Tektronix®

7104
OSCILLOSCOPE
WITH OPTIONS

INSTRUCTION MANUAL

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Tektronix®
COMMITTED TO EXCELLENCE

WARNING

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

PLEASE CHECK FOR CHANGE INFORMATION AT THE REAR OF THIS MANUAL.

7104
OSCILLOSCOPE
WITH OPTIONS

INSTRUCTION MANUAL

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

070-2314-00
Product Group 42

Serial Number: ______________

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INSTRUMENT SERIAL NUMBERS

Each instrument has a serial number on a panel insert, tag, or stamped on the chassis. The first number or letter designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

B000000	Tektronix, Inc., Beaverton, Oregon, USA
100000	Tektronix Guernsey, Ltd., Channel Islands
200000	Tektronix United Kingdom, Ltd., London
300000	Sony/Tektronix, Japan
700000	Tektronix Holland, NV, Heerenveen, The Netherlands

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WARNING

THE REMAINING PORTION OF THIS TABLE OF CONTENTS LISTS THE SERVICING INSTRUCTIONS. THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRICAL SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CALLED OUT IN THE OPERATING INSTRUCTIONS UNLESS QUALIFIED TO DO SO.

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LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (CONT)

The illustrations in section 8 are located near their associated diagrams on the foldout page.

LIST OF TABLES

OPERATORS SAFETY SUMMARY

The following general safety information applies to all operators and service personnel. Specific warnings and cautions will be found throughout the manual where they apply and should be followed in each instance.

TERMS

In This Manual

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

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

As Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

SYMBOLS

In This Manual

⚠ This symbol indicates where applicable cautionary or other information is to be found.

As Marked on Equipment

ϟ DANGER—High voltage.

⏚ Protective ground (earth) terminal.

⚠ ATTENTION—Refer to manual.

WARNINGS

Power Source

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

Grounding the Instrument

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

Use the Proper Power Cord

Use only the power cord and connector specified for your instrument. Use only a power cord that is in good condition. For detailed information on power cords and connectors, see page 1-2 of this manual.

Refer cord and connector changes to qualified service personnel.

Use the Proper Fuse

To avoid fire hazard, use only the fuse specified in the parts list for this instrument, and which is identical in type, voltage rating, and current rating.

Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmosphere

To avoid explosion, do not operate this instrument in an atmosphere of explosive gasses until it has been specifically certified for such operation.

Do Not Remove Panels or Covers

To avoid personal injury, do not remove the protective cabinet panels or covers. Do not operate this instrument without the panels or covers properly installed.

Do Not Remove CRT Implosion Shield

Do not remove the clear plastic implosion shield covering the crt faceplate. This shield provides protection to the operator from crt implosion.

SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary

Do Not Service Alone

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

Use Care When Servicing With Power On

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

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

Power Source

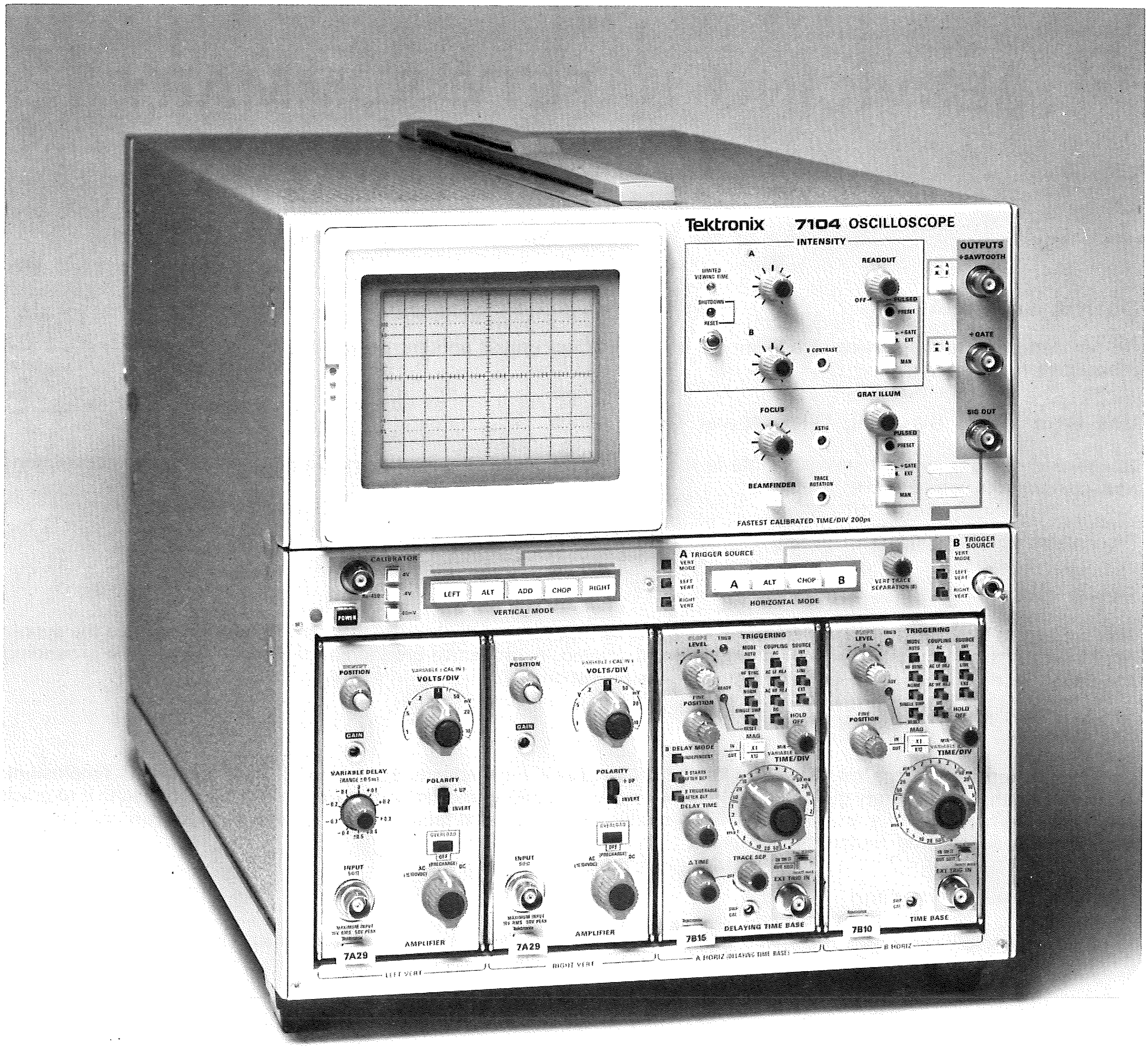
This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Crt Handling

Use care when handling a crt. Breakage of the crt causes a high-velocity scattering of glass fragments (implosion). Protective clothing and safety glasses should be worn. Avoid striking the crt 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.

Silicone Grease Handling

Handle silicone grease with care. Avoid getting the silicone grease in your eyes. Wash hands thoroughly after use.



7104 Features

The TEKTRONIX 7104 Oscilloscope is a solid-state, wide-bandwidth instrument designed for general-purpose applications. The 7104 can also be used to observe or photograph very fast repetitive or single shot waveforms.

The 7104 accepts Tektronix 7000-series plug-in units; the flexibility of the plug-in feature and variety of plug-in units available allows the system to be used for many measurement applications. The left pair of plug-in compartments are for vertical deflection and the right pair are for horizontal deflection. Electronic switching between each pair will produce multitrace vertical and/or horizontal displays.

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GENERAL INFORMATION

INTRODUCTION

OPERATORS MANUAL

The Operators Manual is divided into the following three sections:

Section 1—General Information contains instrument description, electrical specifications, environmental characteristics, standard and recommended accessories, installation, and packaging for shipment instructions.

Section 2—Operating Instructions contain information relative to operating and checking the instrument operation.

Section 3—Instrument Options contains a description of available options and gives the location of the incorporated information for those options.

INSTRUCTION MANUAL

The first two sections of the Instruction Manual contain operating instructions which are identical to the first two sections of the Operators Manual.

WARNING

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Section 3—Theory of Operation contains basic and general circuit analysis that may be useful for servicing or operating the instrument.

Section 4—Maintenance describes routine and corrective maintenance procedures with detailed instructions for replacing assemblies, subassemblies, and individual components.

Section 5—Calibration contains procedures to check the operational performance and electrical characteristics of the instrument. Procedures also include methods for adjustment of the instrument to meet specifications.

Section 6—Instrument Options contains a description of available options and locations of incorporated information for those options.

Section 7—Replaceable Electrical Parts contains information necessary to order replaceable parts and assemblies related to the electrical functions of the instrument.

Section 8—Diagrams and Circuit Board Illustrations includes detailed circuit schematics, locations of assembled boards within the instrument, voltage and waveform information, circuit board component locators, and locations of adjustments to aid in the performing of the Adjustment and Performance Check portion of the Calibration procedure.

Section 9—Replaceable Mechanical Parts includes information necessary to order replaceable mechanical parts and shows exploded drawings which identify assemblies.

INSTALLATION

INITIAL INSPECTION

This instrument was inspected both mechanically and electrically before shipment. It should be free of mars or scratches and should meet or exceed all electrical specifications. To confirm this, inspect the instrument for physical damage incurred in transit and test the electrical performance by following the Operators Checkout Procedure in Section 2, Operating Instructions. Verify Performance Requirements by referring a qualified service person to the servicing sections of the Instruction Manual. If there is damage or deficiency, contact your local Tektronix Field Office or representative.

OPERATING-POWER INFORMATION

This instrument can be operated from either a 115-volt or 230-volt nominal supply source, 48 to 440 hertz. The line fuse remains the same for both 115-volt and 230-volt operation.

CAUTION

To prevent damage to the instrument, always check the LINE VOLTAGE SELECTOR switch located on the rear of the instrument before connecting the instrument to the supply circuit.

WARNING

AC POWER SOURCE AND CONNECTION. This instrument operates from a single-phase power source. It has a three-wire power cord and two-pole, three-terminal grounding-type plug. The voltage to ground (earth) from either pole of the power source must not exceed the maximum rated operating voltage, 250 volts.

Before making connection to the power source, determine that the instrument is adjusted to match the voltage of the power source, and has a suitable two-pole, three-terminal grounding-type plug. Refer any changes to qualified service personnel.

GROUNDING. This instrument is safety class I equipment (IEC designation). All accessible conductive parts are directly connected through the grounding conductor of the power cord to the grounding contact of the power plug.

The power input plug must only be inserted in a mating receptacle with a grounding contact. Do not defeat the grounding connection. Any interruption of the grounding connection can create an electric shock hazard.

For electric shock protection, the grounding connection must be made before making connection to the instrument's input or output terminals.

TABLE 1-1
Power-Cord Conductor Identification

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

The power-cord plug required depends upon the ac input voltage and the country in which the instrument is to be used. Should you require a power-cord plug other than that supplied with your instrument, refer to the standards listed in Table 1-2.

TABLE 1-2
Power-Cord Plug Configuration

Nominal Line Voltage	Reference Standards
115 V AC	[1]ANSI C73.11
	[2]NEMA 5-15-P
	[3]IEC 83
230 V AC	[1]ANSI C73.20
	[2]NEMA 6-15-P
	[3]IEC 83
	[4]BS 1363
	[5]CEE 7, sheets IV, VI, & VII
	[6]AS C112

[1]ANSI—American National Standards Institute
[2]NEMA—National Electrical Manufacturer's Association
[3]IEC—International Electrotechnical Commission
[4]BS—British Standards Institution
[5]CEE—International Commission on Rules for the Approval of Electrical Equipment
[6]AS—Standards Association of Australia

OPERATING VOLTAGE

The LINE VOLTAGE SELECTOR switch (located on the rear panel) allows selection of 115-volt or 230-volt nominal line voltage operation. To convert from 115-volt to 230-volt operation, change the power cord and plug to match the power-source receptacle, then use a small screwdriver to move the LINE VOLTAGE SELECTOR switch to the desired range. The line fuse remains the same for both 115-volt and 230-volt operation.

OPERATING TEMPERATURE

The 7104 can be operated where the ambient air temperature is between 0° and +50° C and can be stored in ambient temperatures from -55° to +75° C. After storage at temperatures outside the operating limits, allow the chassis temperature to reach a safe operating limit before applying power.

The 7104 is cooled by air drawn in through holes in the top, side, and bottom panels and blown out through the fan exhaust. To ensure proper cooling of the instrument, maintain the clearance provided by the feet on the bottom and allow at least 2 inches clearance (more if possible) at the top, sides, and rear of the instrument.

OPERATING POSITION

A bail-type stand, mounted on the bottom of the instrument, permits the instrument to be tilted up about 10° for more convenient crt viewing.

PACKAGING FOR SHIPMENT

If this instrument is to be shipped for long distances by commercial transportation, it is recommended that the instrument be packaged in the original manner. The carton and packaging material in which your instrument was shipped should be saved and used for this purpose.

Also, if this instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag to the instrument showing the following: Owner of the instrument (with address), the name of a person at your firm who can be contacted, complete instrument type and serial number, and a description of the service required.

If the original packaging is unfit for use or not available, package the instrument as follows:

1. Obtain a corrugated cardboard shipping carton having inside dimensions at least six inches greater than the instrument dimensions; refer to Table 1-3 for carton test strength requirements.

2. Enclose the instrument with polyethylene sheeting or equivalent to protect the finish of the instrument.

3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the instrument, allowing three inches on each side.

4. Seal the carton with shipping tape or with an industrial stapler.

5. Mark the address of the Tektronix Service Center and your return address on the carton in one or more prominent locations.

TABLE 1-3
Shipping Carton Test Strength

Gross Weight (lb)	Carton Test Strength (lb)
0-10	200
10-30	275
30-120	375
120-140	500

SPECIFICATION

The electrical characteristics listed in Table 1-4 apply when the following conditions are met: (1) Calibration of the instrument must have taken place at an ambient temperature between +20° and +30° C, (2) the instrument must be allowed a 20-minute warm-up period, (3) all specifications are valid at an ambient temperature of 0° to +50° C, unless otherwise stated, (4) the instrument must be in an environment that meets the limits described in Table 1-5.

Any applicable conditions not listed above are expressly stated as part of that characteristic. Environmental characteristics are listed in Table 1-5 and Physical characteristics are listed in Table 1-6.

TABLE 1-4
Electrical Characteristics

Characteristic	Performance Requirement
VERTICAL SYSTEM	
Deflection Factor	Compatible with all 7000-series plug-in units.
Difference Between Vertical Compartments	1% or less.
Low-Frequency Linearity	0.1 div or less compression or expansion of a center-screen 2-div display positioned anywhere vertically within the graticule area.
Frequency Response	Varies with plug-in unit selected. See 7104 Oscilloscope Vertical Systems Specification, Table 1-7.
Step Response	
Risetime (10 to 90%), with 7A29 Amplifier Unit	350 ps or less (calculated from bandwidth).[1]

[1]Risetime calculated from measured bandwidth using the formula: (Tr = 0.35/BW).

TABLE 1-4 (CONT.)
Electrical Characteristics

Characteristic	Performance Requirement
Isolation Between Vertical Compartments (8 division signal)	
LEFT, RIGHT, ALT Modes	At least 160:1 from dc to 100 MHz and at least 80:1 from 100 MHz to 1 GHz.
Delay Line	Permits viewing leading edge of triggering signal. **NOTE** *7B50-series time-base units will not display leading edge of the trigger signal in 7104 (except 7B50A).*
Difference in Signal Delay Between Vertical Compartments	50 ps or less.
Vertical Display Modes	Selected by front-panel VERTICAL MODE switch.
LEFT	Left vertical-unit displayed.
ALT	Display alternates between left and right vertical units at a rate determined by the horizontal plug-in unit(s).
ADD	Display is algebraic sum of left and right vertical units.
CHOP	Display chops between Left and Right vertical units asynchronously to horizontal plug-in unit(s).
Repetition Rate	1 MHz within 20%.
RIGHT	Right vertical unit displayed.
"Slaved ALT"	Slaved operation occurs if: (1) VERT MODE switch set to ALT, (2) HORIZ MODE switch set to ALT or CHOP, (3) time-base unit is installed in each horizontal compartment and (4) time-base unit installed in A HORIZ compartment operates in Independent mode. When in slaved operation the display alternates between: (1) trace produced by LEFT VERT unit displayed at sweep rate of B time-base unit and (2) trace produced by RIGHT VERT unit displayed at sweep rate of A time-base unit. **NOTE** *VERT TRACE SEPARATION (B) control is inoperative in "Slaved ALT" Mode.*
VERT TRACE SEPARATION (B)	Positions "B" trace at least 4 div above and below "A" trace, when 7104 operates in ALT or CHOP horizontal modes. See note concerning "Slaved ALT" vertical mode.

TABLE 1-4 (CONT.)
Electrical Characteristics

Characteristic	Performance Requirement
TRIGGERING	
A and B TRIGGER SOURCE	Selected by front-panel switches. Lights behind pushbuttons are illuminated to indicate trigger source.
VERT MODE	The trigger source is controlled by vertical display mode selection. Source (sources) is (are) shown by the illumination of the LEFT and RIGHT trigger source buttons. Source follows (is same as) the vertical display with the following two exceptions: VERT MODE — Trigger Source CHOP — LEFT "Slaved ALT" — RIGHT for A TRIGGER; LEFT for B TRIGGER See Vertical Display Modes for slaved operation.
LEFT	Trigger source: LEFT vertical unit. LEFT trigger source button illuminated.
RIGHT	Trigger source: RIGHT vertical unit. RIGHT trigger source button illuminated.

VERT MODE	Trigger Source
CHOP	LEFT
"Slaved ALT"	RIGHT for A TRIGGER LEFT for B TRIGGER

HORIZONTAL SYSTEM

Characteristic	Performance Requirement
Deflection Factor	Compatible with all 7000-series plug-in units.
Gain Difference Between Horizontal Compartments	1% or less.
DC Linearity	0.05 division or less error at each graticule line after adjusting for no error at second and tenth graticule lines.
Fastest Calibrated Sweep Rate	200 ps/div. (See 7104 Horizontal System Specs., Table 1-8.)
Horizontal Display Modes	Selected by front-panel HORIZONTAL MODE switch.
A	A horizontal unit displayed.
ALT	Display alternates between A and B horizontal units.
CHOP	Display chops between A and B horizontal units.
B	B horizontal unit displayed.
Chopped Mode	
Repetition Rate	200 kHz within 20%.
Phase Shift Between Vertical and Horizontal Deflection Systems	2° or less from dc to at least 50 kHz.
Option 2 (B HORIZ compartment only) with 7A19s or 7A29s, at least one of which has the variable delay option	2° or less from dc to 50 MHz after adjusting variable delay for balance at 35 MHz. Phase balance can be obtained at any frequency up to 250 MHz.
Bandwidth	350 MHz

TABLE 1-4 (CONT.)
Electrical Characteristics

Characteristic	Performance Requirement
X-Y Displays	X-Y displays can only be obtained in conjunction with a time-base unit. With an amplifier unit installed in the A(B) horizontal compartment the Z-axis can only be controlled by the time-base unit in the B(A) horizontal compartment. This is independent of the horizontal mode switch selection.
CALIBRATOR	
Waveshape	Square wave.
Polarity	Positive going, with baseline near 0 volt.
Output Resistance	450 Ω.
Output Voltage	(Selected by front-panel CALIBRATOR switch.)
Into 100 kΩ or greater	40 mV, 0.4 V, 4 V.
Into 50 Ω	4 mV, 40 mV, 0.4 V.
Output Current	40 mA available through CALIBRATOR output with optional bnc-to-Current Loop adapter. CALIBRATOR must be set to 4 V for calibrated output.
Amplitude Accuracy (P-P Voltage)	Within 1%.
Repetition Rate	1 kHz within 0.25%.
Duty Factor	49.8% to 50.2%.
Rise Time and Fall Time	500 ns or less into 100 pF or less.
SIGNAL OUTPUTS	
+SAWTOOTH OUT	
Source	Selected by front-panel switch. A: A HORIZ time-base unit. B: B HORIZ time-base unit.
Polarity	Positive-going with baseline at 0 V within 1 V into 1 MΩ.
Output Voltage	
Rate of Rise	
Into 50 Ω	50 mV/unit of time selected by time-base unit time/div switch, within 15%, 100 ns/div maximum sweep rate.
Into 1 MΩ	1 V/unit of time selected by the time-base unit time/div switch, within 10%; 1 μs/div maximum sweep rate.
Output Resistance	Approximately 950 Ω.
+GATE	
Source	Selected by front-panel switch. A: A Gate, derived from A HORIZ time-base unit main gate. B: B Gate, derived from B HORIZ time-base unit main gate.

TABLE 1-4 (CONT.)
Electrical Characteristics

Characteristic	Performance Requirement
+GATE (continued)	
Polarity	Positive-going with baseline at 0 V within 1.0 V into 1 MΩ.
Output Voltage	
Into 50 Ω	0.5 V within 10%.
Into 1 MΩ	10 V within 10% (up to 1 μs/div sweep rate).
Rise Time Into 50 Ω	5 ns or less.
Fall Time Into 50 Ω	15 ns or less.
Output Resistance	Approximately 950 Ω.
SIG OUT	Selected by B TRIGGER SOURCE switch.
Source	Same as B TRIGGER SOURCE.
Output Voltage	
Into 50 Ω	25 mV/div of vertical deflection within 25%.
Into 1 MΩ	For a maximum output of ±2 V: 0.5 V/div of vertical deflection within 25%.
Bandwidth Into 50 Ω	Varies with vertical plug-in selected; see 7104-series Oscilloscope Systems Specification.
DC Centering	0 V within 1 V into 1 MΩ.
Aberrations	25% or less p-p within 50 ns of step.
Output Resistance	Approximately 950 Ω.
READOUT DISPLAY	
Readout Modes	
Free-Run (Not Labeled)	Continuously displayed.
PULSED	Single-shot operation.
Pulse Source	Selected by front-panel switches. +GATE: Triggered by the trailing edge of the +GATE selected by the front-panel switch. EXT: Controlled through rear-panel remote control connector. MAN: Manual trigger, independent of other pulse sources.

TABLE 1-4 (CONT.)
Electrical Characteristics

Characteristic	Performance Requirement
DISPLAY	
Graticule	
Type	Internal, illuminated with variable edge lighting.
Lighting	
Normal	Continuously lighted.
PULSED	Single-shot operation. Lights are pulsed on for approximately 0.5 seconds.
Pulse Source	Selected by front-panel switches. +GATE: Triggered by trailing edge of +GATE selected by front-panel switch. EXT: Controlled through rear-panel remote control connector. MAN: Manual trigger, independent of other pulse sources.
Area	8 × 10 div 0.85 cm/div.
Phosphor	P31.
Vertical and Horizontal Resolution	17 lines/div.
High Voltage	
Screen Voltage	Approximately 12.5 kV.
Limited Viewing Time Indicator	
Steady Yellow	Crt display time is limited to approximately 1 hour.
Flashing Yellow	Crt display time is limited to approximately 1 minute and intensity is being limited.
Geometry	Within 0.1 div of vertical and horizontal graticule lines.
BEAMFINDER	When actuated, limits display to within graticule area and defocuses display.
Photographic Writing Speed	20 cm/nsec (without blue filter). Phosphor: Standard P31. Camera: TEKTRONIX C53; f/1.9 1:0.85 lens. Film: Polaroid Type 107; 3000 ASA.
REMOTE CONNECTORS AND SWITCHES	
Control Illumination	HIGH, MEDIUM and OFF. Three position switch located on rear panel of power supply.
Camera Power	Three-contact connector compatible with TEKTRONIX C-50 Series Cameras.
Bottom Pin	Ground
Center Pin	Single sweep reset.
Top Pin	+15 V.

TABLE 1-4 (CONT)
Electrical Characteristics

Characteristic	Performance Requirement
REMOTE RESET INPUT	Input to reset single-sweep function of time-base units installed in A and B HORIZ compartments.
Signal Required	Closure to ground or switching from the high level (+50 to +10 V; sink less than 40 μA) to low level (+0.5 V to -5 V; sink less than 12 mA) in less than 1 msec, resets the sweep. Compatible to 15 V open collector TTL source.
Minimum Pulse Width	10 μs at 50% amplitude points.
Maximum Safe Input Voltage	+50 V to -5 V (dc + peak ac).
A SINGLE SWEEP READY	Connector (bnc) on rear panel. Remote ready indicator for A HORIZ time-base unit.
Output Signal	Open when not ready. +5 V at 47 Ω source impedance when ready. Output will light a No. 49 bulb.
B SINGLE SWEEP READY	Connector (bnc) on rear panel. Remote ready indicator for B HORIZ time-base unit.
Output Signal	Open when not ready. +5 V at 47 Ω source impedance when ready. Output will light a No. 49 bulb.
GRATICULE/READOUT SINGLE SHOT	Connector (bnc) on rear panel. Switching to the low level (+1 V to -5 V; sink less than 2 mA) from the high level (+10 V to +15 V; sink less than 0.3 mA), in less than 1 μsec, triggers the readout to display one complete readout frame and the GRAT ILLUM to be illuminated for approximately 0.5 sec. Compatible to 15 V open collector TTL source.
Maximum Open Circuit Voltage	+15 V.
Maximum Safe Input Voltage	+15 V to -5 V (dc plus peak ac).
Probe Power	Two probe power connectors on rear panel.
Pin 1	+5 V.
Pin 2	Chassis ground.
Pin 3	-15 V.
Pin 4	+15 V.
Z-AXIS INPUT (External)	Connector (bnc) on rear panel.
Polarity and Sensitivity	Positive 2 V provides complete blanking from maximum intensity condition. Negative 2 V provides complete unblanking from minimum intensity condition.
Low Frequency Limit	Dc.
Input Resistance	Approximately 500 Ω.
Input Capacitance	Less than 50 pF.
Open Circuit Voltage	0 V.
Maximum Safe Input Voltage	15 V, dc plus peak ac.
Maximum Repetition Rate	1 MHz.

TABLE 1-4 (CONT.)
Electrical Characteristics

Characteristic	Performance Requirement
POWER SOURCE	
Voltage Range (AC, RMS)	Selected by rear-panel LINE VOLTAGE SELECTOR switch.
115 V Rated	From 90 V to 132 V.
230 V Rated	From 180 V to 250 V.
Line Frequency	From 48 Hz to 440 Hz.
Maximum Power Consumption	215 W.
Maximum Current	3.3 A at 60 Hz, 90 V Line.
	1.7 A at 60 Hz, 180 V Line.
Fuse Data Line (P1200)	4 A fast blow. (For both LINE VOLTAGE SELECTOR ranges.)

TABLE 1-5
Environmental Characteristics

Characteristic	Information
NOTE *This instrument will meet the electrical characteristics given in the Performance Requirement column of Table 1-4 over the following environmental limits.*	
Temperature	
Operating	0° to +50° C.
Storage	-55° to +75° C.
Altitude	
Operating	5 km (15,000 feet).
Storage	15 km (50,000 feet).
EMC (Electromagnetic Compatibility Option 3 Only)	**NOTE** *Any unused plug-in compartments must be covered with a blank plug-in panel (EMI shielded) in order to meet EMC specifications. See Instrument Options section for additional information.* Meets requirements of MIL-STD-461 A, when tested in accordance with the following test methods of MIL-STD-462: CE-01, CE-03, CS-01, CS-02, CS-06, RE-02, (Limited to 1 GHz), (T) RE-04, RS-01, and RS-03 (Limited to 1 GHz).

TABLE 1-6
Physical Characteristics

Characteristic	Information
Ventilation	Safe operating temperature maintained by dc fan. Automatic resetting thermal cutout protects instrument from overheating.
Finish	Anodized front- and rear-panel with blue-vinyl painted aluminum cabinet.
Overall Dimensions (measured at maximum points).	See Figure 1-1.
Height	13.6 inches. 34.5 cm.
Width	12.0 inches. 30.5 cm.
Length	23.5 inches. 59.2 cm.
Net Weight (Instrument without Plug-Ins)	43.6 lb. 19.8 kg.

TABLE 1-7
Plug-In Incompatibility

The 7104 Oscilloscope is compatible with Tektronix 7000-Series Plug-ins with the following exceptions.

Plug-In Unit	Operating Condition	Symptom	Cause
7D01 7D02 7D20	Any	These plug-in units are not compatible for use with the 7104 Oscilloscope. Any CRT damage caused by the use of the 7D01, 7D02, or 7D20 in the 7104 Oscilloscope will not be covered under instrument warranty.	The 7104 display from these plug-in units can cause permanent reduction in CRT microchannel plate gain; consequently, a permanent reduction in writing rate. For more information, refer to Reduction of Display Gain with Display Output Charge in Section 2, Operating Instructions.

SYSTEM ELECTRICAL SPECIFICATION

Your TEKTRONIX 7104 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 is designed (7000-series).

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

A—Amplifier unit
B—"Real time" time-base unit
C—Curve tracer
D—Digital unit
L—Spectrum analyzer
M—Miscellaneous
S—Sampling unit
T—Sampling time-base unit

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

A "N" suggix letter added to the normal four-digit type number identifies a unit not equipped with the circuitry necessary to encode data for the 7000-series readout system.

Table 1-8 lists the vertical specifications which are system dependent. For more complete specifications on plug-in units for 7000-series oscilloscope system, refer to the Tektronix Products catalog.

Table 1-9 lists the horizontal specifications which are system dependent. For more complete specifications on plug-in units for the 7000-series oscilloscope system, refer to the Tektronix Products catalog.

Table 1-10 lists some special purpose plug-in units available for use with the 7104 Oscilloscope.

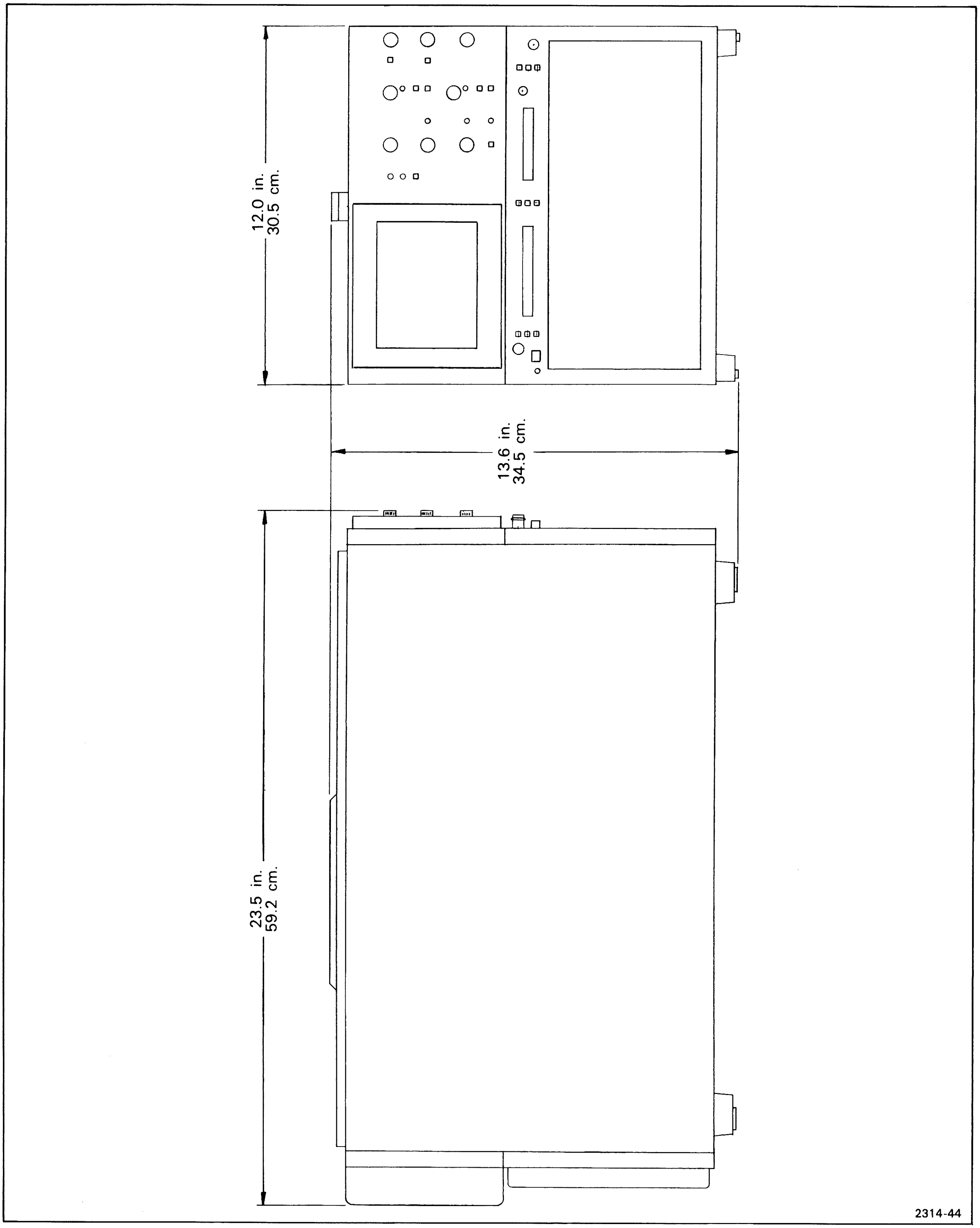


Figure 1-1. 7104 dimensional drawing.

TABLE 1-8
7104 Oscilloscope Vertical System Specification

Amplifier Plug-In Unit	Probe	Bandwidth (MHz)	Rise Time (ns)	Accuracy (%)[1] 0° to +50° C EXT CAL	Accuracy (%)[1] 0° to +50° C INT CAL	VERT SIG OUT BW (MHz)	VERT SIG OUT Tr (ns)
7A11	Integral	250	1.4	2	3	150 MHz	2.4 ns
7A12	None	105	3.4	2	3	110 MHz	3.2 ns
	P6053B			3	4	120 MHz	2.9 ns
7A13	None	100	3.5	1.5	2.5	100 MHz	3.5 ns
	P6053B					105 MHz	3.4 ns
	P6055	65	5.4			65 MHz	5.4 ns
7A14	P6021	55	6.4	2	3	50 MHz	7.0 ns
	P6022	110	3.2			100 MHz	3.5 ns
7A15A/N	None	80	4.4	2	3	70 MHz	5.0 ns
	P6053A			3	4		
7A16A	None	225	1.6	2	3	150 MHz	2.4 ns
	P6053B			3	4		
7A17	None	150	2.4			15 MHz	24 ns
7A18	None	75	4.7	2	3	70 MHz	5.0 ns
	P6053B			3	4		
7A19	None	600	0.6	3	4	600 MHz	0.6 ns
	P6056			4	5		
	P6057						
	P6201	500	0.7	4	5	500 MHz	0.7 ns
7A22	None or Any	1 MHz (within 10%)	350 (within 9%)	2	3	1.0 MHz ±10%	350 ns ±9%
7A24	None	400	0.9	3	4	200 MHz	1.75 ns
	P6056, P6057	400	0.9	4	5		
	P6201	350	1.0	4	5		
7A26	None	200[2]	1.75[2]	2	3	150 MHz	2.4 ns
	P6053B			3	4		
7A29	None	1000[3]	0.35[3,4]	3	4	750 MHz	0.47 ns
	P6056	1000[3]	0.35[3,4]	4	5	700 MHz	0.50 ns
	P6057	800	0.45			600 MHz	0.60 ns
	P6201	600	0.60	4	5	500 MHz	0.70 ns

[1]Deflection Factor accuracy is checked as follows:
EXT CAL 0° to +50° C: Plug-in gain set at a temperature within 10° C of operating temperature, using an external calibrator with accuracy within 0.25%.
INT CAL 0° to +50° C: Plug-in gain set using the oscilloscope calibrator (within 10° C of the operating temperature) in a temperature range between 0° and +50° C.
[2]System temperature range from 0° to +35° C; derate 10% from +35° to +50° C.
[3]System temperature range from 0° to +35° C.
[4]Risetime calculated from measured bandwidth using the formula: (Tr = 0.35/BW).

TABLE 1-9
7104 Oscilloscope System Horizontal Specification

Time-Base Unit	Performance Feature	Maximum Calibrated Sweep Rate	Triggering Frequency Range
7B10	Delayed Sweep	200 psec/div	Dc to 1000 MHz
7B15	Delaying Sweep	200 psec/div	Dc to 1000 MHz
7B92A	Display Switching	500 psec/div	Dc to 500 MHz
7B80	Delayed Sweep	1 ns/div	Dc to 400 MHz
7B85	Delaying Sweep	1 ns/div	Dc to 400 MHz
7B50A	Delayed Sweep	5 ns/div	DC to 150 MHz
7B50 Series (except 7B50A) 7B70 Series 7B92	NOT RECOMMENDED. These time base units are not optimized for the extremely wide horizontal bandwidth of the 7104 and will likely exhibit unacceptable degradation in sweep accuracy and linearity.		

TABLE 1-10
Special Purpose Plug-In Units

Plug-In	Performance Feature
7CT1N	Low-Power Semiconductor Curve Tracer
7D10	Digital Events Delay
7D11	Digital Delay
7D12	A/D Converter; plug-in modules provide flexible measurement capability
7D13	Measures Temperature, Voltage, Current and Resistance
7D14	Directly Gated Counter to 525 MHz
7K11	CATV Preamplifier
7L12	100 kHz to 1.8 GHz Spectrum Analyzer
7L13	1 kHz to 1.8 GHz Spectrum Analyzer
7M11	Dual Delay Line
7M13	Readout Access Unit
7S11	Accepts Plug-In Sampling Heads
7S12	Time Domain Reflectometer and Sampling Applications
7S14	Dual Trace Delayed Sweep Sampler
7T11	Random or Sequential; equivalent or Real-Time Sampling

STANDARD ACCESSORIES

1 ea .... Operators Manual
1 ea .... Instruction Manual
1 ea .... Gray Faceplate Filter (installed)
1 ea .... Power Cord

OPERATING INSTRUCTIONS

PRELIMINARY OPERATION

To operate this instrument effectively, the user must become familiar with the operation and capabilities of the instrument. This section describes the use of front- and rear-panel controls and connectors.

WARNING

To avoid electric-shock hazard, see Installation in the General Information section of this manual before operating this instrument.

REDUCTION OF DISPLAY GAIN WITH DISPLAY OUTPUT CHARGE

It is a characteristic of the 7104 crt to have permanently diminished display gain in the locations of sustained trace operation. This gain reduction manifests itself as reduced writing speed. The gain is diminished in proportion to the logarithm of the charge output (current-time product) from a given display area of the microchannel plate image amplifier.

The limited viewing time system with its two panel indicators, LIMITED VIEWING TIME and SHUTDOWN, and its RESET pushbutton is included to enable long-term use of the crt display by discouraging (1) high continuous trace current operation and (2) long-term, unattended trace-on operation:

For average display currents below 25 nA the yellow LIMITED VIEWING TIME indicator remains off, and display shutdown does not occur. When the average display current is 25 nA, the indicator comes on and shutdown occurs in 1 hour. This time drops to one minute for an average display current of 1.8 μA. The average display current is limited by feedback to the 1.8 μA value. (Singleshot display current is not limited by this system.)

The user can minimize gain loss by taking precautions in three areas: (1) Readout intensity, (2) Trace baselines, and (3) X-Y Displays.

1. Readout intensity

The fixed location, small area, and often fixed pattern of the readout tends to aggravate the gain loss in this area so it is advised that the readout display intensity be kept low.

2. Trace baselines

There will, in time, be distinguishable gain loss in the region of the trace baseline(s). Less severe gain loss will result by using different baseline locations rather than repeatedly using fixed locations for these, such as the 0% line. Operating the timebase in NORMAL trigger mode rather than AUTO trigger mode (bright baseline) will reduce the trace baseline gain loss by removing the trace in the absence of a triggering signal.

3. X-Y displays

Operating in an X-Y mode often means more concentrated display current and hence more concentrated associated gain loss. The user will want to take care that stationary spots or small area displays are not allowed to be operated for extended time periods.

PLUG-IN UNITS

The 7104 accepts up to four Tektronix 7000-series plug-in units, allowing selection of bandwidth, sensitivity, display mode, etc., and provides for future expansion of the system. Refer to Table 1-7.

The overall capabilities of the system are mainly determined by the characteristics of the selected plug-ins. Some typical combinations are given under Applications, in this section, along with simplified set up instructions. For information on other plug-in units, refer to the current Tektronix Products catalog.

INSTALLATION OF PLUG-IN UNITS

CAUTION

To prevent instrument damage plug-in units should not be installed or removed without first turning the instument power off.

To install a plug-in unit into a compartment, align the slots in the top and bottom of the plug-in unit with the associated guide rails in the plug-in compartment. Insert the plug-in unit into the compartment until it locks into place. To remove a plug-in unit, pull out on the release latch to disengage the plug-in. To meet the EMC (electromagnetic compatability) specifications, cover all unused plug-in compartments with an EMC shielded blank plug-in panel, Tektronix Part 016-0155-00.

