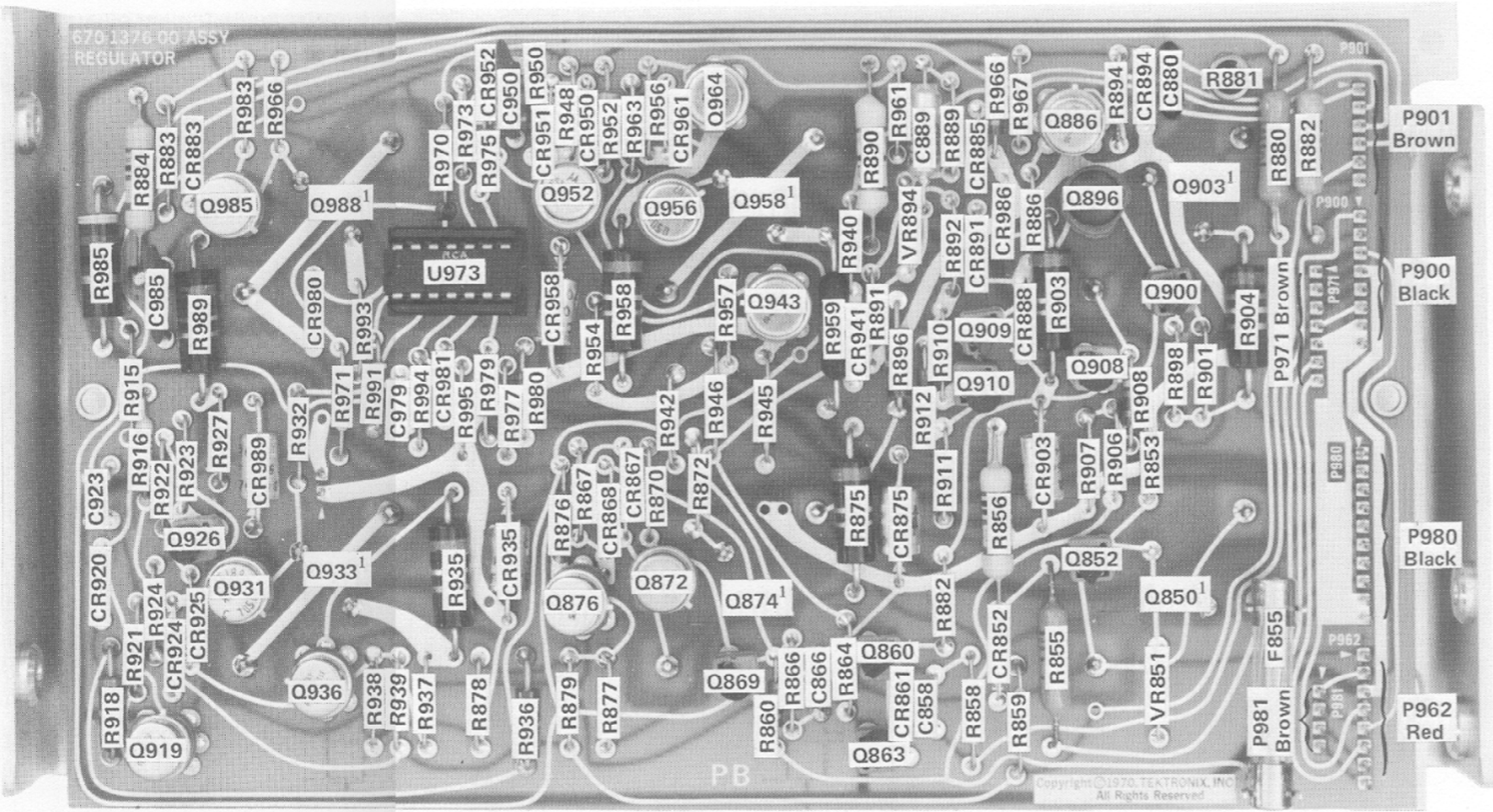
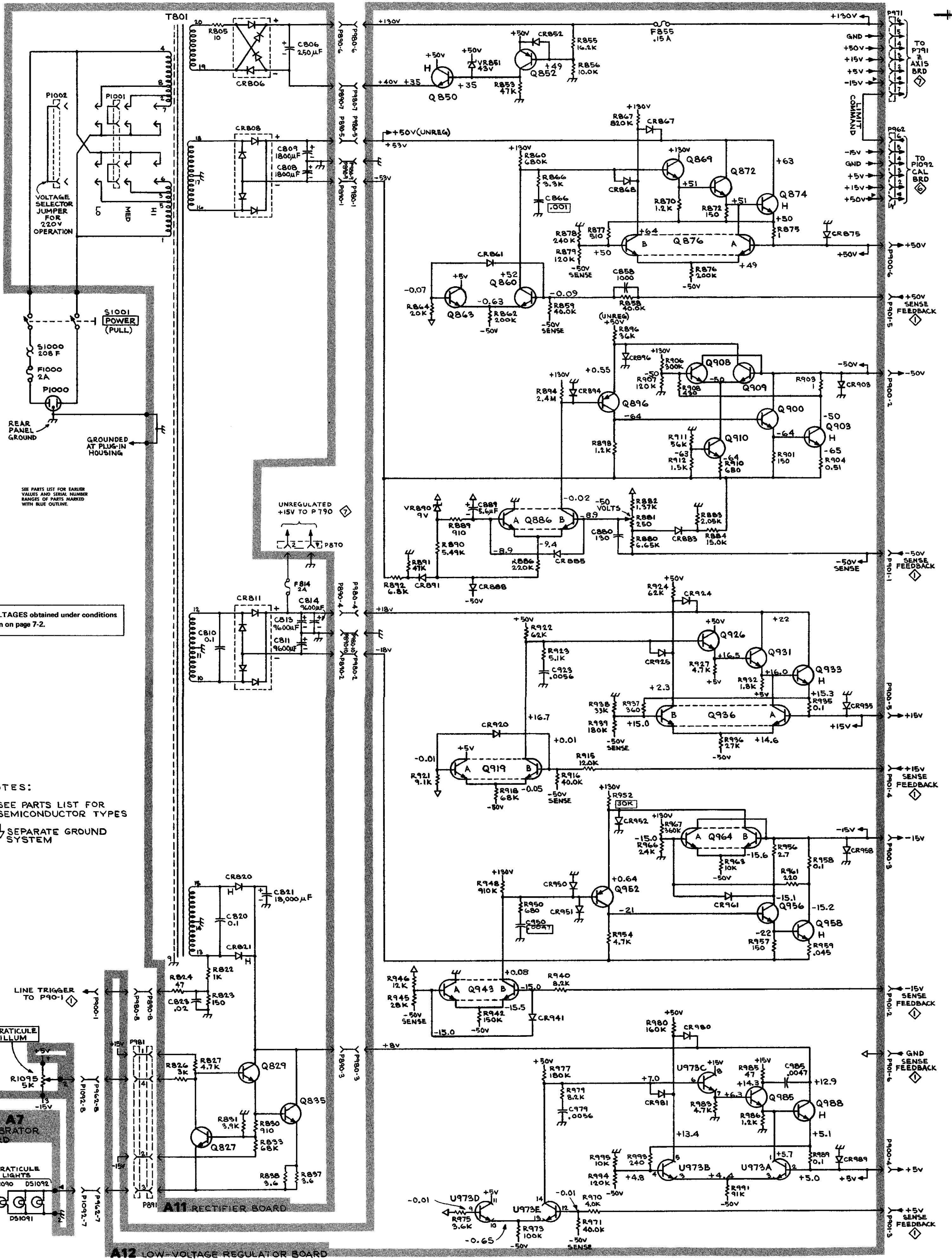