The gain of the 7104 vertical and horizontal systems have been normalized to allow plug-in units to be interchanged among plug-in compartments without adjustment of the system. The basic calibration of the plug-in units should be checked when installed to verify their accuracy (refer to the operating instructions in the plug-in manual).

CONTROLS AND CONNECTORS

The 7104 front and rear panels are shown in Figure 2-1 and Figure 2-2. A brief, functional description of each control and connector is included in the illustration. Refer to Detailed Operating Information for additional information.

FRONT-PANEL COLOR CODING

The 7104 front panel is color coded to define areas by function. Blue identifies the display mode controls; green identifies triggering controls.

Other colors such as gray, orange and yellow, have no functional assignment, but indicate the relationship among controls and/or connectors.

OPERATORS CHECKOUT PROCEDURE

The Operators Checkout Procedure may be used to verify proper operation of the front-panel controls and for familiarization with the instrument. Only instrument functions (not measurement quantities or specifications) are checked in the procedure; therefore, a minimum amount of test equipment is required. If performing the Operators Checkout Procedure reveals improper performance or instrument malfunction, check the operation of associated equipment; then refer to qualified service personnel for repair or adjustment of the instrument.

TEST EQUIPMENT REQUIRED

The following test equipment was used in preparing the Operators Checkout Procedure. Other test equipment which meets these requirements may be substituted. When other equipment is substituted, the control settings or setup may need to be altered.

1. Function Generator

   Description: Frequency range, 250 kilohertz to 1 megahertz; output amplitude, two volts peak-to-peak into 50 ohms; waveform, sine wave.

   Type Used: TEKTRONIX SG 503 (used with TM 500 power module).

2. Cables (2 Required)

   Description: Length, 42 inches; connectors, bnc.

   Type Used: Type RG-58/U, 50-ohm coaxial, Tektronix Part 012-0057-01.

3. T Connector

   Description: Connectors, bnc-to-bnc.

   Type Used: Bnc-to-bnc connector, Tektronix Part 103-0030-00.

4. Adapter

   Description: Connectors, bnc female-to-bnc female.

   Type Used: Bnc female-to-bnc female, Tektronix Part 103-0028-00.

PRELIMINARY SETUP

1. Set the front-panel controls as follows:

A INTENSITY	counterclockwise
FOCUS	midrange
B INTENSITY	counterclockwise
READOUT	OFF
GRAT ILLUM	counterclockwise
POWER	OFF
CALIBRATOR	4 V
VERTICAL MODE	LEFT
A TRIGGER SOURCE	VERT MODE
HORIZONTAL MODE	A
VERT TRACE SEPARATION (B)	midrange
B TRIGGER SOURCE	VERT MODE

2. Connect the 7104 to a power source that meets the voltage and frequency requirements of this instrument. If the available line voltage is outside the limits of the LINE VOLTAGE SELECTOR switch setting (on rear panel), see Operating Power Information under Installation (General Information section).

3. Install Tektronix 7A-series amplifier units in the LEFT VERT and RIGHT VERT compartments. Install Tektronix 7B-series time-base units in the A HORIZ and B HORIZ compartments.

4. Press the POWER switch to the on (locked in) position.

5. Set both time-base units to 1 millisecond/division and triggering to auto mode with ac coupling from the internal source.

6. Rotate the A INTENSITY control until the trace is at a desirable viewing level (near midrange).

7. Connect the CALIBRATOR output to the input of the left amplifier unit with a 42-inch bnc cable.

8. Set the left amplifier deflection factor to display a signal amplitude of 2 divisions on the crt.

9. Set the A horizontal time-base triggering for a stable display.

DISPLAY FOCUS

10. Rotate the FOCUS and ASTIG controls and observe the square-wave display. Notice that the thickness of the trace varies. Set the FOCUS and ASTIG controls for a well-defined trace.

TRACE ALIGNMENT

11. Disconnect the input signal. Using the left amplifier position control align the trace with the center horizontal graticule line. If necessary use the TRACE ROTATION control to align the trace with the center graticule line.

GRATICULE ILLUMINATION

12. Rotate the GRAT ILLUM control throughout its range and notice that the graticule lines are illuminated as the control is turned clockwise.

CONTROL ILLUMINATION

13. Set the rear-panel CONTROL ILLUMINATION switch to HIGH. Notice that the A INTENSITY indicator and the lighted pushbutton switches are all illuminated. Sequentially press all of the HORIZONTAL MODE switch positions and notice the A and B INTENSITY lights; these lights indicate which intensity control is active. Set the CONTROL ILLUMINATION switch to the MEDIUM position. Observe that the selected intensity indicator and the lighted pushbutton switches on the plug-in units are dimmed.

14. Set the rear-panel CONTROL ILLUMINATION switch to the HIGH position. Return the HORIZONTAL MODE switch to A.

VERTICAL DEFLECTION SYSTEM

15. Connect the 4 V CALIBRATOR output to the input connectors of both amplifier units with two 42-inch bnc cables and a bnc T connector. Set the deflection factor of the left amplifier unit to display about 2 divisions of signal on the crt.

16. Notice that the position control of only the left amplifier unit affects the vertical position of the displayed trace. Position the trace to the upper half of the graticule.

17. Set the VERTICAL MODE switch to RIGHT. Set the deflection factor of the right amplifier unit to display about 2 divisions of signal on the crt.

18. Notice that the position control of only the right amplifier unit affects the vertical position of the displayed trace. Position the trace to the lower half of the graticule.

19. Set the VERTICAL MODE switch to ALT. Two traces should be displayed on the crt. The top trace is produced by the left amplifier unit and the bottom trace is produced by the right amplifier unit; the sweep for both traces is produced by the A time-base unit. Set the sweep rate of the A time-base unit to 50 milliseconds/division; notice the display alternates between the left and right amplifier plug-in units after each sweep. Turn the A time-base sweep rate switch through its range; notice that the display alternates between amplifier units at all sweep rates.

20. Set the VERTICAL MODE switch to CHOP. Turn the A time-base unit sweep rate switch throughout its range. A dual-trace display will be presented at all sweep rates, and both amplifier units are displayed by the A time-base unit on a time-sharing basis. Set the A time-base unit sweep rate switch to 0.5 millisecond/division.

21. Set the VERTICAL MODE switch to ADD. The display should be four divisions in amplitude. Notice that the position control of either amplifier unit moves the display. Set the VERTICAL MODE switch to LEFT.

HORIZONTAL DEFLECTION SYSTEM

22. Position the start of the trace to the left graticule line with the A time-base unit position control. Notice that the position control of only the A time-base unit affects the horizontal position of the displayed trace (not the position of the B time-base unit).

23. Set the HORIZONTAL MODE switch to B.

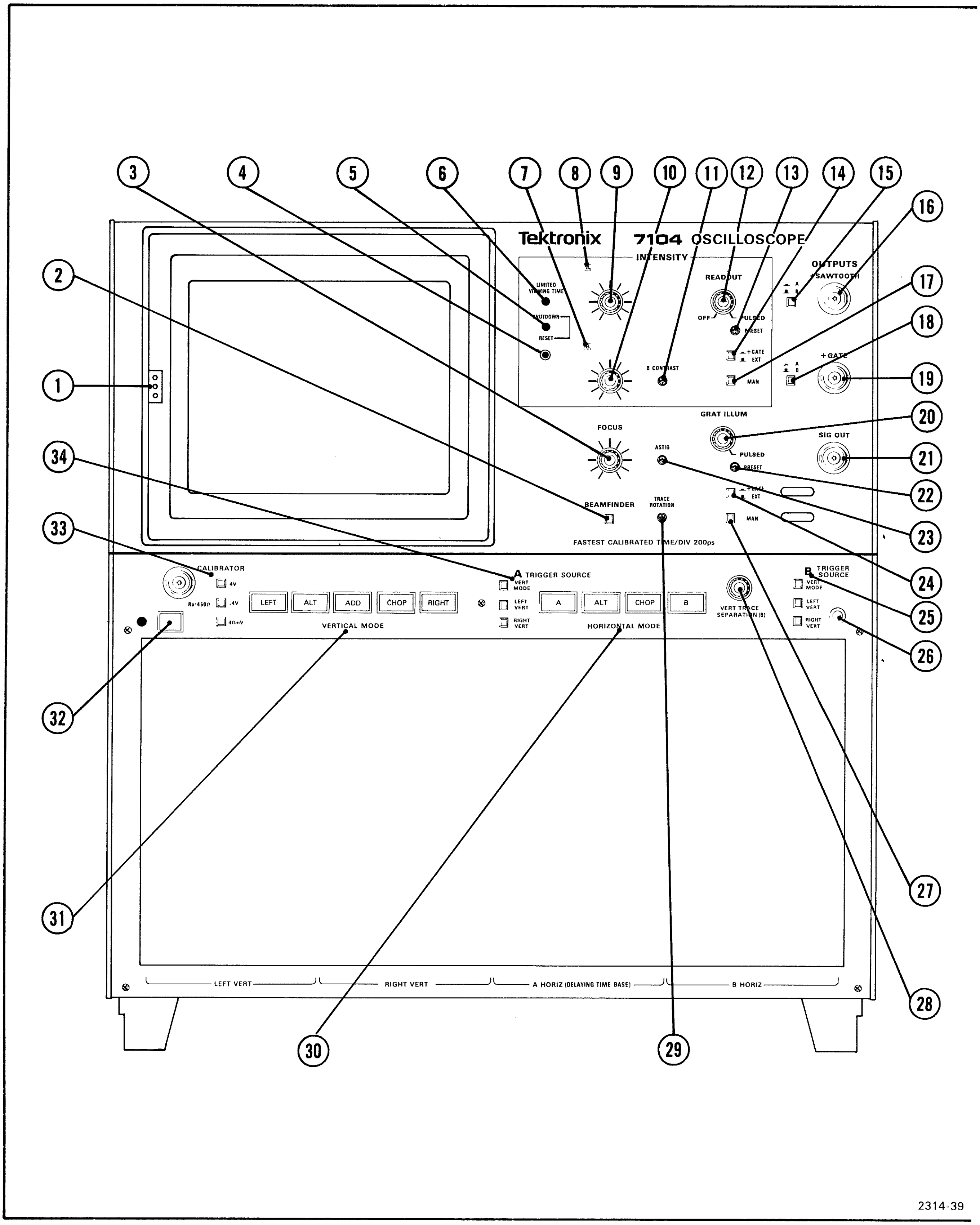


Figure 2-1. Front-panel controls, connectors and indicators.

(1) **Camera Power Connector (not labeled)**—Three-pin connector provides power for camera operation and receives single sweep-reset signal.

(2) **BEAMFINDER**—Switch when pressed compresses and defocuses display within graticule area.

(3) **FOCUS**—Control optimizes crt trace definition.

(4) **RESET**—Switch when pressed initiates another cycle of viewing time.

(5) **SHUTDOWN**—Indicator to signal that crt display is off.

(6) **LIMITED VIEWING TIME**—Indicator to signal that crt display shutdown will occur.

(7) **B INTENSITY**—Indicator illuminates when selected by the HORIZONTAL MODE switch.

(8) **A INTENSITY**—Indicator illuminates when selected by the HORIZONTAL MODE switch.

(9) **A INTENSITY**—Control to determine brightness of trace produced by the plug-in unit installed in the A HORIZ compartment.

(10) **B INTENSITY**—Control to determine brightness of trace produced by the plug-in unit installed in the B HORIZ compartment.

(11) **B CONTRAST**—Control varies brightness of intensified portion of display.

(12) **READOUT INTENSITY**—Control to determine brightness of readout display. Disables Readout System in countercolckwise detent position. Activates PULSE in clockwise detent position.

(13) **READOUT PRESET**—Adjustment (PULSED operation only) sets PULSED readout intensity.

(14) **READOUT +GATE OR EXT**—Switch to select either +GATE or EXT actuation of the PULSED readout mode.

(15) **A OR B +SAWTOOTH**—Switch to select A or B time-base unit as source for +SAWTOOTH OUTPUT signal.

(16) **+SAWTOOTH**—Connector to output signal derived from the A or B time-base unit.

(17) **READOUT MAN**—Switch when pressed actuates one frame of readout display.

(18) **A OR B +GATE**—Switch to select either A or B time-base unit as source of +GATE output.

(19) **+GATE**—Connector to output positive-going gate signal from the time-base unit in the A or B horizontal compartment.

(20) **GRAT ILLUM**—Control varies level of graticule illumination or activates PULSED GRAT ILLUM functions.

(21) **SIG OUT**—Connector to output signal derived from vertical signal as selected by B TRIGGER SOURCE switch.

(22) **GRAT ILLUM PRESET**—Screwdriver adjustment to vary level of graticule illumination in GRAT ILLUM PULSED mode.

(23) **ASTIG**—Screwdriver adjustment used in conjunction with FOCUS control to obtain a well defined display.

(24) **GRAT ILLUM +GATE OR EXT**—Switch to select between +GATE or EXT actuation of graticule illumination.

(25) **B TRIGGER SOURCE**—Switches select internal trigger source for B HORIZ plug-in unit.

(26) **Ground (not labeled)**—Binding post to establish common ground between associated equipment.

(27) **GRAT ILLUM MAN**—Switch when pressed actuates one graticule illumination.

(28) **VERT TRACE SEPARATION (B)**—Control vertically positions the B HORIZ trace with respect to the A HORIZ trace (dual-sweep only).

(29) **TRACE ROTATION**—Screwdriver adjustment to align trace(s) with graticule lines.

(30) **HORIZONTAL MODE**—Switches select input source for horizontal deflection.

(31) **VERTICAL MODE**—Switches select source of input for vertical deflection.

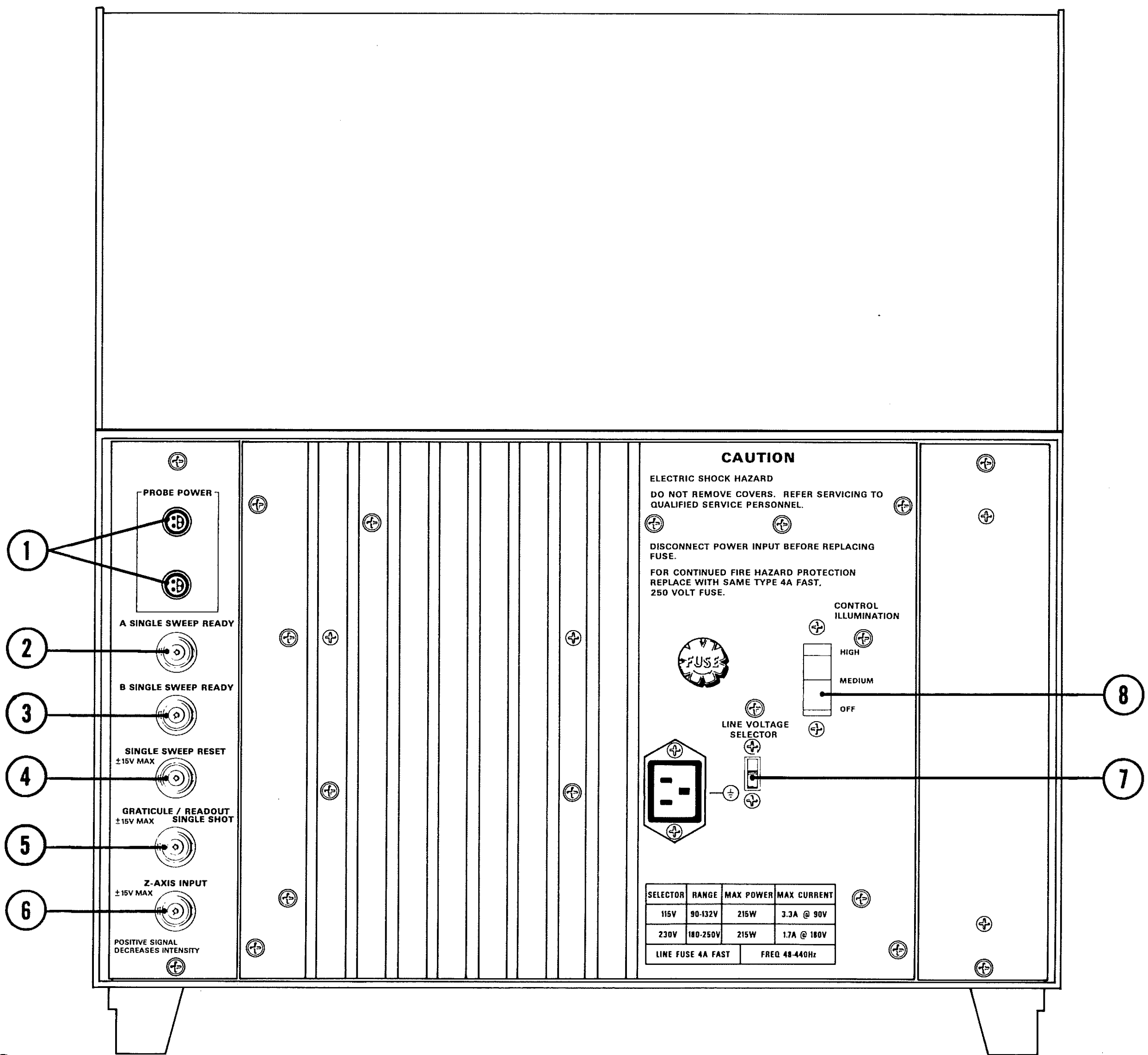
(32) **POWER (Switch and Indicator)**—Switch controls power to instrument; indicator illuminates when power is on.

(33) **CALIBRATOR**—Switches select 4 V, 0.4 V, and 40 mV calibrated square-wave voltages at 1 kHz repetition rate at connector output.

(34) **A TRIGGER SOURCE**—Switches select internal trigger source for A HORIZ plug-in unit.

2314-39

Figure 2-1. Front-panel controls, connectors and indicators (continued).



(1) **PROBE POWER** (2)—Connectors provide power to active probe system

(2) **A SINGLE SWEEP READY**—Connector for output of single-sweep ready signal from time-base unit in A HORIZ compartment.

(3) **B SINGLE SWEEP READY**—Connector for output of single-sweep ready signal from time-base unit in B HORIZ compartment.

(4) **SINGLE SWEEP RESET**—Connector for input to externally reset single-sweep circuits in A HORIZ and B HORIZ compartments.

(5) **GRATICULE/READOUT SINGLE SHOT**—Connector for input of single-shot graticule illumination and single-frame readout.

(6) **Z-AXIS INPUT**—Connector for input to intensity modulate the displayed trace(s).

(7) **LINE VOLTAGE SELECTOR**—Switch to select either 115-volt or 230-volt nominal source.

(8) **CONTROL ILLUMINATION**—Three position switch sets illumination level of the A and B INTENSITY indicators, A and B TRIGGER SOURCE switches and the lighted pushbutton switches on associated plug-in units.

2314-40

Figure 2-2. Rear-panel controls and connectors.

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24. Notice that the position control of only the B time-base unit affects the horizontal position of the displayed trace. Position the start of the trace to the left graticule line with the B time-base unit position control.

25. Set the HORIZONTAL MODE switch to ALT. Two traces should be presented on the crt. If the traces overlap, adjust the VERT TRACE SEPARATION (B) control to position one trace to the bottom of the graticule area. Turn the sweep rate switches of both time-base units throughout their range. Observe that each time-base unit controls one of the traces independently of the other time-base unit. Also notice that when one of the time-base units is set to a slow sweep rate (below about 50 milliseconds/division), sweep alternation is evident (only 1 of the traces is presented on the crt at a time). Set the sweep rates of both time-base units to 0.5 milliseconds/division. Rotate the A INTENSITY control; notice that the intensity of the trace produced by the A time-base unit changes. Likewise, the B INTENSITY control changes the intensity of the trace produced by the B time-base unit only. Return both intensity controls to desirable levels.

26. Set the HORIZONTAL MODE switch to CHOP. Two traces should be displayed on the crt in a manner similar to that of the ALT display. Turn the sweep rate switches of both time-base units throughout their ranges.

27. Set the CALIBRATOR switch to 0.4 V. Set the VERTICAL MODE switch to CHOP. Four traces should be displayed on the crt. If not, adjust the position controls of the amplifier units and the VERT TRACE SEPARATION (B) control to position the four traces into view. Set the position controls of the plug-in units to identify which trace is produced from each plug-in unit (if amplifier units have the identify feature, it can be used to identify the traces). Set the A time-base unit for a sweep rate of 1 millisecond/division. The left amplifier unit should be displayed at the sweep rate of both time-base units.

28. Set the HORIZONTAL MODE switch to ALT. Observe that the display is very similar to that obtained in the previous sweep. The main difference in this display is that the traces are now displayed alternately (noticeable only at slow sweep rates).

29. Set the VERTICAL MODE switch to ALT. Set the CALIBRATOR switch to 4 V. The trace produced by the left amplifier unit should be displayed at the sweep rate of the B time-base unit and the trace produced by the right amplifier unit should be displayed at the A time-base unit sweep rate. This feature is called independent-pairs operation and is obtained only when the VERTICAL MODE switch is in the ALT position, the HORIZONTAL MODE switch is in either the ALT or the CHOP position, and the time-base units are in the independent mode.

TRIGGERING

30. Set the VERTICAL MODE switch to LEFT and the HORIZONTAL MODE switch to A. Center the display on the crt with the left amplifier unit position control. Disconnect the input signal from the right amplifier unit input connector. Sequentially select all of the VERTICAL MODE switch positions. Notice that a stable display is obtained for all positions of the VERTICAL MODE switch (straight line in RIGHT switch position).

31. Set the A TRIGGER SOURCE switch to LEFT VERT. Again, sequentially select all of the VERTICAL MODE switch positions; notice that the display is again stable in all positions, as in the previous step, and that the LEFT VERT pushbutton is illuminated.

32. Set the A TRIGGER SOURCE switch to RIGHT VERT. Sequentially select all of the VERTICAL MODE switch positions and notice that a stable display cannot be obtained in any position (this is because there is no input signal connected to the right vertical unit) and that the RIGHT VERT pushbutton is illuminated. Return the A TRIGGER SOURCE switch to VERT MODE and notice that it is illuminated.

33. The B TRIGGER SOURCE switch operates in a manner similar to the A TRIGGER SOURCE switch when the B time-base unit is selected to provide the display. Set the B TRIGGER SOURCE switch to VERT MODE and the VERTICAL MODE switch to ALT.

34. Set the HORIZONTAL MODE switch to ALT or CHOP. Notice that this is the same display obtained in step 29 (independent-pairs operation).

READOUT

35. Turn the READOUT control clockwise until an alphanumeric display is visible within the top or bottom division of the crt. Change the deflection factor of the amplifier unit that is selected for display. The appropriate readout display should change as the deflection factor is changed. Likewise, change the sweep rate of the time-base unit which is selected for display; the readout display for the time-base unit should change as the sweep rate is changed.

36. Set the time-base unit for X10 magnification. Notice that the readout display will change to indicate the correct magnified sweep rate. If a readout-coded 10X probe is available for use with the amplifier unit, install it on the input connector of the right amplifier plug-in unit. Notice that the deflection factor indicated by the readout is increased by 10 times when probe is added. Return the time-base unit to normal sweep operation and disconnect the probe.

37. Sequentially select all of the VERTICAL MODE and HORIZONTAL MODE switch positions. Notice that the readout from a particular plug-in occupies a specific location on the display area. If either of the vertical plug-in units is a dual-trace unit, the readout for channel 2 is displayed within the lower division of the crt. Return the VERTICAL MODE switch to LEFT and the HORIZONTAL MODE switch to A. Set the READOUT control to OFF.

BEAMFINDER

38. Set the deflection factor of the left amplifier unit to 10 millivolts/division and the calibrator for a 4 V output. Notice that the square-wave display is not visible, since the deflection exceeds the scan area of the crt.

39. Press the BEAMFINDER pushbutton switch; notice that the display is returned to the viewing area in compressed form. Release the BEAMFINDER switch and notice that the display again disappears from the viewing area.

40. With the BEAMFINDER switch pushed in, increase the amplifier-unit deflection factor until the display is reduced to about 2 divisions vertically. Adjust the position control of the displayed amplifier unit to position the compressed display near the center of the graticule. Release the BEAMFINDER switch and observe that the display remains within the viewing area.

CALIBRATOR

41. Connect the CALIBRATOR output to both the left and right vertical units with two bnc cables and a bnc T connector. The display amplitude should be approximately 2 divisions. If not, adjust the deflection factor accordingly.

42. Select different CALIBRATOR pushbuttons (labeled 4 V, 0.4 V, and 40 mV) and notice that the displayed signal changes accordingly. (CALIBRATOR output must be terminated into more than a 100-kilohm load for stated output.) When the CALIBRATOR output is terminated into 50 ohms, the output is 0.1 times the stated output.

Z-AXIS INPUT

43. If an external signal is available (+2 volts peak-to-peak minimum), the function of the Z-AXIS INPUT can be demonstrated. Connect the external signal to both the input connector of the displayed amplifier unit and the Z-AXIS INPUT connector. Set the sweep rate of the displayed time-base unit to display about 5 cycles of signal. Set the amplitude of the signal generator until intensity modulation is visible on the display (change the amplifier unit deflection factor as necessary to produce an on-screen display). The positive peaks of the waveform should be blanked out and the negative peaks intensified. Notice that the setting of the intensity control determines the amount of intensity modulation that is visible. Disconnect the cables.

INTENSITY LIMITING

44. Connect a sinewave signal to the input of the displayed amplifier unit. Set the amplifier deflection factor to display 8 divisions of signal. Set the displayed time-base unit to display at least 20 cycles. Rotate the A or B INTENSITY control clockwise and observe that the yellow LIMITED VIEWING TIME light turns on and then flashes on and off as the intensity control is rotated further clockwise. With the LIMITED VIEWING TIME light flashing, the intensity is limited. Rotating the intensity control clockwise does not increase the displayed brightness. Notice that after about one minute the red SHUTDOWN light starts flashing and then after about 10 seconds turns on steady; at the same time the crt display is turned off. Press the RESET button and the display should return.

DETAILED OPERATING INFORMATION

GRATICULE

The graticule is marked on the inside of the crt faceplate, providing accurate, parallax-free measurements. The graticule is divided into eight vertical and ten horizontal divisions. Each divison is a 0.85 centimeter square divided into five minor divisions along each axis. The vertical gain and horizontal timing of the plug-in units are calibrated to the graticule so that accurate measurements can be made from the crt. The illumination of the graticule lines can be varied with the GRAT ILLUM control.

Figure 2-3 shows the graticule and defines the various measurement lines. The terminology defined here will be used in all discussions involving measurements from the graticule. The markings: 0%, 10%, 90%, and 100% on the left side of the graticule are for accurate rise-time measurements.

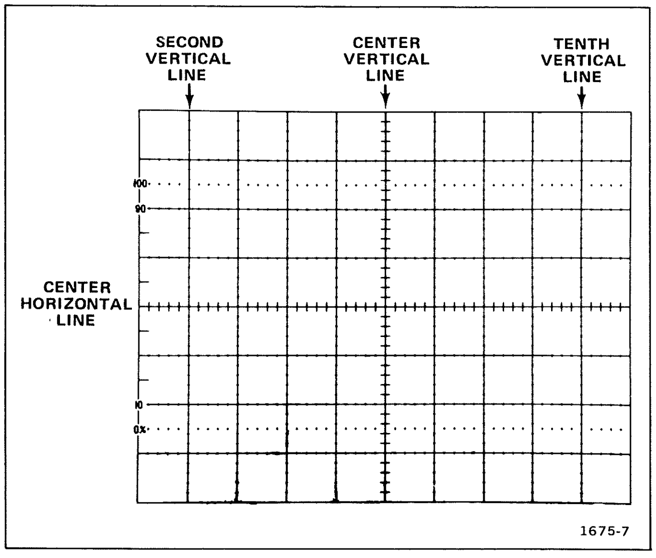


Figure 2-3. Definition of graticule measurement lines.

GRATICULE ILLUMINATION

The GRAT ILLUM control varies the illumination of the graticule lines. The GRAT ILLUM can also be operated in the PULSED mode. With the GRAT ILLUM control set to the PULSED detent position, and the + GATE/EXT switch set to + GATE, the graticule will be illuminated momentarily after the + GATE occurs. The + GATE switch selects whether A gate or B gate triggers the graticule illumination. With the GRAT ILLUM + GATE/EXT switch set to EXT the momentary graticule illumination can be actuated by applying a remote signal to the rear panel GRATICULE/READOUT SINGLE SHOT connector (see Table 1-4 for specifications). When operating in the PULSED mode, the level of illumination is controlled by the GRAT ILLUM PRESET screwdriver adjustment.

LIGHT FILTER

The tinted face-plate filter minimizes light reflections from the face of the crt to improve contrast when viewing the display under high-ambient-light conditions. This filter may be removed for waveform photographs or for viewing high-writing-rate displays. To remove the filter, pull outward on the bottom of the plastic crt mask and remove it from the crt bezel. Remove the tinted filter; leave the clear plastic face-protector (implosion shield) installed and replace the mask. The face-plate protector should be left in place at all times to protect the crt face from scratches and the operator from crt implosion.

WARNING

Do not remove the clear plastic implosion shield covering the crt face plate; the implosion shield provides protection to the operator from crt implosion.

An optional mesh filter is available from Tektronix (included with Option 3). This filter provides shielding against radiated EMI (electromagnetic interference) from the face of the crt. It also serves as a light filter to make the trace more visible under high-ambient conditions. The mesh filter fits in place of the plastic tinted filter. Order the filter by Tektronix Part 378-0603-00.

CONTROL ILLUMINATION

The CONTROL ILLUMINATION switch, located on the rear panel, sets the illumination level of the A and B INTENSITY indicators, the A and B TRIGGER SOURCE switches, and of the lighted pushbutton switches on the plug-in units. The positions available are OFF, MEDIUM, and HIGH. The CONTROL ILLUMINATION switch does not affect the function-indicator lights (such as triggered or single sweep ready lights).

INTENSITY CONTROLS

The A INTENSITY control determines the brightness of the display produced by the plug-in unit installed in the A HORIZ compartment. The B INTENSITY control determines the brightness of the display produced by the plug-in unit installed in the B HORIZ compartment. The READOUT intensity control affects the brightness of only the readout portion of the crt display.

CAUTION

Care should be taken when operating the intensity controls. See: Reduction of Display Gain with Display Output Charge in section 2.

DISPLAY FOCUS

This instrument contains an automatic-focusing circuit which maintains optimum focus for all intensity settings after a correct setting of the FOCUS control is established. The easiest way to obtain the correct setting of the FOCUS control is to set the READOUT INTENSITY control so that the readout portion of the display is clearly visible. Adjust the FOCUS control for the best definition of the readout display.

ASTIGMATISM-FOCUS ADJUSTMENTS

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

NOTE

To check for proper setting of the ASTIG adjustment, slowly turn the FOCUS control through the optimum setting. If the ASTIG adjustment is correctly set, the vertical and horizontal portions of the display will focus at the same position of the FOCUS control. This setting of the ASTIG adjustment should be correct for any display.

1. Install an amplifier unit in the LEFT VERT compartment and a time-base unit in the A HORIZ compartment.

2. Set the VERTICAL MODE switch to LEFT and the HORIZONTAL MODE switch to A.

3. Connect the output of a sine-wave generator to the input of the amplifier unit. Set the sine-wave generator repetition rate to 1 kilohertz and the vertical amplifier deflection factor for a 2-division display.

4. Set the time-base unit sweep rate for 0.2 millisecond/division and the triggering for a stable display. Set the A INTENSITY control so the display is at a usable intensity level (about midrange).

5. Turn the FOCUS control fully counterclockwise and set the ASTIG adjustment to midrange.

6. Set the FOCUS control so the thickness of the sine-wave trace is as thin as possible.

7. Adjust the ASTIG adjustment so the width of the sine-wave trace is as thin as possible.

8. Repeat steps 6 and 7 for the best overall focus.

BEAMFINDER

The BEAMFINDER helps to locate a display that overscans the crt viewing area vertically and/or horizontally. When the BEAMFINDER button is pressed, the display is compressed and defocused within the graticule area. To locate and reposition an overscanned display, use the following procedure:

1. Press the BEAMFINDER pushbutton. While the display is compressed adjust the vertical and horizontal position controls to center the display. Change the vertical and horizontal deflection factors until the vertical deflection is about four divisions high and the horizontal deflection is about six divisions wide (the horizontal deflection needs to be reduced only when operating in an X-Y mode).

2. Release the BEAMFINDER pushbutton; the display should remain within the graticule area.

TRACE ALIGNMENT

The TRACE ROTATION control allows the trace to be aligned with the horizontal graticule lines. To set the control, position the trace to the center horizontal line and adjust the TRACE ROTATION control so that the trace is parallel with the center horizontal graticule line.

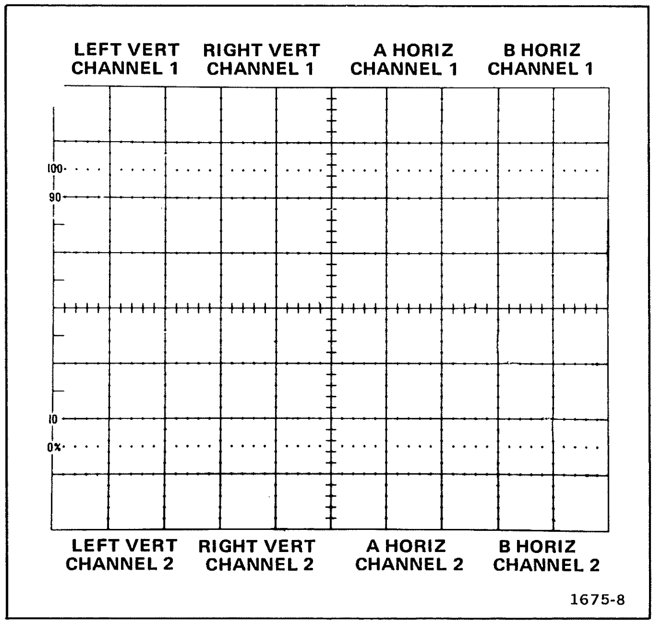


Figure 2-4. Location of readout on the crt identifying the originating plug-in and channel.

READOUT DISPLAY

The Readout System provides an alphanumeric display of information on the crt along with the analog waveform display. The information displayed by the Readout System is obtained from the plug-in units installed in the plug-in compartments.

The readout information from each channel of a plug-in unit is called a word. Up to eight words of readout information can be displayed on the crt (two channels from each of the four plug-in compartments). The location of each readout word is fixed and is directly related to the plug-in unit and channel from which it originated. Figure 2-4 shows the area of the graticule where the readout from each plug-in unit and/or channel is displayed. Notice that the readout from channel 1 of each plug-in unit is displayed in the top division of the graticule and the readout from channel 2 is displayed directly below in the bottom division of the graticule. Usually, the readout information for plug in units and/or channels, which are selected by the mode switches, appear in the readout display. (Some special purpose plug-in units may over-ride the mode switches to display readout even though the compartment is not selected for display.)

Readout Identify

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

Readout Intensity

The READOUT control determines the intensity of only the readout portion of the display, independently of the other traces. The Readout System is inoperative when the READOUT control is in the fully counterclockwise OFF position. This may be desirable when the top and bottom divisions of the graticule are to be used for waveform display or when the trace interruptions necessary to display characters interfere with the waveform display.

Readout Modes

The READOUT control determines the operating mode of the Readout System. With the READOUT control set to free run (out of OFF or PULSED detent positions) the Readout System operates continuously, interrupting the crt display at random (for about 20 microseconds) in order to write each character on the crt. With the READOUT control set to the PULSED position, the Readout System operates in a triggered mode; one complete frame (up to eight words) of readout is displayed. The + GATE or EXT switch determines whether readout is displayed at the end of the + GATE or when an external signal is applied to the rear-panel GRATICULE/READOUT SINGLE SHOT input. The + GATE switch selects whether A gate or B gate triggers the readout.

One frame of readout information is also displayed each time the READOUT MAN (manual) pushbutton is pressed. The brightness of the readout display, when operating in the PULSED mode, is set by the READOUT PRESET control.

CARE OF CRT SCREEN

The following precautions will prolong the useful life of the crt screen used in this instrument.

1. Use minimum beam intensity to produce a clear, well-defined display.

2. Avoid repeated use of the same area of the screen. If a particular waveform is to be displayed for a long period of time, change the vertical position occasionally to use other portions of the display area.

3. Use minimum READOUT INTENSITY to display the readout. For more information see Reduction of Display Gain with Display Output Charge in section 2.

VERTICAL AND HORIZONTAL MODE COMBINATIONS

There are 20 possible combinations of VERTICAL MODE and HORIZONTAL MODE switch settings. The total possible number of display combinations is further multiplied by the variety of plug-in units available for use with this instrument, the interchangeability of plug-ins (i.e., either an amplifier or a time-base unit can be installed in any compartment), and by the capabilities of the plug-in units which are used in the instrument (e.g., a dual-trace amplifier unit can be used in either of the two single-channel modes, in the dual-trace mode or algebraically-added mode; a delaying time base may be used either for a sweep or for delayed sweep). Therefore, it is difficult to list all of the display combinations which can occur during use of the 7104 and available plug-in units. Table 2-1 lists the combination of VERTICAL MODE and HORIZONTAL MODE switch positions available and the type of display obtained with each combination.

Vertical Modes

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

Aternate Mode. The ALT position of the VERTICAL MODE switch produces a display which alternates between the LEFT VERT and RIGHT VERT 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 20 milliseconds/division. At these slower sweep rates, alternate-mode switching becomes perceptible.

Alternate Mode displays have three types of triggering available. When the A and B TRIGGER SOURCE switches

TABLE 2-1
Display Combinations[1]

Vertical Mode	Horizontal Mode	Comments
LEFT	A or B	One trace. Vertical deflection from single unit; horizontal deflection from single unit.
	ALT or CHOP	Two traces. Vertical deflection from single unit; horizontal deflection from both units.
ALT	A or B	Two traces. Vertical deflection from both units; horizontal deflection from single unit.
	ALT or CHOP	Two traces. Vertical deflection from both units; horizontal deflection from both units.
ADD	A or B	One trace. Vertical deflection shows algebraic summation of signals from both units; horizontal deflection from single unit.
	ALT or CHOP	Two traces. Vertical deflection shows algebraic summation of signals from both units; horizontal deflection from both horizontal compartments.
CHOP	A or B	Two traces. Vertical deflection shows signals from both units; horizontal deflection from single unit.
	ALT or CHOP	Four traces. Vertical deflection shows signals from both units; horizontal deflection from both units.
RIGHT	A or B	One trace. Vertical deflection shows signal from single unit; horizontal deflection from single unit.
	ALT or CHOP	Two traces. Vertical deflection shows signal from single unit; horizontal deflection from both units.

[1]Combinations given for single-channel vertical and horizontal units only.

are set to the VERT MODE positions, 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 RIGHT VERT positions of the TRIGGER SOURCE switches, the two signals are displayed showing true time relationship. However, if the signals are not time related, the display from the plug-in that is not providing a trigger signal will be unstable on the crt. The TRIGGER SOURCE switches are illuminated indicating the source of the trigger signal.

When the ALT VERTICAL MODE position is selected and either the ALT or CHOP button of the HORIZONTAL MODE switch is selected, the instrument operates in the independent-pairs mode. Under this condition, the signal from the LEFT VERT unit is always displayed at the sweep rate of the B HORIZ time-base unit, and the signal from the RIGHT VERT unit is displayed at the sweep rate of the A HORIZ time-base unit (non-delayed sweep only). This results in two displays that are completely independent as to vertical deflection and sweep rate. This display is equivalent to the display obtainable with a dual-beam oscilloscope for most repetitive-display combinations.

In independent-pairs mode with the A and B TRIGGER SOURCE switches set to VERT MODE the A time base receives a trigger from the right vertical, and the B time base receives a trigger from the left vertical. This is indicated by the illuminated trigger pushbuttons.

If a delayed-sweep operation is used with this mode, a different sequence is displayed. First, the LEFT VERT unit signal is displayed at the sweep rate of the A HORIZ time-base unit (delaying sweep) and then at the sweep rate of the B HORIZ time-base unit (delayed sweep). The vertical display then shifts to the RIGHT VERT unit and its signal is displayed consecutively at the delaying and delayed sweep rates.

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

When the A or B TRIGGER SOURCE switches are set to VERT MODE, the time-base units are triggered from the left vertical plug-in trigger signal. The LEFT VERT or RIGHT VERT trigger-source positions provide trigger signals to the time-base units from the selected vertical unit only. The trigger source is indicated by the illuminated TRIGGER SOURCE pushbuttons. This allows two time-related signals to be displayed showing true-time relationship. (If the signals are not time-related, the display from the channel that is not providing the trigger signal will appear unstable.)

The CHOP mode can be used to compare two single-shot, transient, or random signals that occur within the time interval determined by the time-base unit (ten times selected sweep rate). To provide correct triggering, the displayed signal which provides the trigger signal must precede the second display in time. Since the signals show true-time relationship, time-difference measurements can be made from the display.

Algebraic Addition. The ADD position of the VERTICAL MODE switch can be used (1) to display the sum or difference of two signals, (2) for common-mode rejection to remove an undesired signal, or (3) 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 is at least 160:1 from dc to 100 megahertz. The rejection ratio decreases to 80:1 from 100 megahertz to 1 gigahertz. The overall deflection on the crt in the ADD mode is the algebraic sum of the signals from the 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-ins is known. This is particularly true when the vertical units are set to different deflection factors, since it is not obvious which portion of the display results from the signal applied to a given plug-in unit. The polarity and repetition rate of the applied signals will also affect the ADD display.

The following precautions should be observed when using the ADD mode.

1. Do not exceed the input-voltage ratings of the plug-in units.

2. Do not apply large signals to the plug-in inputs. A good rule is not to apply a signal of more than about eight times the vertical deflection factor. Larger voltages may result in a distorted display.

3. To ensure the greatest dynamic range in the ADD mode, set the position controls of the plug-in units to a setting which would result in a mid-screen display if viewed in the LEFT or RIGHT positions of the VERTICAL MODE switch.

4. For familiar response from each channel, use identical plug-ins and set the plug-in units for the same type of input coupling mode.

Horizontal Modes

When either the A or B button of the HORIZONTAL MODE switch is pressed, the signal is displayed at the sweep rate of the selected time-base unit. Set the applicable INTENSITY control and TRIGGER SOURCE switch for the desired display.

Alternate Mode. The ALT position of the HORIZONTAL MODE switch provides crt sweeps derived alternately from the two time-base units. Although the ALT horizontal 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 slower sweep rates, the switching between the alternate-mode traces becomes apparent and may interfere with correct analysis of the display.

NOTE

This instrument will not operate in the ALT position of the HORIZONTAL MODE switch if either horizontal plug-in compartment is left vacant.

The A and B INTENSITY controls allow individual adjustment of the traces produced by the time-base units in the A HORIZ and B HORIZ compartments. Correct triggering of both time-base units is essential in obtaining the correct display in the ALT horizontal mode. If either of the time-base units does not receive a correct trigger, and therefore does not produce a sweep, the other unit cannot produce a sweep either. This means that one time-base unit cannot begin its sweep until the previous unit has completed its entire display. This can be avoided if the time-base units are set for auto-mode triggering (sweep free runs if not correctly triggered). See Trigger Source for operation of the A and B TRIGGER SOURCE switches. Also, see Vertical Trace Separation for information on positioning the B HORIZ display when in the ALT dual-sweep mode.

Chopped Mode. When the CHOP button of the HORIZONTAL MODE switch is pressed, the display is electronically switched between the two time-base units at about a 200-kilohertz rate. In general, the CHOP horizontal mode provides the best display when either of the time-base units is set to a sweep rate lower than about 20 milliseconds/division. It also provides the best display when the two time-base units are set to widely differing sweep rates. In the CHOP horizontal mode, equal time segments are displayed from each of the time-base units. This provides a display which does not change greatly, in intensity, as the sweep rate of either time-base unit is reduced (in contrast to ALT horizontal mode operation where the slowest trace tends to be the brightest).

The A and B INTENSITY controls allow individual adjustment of the intensity of the traces produced by the time-base units in the A HORIZ and B HORIZ compartments. Triggering is not as critical in the CHOP horizontal mode as in ALT; if one of the units is not triggered properly, only the trace from the untriggered time-base unit is missing from the display. The other trace is presented in the normal manner. See Trigger Source and Vertical Trace Separation for information on positioning the trace produced by the B HORIZ unit in relation to the trace from the A HORIZ unit.

VERTICAL TRACE SEPARATION

When one of the dual-sweep horizontal modes is selected, the VERT TRACE SEPARATION (B) control allows the trace produced by the B HORIZ sweep to be positioned above or below the trace produced by the A HORIZ sweep. To use the control, first position the trace produced by the A HORIZ plug-in unit. Then adjust the VERT TRACE SEPARATION (B) control to move the trace produced by the B HORIZ plug-in unit away from the A HORIZ display. If both waveforms are larger than four divisions in amplitude, the displays can only be positioned so they do not directly overlap since each waveform cannot be positioned to a unique area of the crt.

TRIGGER SOURCE

The A and B TRIGGER SOURCE switches select the internal trigger signals for the A HORIZ and B HORIZ time-base units. For most applications, these switches can be left in the VERT MODE position. This position is the most convenient since the internal trigger signal is automatically switched as the VERTICAL MODE switch is changed or as the display is electronically switched between the LEFT VERT and RIGHT VERT plug-ins, in the ALT position of the VERTICAL MODE switch. It also provides a usable trigger signal in the ADD position of the VERTICAL MODE switch, since the internal trigger signal in these modes is the algebraic sum of the signals applied to the vertical plug-in units. In the CHOP position the left vertical plug-in is the trigger source. Therefore, the VERT MODE position ensures that the time-base units receive a trigger signal regardless of the VERTICAL MODE switch setting without the need to change the trigger source selection. The A and B TRIGGER SOURCE switches are illuminated and indicate the source of the trigger.

If correct triggering for the desired display is not obtained in the VERT MODE position, the trigger source for either the A HORIZ or B HORIZ time-base unit can be changed to obtain the trigger signal from either the LEFT VERT or RIGHT VERT plug-in. The internal trigger signal is obtained from the selected vertical compartment whether the plug-in in that compartment is selected for display on the crt or not. If the internal trigger signal is obtained from one of the vertical units but the other vertical unit is selected for display, the internal signal must be time-related to the display signal in order to obtain a triggered (stable) display.

CALIBRATOR OUTPUT

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

Voltage

The CALIBRATOR provides accurate output voltages of 40 millivolts, 0.4 volt, and 4 volts into high impedance loads. In addition, it provides 4 millivolts, 40 millivolts, and 0.4 volt into 50-ohm loads.

Current

The optional current loop accessory provides a 40-milliampere output current (the CALIBRATOR must be set for a 4 volt output), which can be used to check and calibrate current-measuring probe systems. The current signal is obtained by clipping the probe around the current loop.

Repetition Rate

The repetition rate of the CALIBRATOR is 1 kilohertz. The calibrator circuit uses frequency-stable components to maintain accurate frequency and a constant duty factor. Thus, the CALIBRATOR can be used for checking the basic sweep timing of time-base units (1-kilohertz rate only).

Wave Shape

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

SIGNAL OUTPUTS

+ Sawtooth Out

The + SAWTOOTH OUT connector provides a positive-going sawtooth signal derived from the time-base unit installed in the A HORIZ compartment or from the time-base unit installed in the B HORIZ compartment.

The front-panel A or B + SAWTOOTH switch determines whether the A HORIZ or the B HORIZ compartment is the source of the + SAWTOOTH output signal. The unit of time for the sawtooth output is determined by the setting of the time-base-unit Time/Division switch. Refer to Table 1-4, in the General Information section, for signal parameters.

+ Gate Out

The + GATE OUT connector provides a positive-going rectangular pulse which is derived from a time-base unit installed in either horizontal plug-in compartment. The A or B + GATE switch selects the source of the + GATE signal from the time-base unit installed in the A HORIZ compartment or the B HORIZ compartment. The duration of the + GATE signal is the same as the duration of the respective unmagnified sweep. The amplitude of the + GATE OUT signal is about 0.5 volt into 50 ohms or about 10 volts into 1 megohm.

Signal Out

The SIG OUT connector provides a sample of the vertical deflection signal. The source of the output signal is determined by the B TRIGGER SOURCE switch. In the VERT MODE position of the B TRIGGER SOURCE switch, the output signal is determined by the setting of the VERTICAL MODE switch. The output signal in the LEFT and RIGHT positions of the VERTICAL MODE switch is obtained only from the selected vertical unit. In the ALT position of the VERTICAL MODE switch, the output signal at the SIG OUT connector switches between signals from the two vertical units, along with the crt display. However, the vertical output signal in the ADD position is a composite signal. In the CHOP position the signal out is derived from the LEFT vertical plug-in. The LEFT VERT and RIGHT VERT positions of the B TRIGGER SOURCE switch are independent of the selection of the VERTICAL MODE switch and provide the vertical output signal only from the selected vertical unit even when it is not selected for display by the VERTICAL MODE switch.

Probe Power

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

DISPLAY PHOTOGRAPHY

A permanent record of the crt display can be obtained with an oscilloscope camera system. The instruction manual for the Tektronix oscilloscope cameras include complete instructions for obtaining waveform photographs.

The crt bezel provides integral mounting for Tektronix oscilloscope cameras. The three pins located on the left side of the crt bezel connect power to compatible camera systems. Control signals are also received from Tektronix automatic cameras to allow camera-controlled single-shot photography (see camera manual for further information).

If the readout portion of the display is to be included on waveform photographs, the following suggestions will aid in obtaining good photographs.

1. Focus the crt display. Focus the camera on the readout portion of the crt display. The auto-focus feature of this instrument will maintain the traces at optimum focus.

2. Set the READOUT INTENSITY control for the minimum setting that allows the characters to be written. This normally occurs at a slightly lower intensity level than is necessary for complete writing of the waveform display. Some experimentation may be necessary to establish the correct level. Too high a setting of the READOUT INTENSITY control will result in a broad, poorly defined photograph of the readout display.

3. If single-shot photography is used, set the READOUT and GRAT ILLUM controls to the PULSED position (see Readout Display and Graticule Illumination for complete operating information). Then, the readout display and graticule illumination occurs in a single-shot manner after the trace is complete (be sure the camera shutter remains open at least 0.5 second after the sweep is completed to photograph the entire readout and graticule).

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. This is accomplished by changing the intensity of the displayed waveform to provide a "gray scale" display.

The voltage amplitude required for visible trace modulation depends on the setting of the A and B INTENSITY controls. A positive two-volt signal will completely blank the display, even at maximum intensity levels; lower amplitude signals can be used to change only the relative trace brightness. Negative-going signals increase the display intensity and positive-going signals decrease the display intensity. Refer to Table 1-4 in the General Information section for specifications on Z-axis signal requirements.

Time markers applied to the Z-AXIS INPUT connector provide a direct time reference on the display. With uncalibrated horizontal sweep or X-Y mode operation, the time markers provide a means of reading time directly from the display. If the markers are not time-related to the display waveform, use a singlesweep display.

REMOTE INPUT SIGNALS

The signal source requirements to operate the remote input functions on the rear panel can be either active (pulse generator, logic circuit, etc.) or passive (switch or relay). Refer to Table 1-4, in the General Information section for specific parameters on each input.

Remote Single Sweep Reset

An external single-sweep-reset signal can be applied to time-base units installed in the horizontal plug-in compartments through the rear-panel SINGLE SWEEP RESET input connector. This remote reset function is a duplication of the manually-operated single-sweep reset function (pushbutton) located on the front panel of the 7B-series time-base units. The signal source for the external single-sweep reset function can be either active (pulse generator, logic circuit, etc.) or passive (switch or relay).

A and B SINGLE SWEEP READY outputs are provided for external indicators. The indicators signify that the time-base unit has been reset, and is ready to present a single sweep when the next trigger pulse arrives. Refer to Table 1-4, in the General Information section of this manual, for signal parameters.

Remote Graticule and Readout Single Shot

The GRATICULE/READOUT SINGLE SHOT bnc connector (located on the rear panel) allows an external signal to actuate one frame of readout information and one momentary illumination of the graticule when the READOUT INTENSITY and GRAT ILLUM controls are set to PULSED, and the + GATE/EXT pushbuttons for READOUT and GRAT ILLUM are set to EXT. The signal source can be either active (pulse generator, logic circuit, etc.) or passive (switch or relay). Refer to Table 1-4, in the General Information section of this manual, for input requirements.

APPLICATIONS

The 7104 Oscilloscope and associated plug-in units provide a flexible measurement system. The capabilities of the overall system depend mainly upon the plug-in units selected for use with this instrument. Specific applications for the individual plug-in units are described in the plug-in unit instruction manual. 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 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.

John D. Lenk, *Handbook of Oscilloscopes, Theory and Application*, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1968.

J. Czech, *Oscilloscope Measuring Techniques*, Springer-Verlag, New York, 1965.

J. F. Golding, *Measuring Oscilloscopes,* Transatlantic Arts, Inc., 1971.

Charles H. Roth, Jr., *Use of the Oscilloscope*, programmed text, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1970.

VERTICAL AMPLIFIER PLUG-IN UNITS

All 7A-series plug-in units (except the 7A21N unit) can be used with the 7104. Bandwidth and sensitivity ranges should be taken into consideration when selecting amplifier plug-in units.

Single-Trace

Any single-channel amplifier will display a signal, with the sweep provided by any 7B-series time-base plug-in. This combination leaves two unused compartments available for other special purpose units. Blank plug-in panels are available to cover any unfilled plug-in compartments.

Dual-Trace

A dual-channel amplifier in either vertical compartment can display two separate signals with the other vertical compartment free for other uses.

Three-Trace

A dual-channel amplifier can be used with any single-channel amplifier to display three separate signals. If two time-base plug-in units are used in the horizontal compartments, two signals can be displayed at one sweep rate while the other signal is displayed at the other sweep rate.

Four-Trace

Two dual-channel amplifiers can display four separate signals. If one time-base unit is used, all four signals will be displayed at the same sweep rate.

TIME-BASE PLUG-IN UNITS

The 7104 is compatible with time-base units of the 7B10 Series, the 7B80 Series, the 7B50A, and the 7B92A. Sweep rates and triggering ranges should be taken into consideration when selecting time-base plug-in units.

To obtain a delayed sweep display, a delaying time-base unit must be installed in the A HORIZ compartment and a delayed time-base unit installed in the B HORIZ compartment. A delayed-sweep display can also be obtained with one horizontal compartment if a dual time-base unit is used. This leaves the other horizontal compartment available for other plug-in units as suggested later in this section.

NOTE

The 7B50 Series (except the 7B50A), the 7B70 Series, and the 7B92 are not optimized for the extremely wide horizontal bandwidth of the 7104 and will likely exhibit unacceptable degradation in sweep accuracy and linearity.

SAMPLING DISPLAYS

Sampling-system plug-in units for the 7000-series oscilloscopes provide displays of fast-changing signals that cannot be examined using any other method. For example, sampling systems available for the 7104 can resolve repetitive signals having less than 10 millivolts of peak amplitude and occurring in less than 1 nanosecond.

The technique used for sampling is very similar in principle to the use of stroboscopic light to study fast motion. Samples of successive waveforms are taken, amplified by a relatively low-bandwidth amplifier, and then displayed on the crt as a replica of the sampled waveforms.

Three sampling systems are available at this time for the 7104: (1) the 7S12, which provides time-domain-reflectometry displays and general-purpose sampling measurements, (2) the 7S11/7T11 system and (3) the 7S14, a dual-channel vertical sampling system, including main and delayed sweep functions. See the Tektronix Products catalog to determine the characteristics of individual units mentioned and of additional units made available after this manual is published.

Single-Trace Sampling

A single-trace sampling display requires either a double-width 7S12 (which includes a time-base), or the 7S11 sampling unit and the 7T11 sampling sweep unit. Direct interconnections between the 7S11 and the 7T11 require these units to be adjacent, with the 7S11 in the RIGHT VERT compartment and the 7T11 in the A HORIZ compartment. If either the 7S12 or the 7S14 is used, it must be located in the middle two compartments to make proper connections with the 7104.

Dual-Trace Sampling

Two 7S11's can be used with a single sampling time-base unit for time-related displays of two signals. Direct interconnections from the LEFT VERT 7S11 pass through the RIGHT VERT 7S11 to reach the A HORIZ time-base unit.

The 7S14 is a dual-channel sampling unit with delaying sweep capabiity. It must be used in the middle two plug-in compartments.

Dual-trace sampling displays can also be made by a 7S12 in the middle two compartments and a 7S11 in the LEFT VERT compartment. In this application, the 7S12 supplies the time-base for both traces.

X-Y Sampling

One 7S11 inserted in the RIGHT VERT compartment and one in the adjacent A HORIZ compartment automatically share a 50 kilohertz free-running strobe condition specified for X-Y displays. The 7S14 has an X-Y operation incorporated as one of its normal mode functions.

SPECIAL PURPOSE PLUG-IN UNITS

The variety of special-purpose plug-in units available allows the 7104 Oscilloscope to be used for many specialized applications. The following is a brief discussion of some of the available special-purpose plug-in units.

Digital Counters and Multimeter Plug-In Units

The digital-multimeter plug-in units measure current, voltage, temperature and resistance; digital-frequency counter plug-in units measure frequency, from dc to above 500 megahertz. These units make use of the readout system to display the measured information on the crt and can function in any compartment, in combination with each other or with any other plug-in units available for use with the 7104 Oscilloscope system.

The ability of digital readout plug-in units to operate with other plug-in units makes it possible to process and monitor signals at the same time the digital measurement is being made. For example, by locating a frequency counter in one of the vertical compartments and an amplifier unit in the other vertical compartment, the crt can display the trigger waveform, superimposed on the displayed signal, to indicate the actual triggering point. Or, if the counter is placed in a horizontal compartment, a low amplitude signal can be applied to a vertical amplifier and amplified before it is internally routed by the TRIGGER SOURCE switches to the counter trigger circuit. This allows the unit to be used on signals too small to trigger other counters.

Readout Access Plug-In Unit

The 7M13 READOUT plug-in unit provides front-panel keyboard operation for convenient access to the crt readout characters. This allows information, such as dates and identifying nomenclature, to be displayed on the crt with the normal crt display. This capability is particularly useful when making photographs.

Transistor Curve-Tracer Plug-In Units

The 7000-series transistor curve-tracer plug-in checks small signal transistors and diodes by producing a display showing the basic characteristic curves for the device being tested. Stepped sweep signals from an internal power supply are applied to the device under test. The resulting output signals are, in turn, applied to the horizontal and vertical deflection systems of the oscilloscope to plot a family of characteristic curves. This plot can be used to check for damaged transistors and diodes, or to select for special or matched characteristics and to calculate gain, leakage, breakdown voltage, etc.

Spectrum Analyzer Plug-In Units

The 7000-series spectrum analyzer plug-in units display signal amplitudes dispersed over portions of the rf spectrum. Absolute signal energy is plotted on the vertical axis against frequency on the horizontal axis. Applications include waveform and distortion analysis, EMC and random noise measurements, filter design, spectrum surveillance, etc.

X-Y OPERATION

In some applications, it is desirable to display one signal versus another (X-Y) rather than against time (interval sweep). The flexibility of the amplifier plug-in units available for use with the 7104 provide the means of applying external signals to the horizontal-deflection system.

Installation of a 7A-series amplifier plug-in unit in one of the horizontal and one of the vertical compartments provides X-Y operation. Using the 7104 in the X-Y mode can only be accomplished in conjunction with a horizontal time-base unit. When an amplifier is installed in a horizontal plug-in compartment, the control of the Z-axis is switched to the one remaining horizontal compartment as is indicated by the A or B intensity control indicator lights. This is independent of the HORIZONTAL MODE switch setting. The time base will control the Z-axis and should be internally triggered on the Y portion of the X-Y display. By varying the time/division switch, the Z-axis is duty cycled and a window can be selected during which the Z-axis is turned on. By operating the instrument in a horizontal alternating mode (X-Y display, Y-T display) the optimum sweep speed is easily selected. For typical X-Y displays the spot velocity is unpredictable. For such displays a dc driven Z-axis produces displays with very nonuniform brightness levels. A display may consist of a very dim transition between two bright spots. In fact in some cases the transition may not be seen at all since there may be enough screen current in the bright spots to activate the intensity limiter. If the time base turns on the Z-axis only during the transition a uniform brightness display can be obtained. The high horizontal bandwidth in conjunction with Z-axis control by a time base allows observation of very fast transitions in X-Y displays. With Option 2, a horizontal delay line is added to the instrument permitting signal phase correction between the vertical and horizontal deflection systems. Some vertical plug-in units have a variable delay function that permits precise phase correction. For further information, refer to the horizontal specifications in this manual and to the individual instruction manuals for the amplifier units.

Some of the 7B-series time-base units can be operated as amplifiers in addition to their normal uses as time-base generators. This feature allows an external signal to provide the horizontal deflection to the crt. For most of the time-base units with the amplifier function, the X (horizontal) deflection 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 A and B TRIGGER SOURCE switches must be set so that the X (horizontal) deflection signal is obtained from one of the vertical amplifier units and Y (vertical) deflection signal is obtained from the other vertical unit. The attenuator switch on the amplifier unit can provide the horizontal with a preconditioned signal, compatible with the horizontal deflection factor. Also, plug-in units need not be moved from one compartment to another to change from X-Y operation to other modes of operation.

RASTER DISPLAYS

A raster-type display can be used effectively to 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 7104 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 at 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 rates.

Information can be displayed on the raster using several different methods. In the ADD position of the VERTICAL MODE switch, the signal from an amplifier unit can be algebraically added to the vertical waveform. With this method, the vertical signal amplitude on the crt should not exceed the distance between the horizontal lines of the raster. Another method of displaying information on the raster is to use the Z-AXIS INPUT to provide intensity modulation for 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.

THEORY OF OPERATION

This section describes the circuitry used in the 7104 Oscilloscope. The description begins with a discussion of the instrument, using the block diagram shown in Figure 3-1, and continues in detail, showing the relationships between the stages in each major circuit. Schematics of all major circuits are given in Section 8, Diagrams and Circuit Board Illustrations. Stages are outlined on the schematics with wide shaded lines. Stage names are in shaded boxes. Refer to these schematics throughout the following circuit description for specific electrical values and relationships.

BLOCK DIAGRAM

The following discussion is provided to assist in understanding the overall concept of the 7104 Oscilloscope mainframe before the individual circuits are discussed in detail. A basic block diagram of the 7104 is shown in Figure 3-1. Only the basic interconnections between the individual blocks are shown on this diagram. Each major circuit within the instrument is given a block. The number of each block refers to the complete circuit diagram located at the rear of this manual.

DESCRIPTION

Vertical signals to be displayed on the crt are applied to the Vertical Channel Switch circuit from both vertical plug-in compartments. The VERTICAL MODE switch is connected to the logic circuit and determines whether the signal from the LEFT VERT or RIGHT VERT compartment is displayed on the crt. The Vertical Channel Switch receives an X-Y inhibit signal from the Readout System to provide the time sharing between the vertical and readout signals.

The selected vertical signal passes through the Delay Line and is amplified by the Vertical Amplifier circuit to drive the vertical deflection plates of the crt (cathode-ray tube). The Vertical Amplifier circuit includes an input from the Readout System to produce the vertical portion of the alpha-numeric readout display.

Horizontal signals for display on the crt are connected to the Horizontal Channel Switch from both horizontal plug-in compartments. The signal from B HORIZ plug-in compartment may pass through the optional X-Y delay compensation network (Option 2 instruments only). The HORIZONTAL MODE switch determines whether the signal from the A HORIZ or B HORIZ compartment is displayed by the crt. The Horizontal Channel Switch receives an X-Y inhibit signal from the Readout System to provide the time sharing between the vertical and readout signals.

The selected horizontal signal is amplified by the Horizontal Amplifier circuit to provide horizontal deflection of the crt. The Horizontal Amplifier circuit accepts an input signal from the Readout System to produce the horizontal portion of the alpha-numeric readout display.

The Readout System provides an alpha-numeric display of information encoded by the plug-in unit(s). The readout display is written on the crt on a time-shared basis with the analog waveform display. The VERTICAL and HORIZONTAL MODE switch circuits determine which plug-in unit(s) displays readout information. The Readout System sends inhibit commands to the Vertical Channel Switch, Horizontal Channel Switch and Z-Axis logic circuits. The Readout System provides signals to produce the alpha-numeric display to the Vertical, Horizontal and Z-Axis Amplifier circuits.

The Logic circuit develops control signals for use in other circuits within the instrument and the plug-in units. These control signals automatically determine the correct instrument operation in relation to the plug-in units, plug-in unit control settings, and 7104 front-panel control settings. The Logic circuit performs three functions:

(1) Receives

a. The external Z-Axis Input signal.

b. The Single Sweep Reset Input from the rear panel.

c. The Z-Axis Inhibit Command from the Readout System.

(2) Sends the A and B SINGLE SWEEP READY signals to the rear panel.

(3) Develops the Z-Axis signal for use by the Z-Axis Amplifier.

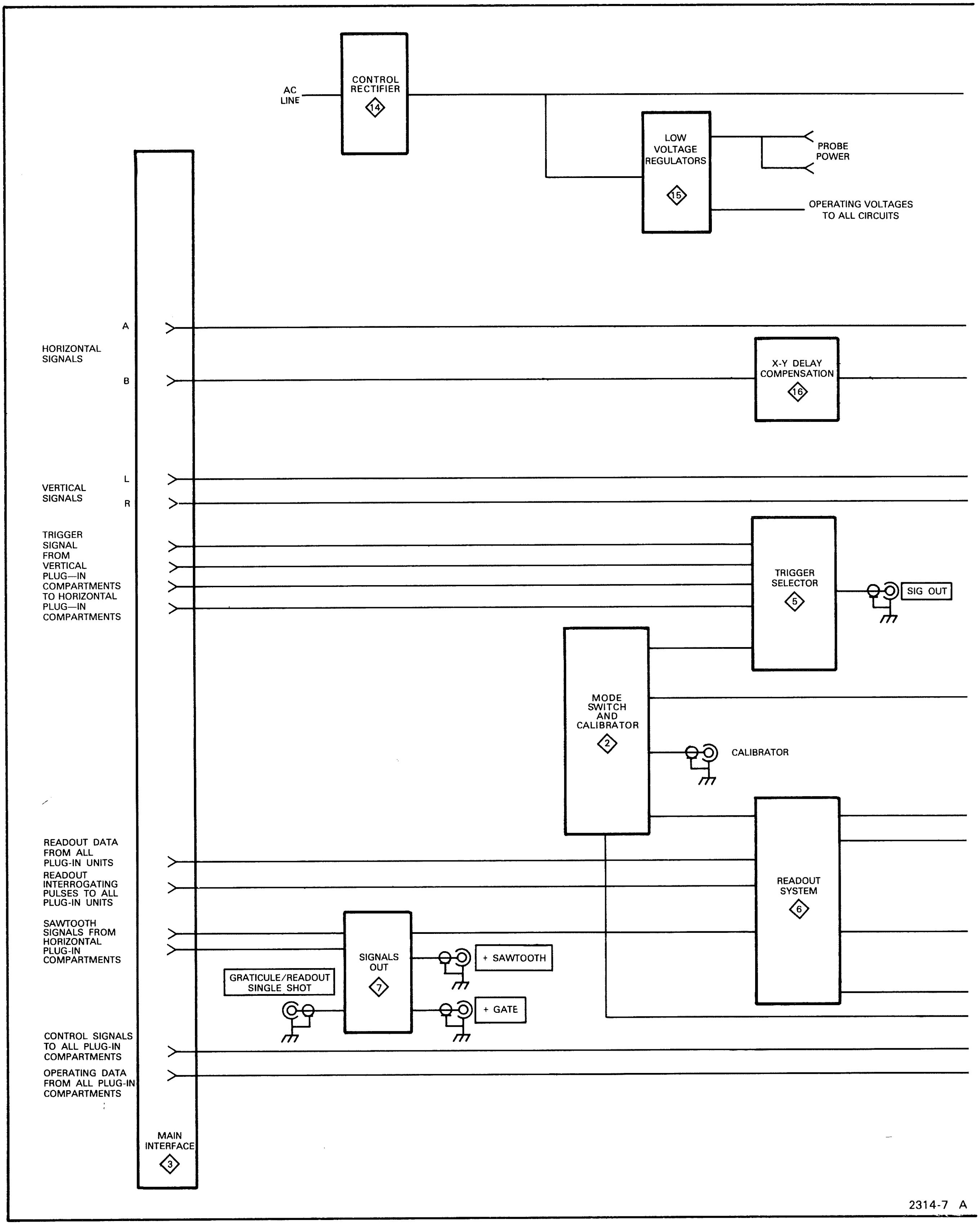


Figure 3-1. Basic block diagram of the 7104 Oscilloscope.

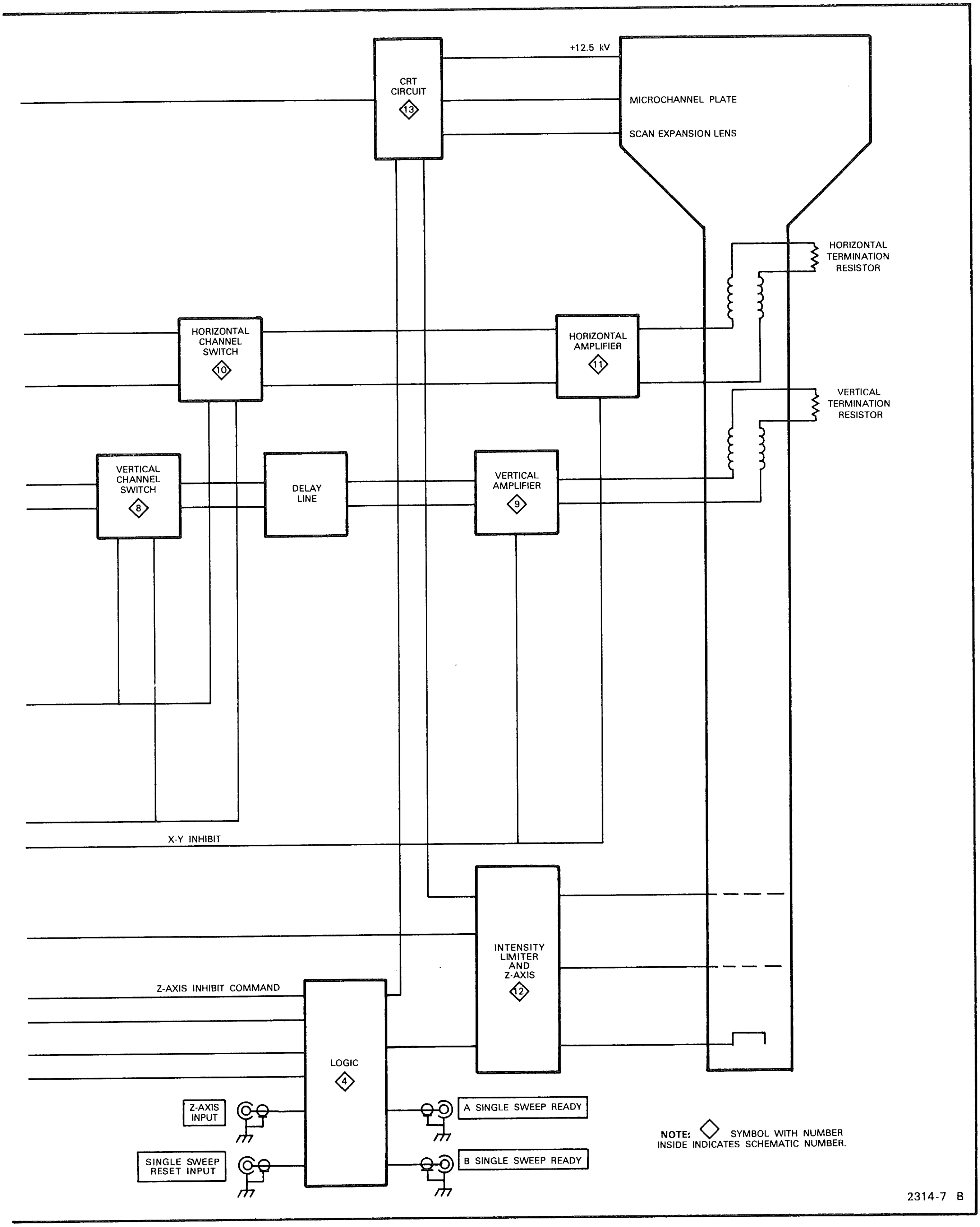


Figure 3-1. Basic block diagram of the 7104 Oscilloscope (continued).

In addition to control circuitry, the CRT Circuit supplies voltages necessary for operation of the crt by:

(1) Developing the operating voltages for the crt Microchannel Plate and the Scan Expansion Lens.

(2) Providing a signal proportional to the average screen current to the input of the intensity limiter level.

(3) Receiving a signal proportional to the intensity level setting from the logic circuit to be used by the Microchannel Plate supply for biasing. The Z-Axis Amplifier provides the drive signal to control the intensity level of the crt display.

The Calibrator circuit produces a one kilohertz square-wave signal which can be used to check the calibration of this instrument and the compensation of probes. The calibrator signal is available as a voltage at the CALIBRATOR connector or as a current through a 40 milliampere optional current loop accessory.

The internal trigger signals from the vertical plug-in units are connected to the Trigger Selector circuit. The Trigger Selector circuit determines whether the trigger signal from the left or right vertical unit is connected to the A or B horizontal unit. The B Trigger Channel Switch also produces the drive signal for the SIG OUT circuit to provide an output that is a sample of the vertical signal.

The Signals Out circuit processes signals from the plug-in units for the front-panel +GATE and +SAWTOOTH outputs.

The Control/Rectifier and Low-Voltage Regulator circuits provide the power necessary to operate the instrument. These voltages are connected to all circuits within the instrument.

DETAILED CIRCUIT OPERATION

A detailed description of the electrical operation and relationship of the circuits in the 7104 Oscilloscope mainframe is provided in this section. The theory of operation for circuits unique to this instrument is described in detail in the discussion. Circuits 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:

Gordon V. Deboo, *Integrated circuits and Semiconductor Devices,* McGraw-Hill, New York, 1971.

Albert Paul Malvino, *Transistor Circuit Approximations,* McGraw-Hill, New York, 1973.

Joseph Milman and Herbert Taub, *Pulse, Digital and Switching Waveforms,* McGraw-Hill, New York, 1965.

LOGIC FUNDAMENTALS

Digital logic techniques are used to perform many functions within the instrument. The function and operation of the logic circuits are described using logic symbology and terminology, aiding in the understanding of these symbols and 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, or a more detailed analysis of digital logic, refer to the following textbooks:

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 Milman and Herbert Taub, *Pulse, Digital and Switching Waveforms,* McGraw-Hill, New York, Chapters 9-11, 1965.

SYMBOLS

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

NOTE

Logic Symbols used on the diagrams depict the logic function as used in this instrument 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 that constitute a HI or LO state vary between individual devices. Whenever possible, the input and output lines are named to indicate the function that they perform when at the HI (true) state.

TABLE 3-1
Basic Logic Reference

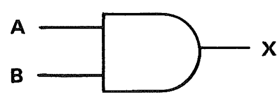
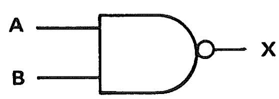
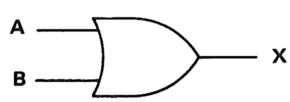
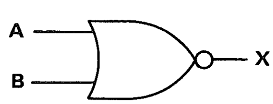
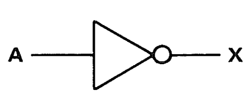
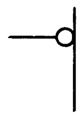
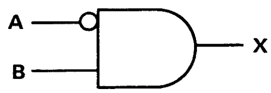
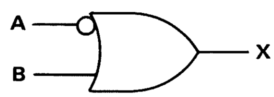
<table>
<tr><th>Device</th><th>Symbol</th><th>Description</th><th>Input/Output Table</th></tr>
<tr><td>AND gate</td><td></td><td>A device with two or more inputs and one output. The output of the AND gate is HI if and only if all of the inputs are at the HI state.</td><td><table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>A</td><td>B</td><td>X</td></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></td></tr>
<tr><td>NAND gate</td><td></td><td>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.</td><td><table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>A</td><td>B</td><td>X</td></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></td></tr>
<tr><td>OR gate</td><td></td><td>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.</td><td><table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>A</td><td>B</td><td>X</td></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></td></tr>
<tr><td>NOR gate</td><td></td><td>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.</td><td><table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>A</td><td>B</td><td>X</td></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></td></tr>
<tr><td>Inverter</td><td></td><td>A device with one input and one output. The output state is always opposite to the input state.</td><td><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></td></tr>
</table>

TABLE 3-1 (CONT.)
Basic Logic Reference

<table>
<tr><th>Device</th><th>Symbol</th><th>Description</th><th>Input/Output Table</th></tr>
<tr><td>LO-state indicator</td><td></td><td>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:</td><td></td></tr>
<tr><td></td><td></td><td>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.</td><td>Input / Output<table><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></td></tr>
<tr><td></td><td></td><td>OR gate with LO-state indicator at the A input:

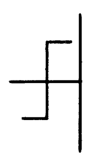
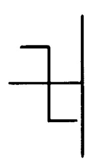
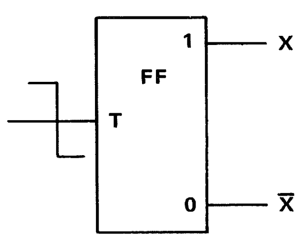
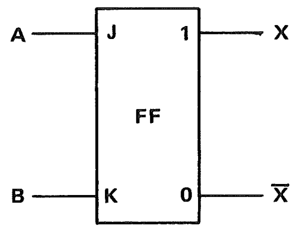
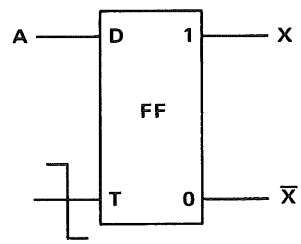
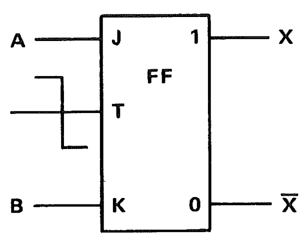
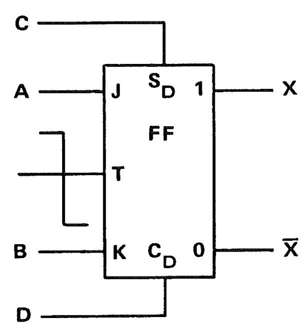
The output of this gate is HI if either the A input is LO or the B input is HI.</td><td>Input / Output<table><tr><th>A</th><th>B</th><th>X</th></tr><tr><td>LO</td><td>LO</td><td>HI</td></tr><tr><td>LO</td><td>HI</td><td>HI</td></tr><tr><td>HI</td><td>LO</td><td>LO</td></tr><tr><td>HI</td><td>HI</td><td>HI</td></tr></table></td></tr>
<tr><td>Edge symbol</td><td></td><td>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.</td><td></td></tr>
<tr><td>Triggered (toggle) Flip-Flop</td><td></td><td>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.</td><td>Input / Output<table><tr><th colspan="2">Condition before trigger pulse</th><th colspan="2">Condition after trigger pulse</th></tr><tr><th>X</th><th>$\overline{X}$</th><th>X</th><th>$\overline{X}$</th></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></td></tr>
</table>

TABLE 3-1 (CONT.)
Basic Logic Reference

<table>
<tr><th>Device</th><th>Symbol</th><th>Description</th><th>Input/Output Table</th></tr>
<tr><td>Set-Clear
(J-K)
Flip-Flop</td><td>
</td><td>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).</td><td>
<table>
<tr><th colspan="2">Input</th><th colspan="2">Output</th></tr>
<tr><td>A</td><td>B</td><td>X</td><td>$\overline{X}$</td></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></td></tr>
<tr><td>D (data) Type
Flip-Flop</td><td>
</td><td>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.</td><td>
<table>
<tr><th>Input</th><th colspan="2">Output</th></tr>
<tr><td>A</td><td>X</td><td>$\overline{X}$</td></tr>
<tr><td>LO</td><td>LO</td><td>HI</td></tr>
<tr><td>HI</td><td>HI</td><td>LO</td></tr>
</table>
Output conditions shown after trigger pulse</td></tr>
<tr><td>Triggered
Set-Clear
(J-K)
Flip-Flop</td><td>
</td><td>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.</td><td>
<table>
<tr><th colspan="2">Input</th><th colspan="2">Output</th></tr>
<tr><td>A</td><td>B</td><td>X</td><td>$\overline{X}$</td></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</td></tr>
<tr><td>Flip-Flop with
Direct Inputs
(may be applied
to all triggered
flip-flops)</td><td>
</td><td>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.</td><td>
<table>
<tr><th colspan="4">Input</th><th colspan="2">Output</th></tr>
<tr><td>A</td><td>B</td><td>C</td><td>D</td><td>X</td><td>$\overline{X}$</td></tr>
<tr><td>1</td><td>1</td><td>LO</td><td>LO</td><td colspan="2">No change[1]</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</td></tr>
</table>

INPUT/OUTPUT TABLES

Input/Output (truth) tables show the input combinations important 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. Examples of input/output tables for individual devices can be seen in Table 3-1.