Fig. 7-13. Low-Voltage Regulator circuit board.

- NOTES:
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
 2. SEPARATE GROUND SYSTEM

P/O A7 CALIBRATOR BOARD

GRATICULE LIGHTS
DS1090 DS1092
DS1091



VOLTAGES obtained under conditions given on page 7-2.

A11 RECTIFIER BOARD

A12 LOW-VOLTAGE REGULATOR BOARD

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 indicate 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 PARTS LIST & ILLUSTRATIONS**

Title	Page Nos. of Parts List
FIGURE 1 FRONT	8-1 thru 8-5
FIGURE 2 CHASSIS & STANDARD ACCESSORIES	8-6 thru 8-11
FIGURE 3 REPACKAGING	<i>(parts list combined with illustration)</i>

SECTION 8

MECHANICAL PARTS LIST

FIGURE 1 FRONT

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description
				†	1	2	3	4	
				Y					
1-1	200-1209-01			1					BEZEL, CRT
	- - - - -			-					mounting hardware: <i>(not included w/bezel)</i>
-2	214-1573-00			2					THUMBSCREW, 6-32 x 0.656 inch long
-3	343-0256-00			2					RETAINER BLOCK, plastic
	- - - - -			-					mounting hardware for each: <i>(not included w/retainer block)</i>
-4	211-0513-00			2					SCREW, 6-32 x 0.625 inch, PHS
-5	337-1439-00			1					SHIELD, implosion
-6	378-0684-00			1					FILTER, light
-7	204-0476-00			1					BODY, terminal
	- - - - -			-					mounting hardware: <i>(not included w/body)</i>
-8	213-0055-00			2					SCREW, thread forming, 2-32 x 0.188 inch, PHS
-9	210-0713-01			3					EYELET, 0.105 OD x 0.125 inch long
-10	378-0624-00			1					REFLECTOR, light
-11	214-1253-00			1					SPRING, housing, graticule lamps
-12	390-0205-00			2					CABINET SIDE
-13	390-0204-00			1					CABINET BOTTOM
	- - - - -			-					mounting hardware: <i>(not included w/cabinet bottom)</i>
-14	211-0503-00			8					SCREW, 6-32 x 0.188 inch, PHS
-15	200-0728-00			2					COVER, handle end, plastic
-16	367-0108-00			1					HANDLE, carrying
	- - - - -			-					mounting hardware: <i>(not included w/handle)</i>
-17	212-0597-00			4					SCREW, shoulder, 10-32 x 0.355 inch long
-18	386-1624-00			2					PLATE, retaining, handle
-19	386-1283-02			2					PLATE, handle mounting, plastic
-20	366-1146-00			1					KNOB, gray—FOCUS
	- - - - -			-					knob includes:
	213-0153-00			1					SETSCREW, 5-40 x 0.125 inch, HSS
-21	366-1283-00			1					KNOB, charcoal—INTENSTIY
	- - - - -			-					knob includes:
	213-0153-00			2					SETSCREW, 5-40 x 0.125 inch, HSS
-22	384-1080-00			1					SHAFT, extension, 2 inches long, w/knob
-23	366-1120-00			1					KNOB, charcoal—GRATICULE ILLUM
	- - - - -			-					knob includes:
	213-0153-00			1					SETSCREW, 5-40 x 0.125 inch, HSS

FIGURE 1 FRONT (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † Y						Description
					1	2	3	4	5	
1-24	136-0387-01			1						JACK, tip (black)
-25	136-0387-00			3						JACK, tip (gray)
-26	358-0216-00			1						BUSHING, front panel, 0.412 inch OD
-27	- - - - -			1						RESISTOR, variable
	- - - - -			-						mounting hardware: (not included w/resistor)
-28	210-0583-00			1						NUT, hex., 0.25-32 x 0.312 inch
-29	210-0940-01			1						WASHER, flat, 0.25 ID x 0.375 inch OD
-30	210-0223-01			1						LUG, solder, 0.25 inch diameter, SE, bent
-31	333-1428-00			1						PANEL, front
-32	214-1562-00			1						ACTUATOR, switch
	- - - - -			-						actuator includes:
	213-0022-00			1						SETSCREW, 4-40 x 0.188 inch, HSS
-33	214-1353-00			1						SPRING, helical compression, 0.75 inch long
-34	200-0745-00			1						COVER, variable resistor
-35	- - - - -			1						RESISTOR, variable
	- - - - -			-						mounting hardware: (not included w/resistor)
-36	210-0590-00			1						NUT, hex., 0.375-32 x 0.438 inch
-37	210-0013-00			1						WASHER, lock, internal, 0.375 ID x 0.688 inch OD
-38	136-0445-00			1						LAMPHOLDER
	- - - - -			-						mounting hardware: (not included w/lampholder)
-39	211-0501-00			2						SCREW, 6-32 x 0.125 inch, PHS
-40	129-0303-00			2						POST, 6-32 x 0.25 OD x 0.237 inch long
-41	407-0915-00			1						BRACKET, angle
	- - - - -			-						mounting hardware: (not included w/bracket)
-42	211-0541-00			2						SCREW, 6-32 x 0.25 inch, 100° csk, FHS
-43	670-1375-00			1						CIRCUIT BOARD ASSEMBLY, switch—TRIG SOURCE A8
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
	211-0156-00			2						SCREW, 1-72 x 0.25 inch, 82° csk, FHS
-44	670-1379-00			1						CIRCUIT BOARD ASSEMBLY, switch—CALIBRATOR A7
	- - - - -			-						circuit board assembly includes:
-45	131-0608-00			16						TERMINAL, pin, 0.365 inch long
-46	136-0220-00			4						SOCKET, transistor, 3 pin, square
-47	260-1132-00			1						SWITCH, push—BEAM FINDER
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
-48	211-0156-00			2						SCREW, 1-72 x 0.25 inch, 82° csk, FHS
-49	386-1964-00			1						SUBPANEL, front
	- - - - -			-						mounting hardware: (not included w/subpanel)
-50	213-0123-00			4						SCREW, thread forming, 6-32 x 0.375 inch, 100° csk, FHS

FIGURE 1 FRONT (cont)

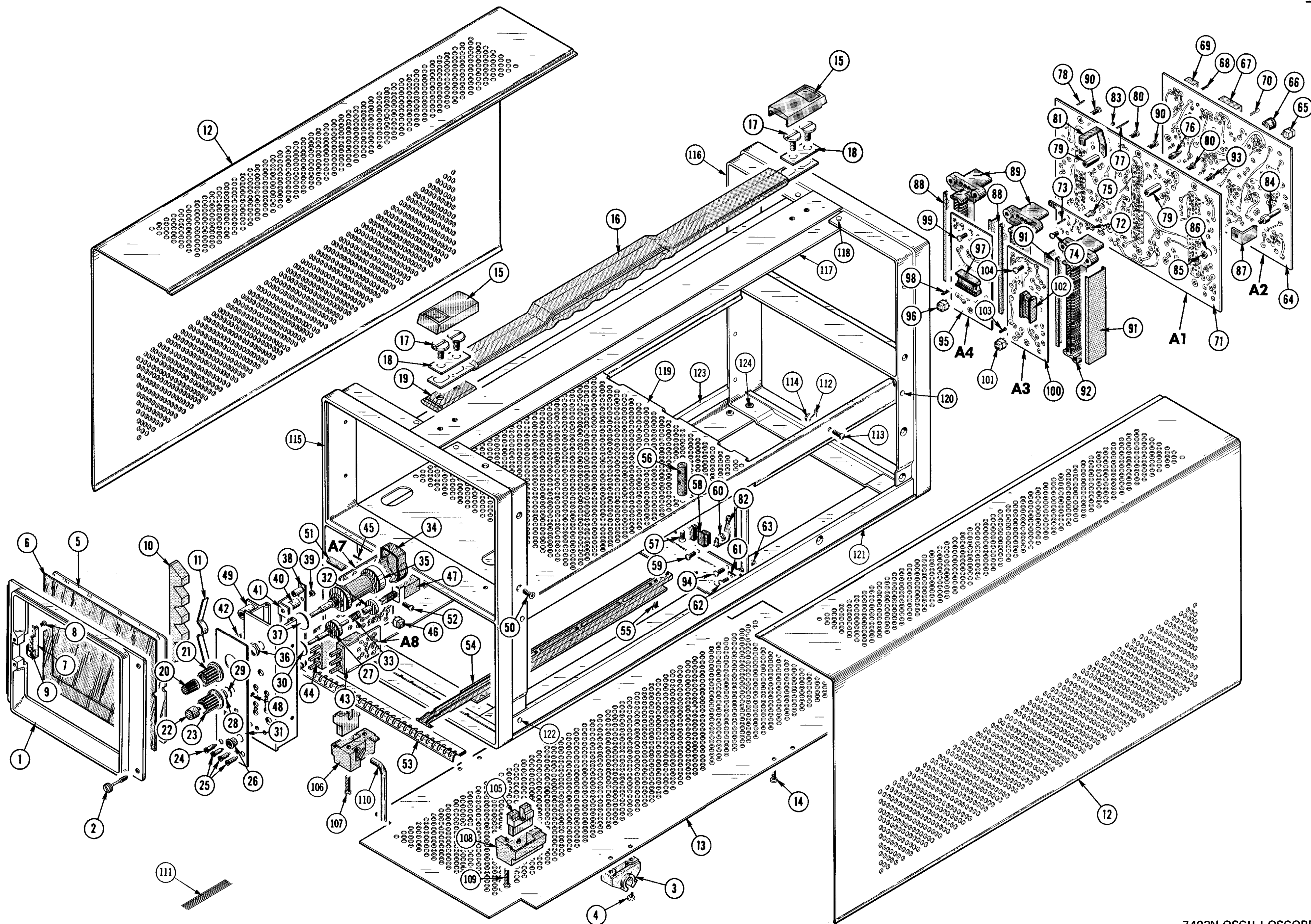
Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q f y	1	2	3	4	5	Description
1-51	129-0080-00			1						POST, plastic 4-40 x 0.25 OD x 0.875 inch long
	- - - - -			-						mounting hardware: <i>(not included w/post)</i>
	211-0040-00			1						SCREW, plastic, 4-40 x 0.25 inch <i>(not shown)</i>
-52	211-0008-00			1						SCREW, 4-40 x 0.25 inch, PHS
-53	348-0278-00			2						SHIELDING GASKET, electrical
-54	351-0295-00			3						GUIDE, slide
	- - - - -			-						mounting hardware for each: <i>(not included w/guide)</i>
-55	213-0088-00			1						SCREW, thread forming, 4-24 x 0.25 inch, PHS
-56	385-0113-00			1						ROD, plastic
	- - - - -			-						mounting hardware: <i>(not included w/rod)</i>
-57	211-0538-00			1						SCREW, 6-32 x 0.312 inch, 100° csk, FHS
-58	131-0930-01			4						CONTACT, electrical, plug-in ground
	- - - - -			-						mounting hardware for each: <i>(not included w/contact)</i>
-59	211-0008-00			1						SCREW, 4-40 x 0.25 inch, PHS
-60	210-0586-00			1						NUT, keps, 4-40 x 0.25 inch
-61	131-1018-00			4						CONTACT, electrical, plug-in ground
	- - - - -			-						mounting hardware for each: <i>(not included w/contact)</i>
-62	211-0007-00			1						SCREW, 4-40 x 0.188 inch, PHS
-63	210-0586-00			1						NUT, keps, 4-40 x 0.25 inch
-64	670-1370-00			1						CIRCUIT BOARD ASSEMBLY—LOGIC A2
	- - - - -			-						circuit board assembly includes:
	388-1929-00			1						CIRCUIT BOARD
-65	136-0220-00			12						SOCKET, transistor, 3 pin, square
-66	136-0235-00			1						SOCKET, transistor, 6 pin
-67	136-0260-01			1						SOCKET, integrated circuit, 16 pin
-68	136-0263-03			35						SOCKET, pin terminal
-69	136-0269-00			4						SOCKET, integrated circuit, 14 pin
-70	214-0579-00			7						PIN, test point
-71	670-1372-00			1						CIRCUIT BOARD ASSEMBLY—MAIN INTERFACE A1
	- - - - -			-						circuit board assembly includes:
	388-1931-00			1						CIRCUIT BOARD
-72	670-1374-00			1						CIRCUIT BOARD ASSEMBLY—VERTICAL INTERCONNECT
	- - - - -			-						circuit board assembly includes:
	388-1933-00			1						CIRCUIT BOARD
-73	131-0787-00			8						TERMINAL, pin, 0.64 inch long
	- - - - -			-						mounting hardware: <i>(not included w/circuit board assembly)</i>
-74	211-0008-00			2						SCREW, 4-40 x 0.25 inch, PHS
-75	351-0213-00			2						GUIDE-POST, lock, 4-40 x 0.285 inch