NON-DIGITAL DEVICES

Not all of the integrated circuit devices in this instrument are digital logic devices. The function of non-digital devices is described individually, using operating waveforms or other techniques to illustrate their function.

1

CABLE DISTRIBUTION

Diagram 1, shows the cable inter-connections between circuit boards within the 7104.

2

MODE SWITCH AND CALIBRATOR

A schematic diagram of the Mode Switch and Calibrator circuits is given on diagram 2, in section 8 of this manual (Diagrams and Circuit Board Illustrations). The schematic is divided by gray shaded lines separating the circuitry into major stages. These stages aid in locating components mentioned here. Sub-headings use the stage names to further identify portions of the circuitry on diagram 2.

CALIBRATOR

The Calibrator circuit provides voltage outputs of 40 millivolts, 0.4 volt and 4 volts at the CALIBRATOR output connector. A current output of 40 milliamperes is available from the Calibrator circuit with an optional current loop adapter. When using the current loop adapter the Calibrator must be operated only in the 4 V switch position, for stated output.

Transistors Q376 and Q382 form a 1 kilohertz, square-wave oscillator. Oscillation occurs as follows: Initially assume that Q376 is conducting and Q382 is not conducting. The voltage at the emitter of Q382 becomes more negative as C376 discharges through R381. Capacitor C376 discharges until the emitter-base junction of Q382 becomes forward biased. As Q382 begins conducting the oscillator changes states. Regeneration starts when Q382 conducts and C376 stops discharging; this reduces the collector current of Q376. Thus, the collector voltage of Q376 rises positive which causes the base and emitter of Q382 to rise positive. The positive going voltage is coupled by C376 to the emitter of Q376, turning it off.

At this time, Q382 is conducting and Q376 is not conducting. The voltage at the emitter of Q376 goes negative as C376 charges through R376. When the emitter-base junction of Q376 becomes forward biased the oscillator will again change states to complete the cycle.

The square-wave signal produced at the collector of Q382 switches Q384 on and off. When Q384 is on, the current from R383 and R384 flows to ground. When Q384 is off, this current flows through CR386 and R386 into the voltage divider network of R387, R392, R393, R394, R395, R396, and R397 to produce the 4 volt, 0.4 volt and 40 millivolt Calibrator output voltages. The accuracy of the Calibrator is set by the 0.4 Volts DC adjustment, R385. Both the 4V and 0.4V calibrator switches must be engaged when adjusting R385. The Calibrator frequency is set by the 1 kHz adjustment, R375.

MODE SWITCHING

The Mode Switching circuit includes front-panel switching and provides the logic for selection of the vertical and horizontal compartments to provide deflection for the crt. The Mode Switching circuit operates in conjunction with the Logic circuit (diagram 4) to develop control signals for use in other circuits within this instrument and plug-in units installed in the plug-in compartments. Table 3-2 shows the outputs produced with all combinations of the front-panel switch positions.

3

MAIN INTERFACE

Diagram 3 shows the plug-in interface and the inter-connections between the plug-in compartments, circuit boards, etc. of this instrument. The signal and voltage connections of each interface connector are also identified in diagram 3.

4

LOGIC

A schematic diagram of the Logic circuit is given on diagram 4, in section 8 of this manual (Diagrams and Circuit Board Illustrations). The schematic is divided by gray shaded lines separating the circuitry into major stages. These stages aid in locating components mentioned here. Sub-headings in the following discussion use these stage names to further identify portions of the circuitry on diagram 4.

@

TABLE 3-2
Mode Switching Inputs/Outputs

FRONT-PANEL SWITCH POSITIONS (INPUTS)																MODE SWITCHING OUTPUTS						
A TRIGGER SOURCE SWITCH			B TRIGGER SOURCE SWITCH			VERTICAL MODE SWITCH					HORIZONTAL MODE SWITCH				A TIME-BASE UNIT DELAY MODE	$\overline{\text{VERT MODE SIG}}$	HORIZ SLAVE ENABLE	RIGHT	$\overline{\text{ADD}}$	A AND B TRIGGER SWITCH LIGHTS		
VERT MODE	LEFT VERT	RIGHT VERT	VERT MODE	LEFT VERT	RIGHT VERT	LEFT	ALT	ADD	CHOP	RIGHT	A	ALT	CHOP	B						VERT MODE	LEFT VERT	RIGHT VERT
	●			●														LO	HI		ON	
		●			●													HI	HI			ON
●			●			●										HI	LO	LO	HI	ON	ON	
●			●					●								HI	LO	LO	LO	ON	ON	ON
●			●						●							CHOP	LO	LO	HI	ON	ON	
●			●							●						LO	LO	HI	HI	ON		ON
●			●				●				●					ALT	LO	ALT	HI	ON	ON	ON
●			●				●							●		ALT	LO	ALT	HI	ON	ON	ON
●							●					●				ALT	HI	HI	HI	ON		ON
●							●						●			ALT	HI	HI	HI	ON		ON
			●				●					●				ALT	HI	LO	HI	ON	ON	
			●				●						●			ALT	HI	LO	HI	ON	ON	
			●				●								●	ALT	LO	ALT	HI	ON	ON	ON

The Logic circuit develops control signals for use in other circuits within this instrument and any plug-in units installed in the vertical and horizontal compartments. These control signals automatically determine the correct instrument operation in relation to the plug-in units installed or selected, plug-in control settings, and 7104 control settings.

HORIZONTAL LOGIC

The Horizontal Logic stage performs three separate logic functions: A Sweep Lockout, B Sweep Lockout, and Alternate Pulse Generation. The majority of the Logic for these functions are contained within the Horizontal Logic IC, U4428. Figure 3-2 identifies the three individual stages of U4428 and the input and output terminals associated with each. Note that some of the input levels are connected internally to more than one of the individual stages.

A Sweep Lockout

The A Sweep Lockout portion of the Horizontal Logic IC (U4428) produces an output level at the collector of Q4462 (A Sweep Inhibit) that determines when the A HORIZ time-base unit can produce a sweep. If this output is HI, the A HORIZ unit is locked out (disabled) not producing a sweep. If the level is LO, the A HORIZ unit is enabled and produces a sweep when triggered.

Only two combinations of input conditions to U4428 will produce a HI A Sweep Inhibit level, as shown by Table 3-3. If non-delayed operation is being used, the first combination disables the A sweep while the B sweep is being displayed in the ALT horizontal mode (both units must be in time-base mode). The second combination disables the A sweep during delayed-sweep operation enabling the B sweep to complete its holdoff before the next A sweep begins.

B Sweep Lockout

The B Sweep Lockout stage produces an output level at the collector of Q4468 determining whether the B HORIZ time-base unit can produce a sweep. A HI output level locks out (inhibits) the B HORIZ unit and a LO level enables the B HORIZ unit to produce a sweep.

The output of this stage is HI only under one set of input conditions to U4428, as shown by Table 3-4. (This set of conditions disables the B sweep while the A sweep is being displayed in the ALT, HORIZONTAL MODE switch position, if both time-base units are in a sweep mode and

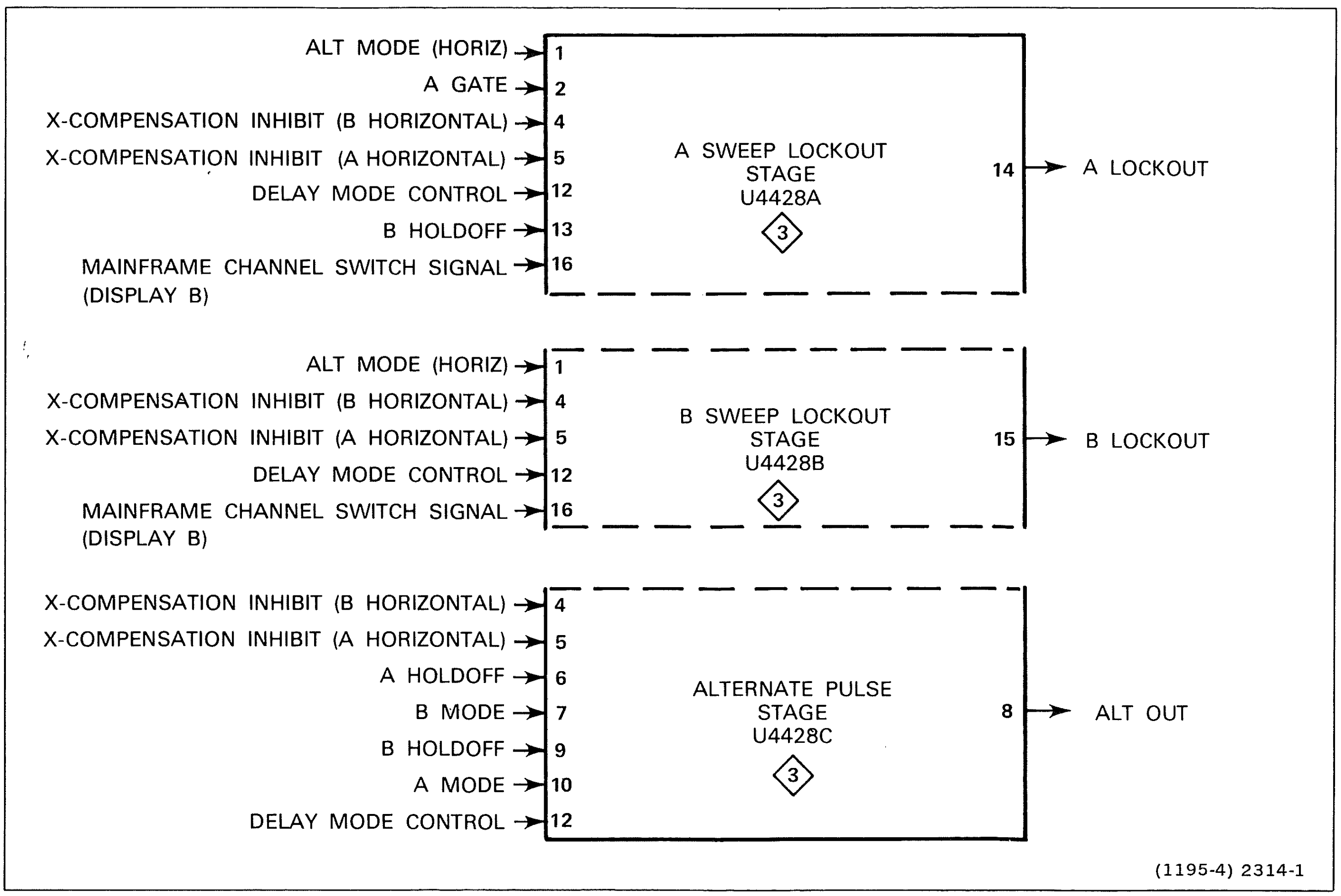


Figure 3-2. Breakdown of separate stages within Horizontal Logic IC (4428).

TABLE 3-3
Input/Output Combinations for A Lockout (U4428 Pin 14)

INPUT							OUTPUT
ALT MODE (HORIZ)	A GATE	X-COMPENSATION INHIBIT (B HORIZONTAL)	X-COMPENSATION INHIBIT (A HORIZONTAL)	DELAY MODE CONTROL	B HOLDOFF	DISPLAY B COMMAND	A LOCKOUT
1	2	4	5	12	13	16	14
HI	Φ	HI	HI	LO	Φ	HI	HI
Φ	LO	Φ	Φ	HI	HI	Φ	HI
ALL OTHER COMBINATION							LO

Φ = HAS NO EFFECT IN THIS CASE

TABLE 3-4
Input/Output Combinations for B Lockout (U4428 Pin 15)

INPUT					OUTPUT
ALT MODE (HORIZ)	X-COMPENSATION INHIBIT (B HORIZONTAL)	X-COMPENSATION INHIBIT (A HORIZONTAL)	DELAY MODE CONTROL	DISPLAY B COMMAND	B LOCKOUT
1	4	5	12	16	15
HI	HI	HI	LO	LO	HI
ALL OTHER COMBINATIONS					LO

non-delayed sweep is used.) For any other combination of input conditions, the B Sweep Lockout level is determined by the Delay Gate (from A time-base unit); see Main Interface, diagram 3.

Alternate Pulse Generator

The third function performed by the Horizontal Logic stage is the production of an Alternate Pulse signal for use by the Plug-In Binary and Vertical Binary stages. The holdoff gate produced at the end of the sweep by the respective time-base unit is differentiated by either C4335 or C4423, providing a positive-going pulse to pin 6 or 9 of U4428. The differentiated A or B holdoff gate may produce the alternate pulse depending upon the operating conditions as shown in Table 3-5.

(1) A (Only) Mode

An Alternate Pulse is produced at the end of each A sweep when the HORIZONTAL MODE switch is set to the A position.

(2) B (Only) Mode

In the B position of the HORIZONTAL MODE switch, an Alternate Pulse is produced at the end of each B sweep. (The A time-base must be in independent, non-delayed mode.)

TABLE 3-5
Input/Output Combinations for Alternate Pulse (U4428 Pin 8)

INPUT							OUTPUT	
X-COMPENSATION INHIBIT (B HORIZONTAL)	X-COMPENSATION INHIBIT (A HORIZONTAL)	A HOLDOFF	B MODE	B HOLDOFF	A MODE	DELAY MODE CONTROL	TIME-BASE WHICH IS SOURCE OF ALTERNATE PULSE	
4	5	6	7	9	10	12	8[2]	HORIZONTAL CONDITIONS
HI	Φ	HI[1]	LO	Φ	HI	Φ	A	A ONLY
Φ	HI	Φ	HI	HI[1]	LO	LO	B	B ONLY
HI	HI	HI[1]	LO	HI[1]	LO	LO	A AND B	ALT OR CHOP
HI	HI	HI[1]	Φ	Φ	Φ	HI	A	A DELAYS B
HI	LO	HI[1]	LO	LO	Φ	Φ	A	A WITH VERTICAL UNIT IN B COMPARTMENT.
LO	HI	LO	Φ	HI[1]	LO	LO	B	B WITH VERTICAL UNIT IN A COMPARTMENT.
ALL OTHER COMBINATIONS							NO OUTPUT PULSE (LO AT OUTPUT)	

Φ = Has no effect in this case.

[1]Positive-going pulse. Where both A and B Holdoff are required to be HI, a HI at either input produces an alternate pulse.

[2]Negative-going pulse.

(3) Alt or Chop Mode

When the HORIZONTAL MODE switch is set to ALT or CHOP (the A time-base unit must be in independent, non-delayed mode), an Alternate Pulse is produced at the end of each sweep. For example, an Alternate Pulse is produced at the end of the A sweep, then at the end of the B sweep, again at the end of the A sweep, etc. Although Alternate Pulses are produced in the CHOP horizontal mode, they are not used in this instrument.

(4) Delayed Sweep (A Delays B)

When the A time-base unit is set for delayed operation, the operation of the Alternate Pulse Generator is changed producing an Alternate Pulse only at the end of the A sweep, even when the HORIZONTAL MODE switch is set to B. This is necessary since the A time-base establishes the amount of delay time for the B time-base unit whenever it is displayed.

(5) Amplifier Unit in Horizontal Compartment

When an amplifier unit is installed in either of the horizontal plug-in compartments, the Alternate Pulse can be produced only from the remaining time-base unit. If amplifier units are installed in both horizontal compartments, an Alternate Pulse is not produced since there are no time-base units to produce a holdoff pulse.

Z-AXIS LOGIC

The Z-Axis Logic stage produces an output current signal at pin 8 of U4485 which sets the intensity of the crt display except for the readout display which is controlled by the Readout System. The output current at pin 8 is determined by the setting of the A or B INTENSITY controls, and the Auxiliary Z-Axis input. The Auxiliary Z-Axis input is produced by either the External Z-Axis input or by an input from any of the plug-in units; see Main Interface, diagram 3. The input current from the A and B INTENSITY controls is switched matching the output current to the horizontal display. The Vertical Chopped Blanking, Horizontal Chopped Blanking, and readout blanking signals are applied to this stage to block the output current and blank the crt display for vertical chopping, horizontal chopping, or during a readout display.

The inputs to the Z-Axis Logic stage (U4485) pins 1, 2, 9, and 16 are current-driven and are variable from zero to four milliamperes.

The Vertical Chopped Blanking signal, the Horizontal Chopped Blanking and the Z-Axis Inhibit signal enables or disables this stage to control all output current. Quiescently, the level at pins 6 and 7 is HI so that the intensity current from pins 1, 2, 9, and 16 can pass to the output. However, both pins 6 and 7 go LO during Vertical Chopped Blanking, during Horizontal Chopped Blanking or during a readout display. This blocks the output current and the crt is blanked. The Vertical Chopped Blanking signal is connected to pins 6 and 7 of U4485 directly from pin 4 of U4320. The Horizontal Chopped Blanking Inhibit signal is connected to U4485 from pin 4 of U4340 through LR4338, Q4336 and CR4471. Notice that this signal is connected to the collector of Q4336. This transistor is normally operating in the saturated condition, and the HI Horizontal Chopped Blanking Inhibit level from U4340 is the collector source voltage. When the Horizontal Chopped Blanking Inhibit level goes LO, the current through Q4336 drops producing a corresponding LO level at its emitter. This level is connected to pins 6 and 7 of U4485 through CR4471.

Transistor Q4336 also controls the levels at pins 6 and 7 for readout displays. The Z-Axis Inhibit from the Readout System is connected to the base of Q4336 through VR4334 and R4335. This level is normally HI, so Q4336 operates as controlled by the Horizontal Chopped Blanking Inhibit level at its collector. When a readout display is to be presented, the Z-Axis Inhibit level drops LO and is coupled to the base of Q4336 through VR4334. Transistor Q4336 is then reverse biased producing a LO level at its emitter. This level is coupled to pins 6 and 7 of U4485 through CR4471 to block the Z-Axis Logic output current during the readout display. (The intensity of the readout display is determined by a separate Readout intensity level connected directly to the Z-Axis Amplifier; see CRT Circuit description.) Diode CR4472 clamps the emitter of Q4336 at about -0.6 volt when the transistor is off.

The A INTENSITY control sets the output current level when the A Gate at pin 14 is HI and the Display B Command connected to pin 15 through Q4488 and Q4492 is LO. The A Intensity current is blocked whenever the A Gate level goes LO indicating that the A sweep is complete or the Display B Command goes HI indicating that the B sweep is being displayed. The current from the A INTENSITY control is connected to pin 16 through R4482.

In the delayed mode, current is added to the A INTENSITY current during the A-sweep time to intensify a portion of the trace. This intensified portion is coincident with the B-sweep time providing an indication of which portion of the A sweep is displayed in the delayed mode. The A Intensified current is supplied to pin 2 of U4485 from the A INTENSITY control through R4481. With this configuration, the intensified current increases as the A INTENSITY control setting is advanced to provide a proportional intensity increase in the intensified zone as the overall A-sweep intensity increases. Therefore, the intensified zone is more readily visible at high intensity levels. A front-panel screwdriver adjustment (B CONTRAST, R2015) allows for optimum contrast between the intensified portion and the overall sweep. The intensified current is added to the A INTENSITY current to produce an intensified zone on the A sweep under the following conditions: HI A Gate level at pin 14, LO Display B Command at pin 15, HI B Gate level at pin 4, and HI Delay Mode Control Out level at pin 5.

The B INTENSITY control determines the output current when the B Gate level at pin 4 and the Display B Command at pin 15 are both HI. The current from the B INTENSITY control is connected to the Z-Axis Logic stage through R4483.

The current level established by the intensity controls can be altered by the Auxiliary Z-Axis current level at pin 9. The current at this pin can come from the Z-AXIS INPUT connector on the rear panel (see diagram 3) or from any of the plug-in compartments. This current either increases or decreases (depending on polarity) the output current to modulate the intensity of the display. Input from the Z-AXIS INPUT connector allows the trace to be modulated by external signals. The Auxiliary Z-Axis inputs from the plug-in compartments allow special-purpose plug-in units to modulate the display intensity. Diodes CR4473 and CR4474 limit the maximum voltage change at pin 9 to about + and -0.6 volt to protect the Z-Axis Logic stage if an excessive voltage is applied to the Z AXIS INPUT connector. Table 3-6 shows Input/Output combinations of the Z-Axis Logic stage.

HORIZONTAL BINARY

The Horizontal Binary stage develops the Display B Command to determine which horizontal plug-in unit provides the sweep displayed on the crt. When the level is HI, the B horizontal unit is displayed; when it is LO, the A horizontal unit is displayed.

The Display B Command is used in the following stages within the Logic circuit: Horizontal Logic (A and B Sweep Inhibit), Z-Axis Logic, Vertical Binary, and Trace Separation. In addition, it is connected to the following circuits elsewhere in the instrument to indicate which horizontal unit is to be displayed: Main Interface (A and B HORIZ plug-in compartments), Horizontal Interface (for horizontal channel selection).

The levels on pins 3, 4, 7, and 10 of U4358 are determined by the HORIZONTAL MODE switch (see diagram 2) which indicates which horizontal mode has been selected by providing a HI output level on only one of four output lines. The remaining lines are LO.

The Horizontal Binary stage operates as follows for each 4 positions of the HORIZONTAL MODE switch (refer to Table 3-7 for input/output conditions):

1. A MODE. By setting the HORIZONTAL MODE switch to A, the Display B Command is LO indicating to all circuits that the A horizontal unit is to be displayed.

2. B MODE. Selecting the B horizontal mode provides a HI Display B Command to all circuits.

3. CHOP MODE. In the CHOP position of the HORIZONTAL MODE switch, the Display B Command switches between the HI and LO levels to produce a display that switches between the A and B horizontal

TABLE 3-6
Input/Output Combinations for the Z-Axis Logic Stage

A INTENSITY 16	B INTENSITY 1	INTENSIFIED 2	A GATE 14	B GATE 4	DELAY MODE CONTROL 5	DISPLAY B COMMAND 15	Z-AXIS SIGNAL 8	SOURCE OF Z-AXIS SIGNAL
VAR	Φ	Φ	HI	Φ	LO	LO	VAR	A INTENSITY
VAR	Φ	Φ	HI	LO	HI	LO	VAR	A INTENSITY
VAR	Φ	VAR	HI	HI	HI	LO	VAR	A INTENSITY PLUS INTENSIFIED
Φ	VAR	Φ	Φ	HI	Φ	HI	VAR	B INTENSITY
OTHER COMBINATIONS							LO	NO OUTPUT

HI = MAX VOLTAGE OR CURRENT
LO = MIN VOLTAGE OR CURRENT
VAR = VARIABLE CURRENT, 0 to 4 mA
Φ = HAS NO EFFECT

TABLE 3-7
Input/Output Combinations of the Horizontal Binary Stage

INPUT						OUTPUT	
HORIZONTAL CHOPPED BLANKING 1	A MODE 3	B MODE 4	B MODE 7	ALTERNATE PULSE 8	CHOP MODE (HORIZ) 10	DISPLAY B COMMAND 6	HORIZONTAL DISPLAY
Φ	HI	LO	LO	Φ	LO	LO	A HORIZONTAL UNIT
Φ	LO	HI	HI	Φ	LO	HI	B HORIZONTAL UNIT
LO[1]	LO	LO	LO	Φ	HI	n+1[2]	CHOP BETWEEN A AND B
Φ	LO	LO	LO	LO[1]	LO	n+1[3]	ALTERNATE BETWEEN A AND B

Φ = Has no effect in this case.
n+1 = If output is LO prior to LO[1], it goes HI, and vice versa.
[1]Actuated by negative-going edge.
[2]Repetition rate one-half horizontal chopped blanking rate.
[3]Repetition rate one-half alternate pulse rate.

units at a 0.2-megahertz rate. The repetition rate of the Display B Command in this mode is determined by the Horizontal Chopped Blanking pulse (see Chop Counter description). Each time the Horizontal Chopped Blanking pulse at pin 1 drops LO, the output at pin 6 switches to the opposite state.

4. ALT MODE. For ALT horizontal operation, the Display B Command switches to the opposite state each time the negative portion of the Alternate Pulse is received from the Horizontal Logic stage. Repetition rate of the Display B Command in this mode is one-half the repetition rate of the Alternate Pulse applied to pin 8.

VERTICAL BINARY

The Vertical Binary stage produces the Vertical Alternate Command, at pin 6 to determine which vertical unit is to be displayed when the VERTICAL MODE switch is set for ALT. When this output level is HI, the RIGHT VERT unit is displayed; when it is LO, the LEFT VERT unit is displayed. In the ALT or CHOP positions of the HORIZONTAL MODE switch (non-delayed operation only), the output of this stage is slaved to the output of the Horizontal Binary stage so that the Vertical Alternate Command is always HI when the Display B Command is LO, and vice versa. This action allows independent-pairs operation (sweep-slaving) in the ALT position of the VERTICAL MODE switch and the ALT or CHOP positions of the HORIZONTAL MODE switch, whereby the LEFT VERT unit is always displayed at the sweep rate of the B time-base and the RIGHT VERT unit is displayed at the sweep rate of the A time-base. Thus, independent-pairs operation can simulate dual-beam operation for repetitive sweeps.

When the A time-base unit is set to the delaying mode, the repetition rate of the Vertical Alternate command is one-half the repetition rate of the Display B Command. This results in each vertical unit being displayed first against the A time-base unit (delaying), then the B time-base unit (delayed), before the display is switched to the other vertical unit.

The Vertical Alternate Command is used in the Plug-In Binary and Vertical Mode Logic stages. The Vertical Binary stage (U4368) uses the same type of IC as the Horizontal Binary stage. Notice the $\overline{\text{display B Command}}$ level at pin 7. This input is the inverse of the Display B Command level at pin 8 (Q4364 generates the $\overline{\text{display B Command}}$ level). Also, notice the line connected to pin 4 of the Vertical Binary IC U4368. The level at pin 4 Horiz Slave Enable is generated by Q4424 and is HI only when the HORIZONTAL MODE switch is set for ALT or CHOP and the time-base units are in nondelayed operation. The Vertical Binary IC uses the information at pin 4 for correct slaving of the Vertical Alternate Command to the Display B Command (necessary for independent-pairs operation). Horizontal Slave Enable is also used by the trigger select logic.

The operation of the Vertical Binary stage in relation to the modes of operation that can occur is described in the following:

1. A OR B MODE. When the HORIZONTAL MODE switch is set to either A or B the Vertical Alternate Command switches to the opposite state each time an Alternate Pulse is received from the Horizontal Logic stage. Repetition rate of the Vertical Alternate Command in this mode is one-half the repetition rate of the Alternate Pulse. The input conditions for these modes are:

Pin 1 LO-Alternate Pulse generated by Horizontal Logic stage goes negative.

Pin 4 Horizontal Slave Enable LO-HORIZONTAL MODE switch in any position except ALT or CHOP, or the A time-base unit is set for delayed sweep.

Pin 10 HI-HORIZONTAL MODE switch set to A or B.

2. ALT OR CHOP MODE (HORIZ): NONDELAYED. In the ALT or CHOP positions of the HORIZONTAL MODE switch, the output level at pin 6 is the same as the $\overline{\text{Display B Command}}$ level at pin 7. The $\overline{\text{Display B Command}}$ level is produced by inverting the Display B Command from the Horizontal Binary stage. Therefore, the repetition rate of the output signal is the same as the Display B Command. With the VERTICAL MODE switch set to ALT and the A time-base unit set for nondelayed operation, the result is that the RIGHT VERT unit is always displayed at the sweep rate of the A time-base unit, and the LEFT VERT unit is always displayed at the sweep rate of the B time-base unit (independent-pairs operation or sweep slaving). The input conditions to provide a HI output level so that the RIGHT VERT unit can be displayed at the A sweep rate are:

Pin 4 Horizontal Slave Enable HI-HORIZONTAL MODE switch set to ALT or CHOP with nondelayed sweep.

Pin 7 HI-The A sweep is to be displayed (Display B Command LO).

Pin 10 LO-HORIZONTAL MODE switch set to any position except A or B.

The input conditions to provide a LO output level so that the LEFT VERT unit can be displayed at the B-sweep rate are:

Pin 4 Horizontal Slave Enable HI-HORIZONTAL MODE switch set to ALT or CHOP with nondelayed sweep.

Pin 7 LO-The B sweep is to be displayed (Display B Command HI).

Pin 10 LO-HORIZONTAL MODE switch set to any position except A or B.

3. ALT OR CHOP MODE (HORIZ): DELAYED. If the A time-base unit is set to the delayed mode when the HORIZONTAL MODE switch is set to either ALT or CHOP, the operation of the stage is changed from that discussed above. Now, the Vertical Alternate Command switches between the HI and LO states at a rate that is one-half the repetition rate of the Display B Command. The resultant crt display in the ALT position of the VERTICAL MODE switch allows the RIGHT VERT unit to be displayed first against the A sweep (delaying) and then against the B sweep (delayed). Then the display switches to the LEFT VERT unit and is displayed consecutively against the A and B sweeps in the same manner. The input conditions for this mode of operation are:

Pin 4 Horizontal Slave Enable LO-The A time-base unit set for delayed operation.

Pin 8 HI or LO-Vertical Alternate Command changes state at HI to LO transition of Display B Command.

Pin 10 LO-HORIZONTAL MODE switch set to any position except A or B.

Table 3-8 shows the input/output combinations for the Vertical Binary stage.

PLUG-IN BINARY

The Plug-In Binary stage produces the Plug-in Alternate Command to alternate dual-trace units. The Plug-In Binary stage, U4412 uses the same type of integrated circuit as the Horizontal Binary and Vertical Binary stages.

When the Plug-In Alternate Command level is HI and the plug-in unit is set for alternate operation, Channel 2 of the dual-trace unit is displayed. When it is LO, Channel 1 is displayed. The repetition rate of the Plug-In Alternate Command is determined by the setting of the VERTICAL MODE switch. For all positions of the VERTICAL MODE switch except ALT, the Plug-In Alternate Command is the same as the Vertical Alternate Command at pin 6 of U4368 (Vertical Binary stage). Since Vertical Alternate Command is derived directly from the Display B Command, this allows the two channels of a dual-trace vertical unit to be slaved to the time-base units (non-delayed, dual-sweep horizontal modes only) in the same manner as previously described for independent-pairs operation between the vertical and time-base units. The resultant crt presentation, when the dual-trace unit is set for alternate operation, displays the Channel 1 trace at the sweep rate of the B time-base unit and the Channel 2 trace at the sweep rate of the A time-base unit.

The Plug-In Alternate Command switches from HI to LO as the Display B Command from the Horizontal Binary stage switches from LO to HI, and vice versa.

When the VERTICAL MODE switch is set to ALT, pin 6 of the Vertical Binary stage switches the vertical display between the two vertical units. However, if either of the vertical plug-in units are dual-trace units, they can be operated in the alternate mode also. To provide a switching command to these units, the Plug-In Binary stage produces an output signal with a repetition rate that is one-half the repetition rate of the signal at pin 6 of U4368. The sequence of operation, when two dual-trace vertical units are installed in the vertical plug-in compartments and they are both set for alternate operation, is as follows (VERTICAL MODE and HORIZONTAL MODE switches set to ALT): 1. Channel 1 of LEFT VERT unit at sweep rate of B time-base unit; 2. Channel 1 of RIGHT VERT unit at sweep rate of A time-base unit; 3. Channel 2 of LEFT VERT unit at sweep rate of B time-base unit; 4. Channel 2 of RIGHT VERT unit at sweep rate of A time-base unit. Notice that under these conditions, both channels of the LEFT VERT unit are displayed at the B-sweep rate and that both channels of the RIGHT VERT unit are displayed at the A-sweep rate. Input conditions when the VERTICAL MODE switch is set at ALT are:

Pin 4 LO-VERTICAL MODE switch set to ALT.

TABLE 3-8
Input/Output Combinations for the Vertical Binary Stage

INPUT					OUTPUT	
ALTERNATE PULSE	HORIZ SLAVE ENABLE	$\overline{\text{DISPLAY B}}$ COMMAND	DISPLAY B COMMAND	A OR B MODE	VERTICAL ALTERNATE COMMAND	
1	4	7	8	10	6	HORIZONTAL MODE SWITCH
LO[1]	LO	Φ	Φ	HI	n+1[2]	A OR B
Φ	HI	HI	LO	LO	HI	DISPLAY RIGHT } ALT OR CHOP, NON-DELAYED MODE (SWEEP-SLAVING)
Φ	HI	LO	HI	LO	LO	DISPLAY LEFT } ALT OR CHOP, NON-DELAYED MODE (SWEEP-SLAVING)
Φ	LO	Φ	LO[1]	LO	n+1[3]	ALT OR CHOP, DELAYED MODE

Φ = Has no effect in this case.

n+1 = If output is LO prior to LO[1] it goes HI, and vice versa.

[1]Actuated by negative-going edge.

[2]Repetition rate one-half alternate pulse rate.

[3]Repetition rate one-half display B rate.

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Pin 8 HI or LO-Plug-In Alternate Command signal changes state at HI to LO transition of the Vertical Alternate Command signal.

Table 3-9 gives the input/output combinations for the Plug-In Binary stage.

VERTICAL CHOPPED BLANKING

Part of integrated circuit U4320 along with the external components shown in Figure 3-3 make up the clock generator stage. Component parts R1, Q1, Q2, and Q3 represent an equivalent circuit within U4320. This circuit along with discrete components C4314-R4312-R4313-R4314 compose a two-megahertz free-running oscillator to provide a timing (clock) signal used to synchronize the vertical, horizontal, and plug-in chopping modes.

This stage operates as follows: Assume that Q2 is conducting and Q1 is off. The collector current of Q2 produces a voltage drop across R1 to turn off Q1. This negative level at the collector of Q2 is also connected to pin 14 through Q3 (see waveforms in Fig. 3-3B at time T_0). Since there is no current through Q1, C4314 begins to charge towards -15 volts through R4312-R4313. The emitter of Q1 goes negative as C4314 charges, until it reaches a level about 0.6 volts more negative than the level at its base. Then Q1 is forward biased and its emitter rapidly rises positive (see Time T_1 on waveforms). Since C4314 cannot change its charge instantaneously, the sudden change in voltage at the emitter of Q1 pulls the emitter of Q2 positive. With Q2 reverse biased, its collector rises positive to produce a positive output level at pin 14.

Now, conditions are reversed. Since Q2 is reverse biased, there is no current through it. Therefore, C4314 can begin to discharge through R4314. The emitter level of Q2 follows the discharge of C4314, until it reaches a level of 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, C4314 begins to charge through R4312-R4313 to start the second cycle. Two outputs are provided from this oscillator. The Delay Ramp signal from the junction of R4312-R4313 is connected to the Vertical Chopped Blanking stage. This signal has the same waveshape as shown by the waveform at pin 13; its slope is determined by the divider ratio between R4312-R4313. A wide pulse train output is provided at pin 14. The frequency of this pulse train is determined by the overall RC relationship between C4314-R4312-R4313-R4314 and its duty cycle is determined by the ratio of R4312 and R4313 to R4314.

The pulse train at pin 14 is connected to pin 16 through C4315. Capacitor C4315, along with the internal resistance of U4320, differentiates the pulse train at pin 14 to produce a narrow negative-going pulse coincident with the falling edge of the pulse train (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 circuit that is also part of U4320. The output at pin 15 is a positive-going clock pulse with a repetition rate of about two megahertz.

The Vertical Chopped Blanking stage is made up of the remainder of U4320. This stage determines if Vertical Chopped Blanking pulses are required, based upon the

TABLE 3-9
Input/Output Combinations for the Plug-In Binary Stage

INPUT			OUTPUT		
ALT MODE INHIBIT (VERT)	VERTICAL ALTERNATE COMMAND	VERTICAL ALTERNATE COMMAND	PLUG-IN ALTERNATE COMMAND		
4	7	8	6	COMMENTS	
LO	Φ	LO[1]	n+1[2]	ALT VERTICAL MODE	
HI	LO	Φ	LO	CHANNEL 1 DISPLAYED	ALL VERTICAL MODES EXCEPT ALT PROVIDE SWEEP-SLAVING FOR NON-DELAYED DUAL-SWEEP OPERATION.
HI	HI	Φ	HI	CHANNEL 2 DISPLAYED	

Φ = Has no effect in this case.

n+1 = If output is LO prior to LO[1] it goes HI, and vice versa.

[1]Actuated by negative-going edge.

[2]Repetition rate one-half Vertical Alternate Command rate.

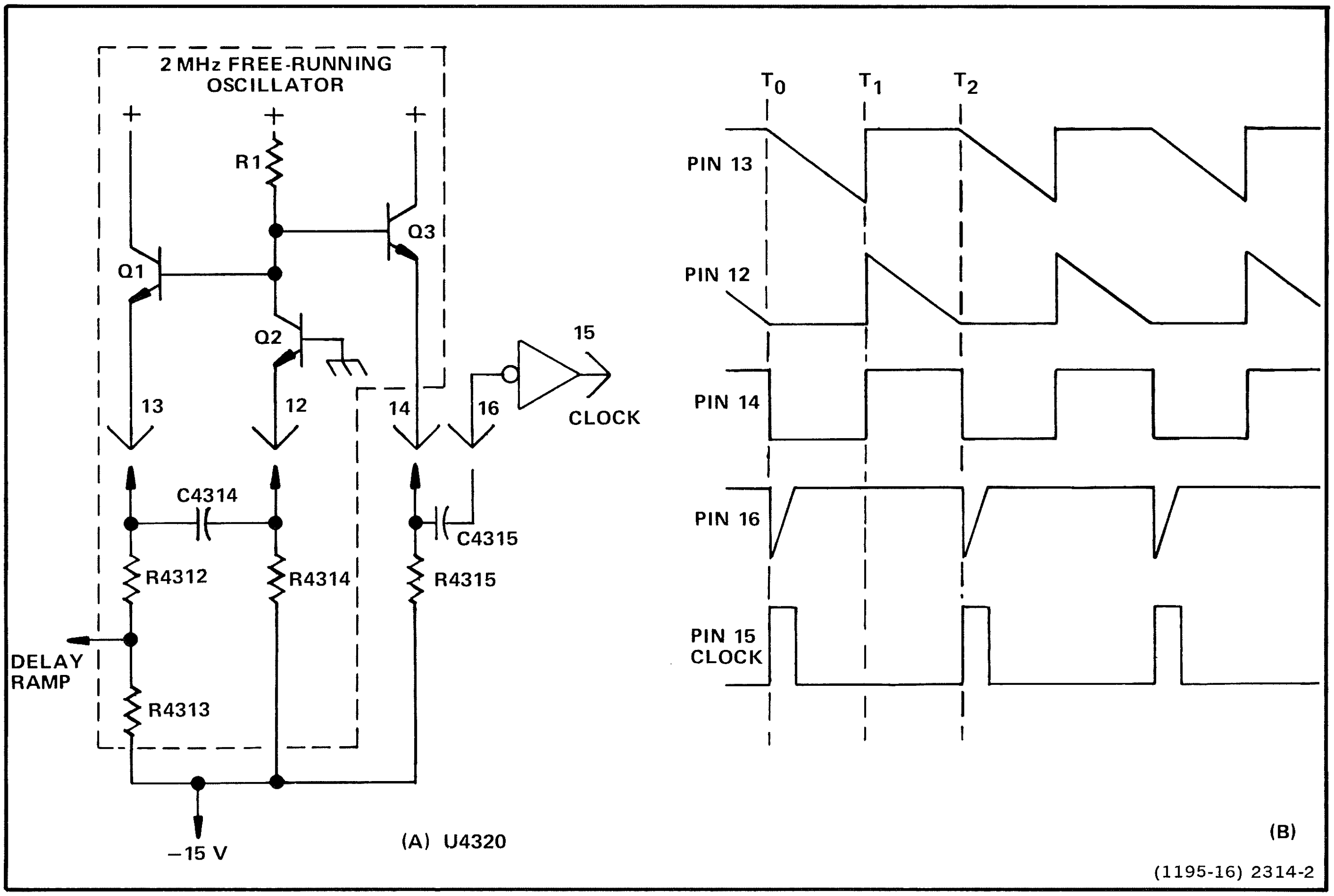

Figure 3-3. (A) Diagram of clock generator stage; (B) Idealized waveforms for clock generator stage.

operating mode of the vertical system or the plug-in units (dual-trace units only). Vertical Chopped Blanking pulses are produced if: 1. VERTICAL MODE switch is set to CHOP; 2. Dual-trace vertical unit is operating in the chopped mode and that unit is being displayed. The repetition rate of the negative-going Vertical Chopped Blanking pulse output at pin 4 is two megahertz for all of the above conditions as determined by the clock generator stage. Table 3-10 shows the input/output combinations for the Vertical Chopped Blanking 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 from pin 13 (U4320) 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. 3-4). 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 and remains LO until the delay ramp goes HI again.