FIGURE 1 FRONT (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y	1	2	3	4	5	Description
1-76	386-1558-00			2						SUPPORT, circuit board
	131-0591-00			35						TERMINAL, pin, 0.835 inch long
-77	131-0592-00			25						TERMINAL, pin, 0.885 inch long
-78	131-0608-00			36						TERMINAL, pin, 0.365 inch long
-79	129-0308-00			4						POST, hex., 4-40 x 0.188 x 0.465 inch long
	- - - - -			-						mounting hardware for each: (not included w/post)
-80	211-0008-00			1						SCREW, 4-40 x 0.25 inch, PHS
-81	131-0804-00			1						LINK, terminal connecting, 1.17 inches long
-82	131-0805-00			2						LINK, terminal connecting, 0.90 inch long
-83	136-0261-00			4						SOCKET, connector pin, 0.145 inch long
-84	214-1568-00			2						PIN, guide
	- - - - -			-						mounting hardware for each: (not included w/pin)
-85	210-0406-00			1						NUT, hex., 4-40 x 0.188 inch
-86	210-0054-00			1						WASHER, lock, split, 0.118 ID x 0.212 inch OD
-87	344-0147-00			2						CLIP, plastic
	131-0767-02			2						CONNECTOR, receptacle, 76 contact
	- - - - -			-						each connector includes:
-88	200-0950-00			2						COVER, plastic
-89	204-0365-00			1						BODY, plastic
	131-0726-00			38						CONTACT, straight, electrical
	131-0727-00			38						CONTACT, offset, electrical
	- - - - -			-						mounting hardware for each: (not included w/connector)
-90	213-0232-00			2						SCREW, thread forming, 2-56 x 0.312 inch, PHS
	131-0767-00			1						CONNECTOR, receptacle, 76 contact
	- - - - -			-						connector includes:
-91	200-0950-00			2						COVER, plastic
-92	204-0365-00			1						BODY, plastic
	131-0726-00			38						CONTACT, straight, electrical
	131-0727-00			38						CONTACT, offset, electrical
	- - - - -			-						mounting hardware: (not included w/connector)
-93	213-0232-00			2						SCREW, thread forming, 2-56 x 0.312 inch, PHS
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
-94	213-0034-00			9						SCREW, thread forming, 4-40 x 0.312 inch, RHS
-95	670-1373-00	B010100	B010399	1						CIRCUIT BOARD ASSEMBLY—VERTICAL INTERFACE A4
	670-1373-01	B010400	B029999	1						CIRCUIT BOARD ASSEMBLY—VERTICAL INTERFACE A4
	670-1373-02	B030000		1						CIRCUIT BOARD ASSEMBLY—VERTICAL INTERFACE A4
	- - - - -			-						circuit board assembly includes:
	388-1932-00			1						CIRCUIT BOARD
-96	136-0220-00			4						SOCKET, transistor, 3 pin, square
-97	136-0260-01			1						SOCKET, integrated circuit, 16 pin
-98	136-0263-03			17						SOCKET, pin terminal
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
-99	211-0008-00			2						SCREW, 4-40 x 0.25 inch, PHS

FIGURE 1 FRONT (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q t y						Description
					1	2	3	4	5	
1-100	670-1371-00			1						CIRCUIT BOARD ASSEMBLY—TRIGGER SELECTOR A3
	- - - - -			-						circuit board assembly includes:
	388-1930-00			1						CIRCUIT BOARD
-101	136-0220-00			3						SOCKET, transistor, 3 pin, square
-102	136-0260-01			1						SOCKET, integrated circuit, 16 pin
-103	136-0263-03			16						SOCKET, pin terminal
	- - - - -			-						mounting hardware: <i>(not included w/circuit board assembly)</i>
-104	211-0008-00			2						SCREW, 4-40 x 0.25 inch, PHS
-105	- - - - -			1						FRAME ASSEMBLY
-106	348-0074-00			2						FOOT, bail limiting, right front & left rear
	- - - - -			-						mounting hardware for each: <i>(not included w/foot)</i>
-107	211-0532-00			2						SCREW, 6-32 x 0.75 inch, PHS
-108	348-0073-00			2						FOOT, bail limiting, left front & right rear
	- - - - -			-						mounting hardware for each: <i>(not included w/foot)</i>
-109	211-0532-00			2						SCREW, 6-32 x 0.75 inch, PHS
-110	377-0119-00			4						INSERT, foot, plastic
-111	348-0282-00			1						FLIP-STAND, cabinet
-112	175-0830-00			ft						WIRE, electrical, 7 wire ribbon, 11 inches long
-113	210-0202-00			1						LUG, solder, SE#6
	- - - - -			-						mounting hardware: <i>(not included w/lug)</i>
-114	211-0504-00			1						SCREW, 6-32 x 0.25 inch, PHS
-115	210-0407-00			1						NUT, hex., 6-32 x 0.25 inch