Notice the delay between the leading edge of the clock pulse generated by U4320, and the leading edge of the Vertical Chopped Blanking pulses. The amount of delay between the leading edges of these pulses is determined by 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 wide pulse train produced in the clock generator stage determines the pulse width of the Vertical Chopped Blanking pulses.

CHOP COUNTER

The Chop Counter stage U4340 produces the Vertical Chopped signal, the Plug-In Chop Command, and the Horizontal Chopped Blanking signal. The clock pulse produced by the clock generator stage provides the timing signal for this stage. The functions of the input and output pins for the Chop Counter IC, U4340, are identified in Figure 3-5A. Idealized waveforms showing the timing relationship between the input and output signals for this stage are shown in Figure 3-5B.

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TABLE 3-10
Input/Output Combinations for the Vertical Chopped Blanking Stage

INPUT						OUTPUT	
CHOP MODE (VERT)	LEFT PLUG-IN MODE (CHOP INHIBIT)	DISPLAY RIGHT COMMAND	ADD MODE (VERT)	RIGHT PLUG-IN MODE (CHOP INHIBIT)	DELAY RAMP	VERTICAL CHOPPED BLANKING	
3	5	6	7	8	10[1]	4[2]	CONDITIONS
HI	Φ	Φ	LO	Φ	LO	LO	CHOP MODE (VERT)
LO	LO	LO	LO	Φ	LO	LO	LEFT PLUG-IN CHOPPED
LO	Φ	HI	LO	LO	LO	LO	RIGHT PLUG-IN CHOPPED
LO	LO[3]	LO	HI	LO[3]	LO	LO	ADD MODE, LEFT OR RIGHT PLUG-IN CHOPPED
ALL OTHER COMBINATIONS						HI	NO VERTICAL CHOPPED BLANKING PULSES AT OUTPUT

Φ = Has no effect in this case.

[1]Ramp signal; considered LO when more negative than about zero volts.

[2]Negative-going pulse at two megahertz rate.

[3]Pin 5 can be HI and not affect operation if pin 8 is LO, and vice versa.

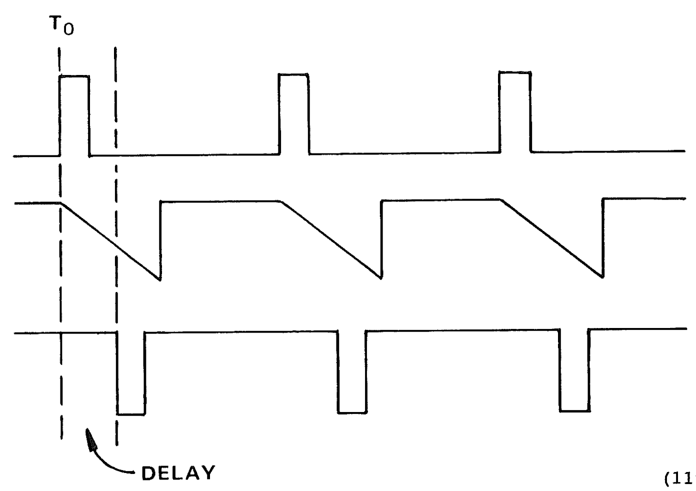

Figure 3-4. Idealized waveforms for the Vertical Chopped Blanking IC (U4320).

The repetition rate of the output signals from this stage is determined by the setting of the HORIZONTAL MODE switch. When the HORIZONTAL MODE switch is set to any position except CHOP, the repetition rate of the Vertical Chopping Signal output at pin 1 is one megahertz (one-half clock rate). This determines the switching between the LEFT and RIGHT VERT units when the VERTICAL MODE switch is set to CHOP. At the same time, the repetition rate of the Plug-In Chop Command at pin 8 is 0.5 megahertz (one-fourth clock rate). This provides a chopping signal to dual-trace vertical units to provide switching between the two channels. The relationship between these output signals and the clock input is shown by the waveforms in Figure 3-5B in the area between T_0 and T_1. During this time, the Horizontal Chopped Blanking at pin 4 remains HI.

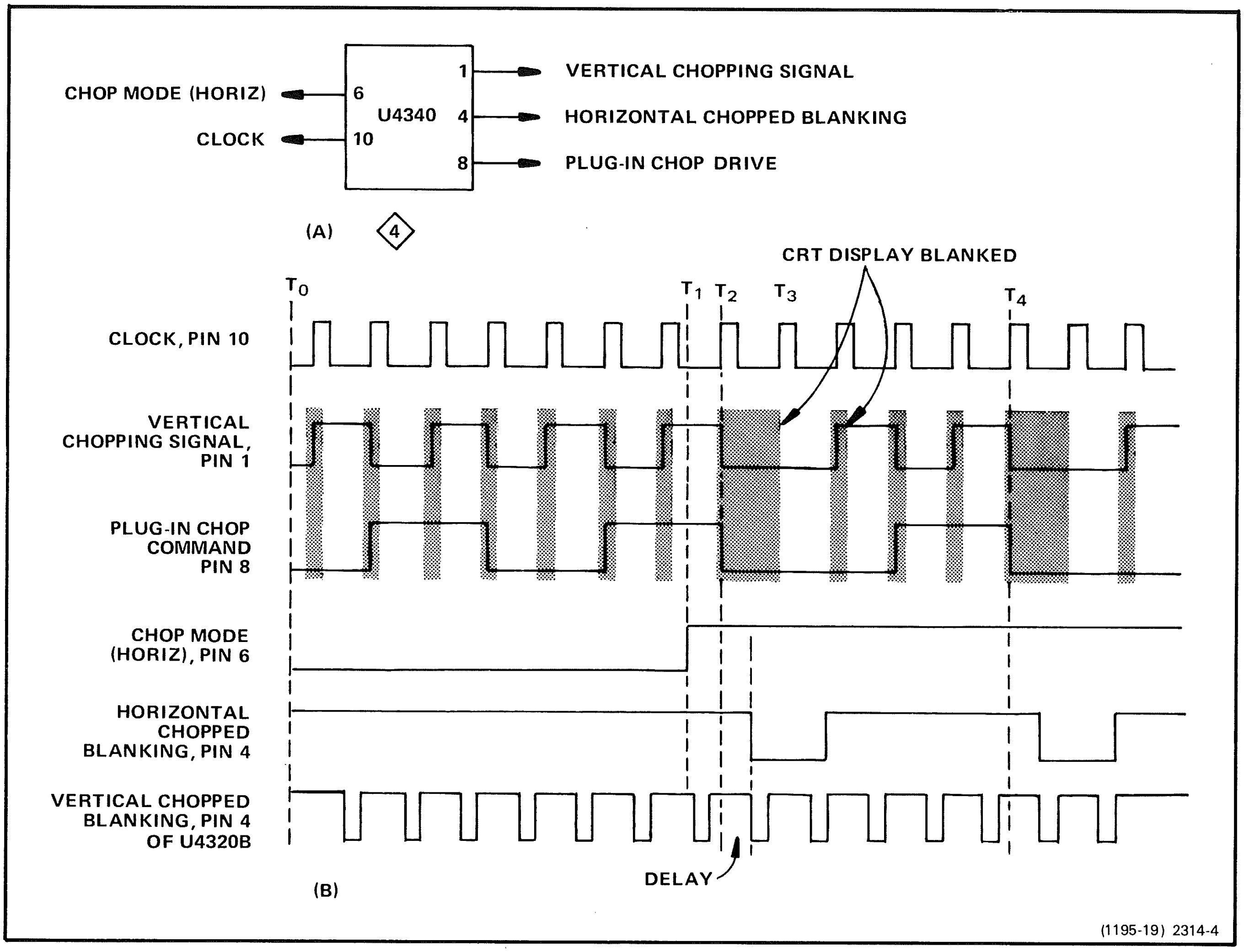

Figure 3-5. (A) Input and output pins for Chop Counter IC, U4340; (B) Idealized waveforms for Chop Counter stage.

When the HORIZONTAL MODE switch is set to CHOP, the basic repetition rate of the Vertical Chopping Signal and the Plug-In Chop Command is altered. For example, if the HORIZONTAL MODE switch is changed to the CHOP position at time T_1 (see Fig. 3-5B), a HI level is applied to pin 6. This stage continues to produce outputs at pins 1 and 8 in the normal manner until both outputs are at their HI level. (See time T_2; this condition only occurs once every fifth clock pulse and only when the HORIZONTAL MODE switch is set to CHOP.) When both of these outputs are at their HI level, the next clock pulse switches both outputs LO, and at the same time switches the Horizontal Chopped Blanking to the LO level.

This change at time T_2 does not appear at pin 4 immediately, due to a delay network in the circuit. The delay is necessary to make the Horizontal Chopped Blanking coincide with the Vertical Chopped Blanking produced by U4320 and the switching between the displayed signals. (Compare bottom two waveforms of Fig. 3-5B; also see Vertical Chopped Blanking for further information.) After the delay time, the output level at pin 4 goes LO where it remains for about 0.5 microsecond which is equal to the period of the clock pulse (two-megahertz repetition rate).

The Horizontal Chopped Blanking time must be longer than the Vertical Chopped Blanking time, since it takes more time for the display to switch between horizontal units than between vertical units. During the time that the level at pin 4 is LO, the crt is blanked and the Vertical Chopping Signal and the Plug-In Chop Command cannot change levels. The clock pulse at T_3 changes only the Horizontal Chopped Blanking output at pin 4. The level on this pin goes HI after the delay time to unblank the crt.

For the next three clock pulses, the Vertical Chopping Signal output and Plug-In Chop Command operate in the normal manner. However, just prior to the fourth clock pulse (time T_4), both outputs are again at their HI level. The fourth clock pulse at T_4 switches the output at pin 1, pin 8, and pin 4 (after delay) to the LO level to start the next cycle. Notice that a Horizontal Chopped Blanking

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pulse is produced at pin 4 with every fifth clock pulse. Also notice that with the HORIZONTAL MODE switch set to CHOP, two complete cycles of the Vertical Chopping Signal are produced with each five clock pulses (repetition rate two-fifths clock rate) and one complete cycle of the Plug-In Chop Command for every five clock pulses (one-fifth clock rate). Notice that the large shaded area produced by the Horizontal Chopped Blanking pulse (see Fig. 3-5) is not part of the display time (crt display blanked). However, about the same time segment is displayed from the vertical signal source with or without Horizontal Chopped Blanking, due to the change in repetition rate when in the CHOP horizontal mode.

The Vertical Chopping Signal at pin 1 of U4340 is connected to the Vertical Mode Logic stage (see following description) through LR4342. This signal is HI when the RIGHT VERT unit is to be displayed and it is LO when the LEFT VERT unit is to be displayed. The Plug-In Chop Command at pin 8 is connected to the plug-in units in the vertical compartments through LR4344, via the Main Interface board. When this signal is HI, Channel 2 of the plug-in units can be displayed; when this level is LO, Channel 1 can be displayed. The Horizontal Chopped Blanking signal at pin 4 is connected through LR4338 to the Horizontal Binary stage U4358, and to the Z-Axis Logic stage U4485 by way of Q4336. When this signal is HI, the crt is unblanked to display the selected signal. When it is LO, the crt is blanked to allow switching between the horizontal units.

VERTICAL MODE LOGIC

The Vertical Mode Logic stage is made up of discrete components CR4323-CR4322, CR4369-CR4368 and buffer Q4382-Q4392. These components develop the Display Right Command, which is connected to the Main Interface, Vertical Interface, and Trigger Selector circuits to indicate which vertical unit is to be displayed. When this output level is HI, the RIGHT VERT unit is displayed; when it is LO, the LEFT VERT unit is displayed.

The VERTICAL MODE switch shown on diagram 2 provides control levels to this stage. This switch provides a HI level on only one of five output lines to indicate the selected vertical mode; the remaining lines are LO. Notice that only four of the lines from the VERTICAL MODE switch are connected to the Logic circuit. Operation of this stage is as follows: When the VERTICAL MODE switch is set to RIGHT, a HI level is connected to the base of Q4382 through R4321. This forward biases Q4382, and the positive-going level at its emitter is connected to the emitter of Q4392. The collector of Q4392 goes HI to indicate that the RIGHT VERT unit is to be displayed. For the CHOP position of the VERTICAL MODE switch, a HI level is applied to the anodes of CR4323-CR4322 through R4322. Both diodes are forward biased so that the Vertical Chopping Signal from pin 1 of U4340 can pass to the base of Q4382. This signal switches between the HI and LO levels at a one-megahertz rate and produces a corresponding Display Right Command output at the collector of Q4392. When the Display Right Command is HI, the RIGHT VERT unit is displayed and when it switches to LO, the LEFT VERT unit is displayed.

In the ALT position of the VERTICAL MODE switch, a HI level is applied to the anodes of CR4369-CR4368 through R4369. These diodes are forward biased so the Vertical Alternate Command from pin 6 of the Vertical Binary stage can pass to the base of Q4382 to determine the Vertical Mode Command level. The Vertical Alternate Command switches between its HI and LO levels at a rate determined by the Vertical Binary stage.

The control levels in the LEFT and ADD positions of the VERTICAL MODE switch are not connected to this stage. However, since only the line corresponding to the selected vertical mode can be HI, the RIGHT, CHOP, and ALT lines must remain at their LO level when either LEFT or ADD is selected. Therefore, the base of Q4382 remains LO to produce a LO Display Right Command signal output level at the collector of Q4392.

A logic diagram of the Vertical Mode Logic stage is shown in Figure 3-6. The discrete components that make up each logic function are identified.

TRACE SEPARATION

The Trace Separation stage is made up of discrete components Q4438, Q4442, Q4448, and Q4456. This stage produces the Trace Separation output to the AUX Y-Axis Input of the Vertical Amplifier circuit to offset the B-sweep display when operated in a dual-sweep mode (horizontal). The level of this output current is determined by the setting of the VERT TRACE SEPARATION (B) control. The current from the VERT TRACE SEPARATION (B) control is switched so that the Trace Separation output is provided only when the B sweep is being displayed in the ALT or CHOP horizontal modes and not when the B sweep only is being displayed, nor for independent-pairs operation (sweep-slaving).

The VERT TRACE SEPARATION (B) control provides current to the Trace Separation output through R4456 and Q4456 when Q4456 is forward biased. When the B sweep is being displayed (for ALT or CHOP horizontal operation), the Display B Command at the base of Q4442 is HI. This forward biases Q4442 causing its collector to go negative to forward bias Q4448. This causes Q4448 to saturate and its collector goes positive to forward bias Q4456. During the time the A sweep is being displayed, the Display B Command is LO. This reverse biases Q4442 and Q4448; Q4456 is reverse biased and the VERT TRACE SEPARATION (B) control is disconnected while the A-sweep is being displayed.

When the HORIZONTAL MODE switch is set to B (only), a HI level is connected to the emitter of Q4442 through R4431. This reverse biases Q4442 even though the Display B Command at its base is HI for this mode. Therefore, the VERT TRACE SEPARATION (B) control has no effect. When the VERTICAL MODE switch is set to ALT and the Delay Mode Control level from the A time-base unit is LO (indicating nondelayed sweep operation), a HI level is applied to the emitter of Q4442 through R4438 and CR4434. This HI level reverse biases Q4442 even though the Display B Command is HI. This action disconnects the VERT TRACE SEPARATION (B) control

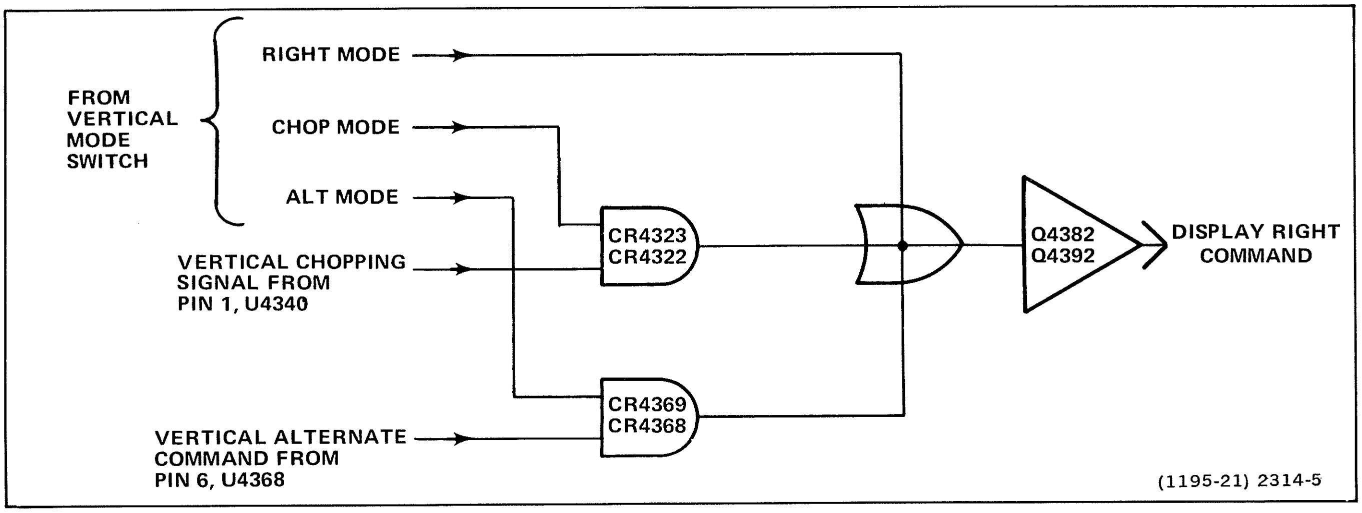


Figure 3-6. Logic diagram of Vertical Mode Logic stage.

for independent-pairs operation so that the vertical position of the B-sweep display is determined by the slaved LEFT VERT plug-in unit only. If delayed-sweep operation is selected, the Delay Mode Control Out level is HI to forward bias Q4438 and Q4443. This allows the VERT TRACE SEPARATION (B) control to position the B-sweep display, since independent-pairs operation is not possible when operating in a delayed-sweep mode.

A logic diagram of the Trace Separation stage is shown in Figure 3-7A. The discrete components which make up each logic function are identified. An input/output table for this stage is given in Figure 3-7B.

MCP (MICROCHANNEL PLATE) INTENSITY TRACKING

The MCP output voltage increases as the A or B INTENSITY controls are rotated past midrange. Tracking is provided by circuitry within U4508. The signal at the collector of Q4494 determines whether A or B INTENSITY control is tracked, if this signal is HI (Q4494 off) the voltage on the bases of transistors A and D of U4508 is -4.3 volts. This voltage is more positive than the voltage on the bases of B and C. Transistors A and D of U4508 are turned on, while transistors C and B of U4508 are turned off. The voltage at pins AS and AR varies from 0 to -10 volts, depending on the setting of the A and B INTENSITY controls. At maximum intensity the voltage is -10 volts. At midrange (-5 volts on pins AS and AR) emitter current stars flowing in transistors D and A of U4508. Current derived from the B INTENSITY control is diverted to ground by transistor A, and current derived from the A INTENSITY control flows through transistor D into the intensity sense line.

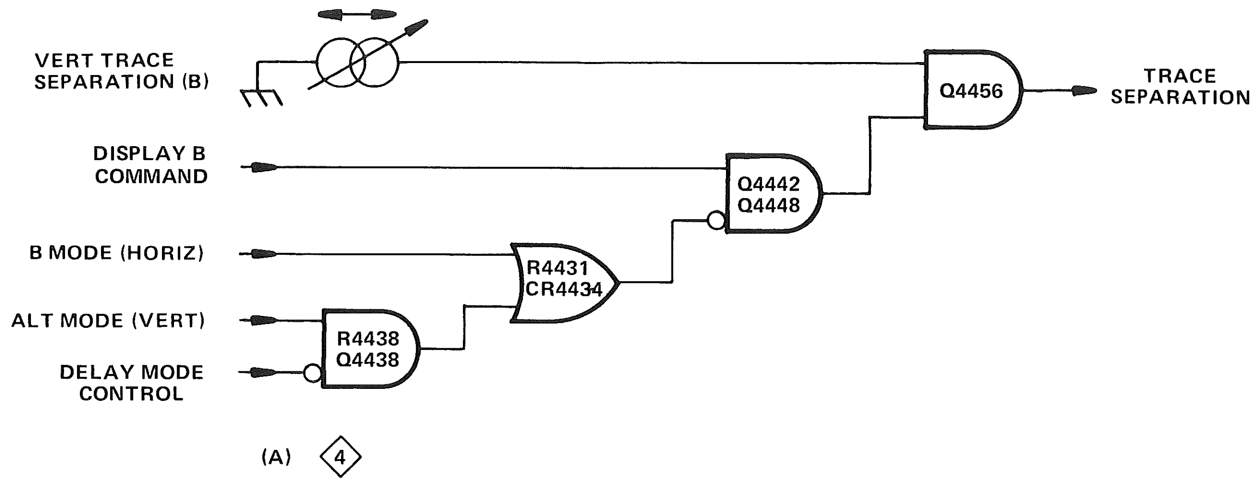
With A INTENSITY control set to midrange, current begins to flow in the Intensity Sense line. The current increases to 50 microamperes when the A INTENSITY control is at maximum. On the High Voltage board (diagram 3) the Intensity Sense line is connected to a current summing node (pin 2 of U1714A) where the MCP output voltage increases in proportion to the Intensity Sense current; this causes a maximum voltage increase of 375 volts.

If the signal at the collector of Q4494 is LO the voltage at the bases of transistors B and C (U4508) is -4.3 volt. This voltage is more positive than the base voltage of transistors D and A of U4508. Now, transistors B and C of U4508 are turned on and the Intensity Sense current is derived from the B INTENSITY control.

The signal at the collector of Q4494 is LO when the HORIZONTAL MODE switch is in ALT, CHOP, or B. Therefore, B INTENSITY control provides the MCP output voltage tracking when the HORIZONTAL MODE switch is in ALT, CHOP, or B. The A INTENSITY control provides the tracking voltage when the HORIZONTAL MODE switch is set to A.

TIME-BASE CONTROLLED Z-AXIS FOR X-Y DISPLAYS

X-Y displays can only be obtained in conjunction with a time-base unit. When an amplifier unit is installed in the A (B) HORIZ compartment, the Z-Axis is controlled by the time-base unit in the B (A) HORIZ compartment, independent of the setting of the HORIZONTAL MODE switch. The B (A) indicator lamp automatically turns on; the selection of the horizontal mode by the HORIZONTAL MODE switch is not affected. X-Y displays often consist of a display where a fast switching transient occurs between two stable states. The switching may be such that the display is predominantly in these two stable states. If the Z-Axis was not duty cycled, but turned on permanently this would result in a display with two bright spots and a barely or not at all visible transient,



(B)

INPUT				OUTPUT
DISPLAY B COMMAND	B MODE (HORIZ)	ALT MODE (VERT)	DELAY MODE CONTROL OUT	TRACE SEPARATION (B)
HI	LO	HI	HI	YES
HI	LO	LO	Φ	YES
ALL OTHER COMBINATIONS				NO OUTPUT

Φ = HAS NO EFFECT IN THIS CASE

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Figure 3-7. (A) Logic diagram of Trace Separation stage; (B) Table of input/output combinations.

since the average screen current associated with these bright spots can be large enough to enable the intensity limiter.

By triggering the time-base unit with the Y-Axis signal, the duty cycle of the Z-Axis can be controlled with the time-base unit time/division control. With the HORIZONTAL MODE switch set to ALT an X-Y display alternating with a Y-T display is obtained. The Z-Axis for both displays is on only during the time that is displayed in the Y-T display. This is a visible aid for optimum control of the Z-Axis duty cycle of X-Y displays. For certain applications of X-Y display, it may be desirable that control of the Z-Axis is determined by the selection of the HORIZONTAL MODE switch. A slide switch located on the Logic board selects how the Z-Axis is controlled during X-Y displays. Normally the switch should be in the IN position such that for X-Y displays the Z-Axis is controlled by a time-base unit.

Without a vertical plug-in unit in a horizontal compartment; diodes CR4487 and CR4495 do not conduct. Q4488 acts as an emitter follower. Resistors R4486 and R4487 perform a dc level shift approximately equal to the emitter-base drop of Q4488. Q4492 is turned off, so the voltage at the collector of Q4492 is a duplicate of the Display B Command. If diode CR4487 is connected to ground by an amplifier unit in the B HORIZ compartment the Display B Command is not applied to the base of Q4488 and the signal at the collector of Q4492 is LO. In this condition the Z-Axis logic IC selects the A INTENSITY input only, independent of other control inputs. If diode CR4495 is connected to ground by an amplifier unit installed in the A HORIZ compartment, Q4492 is saturated. The emitter of Q4488 is held at a HI level, so even when the Display B Command is HI, Q4488 does not conduct. The Z-Axis logic IC selects the B Intensity input when the signal at the collector of Q4492 is HI, regardless of other control inputs.

Transistors Q4494 and Q4498 drive the A and B INTENSITY indicator lights. With an amplifier unit installed in either A or B HORIZ compartments diode CR4496 or CR4493 conducts. This prevents Q4494 and Q4498 from turning on when the HORIZONTAL MODE switch is set to ALT or CHOP.

With an amplifier unit installed in the A HORIZ compartment the signal at the collector of Q4492 is HI, to turn on Q4494 and the B INTENSITY indicator lamp. This indicates that the Z-Axis is controlled by the time-base unit installed in the B HORIZ compartment. The signal at the collector of Q4492A is LO when an amplifier is installed in the B HORIZ compartment. Now, Q4498 is saturated. Base current flows from the +5 V lamp supply, through the B indicator lamp and the resistor R4493 to the base of Q4498. This base current is not sufficient to light the B INTENSITY indicator lamp, so the A INTENSITY indicator lamp is turned on. This indicates that the Z-Axis is controlled by the time-base unit in the A HORIZ compartment.

When time-base units are installed in both A and B horizontal compartments, Q4494 and Q4498 are saturated (with the HORIZONTAL MODE switch in ALT or CHOP). Base current is provided from the +5 V supply on the Mode Switch board, through either the ALT or CHOP switch contacts, and through resistors R4493 and R4496 to the bases of Q4494 and Q4498. Both A and B INTENSITY indicator lights are on.

When the HORIZONTAL MODE switch is set to A or B, the voltage at the collector of Q4492 (which is derived from the Display B Command signal) controls the A and B INTENSITY lights as was previously described.

5

TRIGGER SELECTOR

The Trigger Selector circuit determines the source of the internal triggering signals connected to the A and B horizontal compartments. A schematic diagram of the Trigger Selector is given on diagram 5, in section 8 of this manual (Diagrams and Circuit Board Illustrations). The schematic is divided by gray shaded lines separating the circuitry into major stages. These stages aid in locating components mentioned here. Sub-headings in the following discussion use these stage names to further identify portions of the circuitry on diagram 5.

A AND B TRIGGER CHANNEL SWITCHES

The operation of the A and B Trigger Channel Switch stages is similar. Therefore, only a discussion of the A Trigger Channel Switch is given.

Amplifier units installed in the vertical compartments provide a differential trigger signal to the mainframe. These signals are terminated into 50 ohm power dividers. The 50-ohm strip transmission lines carry half of the input signal from the power dividers to the A and B Trigger Selector circuits. The inputs of the channel switches, U232 and U432, have a 50 ohm input impedance and terminate the transmission lines.

A Trigger Channel Switch

Channel switch U232 has two differential inputs and one differential output. Control voltages at pins 1, 2, 11 and 12 determine whether the input signals are terminated within the channel switch or are coupled through to the output. Active components U252A and Q254 keep the output dc common-mode voltage on pin 3 and pin 13 at +3.2 volts for all modes of the channel switch, U232. The dc common-mode voltage is sensed by resistors R237 and R247 and is compared with a +3.2 volt reference set by divider R251 and R252. If resistors R237 and R247 sense a voltage higher than +3.2 volts, the output of U252A goes negative lowering the base voltage on Q254. This reduces the current into pin 13A which causes the dc common-mode voltage at pin 3 and 13 to decrease. The voltage at pin 13A depends on the channel switch mode. When the VERTICAL MODE switch is set to LEFT, RIGHT or ALT the voltage on pin 13A is +3.8 volts. When the VERTICAL MODE switch is set to ADD the voltage on pin 13A is +4.6 volts.

Each channel within U232 has an independent pair of control pins for channel selection. If the "On" pin is more positive than the "Off" pin, that channel is selected. All of the "On" pins are held at +2.0 volts, the "Off" pins are either at +2.5 volts or at a T^2L LO level. The A Trigger Channel Switch has four operating modes: Left, Right, Alt, and Add; in the Left and Right modes the $\overline{\text{Add}}$ logic level is HI (on pin CF) and the Right logic level (on pin CG) is LO for Left and is HI for Right. In the ALT mode, $\overline{\text{Add}}$ is HI and Right alternates between LO and HI. In the ADD mode both $\overline{\text{Add}}$ and Right are LO. (See the discussion on Mode Switching, diagram 2 in this section of the manual).

Zener diodes VR237 and VR247 shift the dc level downward by 9 volts, to set the output of U274 near ground. Diodes VR237 and VR247 are matched for voltage to within 100 mV.

A and B TRIGGER AMPLIFIER

The operation of the A and B Trigger Amplifiers is similar. Therefore, only a discussion of the A Trigger Amplifier is given. Integrated circuit U274 provides final amplification of the trigger signal. Components R261 and R272 are bias resistors for U274. Zener diodes VR237 and VR247 have a 5% voltage tolerance, therefore the dc voltage level at pins 7 and 9 of U274 is -5.8 volts within 0.45 volt. The dc common-mode voltage, with its 0.45 volt uncertainty, is picked off at pin 5 and pin 12 of U274 and applied to the noninverting input of U252B. The output of U252B is 1.2 volts more positive than the input and is used for internal biasing at pin 15 of U274. Resistor R274 determines the gain of U274. The overall voltage gain of the A trigger selector (from the input connectors J202, J203 and J402, J403 to the output J270, J271 into a load of 50 ohm per side) is one. The dc output level of U274 is zero volts, R235 sets the dc Centering and R279 adjust the DC Common Mode voltage.

Thermal compensation for U232 and U274 is provided by four time constants R240 and C240, C237, R250 and C250, R270, and C270.

The operation of the B trigger selector is similar, except for the signal pickoff of pin 2 and pin 4 of U474 which is used to generate the Vertical Signal Out.

VERTICAL SIGNAL OUTPUT AMPLIFIER

A differential signal is picked off at pin 2 and pin 4 of U474 and is amplified by U492. Before the signal reaches the input of U492 it passes through a compensation circuit consisting of C483, R483, R486, L486, R496, C492 and R493. The characteristic impedance of this circuit is 100 ohms differentially and terminates the 50-ohm strip transmission lines running from the pickoff points, at pin 2 and pin 4 of U474. At pin 2 and pin 4 there is an uncertainty in the dc common-mode level due to the 5% voltage tolerance of zener diodes VR437 and VR447. Integrated circuit U452B passes on this uncertainty for biasing U492. The output signal at J496 is centered at 0 volt by R485. The Vertical Signal Out amplitude is 25 millivolts/division of vertical deflection into a load of 50 ohms, and 0.5 volt/division of vertical deflection into a 1 megohm load. Two time constants R480 and L480, R490 and C490 provide for thermal compensation.

6

READOUT SYSTEM
SN B053266 & Below

A schematic diagram of the Readout System is given on diagram 6, in section 8 of this manual (Diagrams and Circuit Board Illustrations). This schematic is divided by gray shaded lines separating the circuitry into major stages. These stages aid in locating components mentioned here. Stage name headings in the following discussion are used to further identify portions of the circuitry on diagram 6.

The Readout System provides an alpha-numeric display of information encoded by the plug-in units. This display is presented on the crt and is written by the crt beam on a time-shared basis with the analog waveform display.

The following terms are used to describe the Readout System:

Character—A single number, letter or symbol displayed on the crt, either alone or in combination with other characters.

Word—A group of related characters. In the Readout System, a word can consist of up to 10 characters.

Frame—A display of all words for a given operating mode and plug-in combination. Up to 8 words can be displayed in one frame. Figure 3-8 shows the position of each word in a complete frame.

Column—One of the vertical lines in the Character Selection Matrix (see Fig. 3-9). Columns C-0 (column zero) through C-10 (column 10) can be addressed by the system.

Row—One of the horizontal lines in the Character Selection matrix. Rows R-1 (row 1) through R-10 (row 10) and R-14 (row 14) can be addressed by the system.

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

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

DISPLAY FORMAT

Up to 8 words of readout information can be displayed on the crt. The position of each word is fixed and is directly related to the plug-in unit from which it originated. Figure 3-8 shows the area of the graticule where the readout from each plug-in unit is displayed. Notice that Channel 1 of each plug-in unit is displayed within the top division of the crt and Channel 2 is displayed directly

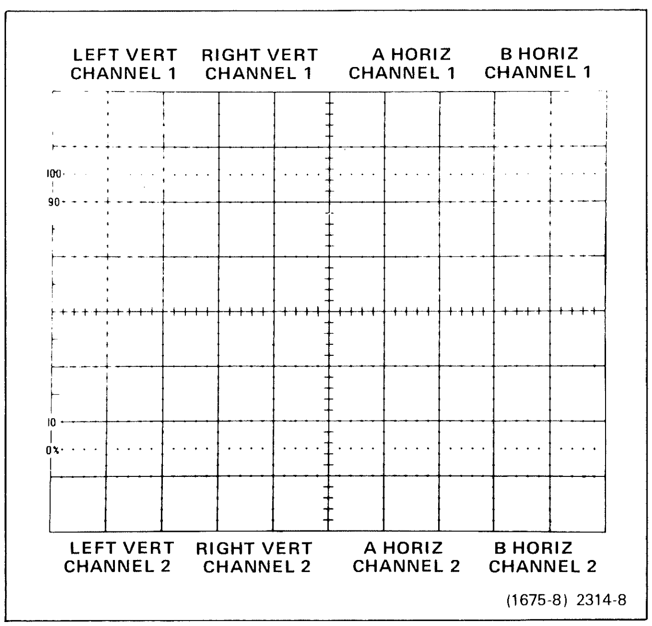


Figure 3-8. Location of readout display on the crt identifying the originating plug-in and channel.

ROW NUMBER ↓ / COLUMN NUMBER →		C-0	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10
ROW NUMBER	CURRENT (MILLI-AMPERES)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	⩾ 1.0
R-1	0	SKIP[a] (R-1 through R-9)	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
R-2	0.1		↙	<	*I*	/	+	−	+	*C*	Δ	>
R-3	0.2		ADD[a] ONE ZERO	ADD[a] TWO ZEROS	SHIFT[a] PREFIX ←	SHIFT[a] PREFIX ← AND ADD ONE ZERO						*IDENTIFY*[a]
R-4	0.3		*m*	*μ*	*n*	*p*	*X*	*K*	*M*	*G*	*T*	*R*
R-5	0.4		*S*	*V*	*A*	*W*	*H*	*d*	*B*	*c*	*Ω*	*E*
R-6	0.5		*U*	*N*	*L*	*Z*	*Y*	*P*	*F*	*J*	*Q*	*D*
R-7	0.6				DECIMAL[a] POINT LOCATION NO. 3	DECIMAL[a] POINT LOCATION NO. 4	DECIMAL[a] POINT LOCATION NO. 5	DECIMAL[a] POINT LOCATION NO. 6	DECIMAL[a] POINT LOCATION NO. 7			
R-8	0.7										DECIMAL[b] POINT	
R-9	0.8											
R-10	0.9	ADD SPACE IN DISPLAY[a]										

(shaded) UNUSED LOCATIONS. AVAILABLE FOR FUTURE EXPANSION OF READOUT SYSTEM

[a]OPERATIONAL ADDRESS.

[b]DECIMAL POINT CHARACTER. SEE DECIMAL POINT CHARACTER DESCRIPTION IN TEXT.

C1195-25

Figure 3-9. Character selection matrix for 7104 Readout System (SN B053266 & Below).

below within the bottom division. Figure 3-10 shows a typical display where only Channel 2 of the Right Vertical and B Horizontal units is selected for display.

Each word in the readout display can contain up to 10 characters, although the typical display will contain between 2 and 7 characters per word. The characters are selected from the Character Selection Matrix shown in Figure 3-9. In addition, 12 operational addresses are provided for special instructions to the Readout System. The unused locations in the Matrix (shaded area) are available for future expansion of the Readout System. The method of addressing the locations in the Character Selection Matrix is described in the following discussion.

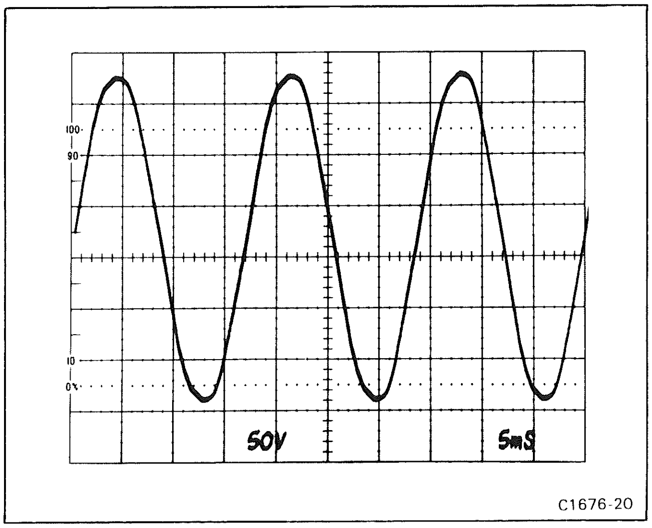


Figure 3-10. Typical readout display where only channel 2 of the Right Vertical and B Horizontal units is displayed.

DEVELOPING THE DISPLAY

This description is intended to relate the basic function of each stage to the operation of the overall Readout System. Detailed information on circuit operation is given later.

The key block in the Readout System is the Timer Stage (see schematic 6). This stage produces the basic signals that establish the timing sequences within the Readout System. The period of the timing signal is about 250 microseconds (drops to about 210 microseconds when Display-Skip is received; see detailed description of Timer stage for further information). This stage also produces control signals for other stages within this circuit and interrupt signals to the Vertical Amplifier, Horizontal Amplifier, and Logic circuits, which allow a readout display to be presented. The Time-Slot Counter stage receives a trapezoidal voltage signal from the Timer stage and directs it to one of ten output lines. These output lines are labeled TS-1 through TS-10 (time-slots 1 through 10) and are connected to the vertical and horizontal plug-in compartments as well as to various stages within the Readout System. The output lines are energized sequentially, so there is a pulse on only one of the 10 lines during any 250 microsecond timing period. After the Time-Slot Counter stage has counted time-slot 10, it produces an End-of-Word pulse which advances the system to the next channel.

Two output lines (row and column) are connected from each channel of the plug-in unit back to the Readout System. Data is typically encoded on these output lines by connecting resistors between them and the time-slot input lines. The resultant output is a sequence of 10 analog current levels that range from 0 to 1 milliampere (100 microamperes/step) on the row and column output lines. This row and column correspond to the row and column of the Character Selection Matrix in Figure 3-9. The standard format for encoding information onto the output lines is given in Table 3-11. (Special-purpose plug-in units may have their own format for readout; these special formats will be defined in the manuals for these units.)

The encoded column and row data from the plug-in units is selected by the Column Data Switch and Row Data Switch stages respectively. These stages take the analog current from the 8 data lines (2 channels from each of the 4 plug-in compartments) and produce a time-multiplexed analog voltage output containing all of the column and row information from the plug-ins. The Column Data Switch and Row Data Switch are

TABLE 3-11
Standard Readout Format

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

sequenced by the binary Channel Address Code from the Channel Counter.

The time-multiplexed output of the Column Data Switch is monitored by the Display-Skip Generator to determine if it represents valid information that should be displayed. Whenever information is not encoded in a time-slot, the Display-Skip Generator produces an output level to prevent the Timer stage from producing the control signals that normally interrupt the crt display and present a character.

The analog outputs of the Column Data Switch and Row Data Switch are connected to the Column Decoder and Row Decoder stages respectively. These stages sense the magnitude of the analog voltage input and produce an output current on one of ten lines. The outputs of the Column Decoder stage are identified as C-1 through C-10 (column 1 through 10) corresponding to the encoded column information. Likewise, the outputs of the Row Decoder stage are identified as R-1 through R-10 (row 1 through 10) corresponding to the encoded row information. The primary function of the row and column outputs is to select a character from the Character Selection Matrix to be produced by the Character Generator stage. These outputs are also used at other points within the system to indicate when certain information has been encoded. One such stage is the Zeros Logic and Memory. During time-slot 1 (TS-1), this stage checks if zero-adding or prefix-shifting information has been encoded by the plug-in unit, and stores it in the memory until time-slots 5, 6, or 8. After storing this information, it triggers the Display-Skip Generator stage so that there is no display during time-slot 1 (as defined by Standard Readout Format; see Table 3-11). When time-slots 5, 6, and 8 occur, the memory is addressed and any information stored there during time-slot 1 is transferred to the input of the Column Decoder stage to modify the analog data during the applicable time-slot.