7403N OSCILLOSCOPE

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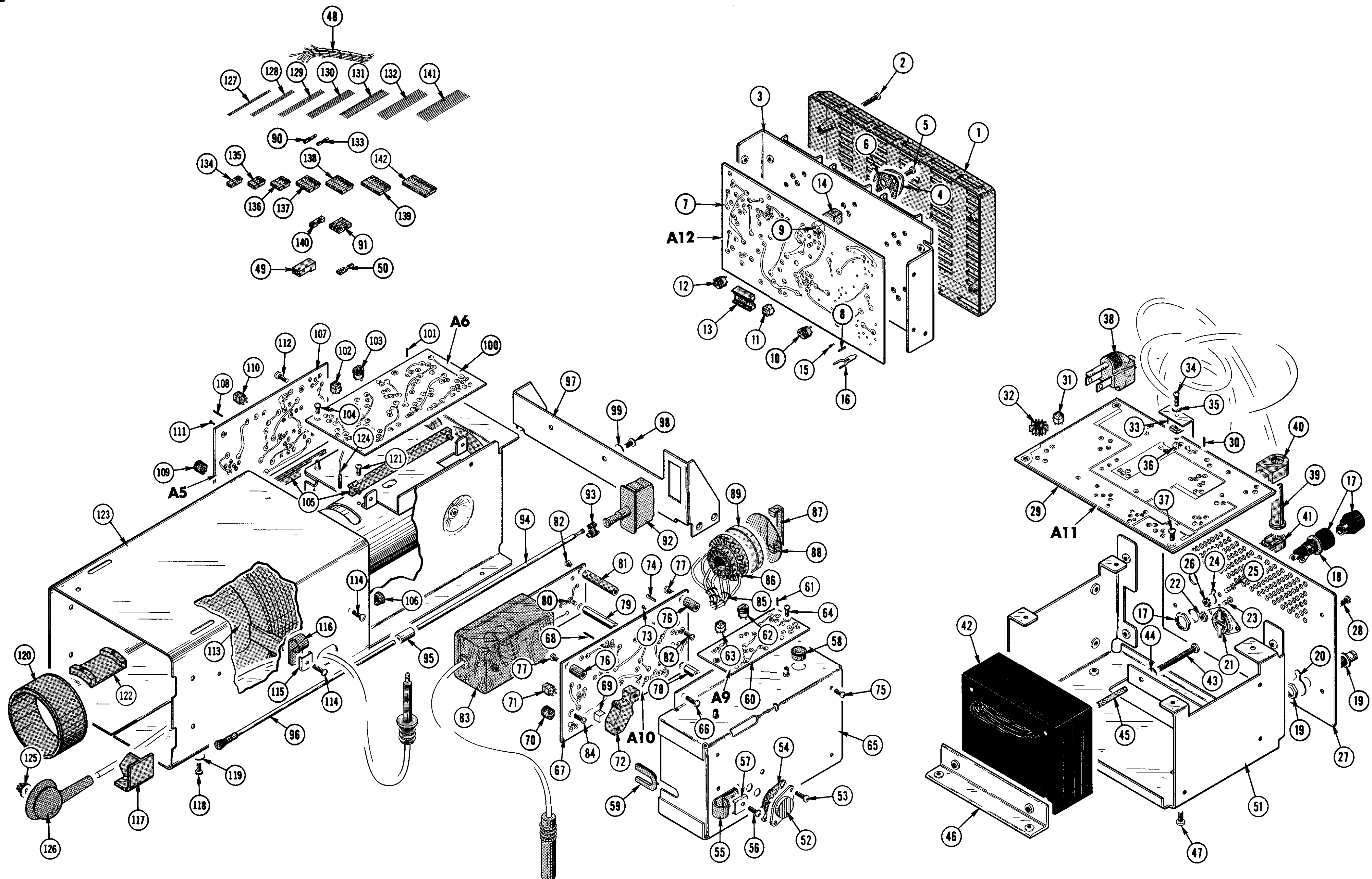


FIGURE 2 CHASSIS & STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † y	1	2	3	4	5	Description
2-1	337-1425-00			1						SHIELD, electrical, regulator
	- - - - -			-						mounting hardware: (not included w/shield)
-2	211-0514-00			4						SCREW, 6-32 x 0.75 inch, PHS
-3	441-0994-01			1						CHASSIS, regulator, w/heatsink
	- - - - -			-						mounting hardware: (not included w/chassis)
	211-0538-00			4						SCREW, 6-32 x 0.312 inch, 100° csk, (not shown)
-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	386-0978-00			1						PLATE, mica, 1.17 x 1.70 inches
-7	670-1376-00	B010100	B029999	1						CIRCUIT BOARD ASSEMBLY—REGULATOR A12
	670-1376-01	B030000		1						CIRCUIT BOARD ASSEMBLY—REGULATOR A12
	- - - - -			-						circuit board assembly includes:
	388-1935-00			1						CIRCUIT BOARD
-8	131-0608-00			45						TERMINAL, pin, 0.365 inch long
-9	131-0847-00			12						TERMINAL POST, 0.435 inch long
-10	136-0183-00			6						SOCKET, transistor, 3 pin
-11	136-0220-00			9						SOCKET, transistor, 3 pin, square
-12	136-0235-00			6						SOCKET, transistor, 6 pin
-13	136-0269-00			1						SOCKET, integrated circuit, 14 pin
-14	136-0361-00			6						SOCKET, transistor
-15	136-0384-00			12						SOCKET, pin terminal
-16	344-0154-00			2						CLIP, electrical, fuse
-17	352-0076-00			1						FUSEHOLDER ASSEMBLY, w/hardware
	- - - - -			-						mounting hardware: (not included w/fuseholder assembly)
-18	210-0873-00			1						WASHER, rubber, 0.50 ID x 0.687 inch OD
-19	131-0955-00			1						CONNECTOR, receptacle, BNC, w/hardware
	- - - - -			-						mounting hardware: (not included w/connector)
-20	210-0255-00			1						LUG, solder, 0.375 inch diameter, SE
-21	- - - - -			1						SWITCH, thermostatic
	- - - - -			-						mounting hardware: (not included w/switch)
-22	210-0586-00			2						NUT, keps, 4-40 x 0.25 inch
-23	211-0008-00			2						SCREW, 4-40 x 0.25 inch, PHS