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

The Character Generator stages produce the characters which are displayed on the crt. Any of the 50 characters shown on the Character Selection Matrix of Figure 3-9 can be addressed by proper selection of the column and row currents. Only one character is addressable in any one time-slot; a space can be added into the displayed word by the Decimal-Point Logic and Character Position Counter stage when encoded by the plug-in. The latter stage counts the number of characters generated and produces an output current to step the display one character position to the right for each character. In addition, the character position is advanced once during each of time-slots 1, 2, and 3, whether a character is generated during these time-slots or not. This action fixes the starting point of the standard-format display such that the first digit of the scaling factor always starts at the same point within each word regardless of the information encoded in time-slot 1, 2, or 3 preceding this digit. Also, by encoding row 10 and column 0 during any time-slot, a blank space can be added to the display. Decimal points can be added to the display at any time by addressing the appropriate row and column. (See Character Selection Matrix for location of decimal points.) The Decimal-Point Logic and Character Position Counter stage is reset after each word by the Word Trigger pulse.

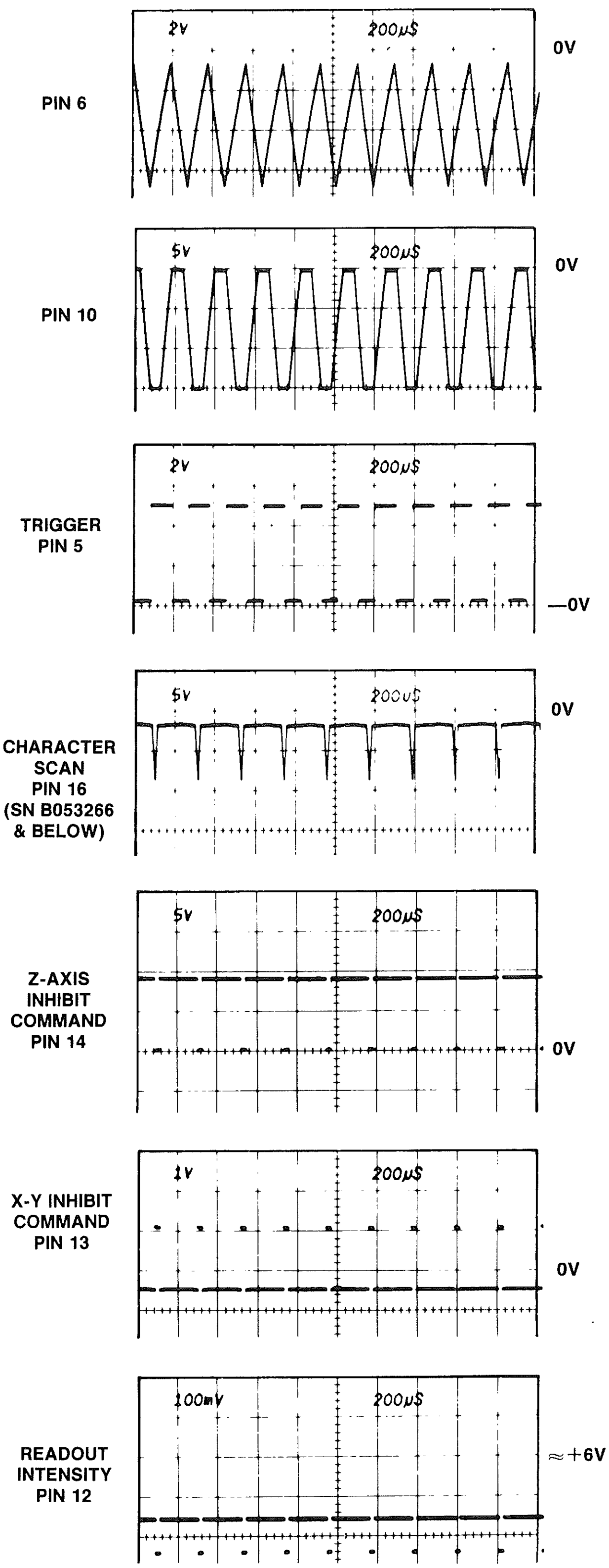
The Format Generator stage provides the output signals to the vertical and horizontal deflection systems of the instrument to produce the character display. The binary Channel Address Code from the Channel Counter stage is connected to this stage, so that the display from each channel is positioned to the area of the crt associated with the plug-in and channel originating the word (see Fig. 3-8). The positioning current or decimal point location current generated by the Decimal Point Logic and Character Position Counter stage is added to the Horizontal (X) signal at the input to the Format Generator stage to provide horizontal positioning of the characters within each word. The X- and Y-Readout signals are connected to the Horizontal Amplifier and Vertical Amplifier through the X- and Y-Buffer stages.

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

TIMER

The Timer stage establishes the timing sequence for all circuits within the Readout System. This stage produces 7 time-related output waveforms (see Fig. 3-11). The triangle waveform produced at pin 6 forms the basis for the remaining signals. The basic period of this triangle waveform is about 250 microseconds as controlled by RC network R2135 and C2135. The triangle waveform is clipped and amplified by U2126 to form the trapezoidal output signal at pin 10. The amplitude of this output signal is exactly 15 volts as determined by U2126 (exact amplitude is necessary to accurately encode data in plug-in units; see Encoding the Data). The trigger output at pin 5 provides the switching signal for the Time-Slot Counter and Word Trigger stages.

The signals at pins 12, 13, 14, and 16 are produced only when the triangle waveform is on its negative slope and the trapezoidal waveform has reached the lower level. The timing sequence of these waveforms is important to

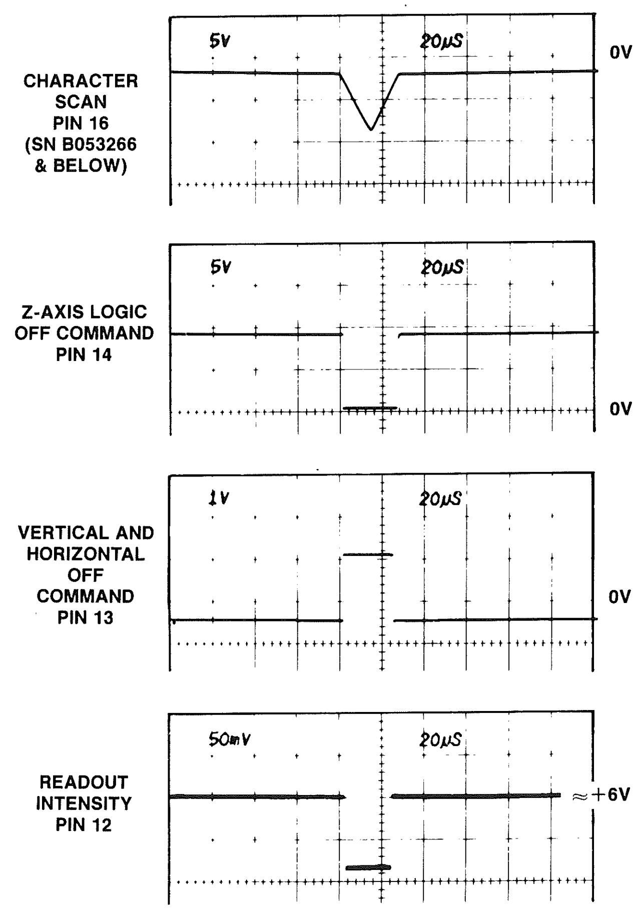


NOTE: TEST OSCILLOSCOPE EXTERNALLY TRIGGERED FROM TP 2251 (SN B053266 & BELOW) OR U2127 PIN 5 (SN B053267 & UP).

(1195-29)2314-11A

Figure 3-11. Output waveforms of the Timer stage.

the operation of the Readout System (see expanded waveforms in Fig. 3-12). The Z-Axis Inhibit command at pin 14 is produced first. This negative-going signal provides a blanking pulse to the Z-Axis Logic stage (see diagram 4) to blank the crt before the display is switched to the Readout System. It also produces the strobe pulse through Q2138 and CR2142 to signal other stages within the Readout System to begin the sequence necessary to produce a character. The collector level of Q2138 is also connected to Symbol Character Generator U2272 by way of CR2140. This activates U2272 during the quiescent period of the strobe pulse (collector of Q2138 negative) and diverts the output current of Row Decoder U2185 to row 2. The purpose of this configuration is to prevent the Zeros Logic and Memory stage U2232 from storing incorrect data during the quiescent period of the strobe pulse. When the strobe pulse goes positive, CR2140 is reverse biased to disconnect Q2138 from U2272 and allow the Row Decoder to operate in the normal manner.



NOTE: TEST OSCILLOSCOPE EXTERNALLY TRIGGERED FROM TP 2251 (SN B053266 & BELOW) OR U2127 PIN 5 (SN B053267 & UP).

(1195-30)2314-12A

Figure 3-12. Detail of output at pins 12, 13, 14 and 16 of U2126.

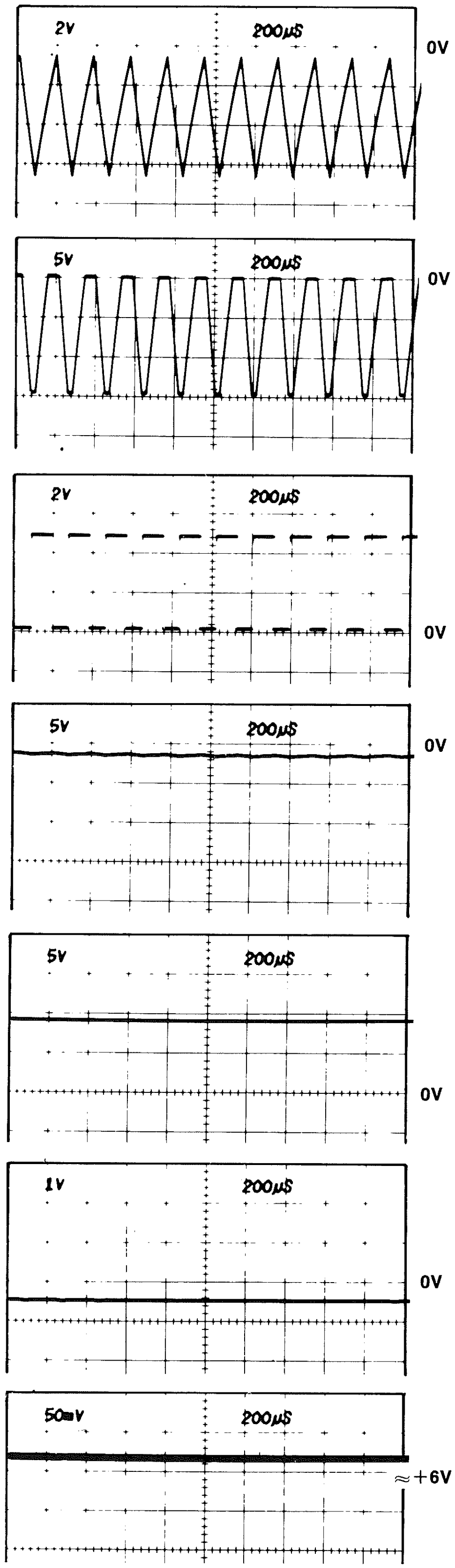
The next signal to be produced is the X-Y Inhibit Command at pin 13. This positive-going signal disconnects the plug-in signals from the vertical and horizontal deflection systems. The Ready signal derived from this output is connected to the Decimal Point Logic and Character Position Counter stage and the Format Generator stage.

The Z Readout output at pin 12 is produced next. This current is connected to the crt circuit to unblank the crt to the intensity level determined by the voltage on the Gate Readout Intensity line. The Character Scan ramp at pin 16 started to go negative as this timing sequence began. However, character generation does not start until the readout intensity level has been established. The triangular Character Scan ramp runs from about -2 volts to about -8.5 volts, then returns back to the original level. This waveform provides the scanning signal for the Character Generator stages. Character Scan adjustment, R2128, sets the dc level of the Character Scan ramp for complete characters on the display.

The Timer stage operates in one of two modes as controlled by the Display-Skip level at pin 4. The basic mode just described is a condition that does not occur unless all ten characters of each word (80 characters total) are displayed on the crt. Under typical conditions, only a few characters are displayed in each word. The Display-Skip level at pin 4 determines the period of the Timer output signal. When a character is to be generated, pin 4 is LO and the circuit operates as just described. However, when a character is not to be displayed, a HI level is applied to pin 4 of U2126 through CR2125 from the Display-Skip Generator stage. This signal causes the Timer to shorten its period of operation to about 210 microseconds. The waveforms in Figure 3-13 show the operation of the Timer stage when the Display-Skip condition occurs for all positions in a word. Notice that there is no output at pins 12, 13, 14, and 16 under this condition. This means that the crt display is not interrupted to display characters. Also notice that the triangle waveform at pin 6 does not go as far negative, and that the negative portion of the trapezoidal waveform at pin 10 is shorter. Complete details on operation of the Display-Skip Generator are given later.

The Timer operation is also controlled by the Single-Shot Lockout level at pin 2. If this level is LO, the Timer operates as just described. However, if the Single-Shot Lockout stage sets a HI level at this pin, the Timer stage is locked out and can not produce any output signals (see Single-Shot Lockout description for further information).

A negative voltage on the Readout Intensity line sets the intensity of the readout display independently of the A or B INTENSITY controls. The Readout Intensity line also provides a means of turning the Readout System off when a readout display is not desired. When the Readout Intensity line is left open, the current from pin 11 of U2126 is interrupted, and at the same time, a positive voltage is applied to pin 4 through CR2124. The positive voltage switches the stage to the same conditions as were present under the Display-Skip condition.



NOTE: TEST OSCILLOSCOPE EXTERNALLY TRIGGERED FROM TP 2251 (SN B053266 & BELOW) OR U2127 PIN 5 (SN B053267 & UP).

(1195-31)2314-13A

Figure 3-13. Timer stage operation when display-skip condition occurs.

Therefore, the crt display is not interrupted to present characters. However, time-slot pulses continue to be generated.

TIME-SLOT COUNTER

Time-Slot Counter U2159 is a sequential switch which directs the trapezoidal-waveform input at pin 8 to one of its 10 output lines. These time-slot pulses are used to interrogate the plug-in units to obtain data for the Readout System. The trigger pulse at pin 15 switches the Time-Slot Counter to the next output line; the output signal is sequenced consecutively from time-slot 1 through time-slot 10. Figure 3-14 shows the time relationship of the time-slot pulses. Notice that only one line carries a time-slot pulse at any given time. When time-slot 10 is completed, a negative-going end-of-word pulse is produced at pin 2. The End-of Word pulse provides a drive pulse for the Word Trigger stage and also provides an enabling level to the Display-Skip Generator during time-slot 1 only.

Pin 16 is a reset input for the Time-Slot Counter. When this pin is held LO, the Time-Slot Counter resets to time-slot 1. The Time-Slot Counter can be reset in this manner only when a Jump Command is received by U2155C and D (see following discussion).

WORD TRIGGER

The Word Trigger stage is made up of U2155A and B. Quiescently, pin 3 of U2155A is LO as established by the operating conditions of U2155D and C. Therefore, the LO End-of-Word pulse produced by the Time-Slot Counter results in a HI level at pin 1 of U2155A. This level is inverted by U2155A to provide a negative-going Word Trigger pulse to the Channel Counter.

Also, a Word Trigger pulse is produced by U2155B when a Jump Command is received at pin 9 of U2155C. This condition can occur during any time-slot (see Row Decoder for further information on origin of the Jump Command). Integrated circuit U2155D and C are connected as a bistable flip-flop. The positive-going Jump Command at pin 9 of U2155C produces a LO at pin 10. This LO is inverted by U2155D to produce a HI at pin 13, which allows pin 9 to be pulled HI through CR2156. The flip-flop has now been set and remains in this condition until reset, even though the Jump Command at pin 8 returns to its LO level. The HI output level at pin 13 turns on Q2159 to pull pin 16 of the Time-Slot Counter LO. This resets the Time-Slot Counter to time-slot 1 and holds it there until the Word Trigger is reset. At the same time, a HI level is applied to pin 4 of the Timer through CR2157 and CR2125. This HI level causes the Timer to operate in the Display-Skip mode, so a character is not generated.

The next Trigger pulse is not recognized by the Time-Slot Counter, since U2159 is locked in time-slot 1 by U2155. However, this Trigger pulse resets the Word Trigger stage through C2155. Pin 1 of U2155D goes LO to enable the Time-Slot Counter and Timer stages for the next time-slot pulse. Simultaneously, when U2155D switches output states, the resulting negative-going edge

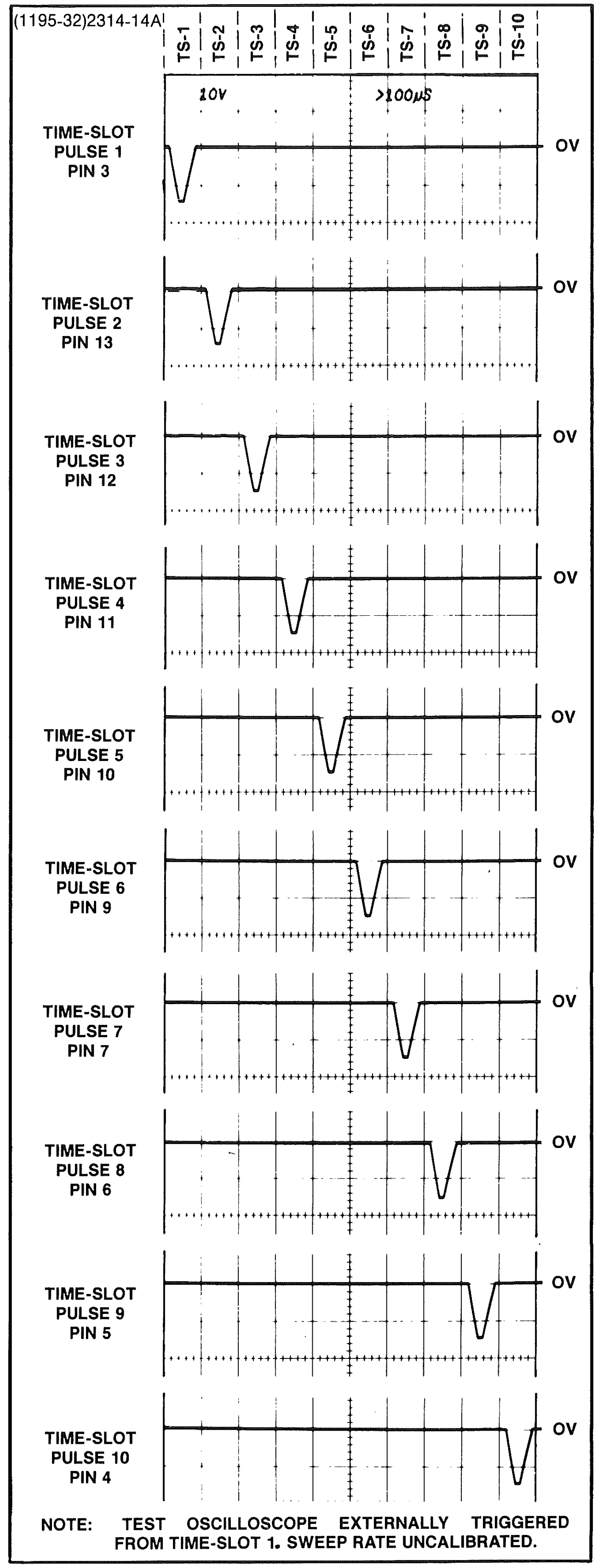


Figure 3-14. Timer relationship of the time-slot (TS) pulses produced by U2159.

is connected to pin 3 of U2155A. This results in a negative-going Word Trigger output at pin 4 of U2155B to advance the Channel Counter to the next word. When the next Trigger pulse is received at pin 15 of U2159 the Time-Slot Counter returns to the normal sequence of operation and produces an output on the time-slot 1 line.

CHANNEL COUNTER

Channel Counter U2250 is a binary counter that produces the Channel Address Code for the Column and Row Decoder stages and the Format Generator stage. This code instructs these stages to sequentially select and display the 8 channels of data from the plug-ins. Table 3-12 gives the 8 combinations of the Channel Address Code and the resultant channel selected with each combination.

TABLE 3-12
Channel Address Code
SN B053266 & Below

Pin 11 U2250	Pin 8 U2250	Pin 9 U2250	Channel Displayed
LO	LO	LO	Channel 2 Left Vertical
LO	LO	HI	Channel 1 Left Vertical
LO	HI	LO	Channel 2 Right Vertical
LO	HI	HI	Channel 1 Right Vertical
HI	LO	LO	Channel 2 A Horizontal
HI	LO	HI	Channel 1 A Horizontal
HI	HI	LO	Channel 2 B Horizontal
HI	HI	HI	Channel 1 B Horizontal

SINGLE-SHOT LOCKOUT

The Single-Shot Lockout stage allows a single readout frame (8 complete words) to be displayed on the crt, after which the Readout System is locked out, so further readout displays are not presented until the circuit is reset. Integrated circuit U2120C and U2120B are connected to form a bistable flip-flop. For free-run operation, pin 8 of U2120C is held HI. This activates U2120C and results in a LO output level at pin 10, enabling the Timer stage to operate in a free-running manner.

The output of the Single-Shot Lockout stage remains LO to allow U2126 to operate in the free-running mode until a LO is received at pin 8 of U2120C. When this occurs, the output level at pin 10 of U2120C does not change immediately. However, the Readout System is now enabled as far as the single-shot lockout function is concerned. If the Channel Counter has not completed word 8, the Readout System continues to operate in the normal manner. However, when word 8 is completed, the negative-going end-of-frame pulse is produced at pin 11 of U2250 as the Channel Counter shifts to the code necessary to display word one. This pulse is coupled to pin 3 of U2120A. The momentary HI at pin 3 activates U2120B and its output stage goes LO to disable U2120C (pin 8 is already LO). The output of U2120C goes HI to disable the Timer stage, so it operates in the Display-Skip mode. The HI at pin 10 of U2120C also holds U2120B enabled, so it maintains control of the flip-flop.

The Single-Shot Lockout stage remains in this condition until a positive-going trigger pulse is applied to pin 8 of U2120C. This trigger pulse produces a LO at pin 10 of U2120C to enable U2126 and disable U2120B. Now, the Timer stage can operate in the normal manner for another complete frame. When word 8 is completed, the Channel Counter produces another end-of-frame pulse to again lock out the Timer stage.

ENCODING THE DATA

Data is conveyed from the plug-in units to the Readout System in the form of an analog (current level) code. The characters that can be selected by the encoded data are shown on the Character Selection Matrix (see Fig. 3-9). Each character requires two currents to define it; these currents are identified as the column current and the row current, corresponding to the column and row of the matrix. The column and row data is encoded by the programming of the plug-in units. Figure 3-15 shows a typical encoding scheme using resistors for a voltage-sensing amplifier plug-in unit. Notice that the 10 TS (time slot) pulses produced by the Time-Slot Counter stage are connected to the plug-in unit. However, time-slots 5, 6, and 10 are not used by the plug-in unit to encode data when using the Standard Readout Format. (See Table 3-11 for Standard Readout Format.) The amplitude of the time-slot pulse is exactly -15 volts as determined by the Timer stage. Therefore, the resultant output current from the plug-in units can be accurately controlled by the programming resistors in the plug-in units.

For example, in Figure 3-15 resistors R10 through R90 control the row-analog data, which is connected back to the Readout System. Figure 3-16 shows an idealized output current waveform of row-analog data, which results from the time-slot pulses. Each of the row levels of current shown in these waveforms correspond to 100 microamperes of current. The row numbers on the left-hand side of the waveform correspond to the rows in the Character Selection Matrix (see Fig. 3-9). The row-analog data is connected back to the Readout System via terminal B37 of the plug-in interface.

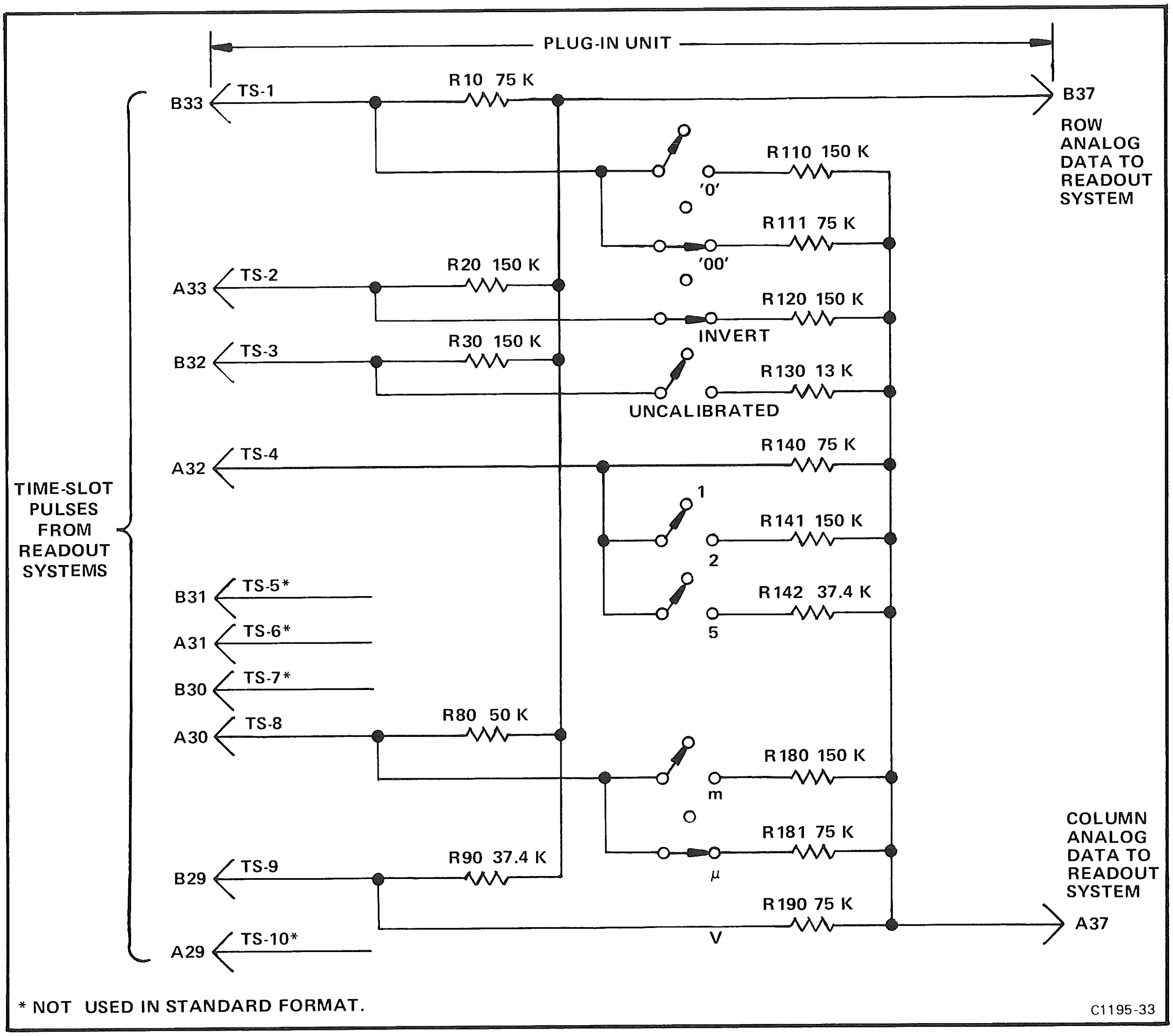


Figure 3-15. Typical encoding scheme for voltage-sensing plug-in unit. Coding shown for deflection factor of 100 microvolts.

The column-analog data is defined by resistors R110 through R190. The program resistors are connected to the time-slot lines by switch closures to encode the desired data. The data, as encoded by the circuit shown in Figure 3-15, indicates a 100 microvolt sensitivity with the crt display inverted and calibrated deflection factors. This results in the idealized output current waveforms shown in Figure 3-16 at the column-analog data output, terminal A37 of the plug-in interface.

Resistor R111, connected between time-slot 1 and the column-analog data output, encodes two units of current during time-slot 1. Referring to the Character Selection Matrix, two units of column current, along with the two units of row current encoded by resistor R10 (row 3), indicates that two zeros should be added to the display.

Resistor R120 adds one unit of column current during time-slot 2 and, along with the one unit of current from the row output, the Readout System is instructed to add an invert arrow to the display. Resistor R130 is not connected to the time-slot 3 line, since the deflection factor is calibrated. Therefore, there is no display on the crt. (See Display-Skip Generator for further information.)

During time-slot 4, two units of column current are encoded by R140. There is no row current encoded during this time slot; this results in the numeral 1 being displayed on the crt. Neither row-n or column-analog data is encoded during time-slots 5, 6, and 7 as defined by the Standard Readout Format. During time-slot 8, two units of column current and three units of row current are encoded by resistors R181 and R80, respectively. This

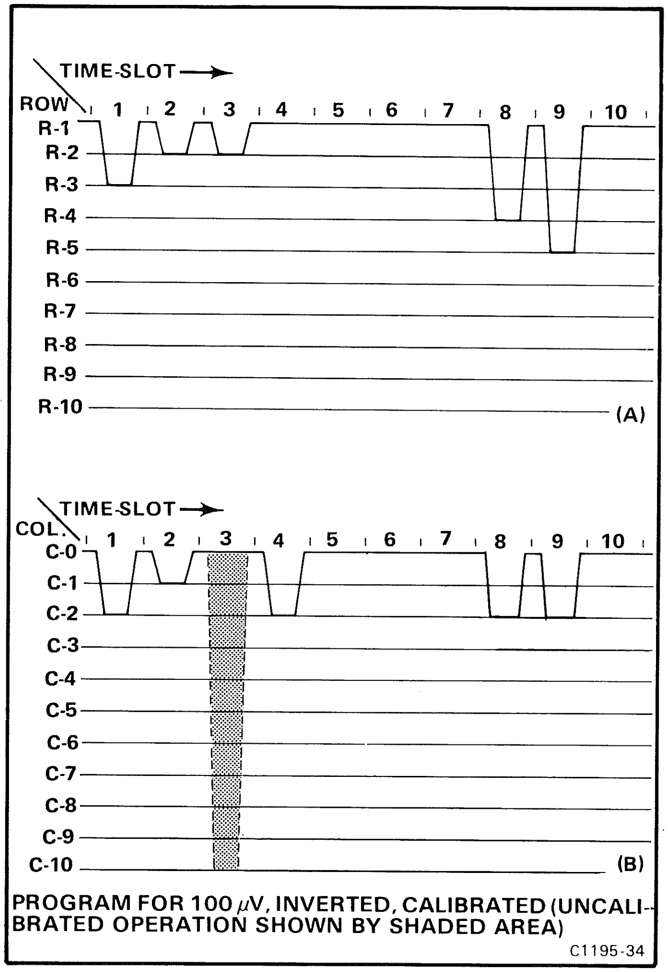


Figure 3-16. Idealized current waveforms of (A) Row analog data and (B) Column analog data.

addresses the μ prefix in the Character Selection Matrix. The final data output is provided from time-slot 9 by R190 connected to the column output and R90 to the row output. These resistors encode two units of column current and four units of row current to cause a V (volts) symbol to be displayed. Time-slot 10 is not encoded, in accordance with the Standard Readout Format. The resultant crt readout will be ↓ 100 μV.

In the above example, the row-analog data was programmed to defined which row of the Character Selection Matrix was addressed to obtain information in each time-slot. The column data changes to encode the applicable readout data as the operating conditions change. For example, if the variable control of the plug-in unit was activated, R130 would be connected between time-slot 3 and the column-analog data output line. This encodes 10 units of column current (see shaded area in time-slot 3 of the waveform shown in Fig. 3-16). Since one unit of row current is also encoded during this time-slot by R30, a > (greater than) symbol is added to the display. The crt readout will now show > 100 μV. In a similar manner, the other switches can change the encoded data for the column output and thereby change the readout display. See the descriptions which follow for decoding this information.

The column analog data encoded by most plug-in units can be modified by attenuator probes connected to the input connectors of amplifier plug-in units. A special coding ring around the input connector of the plug-in unit senses the attenuation ratio of the probe (with readout-encoded probes only). The probe contains a circuit that provides additional column current. For example, if a 10X attenuator probe is connected to a plug-in unit encoded for 100 microvolts as shown in Figure 3-15, an additional unit of current is added to the column-analog data during time-slot 1. Since two units of current were encoded by R111, this additional current results in a total of three units of column-analog current during this time-slot. Referring to the Character Selection Matrix, three units of column current, along with the two units of row current encoded by R10, indicates that the prefix should be shifted one column to the left. Since this instruction occurs in the same time-slot that previously indicated that two zeros should be added to the display and only one instruction can be encoded during a time-slot, the zeros do not appear in the display. The crt readout will now be changed to 1 mV (readout program produced by plug-in same as for previous example).

Three other lines of information are connected from the plug-in compartments to the Readout System. The column- and row-analog data from channel 2 of a dual-channel plug-in are connected to the Readout System through terminals A38 and B38 of the plug-in interface, respectively. Force-readout information is encoded on terminal A35; the function of this input is described under Column and Row Data Switches. The preceding information gave a typical example of encoding data from an amplifier plug-in unit. Specific encoding data and circuitry is shown in the individual plug-in unit manuals.

COLUMN AND ROW DATA SWITCHES

The encoding data from the plug-in units is connected to the Column and Row Data Switch stages. A column-data line and a row-data line convey analog data from each of the 8 data sources (2 channels from each of the 4 plug-in compartments).

The Column Data Switch U2190 and the Row Data Switch U2180 receive the Channel Address Code from the Channel Counter (refer to diagram 6 at the rear of this manual). This binary code directs the Column Data Switch and the Row Data Switch as to which channel should be the source of the encoding data. Table 3-12 gives the eight combinations of the Channel Address Code and the resultant channel selected with each combination. These stages have nine inputs and provide a time-multiplexed output at pin 7, which includes the information from all of the input channels. Eight of the nine inputs to each stage originate in the plug-in units; the ninth input comes from a special data-encoding network composed of resistors R2191 through R2199 and R2201 through R2209. (See Zeros Logic and Memory description for further information on ninth channel.)

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In addition to the encoding data inputs from the plug-in units, inputs are provided to the Column Data Switch from the VERTICAL MODE and HORIZONTAL MODE switches to inhibit the readout for any plug-in unit(s) not selected for display. When a unit is not selected, the line corresponding to the opposite channel is HI to forward bias the associated diodes: CR2162 and CR2163, CR2166 and CR2167, CR2170 and CR2171, or CR2174 and CR2175. The forward-biased diodes cause the channel switches to bypass the encoded data from the inhibited channel. However, since it may be desired to display information from special-purpose plug-in units (even though they do not produce a normal waveform display on the crt), a feature is provided to override the channel inhibit. This is done by applying a LO to the associated Force Readout input. The LO level diverts the HI channel-inhibit current and allows the data from this plug-in unit to reach the Column Data Switch, even though it has not been selected for display by the mode switch.

Row Match adjustment, R2183, sets the gain of the Row Data Switch to match the gain of the Row Decoder for correct output. Column Match adjustment, R2214, performs the same function for the Column Data Switch stage.

DISPLAY-SKIP GENERATOR

The Display-Skip Generator is made up of Q2215, Q2223, Q2229, and Q2225. This stage monitors the time-multiplexed column data at the output of the Column Data Switch during each time-slot to determine if the information is valid data that should result in a crt display. Quiescently, there is about 100 microamperes of current flowing through R2213 from Q2240 and the Zeros Logic and Memory stage. (The purpose of this quiescent current will be discussed in connection with the Zeros Logic and Memory stage.) This current biases Q2215A so that its base is about 0.2 volt more positive than the base of Q2215B in the absence of column data. Therefore, since Q2215A and Q2215B are connected as a comparator, Q2215A will remain on unless its base is pulled more negative than the base of Q2215B.

The analog data output from the Column Data Switch produces a 0.5 volt (approximately) change for each unit of column current that has been encoded by the plug-in unit. Whenever any information appears at the output of the Column Data Switch, the base of Q2215A is pulled more negative than the base of Q2215B, resulting in a negative (LO) Display-Skip output to the Timer stage through Q2225. Recall that a LO was necessary at the skip input of the Timer so it could perform the complete sequence necessary to display a character.

Transistors Q2223 and Q2229 also provide Display-Skip action. The End-of-Word level connected to their emitters is LO only during time-slot 1. This means they are enabled only during this time-slot. These transistors allow the Zeros Logic and Memory stage to generate a Display-Skip signal during time-slot 1 when information that is not to be displayed on the crt has been stored in memory (further information is given under Zeros Logic and Memory).

COLUMN AND ROW DECODERS

The Column Decoder U2244 and Row Decoder U2185 sense the magnitude of the analog voltages at their inputs (pin 10) and produce a binary output on one of ten lines corresponding to the column or row data encoded by the plug-in unit. These outputs provide the Column Digital Data and Row Digital Data, which is used by the Character Generator stages to select the desired character for display on the crt. The column and row data is also used throughout the Readout System to perform other functions.

The input current at pin 9 of the Column Decoder stage is steered to only one of the ten Column Digital Data outputs. When a Display-Skip signal is present (collector of Q2225 HI), pin 9 is pulled HI through CR2226. This ensures that no current is connected to the Character Generator stage under this condition. Notice the corresponding input on the Row Decoder. This input is connected to ground and causes only one of the ten row outputs to saturate to ground.

The network at the input of the Row Decoder, made up of Q2153 and its associated components, is a row-14 detector that produces the Jump Command. This row current is encoded by special-purpose plug-ins to cause all or part of a word to be jumped. Whenever row 14 (13 units of row current, or 1.3 milliamperes) is encoded, the base of Q2153 is pulled negative enough so that this transistor is reverse biased to produce a HI Jump Command output at its collector. The Jump Command is connected to the Word Trigger stage to advance the Channel Counter to the next word and to reset the Time-Slot Counter to time-slot 1.

ZEROS LOGIC AND MEMORY

The Zeros Logic and Memory stage, U2232, stores data encoded by the plug-in units to provide zeros-adding and prefix-shifting logic for the Readout System. The Strobe pulse at pin 15 goes positive when the data has stabilized and can be inspected. This activates the Zeros Logic and Memory stage so that it can store the encoded data.

Typical output waveforms of the five possible input conditions that can occur are shown in Figure 3-17. When time-slot 1 occurs, a store command is given to all of the memories. If the plug-in units encoded data for column 1, 2, 3, 4, or 10 during time-slot 1, the appropriate memory (or memories) is set. Notice that row 3 information from the Row Decoder must also be present at pin 16 for data to be stored in the memory of U2232.

If data was encoded during time-slot 1, a negative-going output is produced at pin 7 while the memories are being set. This negative-going pulse is connected to the base of Q2229 in the Display-Skip Generator to produce a Display-Skip output. Since the information encoded during time-slot 1 was only provided to set the memories and not intended to be displayed on the crt at this time, the Display-Skip output prevents a readout display during this time-slot.

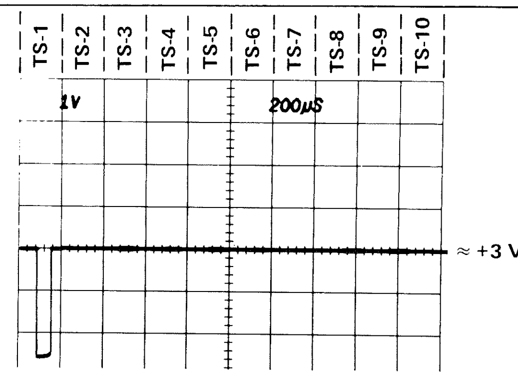
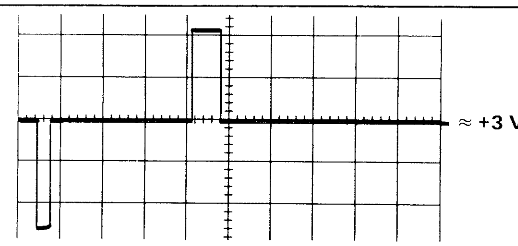
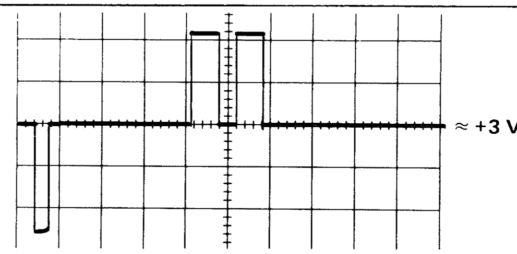
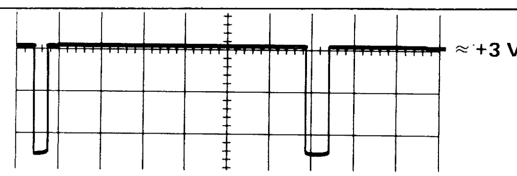
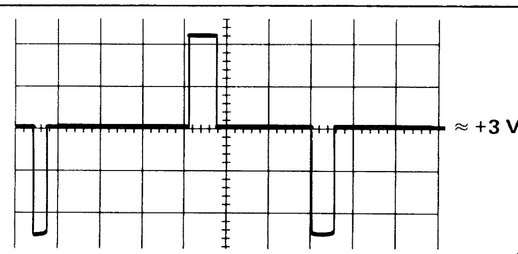
<table>
<tr><th>INPUT PIN OF U2232 ACTIVATED</th><th>COMMAND</th><th>TIME-SLOTS</th></tr>
<tr><td>14</td><td>IDENTIFY</td><td></td></tr>
<tr><td>12</td><td>ADD ONE ZERO</td><td></td></tr>
<tr><td>13</td><td>ADD TWO ZEROS</td><td></td></tr>
<tr><td>10</td><td>DECREASE PREFIX</td><td></td></tr>
<tr><td>11</td><td>DECREASE PREFIX AND ADD ONE ZERO</td><td>
C1195-36</td></tr>
</table>

Figure 3-17. Typical output waveforms for Zeros Logic and Memory stage operation (at pin 7 of U2232).