FIGURE 2 CHASSIS & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y						Description
					1	2	3	4	5	
2-24	210-0202-00			1						LUG, solder, SE #6
	- - - - -			-						mounting hardware: <i>(not included w/lug)</i>
-25	211-0504-00			1						SCREW, 6-32 x 0.25 inch, PHS
-26	210-0407-00			1						NUT, hex., 6-32 x 0.25 inch
-27	386-1954-00			1						PANEL, rear, power
	- - - - -			-						mounting hardware: <i>(not included w/panel)</i>
-28	211-0565-00			4						SCREW, 6-32 x 0.25 inch, THS
-29	670-1382-00			1						CIRCUIT BOARD ASSEMBLY—RECTIFIER A11
	- - - - -			-						circuit board assembly includes:
	388-1941-00			1						CIRCUIT BOARD
-30	131-0608-00			30						TERMINAL, pin, 0.365 inch
-31	136-0220-00			2						SOCKET, transistor, 3 pin, square
	344-0154-00			4						CLIP, electrical, fuse
-32	214-1292-00			2						HEATSINK, transistor
-33	214-1608-00			1						HEATSINK, transistor, right angle
	- - - - -			-						mounting hardware: <i>(not included w/heatsink)</i>
-34	211-0012-00			1						SCREW, 4-40 x 0.375 inch, PHS
-35	210-0935-00			1						WASHER, fiber, 0.14 ID x 0.375 inch OD
-36	210-0586-00			1						NUT, keps, 4-40 x 0.25 inch
	- - - - -			-						mounting hardware: <i>(not included w/circuit board assembly)</i>
-37	211-0507-00			3						SCREW, 6-32 x 0.312 inch, PHS
	211-0511-00			1						SCREW, 6-32 x 0.50 inch, PHS <i>(not shown)</i>
-38	161-0033-09			1						CABLE ASSEMBLY, power
-39	200-1004-00			1						CABLE NIPPLE, plastic
-40	358-0371-00			1						BUSHING, strain relief, top
-41	358-0372-00			1						BUSHING, strain relief, bottom
-42	- - - - -			1						TRANSFORMER
	- - - - -			-						mounting hardware: <i>(not included w/transformer)</i>
-43	212-0522-00			2						SCREW, 10-32 x 2.50 inches, HHS
-44	210-0812-00			2						WASHER, fiber, 0.188 ID x 0.375 inch OD
-45	166-0457-00			2						TUBE, insulating, 1.875 inches long
-46	407-0921-00			1						BRACKET, angle
	- - - - -			-						mounting hardware: <i>(not included w/bracket)</i>
-47	212-0023-00			2						SCREW, 8-32 x 0.375 inch, PHS
-48	179-1637-00			1						WIRING HARNESS, power
	- - - - -			-						wiring harness includes:
-49	200-1075-00			4						COVER, terminal, plastic
-50	131-0851-00			4						CONNECTOR, plug
	346-0077-00			1						STRAP, power cable, plastic

FIGURE 2 CHASSIS & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y	1	2	3	4	5	Description
2-51	441-0993-00			1						CHASSIS, power supply
	- - - - -			-						mounting hardware: <i>(not included w/chassis)</i>
	212-0040-00			6						SCREW, 8-32 x 0.375 inch, 100° csk, FHS
-52	- - - - -			2						TRANSISTOR
	- - - - -			-						mounting hardware for each: <i>(not included w/transistor)</i>
-53	211-0507-00			2						SCREW, 6-32 x 0.312 inch, PHS
-54	386-0978-00			1						PLATE, mica, 1.17 x 1.70 inches
-55	343-0006-00			1						CLAMP, cable, plastic, 0.50 inch diameter
	- - - - -			-						mounting hardware: <i>(not included w/clamp)</i>
-56	211-0510-00			1						SCREW, 6-32 x 0.375 inch, PHS
-57	210-0863-00			1						WASHER, D shape, 0.191 ID x 0.515 inch
-58	348-0063-00			1						GROMMET, plastic, 0.485 ID x 0.50 inch OD
-59	348-0085-00			4						GROMMET, plastic, U shape
-60	670-1383-00	B010100	B029999	1						CIRCUIT BOARD ASSEMBLY—Z AXIS A9
	670-1383-01	B030000		1						CIRCUIT BOARD ASSEMBLY—Z AXIS A9
	- - - - -			-						circuit board assembly includes:
	388-1942-00			1						CIRCUIT BOARD
-61	131-0608-00			32						TERMINAL, pin, 0.365 inch long
-62	136-0183-00			1						SOCKET, transistor, 3 pin
-63	136-0220-00			3						SOCKET, transistor, 3 pin, square
	- - - - -			-						mounting hardware: <i>(not included w/circuit board assembly)</i>
-64	211-0008-00			2						SCREW, 4-40 x 0.25 inch, PHS
-65	337-1431-00			1						SHIELD, high voltage
	- - - - -			-						mounting hardware: <i>(not included w/shield)</i>
-66	211-0504-00			3						SCREW, 6-32 x 0.25 inch, PHS
-67	670-1380-00			1						CIRCUIT BOARD ASSEMBLY—HIGH VOLTAGE A10
	- - - - -			-						circuit board assembly includes:
	388-1939-00			1						CIRCUIT BOARD
-68	131-0589-00			3						TERMINAL, pin, 0.50 inch long
-69	131-0847-00			4						TERMINAL, pin, 0.435 inch long
-70	136-0183-00			1						SOCKET, transistor, 3 pin
-71	136-0220-00			2						SOCKET, transistor, 3 pin, square
-72	136-0361-00			2						SOCKET, transistor
-73	136-0384-00			4						SOCKET, pin, terminal
-74	214-0579-00			1						PIN, test point
	166-0292-00			2						SLEEVE, support, plastic, 0.155 inch diameter
	- - - - -			-						mounting hardware: <i>(not included w/circuit board assembly)</i>
-75	211-0008-00			3						SCREW, 4-40 x 0.25 inch, PHS

FIGURE 2 CHASSIS & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † y	1	2	3	4	5	Description
2-76	129-0143-00			2						POST, plastic, 4-40 x 0.312 OD x 0.406 inch long
	- - - - -			-						mounting hardware for each: <i>(not included w/post)</i>
-77	211-0008-00			1						SCREW, 4-40 x 0.25 inch, PHS
-78	129-0098-00			1						POST, hex., 4-40 x 0.25 x 0.406 inch long
-79	129-0305-00			1						POST, hex., studed, 4-40 inch
	- - - - -			-						mounting hardware: <i>(not included w/post)</i>
-80	211-0008-00			1						SCREW, 4-40 x 0.25 inch, PHS
-81	129-0304-00			1						POST, plastic, 4-40 x 0.25 ID x 1.23 inches long
	- - - - -			-						mounting hardware: <i>(not included w/post)</i>
-82	211-0008-00			2						SCREW, 4-40 x 0.25 inch, PHS
-83	119-0286-00			1						MULTIPLIER, high voltage
	- - - - -			-						mounting hardware: <i>(not included w/multiplier)</i>
-84	211-0008-00			2						SCREW, 4-40 x 0.25 inch, PHS
-85	136-0446-00			1						WIRING HARNESS, CRT socket
	- - - - -			-						wiring harness includes:
-86	136-0304-02			1						SOCKET, CRT, w/connectors
-87	343-0254-00			1						CLAMP, CRT socket
-88	367-0117-00			1						HANDLE, CRT socket
-89	200-0917-01			1						COVER, CRT socket
	179-1263-00			1						WIRING HARNESS, HIGH VOLTAGE
	- - - - -			-						wiring harness includes:
-90	131-0621-00			3						CONNECTOR, terminal
-91	352-0199-00			1						HOLDER, terminal connector, 3 wire <i>(black)</i>
-92	260-1222-00			1						SWITCH, push-pull—POWER
-93	376-0127-00			1						COUPLER, shaft, plastic
-94	384-1107-00			1						SHAFT, extension, 7.232 inches long
-95	376-0053-00			1						COUPLING, shaft, 0.128 ID x 0.312 OD x 0.75 inch long
-96	384-1081-00			1						SHAFT, extension, w/knob
-97	407-0914-00			1						BRACKET, chassis
	- - - - -			-						mounting hardware: <i>(not included w/bracket)</i>
	211-0538-00			4						SCREW, 6-32 x 0.312 inch, 100° csk, FHS
	210-0457-00			4						NUT, keps, 6-32 x 0.312 inch
-98	211-0510-00			2						SCREW, 6-32 x 0.375 inch, PHS
-99	210-0949-00			2						WASHER, flat, 0.141 ID x 0.50 inch OD
-100	670-1378-00			1						CIRCUIT BOARD ASSEMBLY—HORIZONTAL A6
	- - - - -			-						circuit board assembly includes:
	388-1937-00			1						CIRCUIT BOARD
-101	131-0608-00			11						TERMINAL, pin, 0.365 inch long
-102	136-0220-00			4						SOCKET, transistor, 3 pin, square
-103	136-0183-00			6						SOCKET, transistor, 3 pin
	- - - - -			-						mounting hardware: <i>(not included w/circuit board assembly)</i>
-104	211-0008-00			2						SCREW, 4-40 x 0.25 inch, PHS

FIGURE 2 CHASSIS & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † y	1	2	3	4	5	Description
2-105	351-0087-00			2						GUIDE, circuit card, 4.75 inches long
-106	348-0056-00			2						GROMMET, plastic, 0.354 ID x 0.406 inch OD
-107	670-1377-00	B010100	B029999	1						CIRCUIT BOARD ASSEMBLY—VERTICAL A5
	670-1377-01	B030000		1						CIRCUIT BOARD ASSEMBLY—VERTICAL A5
	- - - - -			-						circuit board assembly includes:
	388-1936-00			1						CIRCUIT BOARD
-108	131-0589-00			6						TERMINAL, pin, 0.50 inch long
-109	136-0183-00			4						SOCKET, transistor, 3 pin
-110	136-0220-00			7						SOCKET, transistor, 3 pin, square
-111	136-0261-00			4						SOCKET, connector pin
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
-112	211-0008-00			2						SCREW, 4-40 x 0.25 inch, PHS
-113	119-0288-00	B010100	B010399	1						DELAY LINE ASSEMBLY
	119-0288-01	B010400		1						DELAY LINE ASSEMBLY
	- - - - -			-						mounting hardware: (not included w/delay line assembly)
-114	213-0054-00			4						SCREW, thread forming, 6-32 x 0.312 inch, PHS
-115	210-0863-00			1						WASHER, D shape, 0.191 ID x 0.515 inch OD
-116	343-0013-00			1						CLAMP, cable, 0.375 inch diameter
-117	386-1952-00			4						SUPPORT, CRT, front
	- - - - -			-						mounting hardware for each: (not included w/support)
-118	211-0603-00			1						SCREW, 6-32 x 0.312 inch, HHS
-119	210-0803-00			1						WASHER, flat, 0.15 ID x 0.375 inch OD
-120	- - - - -			1						COIL
	- - - - -			-						mounting hardware: (not included w/coil)
-121	213-0138-00			2						SCREW, thread forming, 4-24 x 0.188 inch, PHS
-122	343-0217-00			1						CLAMP, coil, plastic
-123	- - - - -			1						SHIELD & CHASSIS ASSEMBLY
	- - - - -			-						mounting hardware: (not included w/shield & chassis assembly)
	211-0541-00			2						SCREW, 6-32 x 0.25 inch, 100° csk, FHS
-124	195-0085-00			1						LEAD SET, CRT deflection
	- - - - -			-						lead set includes:
	131-0865-00			4						TERMINAL, pin, S-pin, male
	131-1093-00			1						CONNECTOR, anode
	- - - - -			-						connector includes:
-125	131-0026-00			1						CONNECTOR, cable
-126	200-0544-00			1						COVER, anode connector
-127	175-0825-00			ft						WIRE, electrical, 2 wire ribbon, 16 inches long
-128	175-0826-00			ft						WIRE, electrical, 3 wire ribbon, 45.50 inches long
-129	175-0827-00			ft						WIRE, electrical, 4 wire ribbon, 4.25 inches long
-130	175-0829-00			ft						WIRE, electrical, 6 wire ribbon, 23 inches long
-131	175-0830-00			ft						WIRE, electrical, 7 wire ribbon, 14.75 inches long
-132	175-0857-00			ft						WIRE, electrical, 8 wire ribbon, 18 inches long

FIGURE 2 CHASSIS & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † y	1	2	3	4	5	Description
2-133	131-0707-00			75						CONNECTOR, terminal
	131-0708-00			6						CONNECTOR, terminal
-134	352-0169-01			2						HOLDER, terminal connector, 2 wire (brown)
	352-0169-04			2						HOLDER, terminal connector, 2 wire (yellow)
-135	352-0161-02			1						HOLDER, terminal connector, 3 wire (red)
-136	352-0162-01			2						HOLDER, terminal connector, 4 wire (brown)
-137	352-0164-00			1						HOLDER, terminal connector, 6 wire (black)
	352-0164-01			2						HOLDER, terminal connector, 6 wire (brown)
-138	352-0165-00			5						HOLDER, terminal connector, 7 wire (black)
-139	352-0166-00			2						HOLDER, terminal connector, 8 wire (black)
	352-0199-00			1						HOLDER, terminal connector, 3 wire (black)
-140	352-0197-00			1						HOLDER, terminal connector, 1 wire (black)
-141	175-0833-00			ft						WIRE, electrical, 10 wire ribbon, 10 inches long
-142	352-0168-00			1						HOLDER, terminal connector, 10 wire (black)