During time-slot 5, a memory within U2232 is interrogated. If information was stored in this memory, a positive-going output is produced at pin 7. This pulse is connected to pin 10 of the Column Decoder through Q2240 to add one unit of current at the input of the Column Decoder. This produces a zero after the character displayed during time-slot 4. During time-slot 6, another memory within U2232 is interrogated to see if another zero should be added. If another zero is necessary, a second positive output is produced at pin 7, which again results in a column 1 output from the Column Decoder and a second 0 in the crt display.

Finally, another memory within U2232 is interrogated during time-slot 8 to obtain information on whether the prefix should be changed, or left at the value that was encoded. If data has been encoded that calls for a shift in prefix, a negative-going output level is produced at pin 7. This negative level subtracts one unit of column current from the data at the input to the Column Decoder. Notice, on the Character Selection Matrix of Figure 3-9, that when row 4 is programmed, a reduction of one column results in a one-column shift of the prefix. For example, with the 100 μV program shown in Figure 3-15, if the data received from the plug-in called for a shift in prefix, the crt readout would be changed to 1 mV (zeros deleted by program; see Encoding the Data).

The 100 microamperes of quiescent current through R2213 provided by Q2240 (see Display-Skip Generator) allows the prefix to be shifted from m (100 microamperes of column current, column 1) to no prefix (0 column current, column 0) so only the unit of measurement encoded during time-slot 9 is displayed. Notice that reducing the prefix program from column 1 to column 0 programs the Readout System to not display a character at this readout location.

A further feature of the Zeros Logic and Memory is the Identify function. If 10 units of column current are encoded by the plug-in unit along with row 3 during time-slot 1, the Zeros Logic and Memory produces a negative-going output pulse at pin 1 to switch the Column Data Switch and Row Data Switch to the ninth channel. Then, time-slot pulses 2 through 9 encode an output current through resistors R2201 and R2199 for column data and R2201 and R2209 for row data. This provides the current necessary to display the word IDENTIFY in the word position allotted to the channel that originated the Identify command. After completion of this word, the Column Data Switch and Row Data Switch continue with the next word in the sequence.

The Word Trigger signal from the Word Tigger stage is connected to pin 9 of U2232 through C2242. At the end of each word of readout information, this pulse goes LO. This erases the four memories in the Zeros Logic and Memory in preparation for the data to be received from the next channel.

CHARACTER GENERATOR

The Character Generator stage consists of five similar integrated circuits (U2270, U2272, U2274, U2276, U2278), which generate the X (horizontal) and Y (vertical) outputs at pins 16 and 1, respectively, to produce the character display on the crt. Each integrated circuit can produce 10 individual characters; U2270 (designated "Numerals") can produce the numerals 0 through 9 shown in row 1 of the Character Selection Matrix (Fig. 3-9). Integrated circuit U2272 can produce the symbols shown in row 2 of the Character Selection Matrix and U2274 produces the prefixes and some letters, used as prefixes, shown in row 4. Integrated circuits U2276 and U2278 produce the remaining letters shown in rows 5 and 6 of the Character Selection Matrix.

All of the Character Generator stages receive the Column Digital Data from the Column Decoder U2244 in parallel. However, only one of the Character Generators receives row data at a particular time and only the stage receiving this row data is activated. For example, if column 2 is encoded, the five Character Generators are enabled so that either a 1, >, μ, V, or an n can be produced. If row 4 has been encoded at the same time, only the Prefix Character Generator U2274 will produce an output to result in a μ being displayed. The activated Character Generator provides current output for the Format Generator to produce the selected character on the crt. In a similar manner, any of the characters shown in the Character Selection Matrix can be displayed by correct addressing of the row and column.

DECIMAL POINT LOGIC AND CHARACTER POSITION COUNTER

Decimal Point Logic and Character Position Counter U2260 performs two functions. The first function is to add a staircase current to the X (horizontal) signal to space the characters horizontally on the crt. After each character is generated, the negative-going edge of the Ready signal at pin 5 advances the Character Position Counter. This produces a current-step output at pin 3 which, when added to the X signal, causes the next character to be displayed one character space to the right. This stage can also be advanced when a Space instruction is encoded so a space is left between the displayed characters on the crt. Row 10 information from the Row Decoder is connected to pin 4 of U2260. When row 10 and column 0 are encoded, the output of this stage advances one step to move the next character another space to the right. However, under this condition, no display is produced on the crt during this time-slot, since the Character Generators are not activated.

Time-slot pulses 1, 2, and 3 are also connected to pin 4 of U2260 through VR2262, VR2263, and VR2264 respectively and R2262 and R2265. This configuration adds a space to the displayed word during time-slots 1, 2, and 3 even if information is not encoded for display during these time-slots. With this feature, the information displayed during time-slot 4 (scaling data) always starts in the fourth character position whether data has been displayed in the previous time-slots or not. Therefore, the resultant crt display does not shift position as normal-invert or cal-uncal information is encoded. The Word Trigger pulse connected to pin 8 resets the Character Position Counter to the first character position at the end of each word.

The Decimal Point Logic portion of this stage allows decimal points to be added to the crt display. With the Standard Readout Format, row 7, encoded coincident with columns 3 through 7, addresses a decimal at one of the five locations identified in row 7 of the Character Selection Matrix (Fig. 3-9). This instruction refers to the decimal-point location in relation to the total number of characters possible in one word (see Fig. 3-18). For example, column 3 encoded with row 7 during time-slot 1 places a decimal point in location number 3. As shown in Figure 3-18, this displays a decimal point after the third character that can be displayed on the crt. (The first three time-slots produce a space whether data is encoded or not; see previous paragraph.)

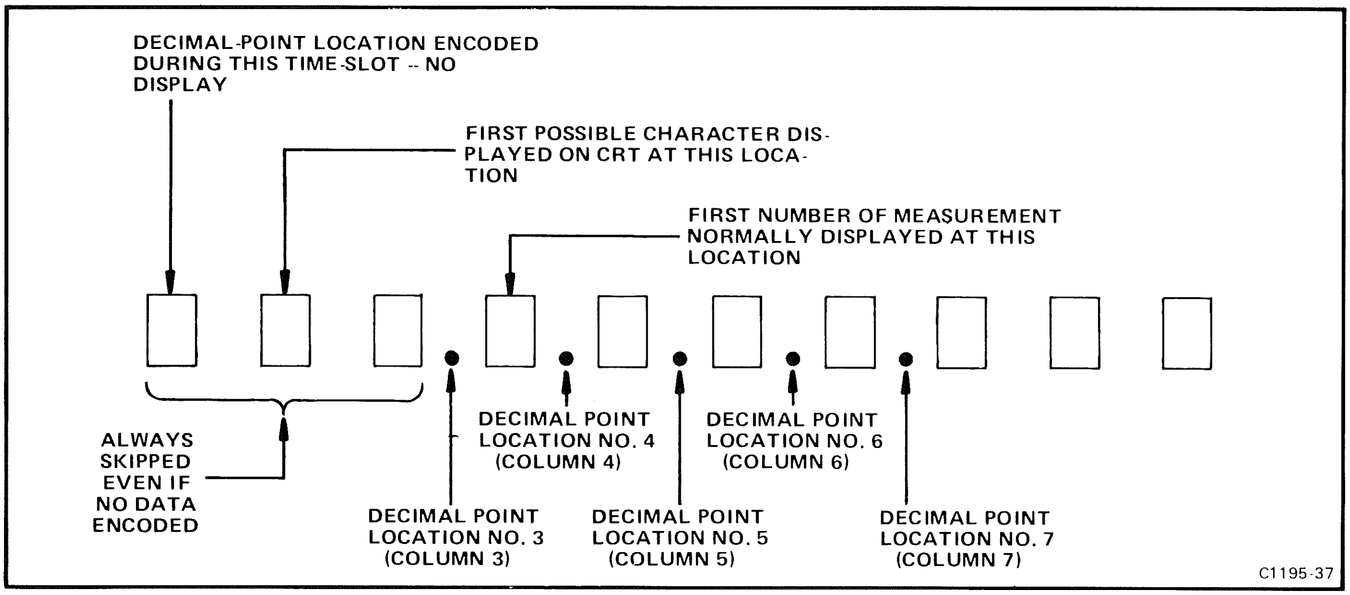


Figure 3-18. Readout word relating 10 possible character locations to the decimal point instructions that can be encoded; and the resultant crt display.

When decimal-point data is encoded, the crt is unblanked so a readout display is presented. Since row 7 does not activate any of the five Character Generators, the crt beam is deflected vertically by the application of row-7 data to the Y input of the Format Generator through R2278 and R2280. This places the decimal point between the characters along the bottom line of the readout word. After the decimal point is produced in the addressed location, the crt beam returns to the location indicated by the Character Position Counter to produce the remainder of the display.

FORMAT GENERATOR

The X- and Y-deflection signals produced by the Character Generator stage are connected to pins 2 and 7, respectively, of the Format Generator. The Channel Address Code from the Channel Counter is also connected to pins 1, 8, and 15 of this stage. The Channel Address Code directs the Format Generator to add current to the X and Y signals to deflect the crt beam to the area of the crt associated with the plug-in channel that originated the information (see Fig. 3-8). The Channel Address Code and the resultant word positions are shown in Table 3-12. The Ready signal at pin 13 (coincident with the X/Y Inhibit Command output) activates this stage when a character is to be displayed on the crt. Variable resistor R2273 determines the horizontal and vertical size of the displayed characters. The character-position current from the Decimal Point Logic and Charcter-Position Counter stage is added to the X (horizontal) input signal to space the characters horizontally on the crt (see previous discussion).

Y-OUTPUT

The Y-output signal at pin 6 of Format Generator U2284 is connected to the Y-Output amplifier Q2287 and Q2299. This stage provides a low impedance load for the Format Generator while providing isolation between the Readout System and the driven circuits. Vertical Separation adjustment R2291 changes the gain of this stage to control the vertical separation between the readout words displayed at the top and bottom of the graticule area.

X-OUTPUT

The X-Output amplifier Q2286 and Q2296 operates like the Y-Output amplifier, to provide the horizontal deflection from the readout signal available at pin 4 of U2284. The gain of this stage is fixed by the values of the resistors in the circuit.

DISPLAY SEQUENCE

Figure 3-19 shows a flow chart for the Readout System. This chart illustrates the sequence of events that occurs in the Readout System each time a character is generated and displayed on the crt.

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READOUT SYSTEM SN B053267 & Above

The Readout System provides an alphanumeric display of information encoded by the plug-in units. This display is presented on the CRT and is written by the CRT beam on a shared basis with the analog waveform display.

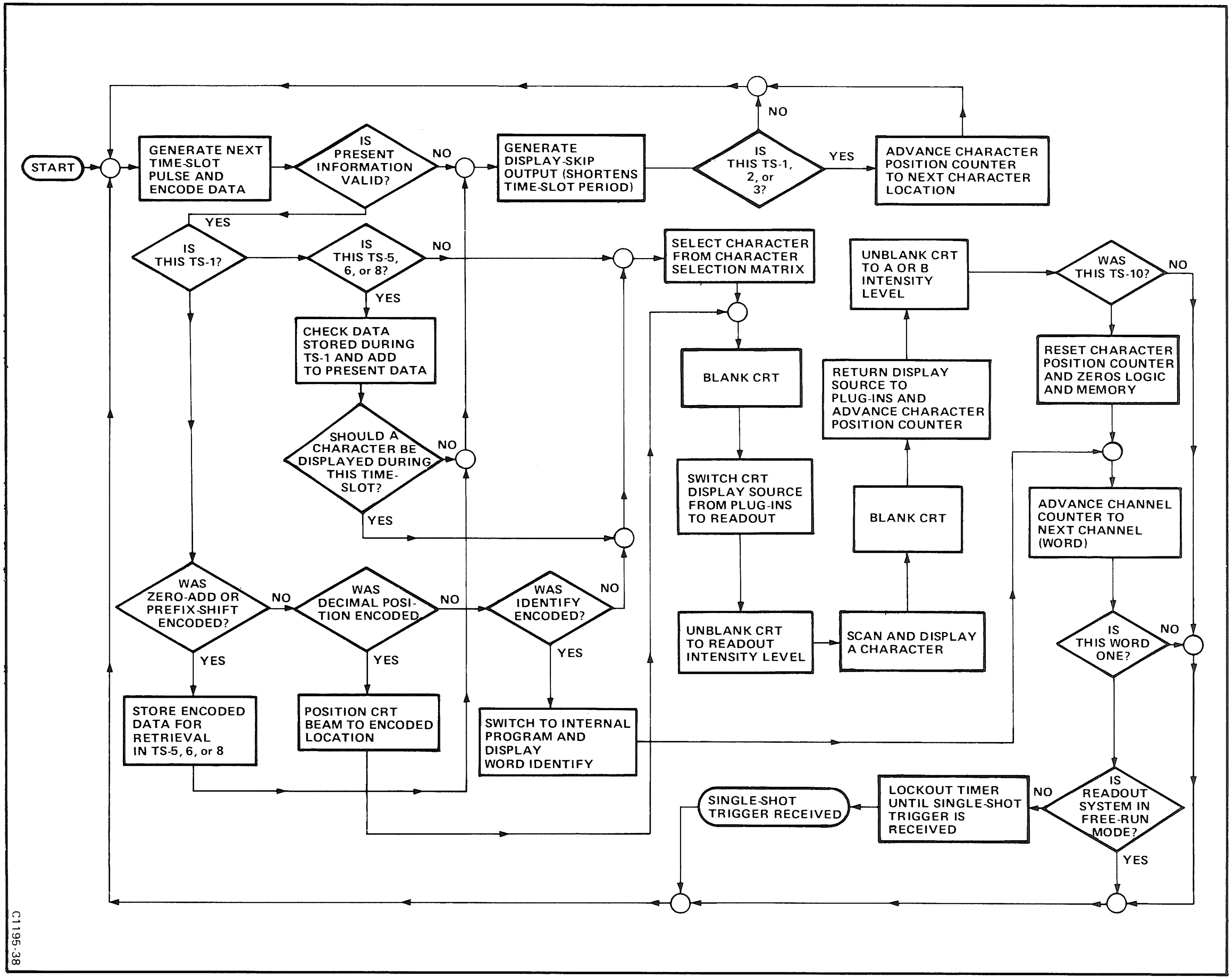


Figure 3-19. Flow chart for character generation by the Readout System.

The following terms are used to describe the Readout System:

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

Word—A group of related characters. In the Readout System, a word can consist of up to 10 characters.

Frame—A display of all words for a given operating mode and plug-in combination. Up to 8 words can be displayed in one frame. Figure 3-8 shows the position of each word in a complete frame.

Column—One of the vertical lines in the Character Selection Matrix (see Fig. 3-20). Columns C-0 (column zero) through C-10 (column 10) can be addressed by the system.

Row—One of the horizontal lines in the Character Selection matrix. Rows R-1 (row 1) through R-10 (row 10) and R-14 (row 14) can be addressed by the system.

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

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

Hexidecimal—The hexidecimal numbering system uses the numerals 0 through 9 and the letters A through F to represent the sixteen possible cominations of four binary digits.

Octal—The octal numbering system uses the numerals 0 through 7 to represent the eight possible combinations of three binary digits.

Binary Coded Decimal—The Binary Coded Decimal system uses ten unique combinations of four binary digits to represent the decimal numbers 0 through 9.

DISPLAY FORMAT

Up to 8 words of readout information can be displayed on the CRT. The position of each word is fixed and is directly related to the plug-in unit from which it originated. Figure 3-8 shows the area of the graticule where the readout from each plug-in unit is displayed. Notice that Channel 1 of each plug-in unit is displayed within the top division of the CRT, and Channel 2 is displayed directly below within the bottom division. Figure 3-10 shows a typical display where only Channel 2 of the Right Vertical and B Horizontal units are selected for display.

Each word in the readout display can contain up to 10 characters, although the typical display will contain between 2 and 7 characters per word. The characters are selected from the Character Selection Matrix shown in Figure 3-20. In addition, 13 operational addresses are provided for special instructions to the Readout System. The unused locations in the Matrix (shaded area) are available for future expansion of the Readout System. The method of addressing the locations in the Character selection Matrix is described in the following discussion.

DEVELOPING THE DISPLAY

This description is intended to relate the basic function of each stage to the operation of the overall Readout System. Detailed information on circuit operation is given later.

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

Two output lines (row and column) are connected from each channel of the plug-in unit back to the Readout System. Data is typically encoded on these output lines by connecting resistors between them and the time-slot input lines. The resultant output is a sequence of 10 analog current levels that range from 0 to 1 millampere (100 microamperes/step) on the row and column output lines. This row and column corresponds to the row and column of the Character Selection Matrix in Figure 3-20. The standard format for encoding

		Hexidecimal from U2246 →	F	E	D	C	B	A	9	8	7	6	F
Hexidecimal from U2186 ↓	Row Number ↓	Column Number →	C-0	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10
		Current (mA)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	≥1.0
E	R-1	0	↑ SKIP* ↓	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
D	R-2	0.1		↓	<	*I*	/	+	−	+	*C*	⅃	>
C	R-3	0.2		Add one zero*	Add two zeros*	Reduce one prefix*	Reduce prefix and add one zero*						*IDENTIFY**
B	R-4	0.3		*m*	*μ*	*n*	*p*	*X*	*K*	*M*	*G*	*T*	*R*
A	R-5	0.4		*S*	*V*	*A*	*W*	*H*	*d*	*B*	*c*	*Ω*	*E*
9	R-6	0.5		*U*	*N*	*L*	*Z*	*Y*	*P*	*F*	*J*	*Q*	*D*
8	R-7	0.6				Decimal point no. 3*	Decimal point location no. 4*	Decimal point location no. 5*	Decimal point location no. 6*	Decimal point location no. 7*			
7	R-8	0.7										•	
6	R-9	0.8											
F	R-10	0.9	Add space in display*										
F	R-14	1.3	← JUMP* →										

* Operational address.

▢ Unused locations. Available for future expansion of Readout System.

Figure 3-20. Character selection matrix for 7104 Readout System (SN B053267 & Above).

information onto the output lines is given in Table 3-11 (Special-purpose plug-in units may have their own format for readout and these special formats will be defined in the manuals for these units).

The encoded column and row data from the plug-in units is selected by the Column Data Switch and Row Data Switch stages respectively. These stages take the analog current from the 8 data lines (2 channels from each of the 4 plug-in compartments) and produce a time-multiplexed analog voltage output containing all of the column and row information from the plug-ins. The Column Data Switch and Row Data Switch are sequenced by the binary Channel Address Code from the Channel Counter.

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

The analog outputs of the Column Data Switch and Row Data Switch are connected to the Column Decoder and Row Decoder stages respectively. These stages sense the magnitude of the analog voltage input and produce an output current on one of ten lines. The outputs of the Column Decoder stage are identified as C-1 through C-10 (column 1 through 10) corresponding to the encoded column information. Likewise, the outputs of the Row Decoder stage are identified as R-1 through R-10 (row 1 through 10) corresponding to the encoded row information. The row and column outputs are then converted to Binary Coded Decimal and used to address memory locations within the Character Generator. These outputs are also used at other points within the system to indicate when certain information has been encoded. One such stage is the Zeros Logic and Memory. During time-slot 1 (TS-1), this stage checks if zero-adding or prefix-shifting information has been encoded by the plug-in unit, and stores it in the memory until time-slots 5, 6, or 8. After storing this information, it triggers the Display-Skip Generator stage so that there is no display during time-slot 1 (as defined by Standard Readout Format; see Table 3-11). When time-slots 5, 6, and 8 occur, the memory is addressed and any information stored there during time-slot 1 is transferred to the input of the Column Decoder stage to modify the analog data during the applicable time-slot.

Another operation of the Zeros Logic and Memory stage is to produce the Identify function. When time-slot 1 is encoded for Identify (column 10, row 3), this stage produces an output level connected with the Row Decimal-to-BCD Converter and the Row and Column Data Switches. This output level connects the Column Data Switch with a coding network within the Readout system to produce an analog current during time-slots 2 through 9. The current is then converted to Binary Coded Decimal and combined with the Row Decimal-to-BCD Converter output to address locations within the Character Generator necessary to display "IDENTIFY" on the CRT. The Zeros Logic and Memory stage is reset after each word by the End-of-Word pulse.

Each character displayed on the CRT consists of a series of connected points within an 8-point by 8-point grid. The Character Generator contains grid locations of the points required to create any of the 50 possible characters shown in the Character Selection Matrix of Figure 3-20. The row and column data encoded during a time-slot are converted to BCD and used to address a location within the Character Generator containing the first grid point of the character to be displayed. The 4-bit binary output from the Lower Order Address Generator is combined with the address created by the row and column data to provide the other grid points necessary to complete the character.

Only one character is addressable in any one time-slot or a space can be added into the displayed word by the Horizontal Character Position Counter stage, when encoded by the plug-in. The latter stage counts the number of characters generated and produces an output current to step the display one character position to the right for each character. In addition, the character position is advanced once during each of time-slots 1, 2, and 3, whether a character is generated during these time-slots or not. This action fixes the starting point of the standard-format display such that the first digit of the scaling factor always starts at the same point within each word regardless of the information encoded in time-slot 1, 2, or 3 preceding this digit. Also, by encoding row 10 and column 0 during any time-slot, a blank space can be added to the display. Decimal points can be added to the display at any time by addressing the appropriate row and column (See Character Selection Matrix for location of decimal points). The Horizontal Character Position Counter stage is reset after each word by the Word Trigger pulse.

The Character Generators binary output is shaped by the X and Y Vector Generators into the appropriate X and Y-Axis signals to create characters. The Vector Amplifier outputs are amplified by the X and Y Output Amplifiers for use by the instruments horizontal and vertical deflection systems. The Channel Counter output is also used by these stages so the display from each channel is positioned to the area of the CRT which is associated with the plug-in and channel originating the word (see Fig. 3-8). The character positioning current or decimal positioning current generated by the Horizontal Character Position Counter and Decimal Point Logic stages is added to the X (horizontal) signal at the input to the X Output Amplifier, providing horizontal positioning of the characters within each word.

The Word Trigger stage produces a trigger from the End-of-Word pulse generated by the Time-Slot Counter stage after the tenth time-slot. This Word Trigger pulse advances the Channel Counter to display the information from the next channel or plug-in. This Word Trigger stage can also be advanced to jump a complete word, or a portion of a word, when a Jump Command is received from the Row Data Switch stage.

TIMER

The Timer stage produces the timing sequence for all circuits within the Readout System. This stage produces six time-related output waveforms (see Fig. 3-11). The triangle waveform produced at pin 6 forms the basis for the remaining signals. The basic period of this triangle waveform is about 250 microseconds, as controlled by RC network R2135 and C2135. The triangle waveform is clipped and amplified by U2126 to form the trapezoidal output signal at pin 10. The amplitude of this output signal is exactly 15 volts, as determined by U2126 (exact amplitude is necessary to accurately encode data in plug-in units; see Encoding the Data). The trigger output at pin 5 provides the switching signal for the Time-Slot Counter and Word Trigger stages.

The signals at pin 12, 13, and 14 are produced only when the triangle waveform is on its negative slope and the trapezoidal waveform has reached the lower level. The timing sequence of these waveforms is important to the operation of the Readout System (see expanded waveforms in Fig. 3-12). The Z-Axis inhibit command at pin 14 is produced first. This negative-going signal provides a blanking pulse to the Z-Axis Logic stage to blank the CRT before the display is switched to the Readout System. It also produces the strobe pulse through Q2138 and CR2139 which is connected to pin 15 of U2232.

The purpose of this configuration is to prevent the Zeros Logic and Memory stage U2232 from storing incorrect data during the quiescent period of the strobe pulse. When the strobe pulse goes positive, CR2139 is reverse biased to disconnect Q2138 and allow U2232 to operate in the normal manner.

The next signal to be produced is the X-Y Inhibit Command at pin 13. This positive-going signal disconnects the plug-in signals from the vertical and horizontal deflection systems. The Ready signal is also derived from this output and connected to the Character Generator stage and the two Output Amplifier stages.

The Z Readout output at pin 12 is produced next. This current is connected to the CRT circuit to unblank the CRT to the intensity level determined by the voltage on the Readout Intensity line.

The Timer stage operates in one of two modes as controlled by the Display-Skip level at pin 4. The basic mode just described is a condition that does not occur unless all ten characters of each word (80 characters total) are displayed on the CRT. Under typical conditions, only a few characters are displayed in each word. The Display-Skip level at pin 4 determines the period of the Timer output signal. When a character is to be generated, pin 4 is LO and the circuit operates as just described. However, when a character is not to be displayed, a HI level is applied to pin 4 of U2126 through CR2125 from the Display-Skip Generator stage. This signal causes the Timer to shorten its period of operation to about 210 microseconds. The waveforms in Figure 3-13 show the operation of the Timer stage when the Display-Skip condition occurs for all positions in a word. Notice that there is no output at pins 12, 13, and 14 under this condition. This means that the CRT display is not interrupted to display characters. Also notice that the triangle waveform at pin 6 does not go as far negative, and that the negative portion of the trapezoidal waveform at pin 10 is shorter. Complete details on operation of the Display-Skip Generator are given later.

The Timer operation is also controlled by the Single-Shot Lockout level at pin 2. If this level is LO, the Timer operates as just described. However, if the Single-Shot Lockout stage sets a HI level at this pin, the Timer stage is locked out and can not produce any output signals (see Single-Shot Lockout description for further information).

A negative voltage on the readout intensity line sets the intensity of the readout display independently of the A or B INTENSITY controls. The Readout Intensity line also provides a means of turning the Readout System off when a readout display is not desired. When the Readout Intensity line is left open, the current from pin 11 of U2126 is interrupted, and at the same time, a positive voltage is applied to pin 4 through CR2124. The positive voltage switches the stage to the same conditions as were present under the Display-Skip condition. Therefore, the CRT display is not interrupted to present characters. However, time-slot pulses continue to be generated.

TIME-SLOT COUNTER

Time-Slot Counter U2159 is a sequential switch which directs the trapezoidal waveform input at pin 8 to one of its 10 output lines. These time-slot pulses are used to interrogate the plug-in units to obtain data for the Readout System. The trigger pulse at pin 15 switches the Time-Slot Counter to the next output line, causing the output signal to be sequenced consecutively from time-slot 1 through time-slot 10. Figure 3-14 shows the time relationship of the time-slot pulses. Notice that only one line carries a time-slot pulse at any given time. When time-slot 10 is completed, a negative-going end-of-word pulse is produced at pin 2. The end-of-word pulse provides a drive pulse for the Word Trigger stage and also provides an enabling level to the Display-Skip Generator during time-slot 1 only.

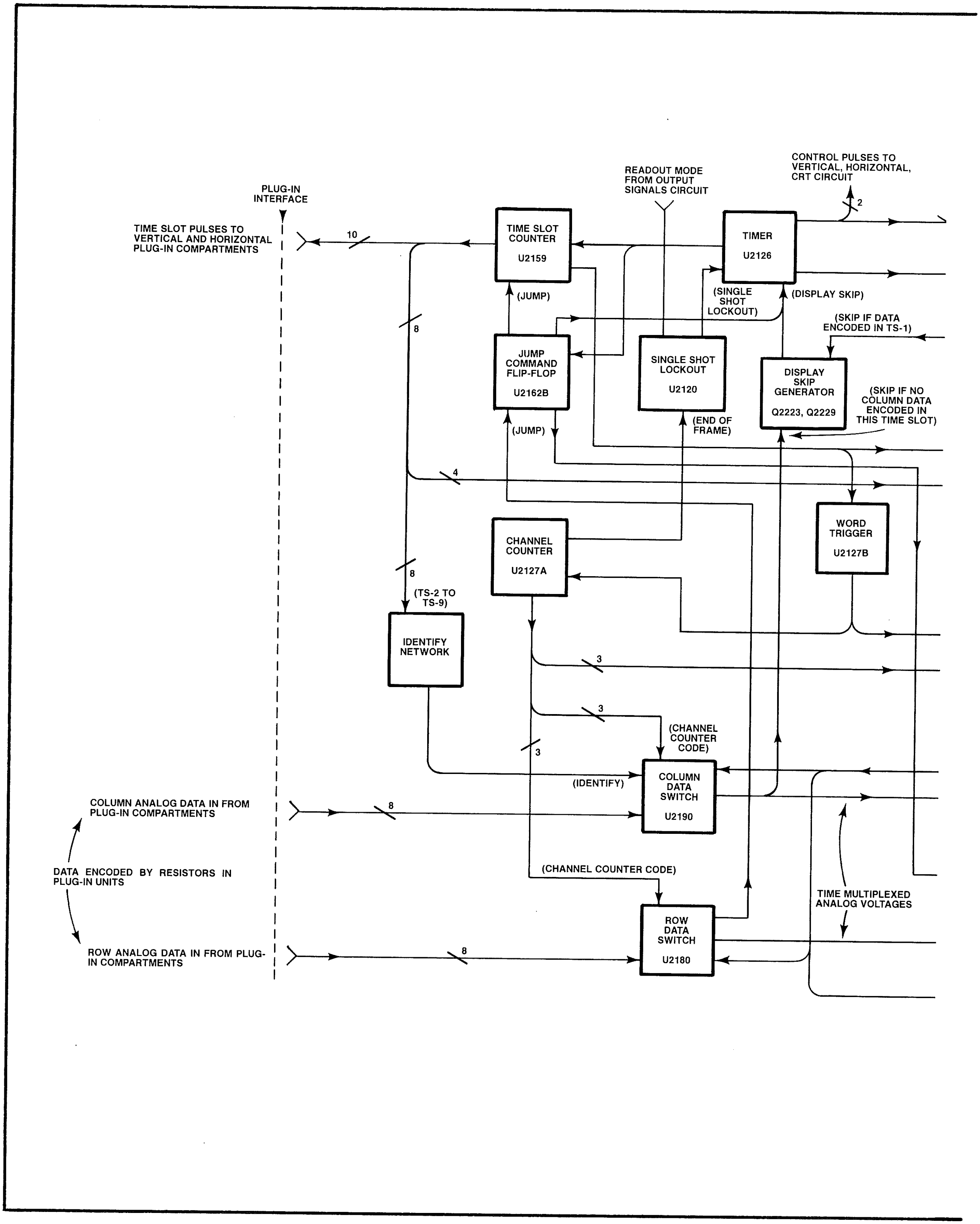


Figure 3-21. Detailed block diagram of 7104 Readout System (SN B053267 & Above).

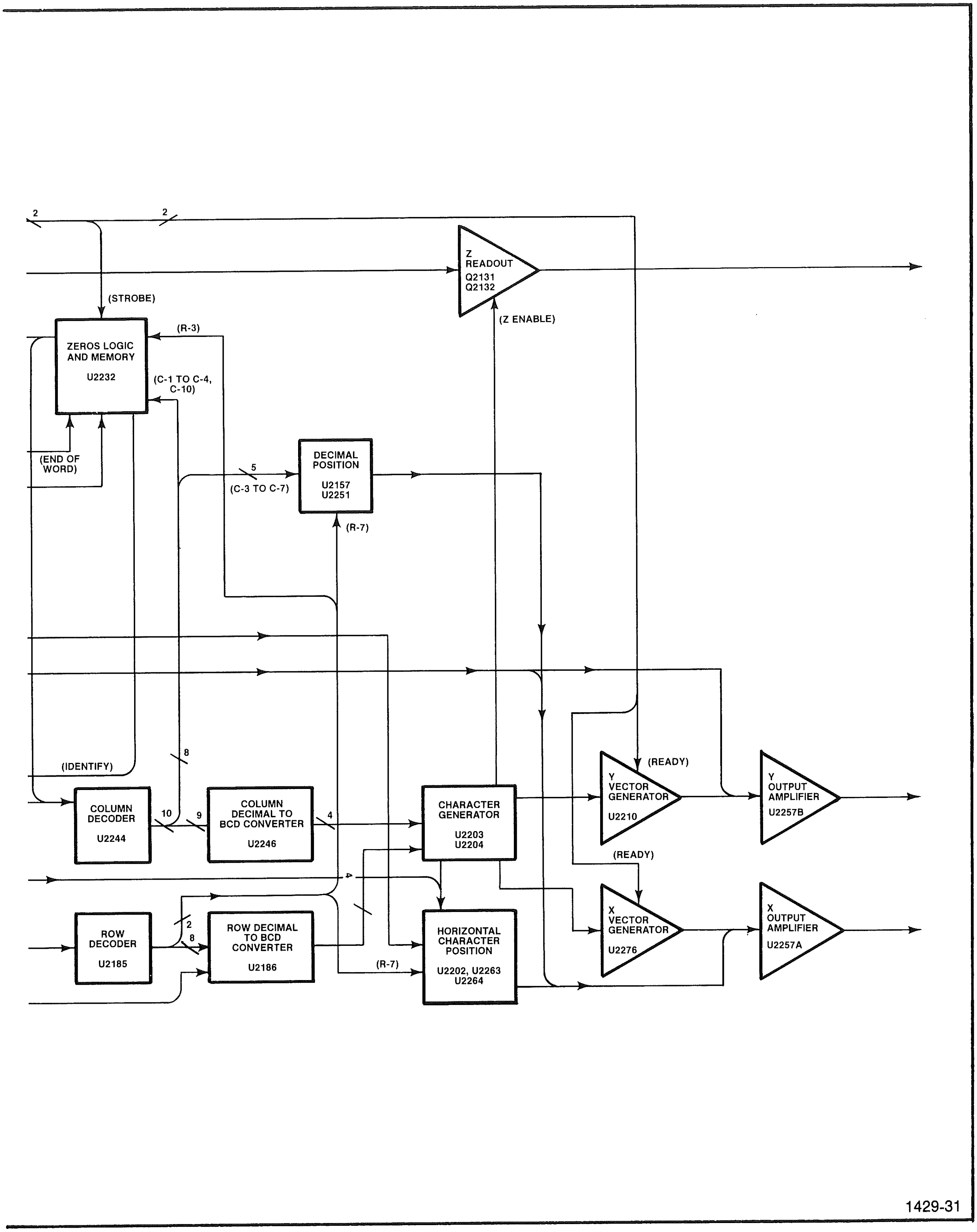


Figure 3-21. Detailed block diagram of 7104 Readout System (SN B053267 & Above).

Pin 16 is a reset input for the Time-Slot Counter. When this pin is held LO, the Time-Slot Counter resets to time-slot 1.

WORD TRIGGER

The Word Trigger U2127B is a single-shot multivibrator that provides a reset pulse for the Horizontal Character Position Counter stage. The negative-going end-of-word pulse from pin 2 of U2159 triggers the single shot and causes its output to go high at pin 11.

CHANNEL COUNTER

Channel Counter U2127A is a binary counter that produces the Channel Address Code for the Column and Row Decoder stages and the Output Amplifier stages. This code instructs these stages to sequentially select and display the 8 channels of data from the plug-ins. Table 3-13 gives the 8 combinations of the Channel Address Code and the resultant channel selected with each combination.

TABLE 3-13
Channel Address Code
SN B053267 & Above

Pin 5 U2127	Pin 4 U2127	Pin 3 U2127	Channel Displayed
LO	LO	LO	Channel 1 Left Vertical
LO	LO	HI	Channel 2 Left Vertical
LO	HI	LO	Channel 1 Right Vertical
LO	HI	HI	Channel 2 Right Vertical
HI	LO	LO	Channel 1 A Horizontal
HI	LO	HI	Channel 2 A Horizontal
HI	HI	LO	Channel 1 B Horizontal
HI	HI	HI	Channel 2 B Horizontal

SINGLE-SHOT LOCKOUT

The Single-Shot Lockout stage allows a single readout frame (8 complete words) to be displayed on the CRT, after which the Readout System is locked out, so further readout displays are not presented until the circuit is reset. Integrated circuit U2120C and U2120B are connected to form a bistable flip-flop. For free-run operation, pin 8 of U2120C is held HI. This activates U2120C and results in a LO output level at pin 10, enabling the Timer stage to operate in a free-running manner.

The output of the Single-Shot Lockout stage remains LO to allow U2126 to operate in the free-running mode until a LO is received at pin 8 of U2120C. When this occurs, the output level at pin 10 of U2120C does not change immediately. However, the Single Shot Lockout circuit is now enabled.

If the Channel Counter has not completed word 8, the Readout System continues to operate in the normal manner. When word 8 is completed, the negative-going end-of-frame pulse is produced at pin 5 of U2127A as the Channel Counter shifts to the code necessary to display word one. This pulse is applied to pin 8 of U2120C, which produces a HI at pin 6 of U2120B because of the momentary LO at pin 9. The HI at pin 6 produces a LO at pin 4, which causes pin 3 of U2120A to go LO. Because pin 2 is already LO, pin 1 goes HI. This disables the Timer stage, so it operates in the Display-Skip mode.

The Single-Shot Lockout stage remains in this condition until a positive-going trigger pulse is applied to pin 2 of U2120A. This trigger pulse produces a LO at pin 1 of U2120A to enable U2126 and disable U2120B. Now, the Timer stage can operate in the normal manner for another complete frame. When word 8 is completed, the Channel Counter produces another end-of-frame pulse to again lock out the Timer stage.

ENCODING THE DATA

Data is conveyed from the plug-in units to the Readout System in the form of an analog (current level) code. The characters that can be selected by the encoded data are shown on the Character Selection Matrix (see Fig. 3-20). Each character requires two currents to define it. These currents are identified as the column current and the row current, corresponding to the column and row of the matrix. The column and row data is encoded by programming the plug-in units. Figure 3-15 shows a typical encoding scheme using resistors for a voltage-sensing amplifier plug-in unit. Notice that the 10 TS (time slot) pulses produced by the Time-Slot Counter stage are connected to the plug-in unit. However, time-slots 5, 6, and 10 are not used by the plug-in unit to encode data when using the Standard Readout Format (See Table 3-11 for Standard Readout Format). The amplitude of the time-slot pulse is exactly −15 volts as determined by the Timer stage. Therefore, the resultant output current from the plug-in units can be accurately controlled by the programming resistors in the plug-in units.

For example, in Figure 3-15 resistors R10 through R90 control the row analog data, which is connected back to the Readout System. Figure 3-16 shows an idealized output current waveform of row analog data resulting from the time-slot pulses. Each of the row-current levels shown in these waveforms correspond to 100 microamperes of current. The row numbers on the left-hand side of the waveform correspond to the rows in the Character Selection Matrix (see Fig. 3-20). The row analog data is connected back to the Readout System via terminal B37 of the plug-in interface.

The column analog data is defined by resistors R110 through R190. The program resistors are connected to the time-slot lines by switch closures to encode the desired data. The data, as encoded by the circuit shown in Figure 3-15, indicates a 100 microvolt sensitivity, with the CRT display showing inverted and calibrated deflection factors. This results in the idealized output current waveforms shown in Figure 3-16 at the column analog data output, terminal A37 of the plug-in interface.

Resistor R111, connected between time-slot 1 and the column analog data output, encodes two units of current during time-slot 1. Referring to the Character Selection Matrix, Figure 3-20, two units of column current, along with the two units of row current encoded by resistor R10 (row 3), indicates that two zeros should be added to the display. Resistor R120 adds one unit of column current during time-slot 2 and, along with the one unit of current from the row output, the Readout System is instructed to add an invert arrow to the display. Resistor R130 is not connected to the time-slot 3 line, since the deflection factor is calibrated. Therefore, there is no display on the CRT during TS-3. (See Display-Skip Generator for further information).