STANDARD ACCESSORIES

175-1178-00	2	CABLE, special purpose, 20 inches long (not shown)
070-1124-00	1	MANUAL, instruction (not shown)

CARTON ASSEMBLY
(Part No. 065-0154-00)

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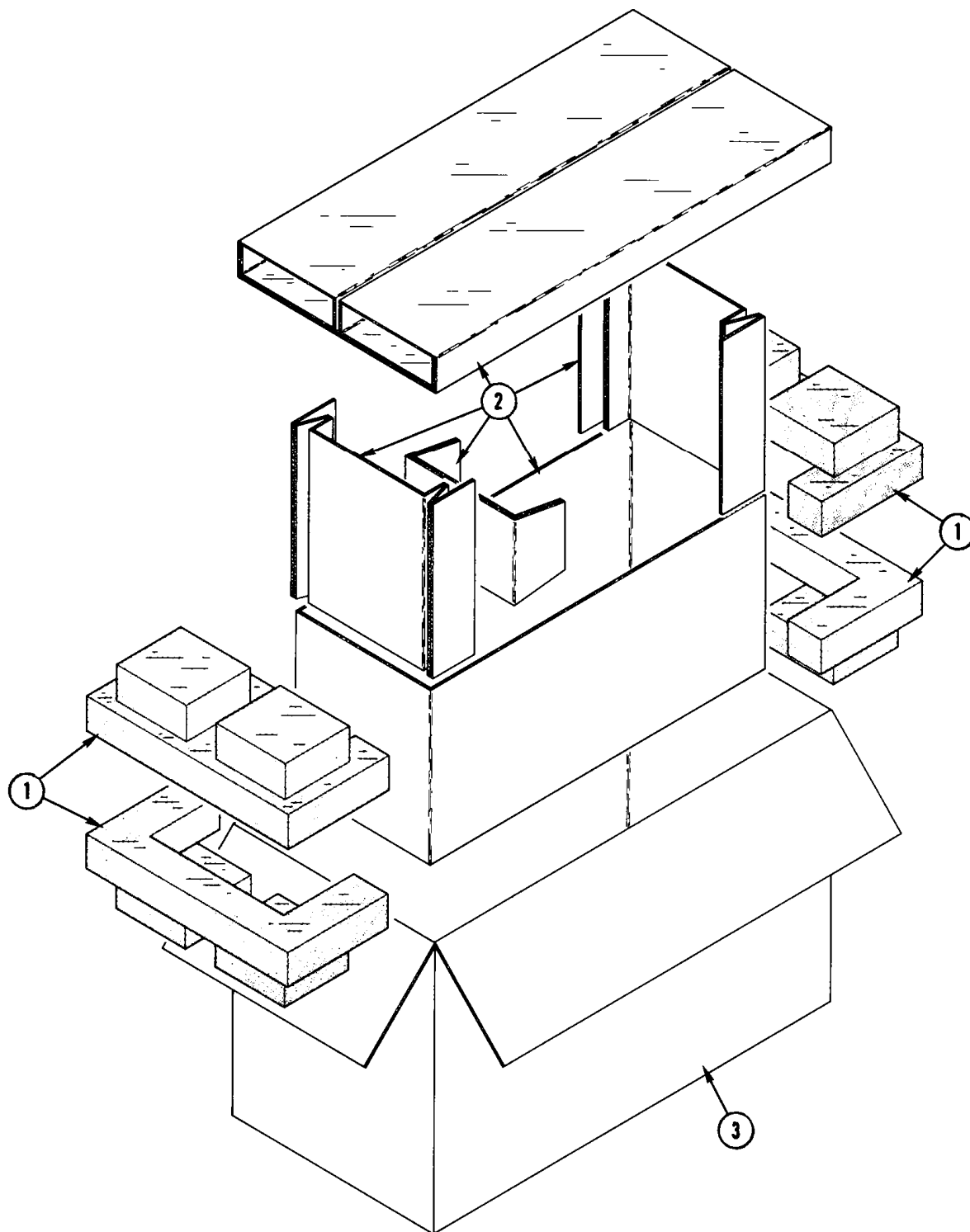


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q ↑ y	1 2 3 4 5	Description
3-	065-0154-00			1		CARTON ASSEMBLY
	- - - - -			-		carton assembly includes:
-1	004-0281-00			2		ETHAFRAME
-2	004-1092-00			1		PAD SET, 5 piece
-3	004-0766-00			1		CARTON

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MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. 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.

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

A2 LOGIC Circuit Board Assembly

CHANGE TO:

670-1370-01	Complete Board			
R56	315-0511-00	510 Ω	1/4 W	5%
R57	315-0682-00	6.8 k Ω	1/4 W	5%

A12 LOW-VOLTAGE REGULATOR
Circuit Board Assembly

CHANGE TO:

670-1376-04	Complete Board			
R991	315-0473-00	47 k Ω	1/4 W	5%

MECHANICAL PARTS LIST CORRECTION

Section 8 Page 8-3

CHANGE TO:

1-64	670-1370-00	B010100-B039999	1	CIRCUIT BOARD ASSEMBLY-LOGIC A2
	670-1370-01	B040000	1	CIRCUIT BOARD ASSEMBLY-LOGIC A2

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CHANGE TO:

2-7	670-1376-04	B040000	1	CIRCUIT BOARD ASSEMBLY- REGULATOR A12
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ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

CHANGE TO:

R877	315-0561-00	560 Ω	1/4 W	5%
R961	315-0241-00	240 Ω	1/4 W	5%

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

A10 HIGH VOLTAGE Circuit Board Assembly

CHANGE TO:

670-1380-01

Complete Board

CR750	152-0242-00	Silicon	Selected from 1N486A or Replaceable by CD12691
CR752	152-0242-00	Silicon	Selected from 1N486A or Replaceable by CD12691
CR756	152-0242-00	Silicon	Selected from 1N486A or Replaceable by CD12691
CR757	152-0242-00	Silicon	Selected from 1N486A or Replaceable by CD12691
R748	301-0105-00	1 M Ω	1/2 W 5%

MECHANICAL PARTS LIST CORRECTION

SECTION 8 Page 8-8

CHANGE TO:

-67	670-1380-01	1	CIRCUIT BOARD ASSEMBLY - HIGH VOLTAGE A10
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