During time-slot 4, two units of column current are encoded by R140. There is no row current encoded during this time-slot, resulting in the numeral 1 being displayed on the CRT. Neither row nor column analog data is encoded during time-slots 5, 6 and 7 as defined by the Standard Readout Format. During time-slot 8, two units of column current and three units of row current are encoded by resistors R181 and R80, respectively. This addresses the μ prefix in the Character Selection Matrix. The final data output is provided from time-slot 9 by R190 connected to the column output and R90 to the row output. These resistors encode two units of column current and four units of row current to cause a V (volts) symbol to be displayed. Time-slot 10 is not encoded, in accordance with the Standard Readout Format. The resultant CRT readout will be 100 μV.

In the above example, the row analog data was programmed to define which row of the Character Selection Matrix was addressed to obtain information in each time-slot. The column data changes to encode the applicable readout data as the operating conditions change. For example, if the variable control of the plug-in unit was activated, R130 would be connected between time-slot 3 and the column analog data output line. This encodes 10 units of column current (see shaded area in time-slot 3 of the waveform shown in Fig. 3-16). Since one unit of row current is also encoded during this time-slot by R30, a $>$ (greater than) symbol is added to the display. The crt readout will now show $>$ 100 μV. In a similar manner, the other switches can change the encoded data for the column output and thereby change the readout display. See the descriptions which follow for decoding this information.

The column analog data encoded by most plug-in units can be modified by attenuator probes connected to the input connectors of amplifier plug-in units. A special coding ring around the input connector of the plug-in unit senses the attenuation ratio of the probe (with readout-encoded probes only). The probe contains a circuit that provides additional column current. For example, if a 10X attenuator probe is connected to a plug-in unit encoded for 100 microvolts as shown in Figure 3-15, an additional unit of current is added to the column analog data during time-slot 1. Since two units of current were encoded by R111, this additional current results in a total of three units of column analog current during this time-slot. Referring to the Character Selection Matrix, three units of column current, along with the two units of row current encoded by R10, indicates that the prefix should be shifted one column to the left. Since this instruction occurs in the same time-slot that previously indicated that two zeros should be added to the display and only one instruction can be encoded during a time-slot, the zeros do not appear in the display. The CRT readout will now be changed to 1 mV (readout program produced by plug-in same as for previous example).

Three other lines of information are connected from the plug-in compartments to the Readout System. The column and row analog data from channel 2 of a dual-channel plug-in are connected to the Readout System through terminals A38 and B38 of the plug-in interface, respectively. Force readout information is encoded on terminal A35 and the function of this input is described under Column and Row Data Switches. The preceding information gave a typical example of encoding data from an amplifier plug-in unit. Specific encoding data and circuitry is shown in the individual plug-in unit manuals.

COLUMN AND ROW DATA SWITCHES

The encoding data from the plug-in units is connected to the Column and Row Data Switch stages. A column-data line and a row-data line convey analog data from each of the 8 data sources (2 channels from each of the 4 plug-in compartments).

The Column Data Switch U2190 and the Row Data Switch U2180 receive the Channel Address Code from the Channel Counter. This binary code directs the Column Data Switch and the Row Data Switch to the channel which should be the source of the encoding data. Table 3-13 gives the eight combinations of the Channel Address Code and the resultant channel selected with each combination. These stages have nine inputs and provide a time-multiplexed output at pin 7, which includes the information from all of the input channels. Eight of the nine inputs to each stage originate in the plug-in units and the ninth input to U2190 comes from a special data-encoding network composed of resistors R2191 through R2199. (See Zeros Logic and Memory description for further information on ninth channel).

In addition to the encoding data inputs from the plug-in units, inputs are provided to the Column Data Switch from the VERTICAL MODE and HORIZONTAL MODE switches to inhibit the readout for any plug-in unit(s) not selected for display. When a unit is not selected, the line corresponding to the opposite channel is HI to forward bias the associated diodes: CR2162 and CR2163, CR2166 and CR2167, CR2170 and CR2171, or CR2174 and CR2175. The forward-biased diodes cause the channel switches to bypass the encoded data from the inhibited channel. However, since it may be desired to display information from special-purpose plug-in units (even through they do not produce a normal waveform display on the CRT), a feature is provided to over-ride the channel inhibit. This is done by applying a LO to the associated Force Readout input. The LO level diverts the HI channel-inhibit current and allows the data from this plug-in unit to reach the Column Data Switch, even though it has not been selected for display by the mode switch.

Row Match adjustment, R2183, sets the gain of the Row Data Switch to match the gain of the Row Decoder for correct output. Column Match adjustment, R2243 performs the same function for the Column Data Switch stage.

DISPLAY-SKIP GENERATOR

The Display-Skip Generator is made up of Q2223, Q2226, Q2227 and Q2229. This stage monitors the time-multiplexed column data at the output of the Column Data Switch during each time-slot to determine if the information is valid data that should result in a CRT display. Quiescently, about 100 microamperes of current flows through R2242 from Q2243 and the Zeros Logic and Memory stage. (The purpose of this quiescent current will be discussed in connection with the Zeros Logic and Memory stage). This current biases Q2223A so that its base is about 0.2 volt more positive than the base of Q2223B in the absence of column data. Therefore, since Q2223A and Q2223B are connected as a comparator, Q2223A will remain on unless its base is pulled more negative than the base of Q2223B.

The analog data output from the Column Data Switch produces a 0.5 volt (approximately) change for each unit of column current that has been encoded by the plug-in unit. Whenever any information appears at the output of the Column Data Switch, the base of Q2223A is pulled more negative than the base of Q2223B, resulting in a negative (LO) Display-Skip output to the Timer stage through Q2229. Recall that a LO was necessary at the skip input of the Timer so it could perform the complete sequence necessary to display a character.

Transistors Q2226 and Q2227 also provide Display-Skip action. The end-of-word level connected to their emitters is LO only during time-slot 1. This means they are enabled only during this time-slot. These transistors allow the Zeros Logic and Memory stage to generate a Display-Skip signal during time-slot 1 when information that is not to be displayed on the CRT has been stored in memory (further information is given under Zeros Logic and Memory).

COLUMN AND ROW DECODERS

The Column Decoder U2244 and Row Decoder U2185 sense the magnitude of the analog voltages at their inputs (pin 10) and produce a binary output on one of ten lines corresponding to the column or row data encoded by the plug-in unit. These outputs provide the Column Digital Data and Row Digital Data, which is encoded by the Decimal-to-BCD converters to create the address used by the Character Generator in determining which character will be displayed. The column and row data is also used throughout the Readout System to perform other functions.

The input current at pin 9 of the Column Decoder stage is steered to only one of the ten Column Digital Data outputs. When a Display-Skip signal is present (collector of Q2229 HI), pin 9 is pulled HI through CR2229. This ensures that no current is connected to the Character Generator stage under this condition. Notice the corresponding input on the Row Decoder. This input is connected to ground and causes only one of the ten row outputs to saturate to ground.

The network at the input of the Row Decoder, made up of Q2181 and its associated components, is a Row-14 detector that produces the Jump Command. This row current is encoded by special-purpose plug-ins to cause all or part of a word to be jumped. Whenever row 14 (13 units of row current, or 1.3 millampleres) is encoded, the base of Q2181 pulled negative enough so that this transistor is forward biased to produce a LO Jump Command output at its emitter. The Jump Command is connected to the set input of RS flip-flop U2162B, whose reset input is connected to the Trigger Signal from pin 5 of the Timer. When the Jump Command and Trigger inputs are low, U2162B produces a LO output to reset the time-slot Counter as well as advancing the Horizontal Character Position Counter and the Channel Counter. U2162B also produces a HI output to signal Display Skip at pin 4 of the Timer.

ZEROS LOGIC AND MEMORY

The Zeros Logic and Memory stage U2232 stores data encoded by the plug-in units to provide zeros-adding and prefix-shifting logic for the Readout System. The Strobe pulse at pin 15 goes positive when the data has stabilized and can be inspected. This activates the Zeros Logic and Memory stage so that it can store the encoded data.

Typical output waveforms of the five possible input conditions that can occur are shown in Figure 3-17. When time-slot 1 occurs, a store command is given to all of the memories. If the plug-in units encoded data for column 1, 2, 3, 4, or 10 during time-slot 1, the appropriate memory (or memories) is set. Notice that row 3 information from the Row Decoder must also be present at pin 16 for data to be stored in the memory of U2232.

If data was encoded during time-slot 1, a negative-going output is produced at pin 7 while the memories are being set. This negative-going pulse is connected to the base of Q2229 in the Display-Skip Generator to produce a Display-Skip output. Since the information encoded during time-slot 1 was only provided to set the memories and not intended to be displayed on the CRT at this time, the Display-Skip output prevents a readout display during this time-slot.

During time-slot 5, a memory within U2232 is interrogated. If information was stored in this memory, a positive-going output is produced at pin 7. This pulse is connected to pin 10 of the Column Decoder through Q2243 to add one unit of current at the input of the Column Decoder. This produces a zero after the character displayed during time-slot 4. During time-slot 6, another memory within U2232 is interrogated to see if another zero should be added. If another zero is necessary, a second positive output is produced at pin 7, which again results in a column 1 output from the Column Decoder and a second 0 in the CRT display.

Finally, another memory within U2232 is interrogated during time-slot 8 to determine whether the prefix should be changed, or left at the value that was encoded. If data has been encoded that calls for a shift in prefix, a negative-going output level is produced at pin 7. This negative level subtracts one unit of column current from the data at the input to the Column Decoder. Notice, on the Character Selection Matrix of Figure 3-20, that when row 4 is programmed, a reduction of one column results in a one-column shift of the prefix. For example, with the 100 μV program shown in Figure 3-15. If the data received from the plug-in called for a shift in prefix, the CRT readout would be changed to 1 mV (zeros deleted by program; see Encoding the Data).

The 100 microamperes of quiescent current through R2242 provided by Q2243 (see Display-Skip Generator) allows the prefix to be shifted from m (100 microamperes of column current, column 1) to no prefix (0 column current, column 0) so only the unit of measurement encoded during time-slot 9 is displayed. Notice that reducing the prefix program from column 1 to column 0 programs the Readout System to not display a character at this readout location.

A further feature of the Zeros Logic and Memory is the Identify function. If 10 units of column current are encoded by the plug-in unit along with row 3 during time-slot 1, the Zeros Logic and Memory produces a negative-going output pulse at pin 1 to switch the Column Data Switch and Row Data Switch to the ninth channel. Then, time-slot pulses 2 through 9 encode an output current through resistors R2191 through R2199 for column data and enable pin 10 of U2186. This provides the addresses necessary to display the word IDENTIFY in the word position allotted to the channel that originated the Identify command. After completion of this word, the Column Data Switch and Row Data Switch continue with the next word in the sequence.

The end-of-word signal from the Time-Slot Counter is connected to pin 9 of U2232 through C2239. At the end of each word of readout information, this pulse goes LO. This erases the four memories in the Zeros Logic and Memory in preparation for the data to be received from the next channel.

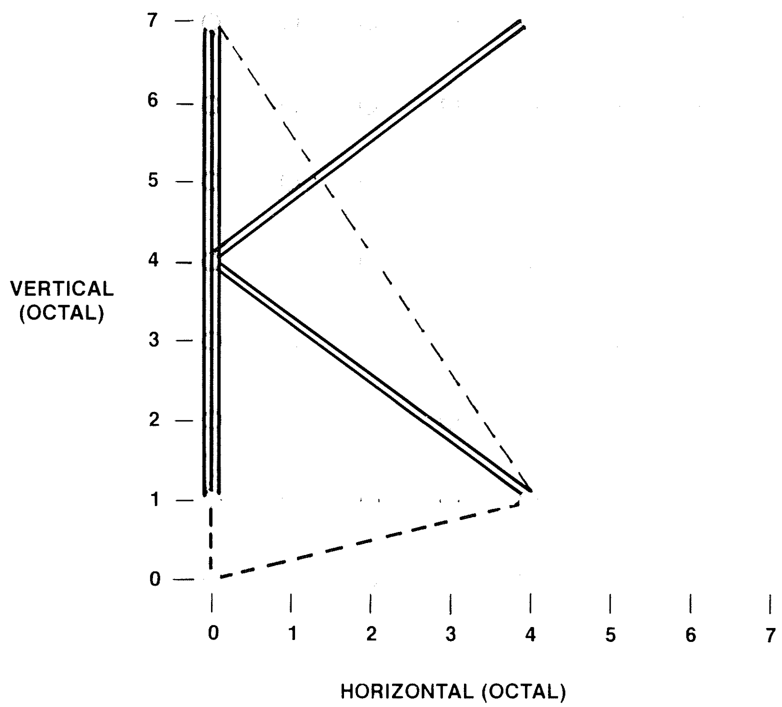
CHARACTER GENERATOR

Each character to be displayed on the instrument CRT consists of a series of connecting points developed on a possible 8-point by 8-point grid (see Fig. 3-22). The 8-bit binary output from the Character Generator is used to determine the location of points within the grid, whether or not to provide a trace connecting two points, and the point at which a character has been completed. The Character Generator stage consists of an oscillator, the Lower Order Address Generator, and an EPROM connected to a latch.

Q2151 and Q2152 form a square-wave oscillator whose frequency is adjustable with C2155 to provide 16 cycles within the time allotted for developing a character. The base of Q2152 goes LO when the Timer produces a negative going Ready pulse at pin 13. This starts the oscillator by turning Q2152 on. The emitter of Q2151 becomes more negative as C2154 and C2155 discharge through R2154. The capacitors continue to discharge until the emitter-base junction of Q2151 becomes forward biased. Q2151 then begins to conduct and causes the oscillator to begin changing states. As Q2151 conducts, the discharge through C2154 and C2155 stops and causes a collector current reduction in Q2152. The current reduction causes the emitter and base of Q2152 to rise positive which pulls the emitter of Q2151 along with them through C2154 and C2155. This positive shift on the emitter of Q2151 turns it off. Now with C2151 conducting and Q2152 turned off, the voltage on the emitter of Q2152 begins to go negative with C2154 and C2155 beginning to charge through R2155. When the emitter-base junction of Q2152 becomes forward biased, the oscillator again changes states and completes one cycle.

The signal produced by the oscillator at the collector of Q2152 switches Q2153 on and off to create the clock pulses used by the Lower Order Address Generator and the EPROM latch. The oscillator will continue to run until the Timer Ready output at pin 13 goes positive and pulls up the base of Q2152.

The Lower Order Address Generator is a 4-bit binary counter and consists of U2202B. The negative going Timer Ready pulse is inverted by Q2142 and used to reset U2202B. The oscillator is also enabled by the Ready signal and begins providing the clock input at pin 13. The counter then begins at 0000 and counts at the frequency of the oscillator, continuing to do so until the Ready signal goes positive. The Lower Order Address Generator's 4-bit output is connected to the four lower order address inputs on the Character Generator, U2203.



"K" CHARACTER				
CHARACTER GENERATOR ADDRESS (HEXIDECIMAL)	CHARACTER GENERATOR OUTPUT BINARY 8 7 6 5 4 3 2 1	CHARACTER GENERATOR OUTPUT OCTAL	BIT 7 MOVE - - - - DRAW ———	BIT 8 END OF CHARACTER?
B 9 0	0 0 0 0 0 0 0 0	0 0 0	MOVE	NO
B 9 1	0 0 0 0 1 0 0 0	0 1 0	MOVE	NO
B 9 2	0 1 1 1 1 0 0 0	1 7 0	DRAW	NO
B 9 3	0 1 0 0 1 0 0 0	1 1 0	DRAW	NO
B 9 4	0 1 1 1 1 0 0 0	1 7 0	DRAW	NO
B 9 5	0 0 0 0 1 1 0 0	0 1 4	MOVE	NO
B 9 6	0 1 1 0 0 0 0 0	1 4 0	DRAW	NO
B 9 7	0 1 1 1 1 1 0 0	1 7 4	DRAW	NO
B 9 8	0 1 1 0 0 0 0 0	1 4 0	DRAW	NO
B 9 9	0 1 0 0 1 1 0 0	1 1 4	DRAW	NO
B 9 A	1 0 0 0 0 0 0 0	2 0 0	MOVE	YES

Figure 3-22. Developing a typical character on the crt (SN B053267 & Above).

U2204 is an octal D-type flip-flop used as a latch to stabilize and synchronize the Character Generator EPROM output. It is reset by the same signal that starts the oscillator and is clocked at pin 11 by the oscillator output from Q2153. Q2204 will be considered to be part of the Character Generator in the discussion that follows.

The Character Generator U2203 is a 4k X 8-bit EPROM which contains the binary words used by the output stages in creating the signals necessary to form readout characters. There are twelve address inputs, with the lower four coming from the Lower Order Address Generator, the center four from the Column Decimal-to-BCD Converter, and the upper four from the Row Decimal-to-BCD Converter. As previously mentioned, each character is developed on an 8-point by 8-point grid (see Fig. 3-22 for a typical character). The Character Generator's 8-bit output provides the information necessary to move the instrument beam around within the grid, to turn the beam on and off, and to indicate when a character is complete.

The row and column data cause a 4-bit binary code to be generated at the outputs of the Row and Column Decimal-to-BCD Converters when a readout character is to be displayed. The Lower Order Address Generator is enabled and also provides a 4-bit binary code. These twelve bits are combined to form the EPROM address containing the 8-bit binary word which will locate the instrument beam at the character's starting grid location.

The 8-bit word can be broken down into four parts. The lower three bits are the horizontal grid coordinate, bits 4 through 6 are the vertical coordinate, bit 7 turns the Z Readout on and off, and bit 8 indicates whether or not the character is complete.

The character grid (Fig. 3-22) can be thought of as having vertical and horizontal coordinates numbered 0 through 7, with location "0,0" in the lower left corner. The 8-bit binary word from the Character Generator is converted to octal to easier recognize the vertical and horizontal coordinates. A binary "00001010" becomes octal "012". This number would cause the instrument CRT beam to point at grid coordinates vertical "1" and horizontal "2". The fact that the first octal digit is "0" indicates two things. First it shows that bit 7 of the binary word is LO which turns off Q2132 and the Z Readout signal to the instrument. It also shows that bit 8 is LO so the character is not complete. When bit 7 is HI, it advances the Horizontal Character Position Counter for the next character within the readout word.

The 4-bit outputs from the Row and Column Decimal-to-BCD Converters remain the same until the character is complete. However, the Lower Order Address Generator keeps counting and combines with the Row and Column Decimal-to-BCD Converter's outputs to address all the EPROM locations necessary to form the readout character.

Suppose the next address produces a Character Generator output of "01111010" or octal "172". The octal digit "1" indicates binary bit 7 is high which will turn on Q2132 and the Z Readout output to the instrument. The instrument will now provide a trace from the previous vertical and horizontal coordinates to the new ones, vertical "7" and horizontal "2". Thus the character is formed by a series of binary words causing the instrument CRT beam to move or draw between points.

HORIZONTAL CHARACTER POSITION COUNTER

The Horizontal Character Position Counter U2202A is a 4-bit binary counter. Its output is converted to current by R2266 through R2269 and added to the X (horizontal) signal for spacing readout characters horizontally on the CRT. The counter is reset to "0000" with a Word Trigger pulse from U2127B and is advanced with inputs from two possible sources. The first is a HI End-of-Character signal from pin 19 of U2204. The counter can also be advanced when a Space instruction is encoded by the plug-in unit to cause a space to be left between two characters on the CRT. A Space instruction occurs when row 10 from the Row Decoder goes LO and is inverted by U2157D to advance the Horizontal Character Position Counter. No character could be displayed in this situation as no character information is stored at the Character Generator addresses formed using row 10.

Time slots 1, 2, and 3 are also connected to the Space instruction through VR2185, VR2186, and VR2187 respectively. This configuration adds a space to the displayed word during time slots 1, 2, and 3, even if information is not encoded during these time slots. With this feature, the information which is displayed during time-slot 4 (1-2-5 data) always starts in the fourth character position whether data has been displayed in the previous time-slots or not. Therefore, the resultant CRT display does not shift positions as normal/invert or cal/uncal information is encoded by the plug-in.

DECIMAL POSITION LOGIC

The Decimal Position Logic stage allows decimal points to be displayed at five possible locations within a readout word (see Fig. 3-18). The decimal location encoded by a plug-in during time-slot one is achieved by adding positioning current to the X (horizontal) readout signal. Circuitry for this stage includes five 2-input NOR gates in U2157 and U2251 with precision resistors connected to their outputs. One input of each NOR gate is connected to row 7 on the Row Decoder and the other to one of columns 3 through 7 on the Column Decoder. When a decimal is to be displayed, row 7 goes LO and disables the Horizontal Character Position

Counter by keeping the four outputs of U2264 LO. It also sets one input of each of the five NOR gates to LO. One of columns 3 through 7 also goes LO, depending on which decimal position is encoded, causing the NOR gate to which it's connected to go HI. This high adds current to the X (horizontal) signal in the amount determined by the resistor connected to the NOR gate's output. Each Character Generator location addressed by row 7 and column 3 through 7 contains information necessary to form a decimal point on the CRT in the position indicated. The Horizontal Character Position Counter resumes normal operation and the Decimal Position Logic is disabled when row 7 goes back up at the end of the time-slot.

Some plug-ins require decimal points at locations in the readout word other than the five provided by the Decimal Position Logic stage. An additional decimal point can be displayed in any position normally available to characters by encoding row 8 with column 9. The Horizontal Character Position Counter provides positioning current in this mode and the Decimal Position Logic stage is disabled.

X AND Y VECTOR GENERATORS

The Y Vector Generator is in two stages and consists of U2210A and B. Vertical character size adjustment is provided with R2210 as a variable feedback resistor for U2210A. Input to the Vector Generator is provided by the three bits of vertical character information from pins 9, 12, and 15 of the Character Generator latch U2204. The digital highs and lows across R2206, R2207 and R2208 are mixed as stepped current levels at pin 2 of U2210A. These sudden analog steps are converted into a smooth transition from one level to the next by RCL network R2212, C2212, and L2212. U2210B current buffers the resulting signal to be mixed with the Channel Counter vertical information at the input of the Y Output Amplifier.

The X Vector Generator operates similarly to the Y Vector Generator. Gain for the stage is fixed by the circuit components and its output is current buffered to be mixed at the input of the X Output Amplifier.

X AND Y OUTPUT AMPLIFIERS

The Y Output Amplifier provides the Y (vertical) signal to the instrument by combining the signal from the Y Vector Generator with the channel 1 or 2 information from the Channel Counter. The amplifier consists of U2257B with Q2255 in its input circuit. Amplifier gain is adjustable with R2260 to control the vertical separation between readout words displayed at the top and bottom of the graticule area. Q2255 switches the amplifier input on and off with the Timer Ready signal, using Q2250 to provide impedance matching. The channel 1 or 2 information from pin 3 of the Channel Counter U2127A is inverted by U2251A and converted to current by R2252 and R2253. The Channel Counter produces a LO at pin 3 when the readout word is to be displayed at the top of the graticule. The LO is inverted to HI by U2251A and adds current to the Y (vertical) readout signal.

The X Output Amplifier consists of U2257A and Q2296. It operates similarly to the Y Output Amplifier to provide the X (horizontal) signal to the instrument. Input to the amplifier is a combination of outputs from the X Vector Generator, Horizontal Character Position Counter, Decimal Position Logic, and horizontal word position information from the Channel Counter. The gain of this stage is fixed by the resistor values in the circuit.

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SIGNALS OUT

The Signals Out circuit provides the + SAWTOOTH and + GATE signals to the front panel. These output signals are samples of signals from the associated time-base units.

A schematic diagram of the signals Out circuit is given on diagram 7, in Section 8 of this manual (Diagrams and Circuit Board Illustrations). The schematic is divided by gray shaded lines separating the circuitry into major stages. These stages aid in locating components mentioned here. Sub-headings in the following discussion use the stage names to further identify portions of the circuitry on diagram 7.

+ SAWTOOTH AMPLIFIER

The sawtooth signals from the A and B time-base units are connected to the Sawtooth Amplifier stage through series resistors R93 and R95 respectively (see diagram 3). The front-panel selector switch, S1930, determines whether the A-sweep or the B-sweep sawtooth signal provides the + SAWTOOTH signal. The unused sawtooth signal is terminated by R1941.

Transistors Q1943-Q1942-Q1946 form an inverting feedback amplifier. Gain of the stage is about 2, as determined by the ratio of feedback resistor R1944 to the input resistance (made up of R1940 and on diagram 3, either R93 or R95 depending on which sawtooth source is selected).

+ GATE AMPLIFIER

The front-panel + GATE switch (S1940) selects the gate signal from either A or B time-base unit. The unused + gate is terminated in R1931. Before a gate occurs, Q1934 is biased off and Q1938 is conducting; its collector potential is low enough to cut off Q1928. When a gate occurs, it is coupled to the base of Q1934, causing it to conduct thereby cutting off Q1938. The current through R1911 now flows through Q1928 to produce the + GATE signal. The signal at the collector of Q1934 is picked off to drive the Graticule Illumination stage and/or the readout system in PULSED mode.

GRATICULE ILLUMINATION

Variable resistor R1900 (GRAT ILLUM) determines the brightness of the graticule lights (except when in the PULSED position) by controlling the output of the graticule light supply (see LV Regulators, diagram 15). Variable resistor R1902 (GRAT ILLUM PRESET) determines the brightness of the graticule lights when the GRAT ILLUM control is set to PULSED. In the PULSED mode, the graticule lights are gated on for approximately 0.5 seconds. Programmable unijuction transistor Q1908, in conjunction with Q1910, generates the pulse to turn the graticule lights on. A negative signal (from the MAN pushbutton, the + Gate or from an external input) will cause Q1908 to conduct and start discharging C1908. At this time, Q1910 turns off, which allows R1902 to control the output of the graticule light supply. Capacitor C1908 discharges until Q1908 cannot maintain conduction. As Q1908 turns off C1908 begins to charge positive until the zener voltage of VR1910 is reached which turns on Q1910; its collector then goes negative to turn the graticule light supply off. When in the PULSED mode and operating from the + GATE source, the graticule lights will turn on momentarily at the trailing edge of the + GATE (end of each sweep).

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VERTICAL CHANNEL SWITCH

The Vertical Channel Switch circuit selects the vertical deflection signal from the output of the LEFT and/or RIGHT VERT plug-in compartment(s) for display on the crt.

A schematic diagram of the Vertical Channel Switch is given on diagram 8, in Section 8 of this manual (Diagrams and Circuit Board Illustrations). The schematic is divided by gray shaded lines separating the circuitry into major stages. These stages aid in locating components mentioned here. Sub-headings in the following discussion use the stage names to further identify portions of the circuitry on diagram 8.

CHANNEL SWITCH

The vertical deflection signal from the left and right vertical plug-in units is either terminated within the stage or coupled through the stage as determined by the Vertical Channel Selector stage. The Channel Switch stage is made up primarily of integrated circuit U668. Inputs 7 and 9 provide a differential input for the signal from the right vertical plug-in unit. Input pins 17 and 19 provide a differential input for the signal from the left vertical plug-in unit. The differential output signal at pins 3 and 13 is connected to J694 and J592 respectively.

Components U682, Q682, Q676, and Q672 supply standing current to U668 and maintain the output common-mode dc level at +8.5 volts for all Channel Switch modes. The common-mode level at pins 3 and 13 of U668 is sensed by R559-R659, and compared with a reference level determined by divider R680-R681. Assume, for example, that pin 2 of U682 is lower than pin 3, indicating an output level below +8.5 volts. The output of U682 at pin 6 will be driven positive and current will flow in R683. This current must be supplied from the +15 V supply via R682, thereby lowering the base voltage of Q682. This increases the collector current in Q682. Transistor Q676 operates as a common-base amplifier and passes along the increased collector current to pin 3a of U668. This increases the output common-mode level, thus bringing U682 into balance. The voltage at pin 3a of U668 depends on the Channel Switch mode: in LEFT, RIGHT, ALT, or CHOP pin 3a is at +10.5 V; in ADD it is +12.5 V; when X-Y Inhibit is HI, pin 3a is +8.5 volts. In all modes, the current supplied by Q676 is 160 milliamperes plus or minus small variations required to keep the output level at +8.5 volts.

VERTICAL CHANNEL SELECTOR

The Vertical Channel Selector interfaces the Channel Switch, U668, to the logic signals arriving from the Main Interface. The Channel Switch stage requires two pairs of complementing control voltages; one pair for each channel. The HI control voltage is +4.0 V, the complementing LO voltage is +3.5 V. To select a channel, the HI level must be applied to the On input of U668 (pin 2 for LEFT, and pin 12 for RIGHT VERTICAL MODE switch positions) and the LO level must appear at the OFF input (pin 1 for LEFT, and pin 11 for RIGHT VERTICAL MODE switch positions). To inhibit a channel the control voltages should be reversed.

When the VERTICAL MODE switch is set to LEFT the Display Right line, entering on P680 pin 6, is set LO (-0.6 V), the Add line (P680 pin 5) is LO (0 V) and, normally, X-Y Inhibit is LO (-0.6 V). Transistors Q652, Q658 and Q558 are turned on; Q656 and Q556 are off. The result is pins 1 and 12 of U668 are pulled down to +3.5 V but pins 2 and 11 are only pulled down to +4.0 V. Consequently, the LEFT VERT channel is turned on while the RIGHT VERT channel is turned off. Signals appearing at J602 and J603 are amplified and fed to the outputs at J592 and J694. Similarly, if Display Right is HI (+1 V), the RIGHT VERT channel is turned on and LEFT VERT channel off. RIGHT VERT channel signals are amplified and fed to the outputs. LEFT VERT channel signals are terminated within U668.

When the VERTICAL MODE switch is set to either ALT or CHOP, the Display Right signal line switches between the LO and HI levels at a rate determined by either the Chop Counter or Vertical Binary stages (see Logic description diagram 4). This action displays the signal from the left vertical unit when the Display Right signal line is LO and displays the signal from the right vertical unit when the signal line is HI.

When ADD vertical mode operation is selected, the Add signal line is HI, and the Display Right signal is LO. This allows both the right and left vertical signals to pass to the output of U668. The signals from both vertical units are algebraically added and the resultant signal determines the vertical deflection. The X-Y Inhibit command has absolute control over the output of the Channel Switch stage. Quiescently, this signal is LO; however when the Readout System is ready to display information on the crt, this level goes HI, to block the signals from both vertical units.

When X-Y Inhibit is HI (+1 V) Q652 is turned off. Current in R653 now flows through CR552 and CR654 lowering the base voltage of Q556 by one diode drop, and that of Q658 by two diode drops. This ensures that Q558 and Q656 are turned on regardless of the state of Display Right or Add.

RIGHT AND LEFT CHANNEL FEEDBESIDE

The operation of the Left and Right Channel Feedbeside stages are identical. Therefore, only a discussion of the Right Channel Feedbeside is given.

The function of the Feedbeside stage is to compensate for low-frequency imperfections in the frequency response of the Channel Switch stage, U668. Self heating of the transistor base-emitter junction, in some transistors within U668, causes the low-frequency gain to appear larger than the midband gain. To correct this, a portion of the input signal is picked off through R502 and R504 and applied to U508. This differential signal is converted to a single-ended signal and distributed into four RC (resistive-capacitative) networks, each having a different time constant. Variable components R512, R515, R520, R525, R530, and C538 are adjusted to provide an accumulated waveform. This waveform is converted to a paraphase signal by U538, Q542 and Q548, and is then injected into U668 through pins 6 and 4, where it is subtracted from the signal entering U668 at pins 7 and 9. Proper adjustment results in flat-frequency response and optimum-transient response at the output pins 3 and 13.

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VERTICAL AMPLIFIER

A schematic diagram of the Vertical Amplifier is given on diagram 9, in section 8 of this manual (Diagrams and Circuit Board Illustrations). The schematic is divided by gray shaded lines separating the circuitry into major stages. These stages aid in locating components mentioned here. Sub-headings in the following discussion use the stage names to further identify portions of the circuitry on diagram 9.

The Vertical Amplifier circuit provides final amplification for the vertical signal received from delay-line DL694 before it is applied to the crt vertical deflector. In addition, low-frequency signals to provide the VERT TRACE SEPARATION (B) function and crt scale factor readout are accepted at the Aux Y-Axis and Y Readout inputs, respectively. The vertical portion of the BEAMFINDER function is also handled in the Vertical Amplifier.

DELAY-LINE COMPENSATION

Delay-line DL694 delays the vertical signal approximately 51 nanoseconds to allow the horizontal circuits time to initiate a sweep before the vertical signal reaches the crt vertical deflector. This allows the instrument to display the triggering event when using internal triggering. The delay-line is composed of a matched pair of 50 ohm coaxial cables. The signal from the delay lines is coupled on to the 50 Ω microstrip via J702 and J704. Transient response front-corner adjustment is provided by RLC network R705, C705 and parasitic inductance of C705.

Hybrid circuit U762 and its associated circuitry provides frequency compensation to offset delay line losses due to "skin-effect" in the cable. This compensation is achieved by attenuating the signal at low-frequencies approximately 4.8 dB. At high frequencies (above 1.5 gigahertz) the signal passes with little attenuation. Hybrid circuit U762 also terminates the delay line in its characteristic impedance (50 ohms) for frequencies greater than about 50 MHz. At dc, U762 presents an impedance of 41 Ω to each cable; reverse termination of U668. Vertical Channel Switch, prevents standing waves below 50 MHz.

OUTPUT AMPLIFIER

The Output Amplifier consists of 2 thin-film, hybrid wideband amplifiers, U842 and U862, and their associated bias circuitry. These amplifiers provide a voltage gain of approximately 4.5 each, resulting in an overall voltage gain from J702 and J704 to the crt vertical deflector of about 11. All signal path interconnections between and within hybrids are made with 50 ohm strip transmission lines via the HYPCON system.

Integrated circuit U842 receives the delayed and compensated signal from U762 at input pins 7 and 9. Variable resistor R855 provides Vertical Amplifier gain adjustment by shunting the differential signal. Trimmer R836 is a transient response adjustment effective in the first 10 nanoseconds of the step response. The output of U842 is fed through level shifters VR852 and VR862 to U862. Bias current for U842 is supplied by Q892 and R893 through U862. Active devices Q892, U876B and associated circuitry operate as a power supply with (negative) output impedance of 25 ohms. This supply acts to maintain a constant common-mode dc level at the input to U862 regardless of current demand from U842.

Bias levels for U862 are provided by U876A. Diode CR875 temperature compensates the +23.9 V supply to maintain constant standing current in U862.

FEEDBESIDE

The function of the Feedbeside stage is to compensate for low-frequency imperfections in the frequency response of the Output Amplifier stage, U842 and U862. Self heating of the transistor base-emitter junction, in some transistors within U842 and U862, cause the low-frequency gain to appear larger than the midband gain. To correct this, a portion of the input signal is picked off via the Delay Line Compensation stage and applied to U782. The paraphase signal is converted to a single-ended signal by U782 and distributed into six RC (resistive-capacitive) networks, each having a different time constant. Resistors R785, R787, R791, R795, R801, R806, and Capacitor C808 are adjusted to provide an accumulated waveform. This waveform is converted to a paraphase signal by U808, Q824, and Q814, and is then injected into U842 through pins 1 and 5, where it is subtracted from the signal entering U842 at pins 7 and 9. Proper adjustment of the seven RC components results in a flat-frequency response and optimum-transient response at the output of U862 (pins 17 and 19).

Diodes CR767 and CR777 improve the vertical amplifier overdrive recovery by limiting the amplitude of the feedbeside-correction signals that exceed the dynamic range of the Output Amplifier. Thermistor RT813 adjusts the gain of the feedbeside amplifier to provide increased correction at high ambient temperature where transistor self-heating is aggravated.

AUXILIARY AMPLIFIER

The Auxiliary Amplifier is used to inject low-frequency (≤ 2 MHz) signals associated with crt scale-factor readout and alternate sweep switching into the vertical deflection system. Normally, the X-Y Inhibit signal entering on pin 8 of P789 is LO (-0.6 V), Q722 and Q712 are off, and Q732 is on. The Aux Y-Axis signal (trace separation) on pin 1 of P790 is coupled through Q732 to the input of paraphase amplifier Q742 and Q752. Transistors Q748 and Q758 form a shunt-feedback amplifier with sufficient gain to drive the inputs of U762 (pins 5 and 11).

When the Readout System initiates a character display, it sets the X-Y Inhibit logic level HI (+1 V). Emitter follower Q718 turns Q722 on. The voltage on the collector of Q772 drops to zero which turns Q732 off and turns Q712 on. The Aux Y-Axis signal is then blocked by Q732. Y Readout signals are inverted by U705. Readout centering is added to the composite readout signal and then applied to the input of the paraphase amplifier via Q712. At the end of the character display period X-Y Inhibit returns to -0.6 V.

OUTPUT AMPLIFIER

The BEAMFINDER switch when depressed changes the current source for U862 to provide the BEAMFINDER function. Normally, the current source for U862 is supplied from the +15 V supply through Q862 and R862. However, when the BEAMFINDER switch is actuated, Q862 is turned off so the only current source for U862 is through R862. This limits the dynamic range of the stage by limiting its available current, so the display is compressed vertically within the crt graticule area.

Components Q878, VR878, and R878 clamp the output dc common-mode level to less than 44 V when the BEAMFINDER switch is depressed.

The signal at the output of U862 (pins 17 and 19) is connected via a flexible coplanar transmission line to the crt vertical deflector neck pins. A distributed deflector is used in the crt for maximum bandwidth. The signal travels along the deflector at a velocity essentially the same as the velocity of the electron beam passing through the vertical deflector. This synchronism of the deflection signal and the electron beam reduces the loss in high-frequency sensitivity due to electron-transit time through the deflector. After propagating along the deflector, the signal exits the crt via a second flexible coplanar transmission line and terminates in U883. A double-terminated transmission-line system, with a characteristic impedance of 200 ohms side-to-side, is formed by the output of U862, the two flexible lines, the crt vertical deflector, U883, and the crt vertical termination. Standing current for U862 is supplied from +50 V supply via U883 and the crt deflector transmission-line system.

POWER SUPPLY SHUTDOWN

The 23.9 V supply is monitored by the Power Supply Shutdown stage. When this voltage drops significantly, indicating an overload condition, Q864 will turn on pulling the gate of Q873 positive to cause Q873 to turn on. This action overloads the +50 V power supply which in turn causes the high-efficiency power supply to shutdown.

A drop in the +23.9 V supply may indicate either an open connection or a short to ground in the crt deflector transmission line system (or supply). The latter case is particularly serious and may damage U862, even with the Power Supply Shutdown stage operating. For this reason, care should be taken not to short or open the crt deflector connections when the instrument power is on.

The Power Supply Shutdown circuit also accepts an input from the Horizontal Amplifier circuit (diagram 11) via a thermal cutout, from pin 10 of P782. This input is normally about +14.8 V but will decrease if a fault occurs in the Horizontal Amplifier or if the thermal cutout opens. The latter case indicates excessive temperature in the Horizontal and Vertical Amplifier circuits which will significantly reduce amplifier operating life. The thermal cutout will open at about +55° C ambient if the fan is operating properly or at +35° C ambient if the fan is disabled or totally blocked.

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HORIZONTAL CHANNEL SWITCH

A schematic diagram of the Horizontal Channel Switch is given on diagram 10, in Section 8 of this manual (Diagrams and Circuit Board Illustrations). The schematic is divided by a gray shaded line separating the circuitry into major stages. These stages aid in locating components mentioned here. Sub-headings in the following discussion use the stage names to further identify portions of the circuitry on diagram 10.

The Horizontal Channel Switch circuit determines whether the signal from the output of the A horizontal or B horizontal plug-in unit provides the horizontal deflection signal. This circuit also accepts an input from the Readout System (diagram 6) which blocks the horizontal signal while the readout display is presented on the crt.

CHANNEL SWITCH

The Channel Switch stage consists primarily of U962. The differential horizontal signal from the A HORIZ plug-in compartment is applied to pins 17 and 19. The differential horizontal signal from the B HORIZ plug-in compartment is applied to pins 7 and 9. The Display B control signal determines whether the A or B horizontal signal is coupled to the output pins 3 and 13.

Integrated circuit U962 has a standing current of approximately 37 milliamperes for each channel. The standing current in channel A is the quiescent current drawn by current sinks Q992 and Q994, and by R998 and R999. The standing current in channel B is the quiescent current drawn by current sinks Q962 and Q964, and by R968 and R969. The standing current in both channels is summed together in U962 and flows out of pins 3 and 13. This current is also the standing current for U1018 (see diagram 11), the Input Clamp. It is important to notice that the current sinks described above control the standing currents in both channels of the Channel Switch and the Input Clamp. This current comes from the +15 V supply primarily through R1047, R1043, R1067, and R1063 at the Channel Switch stage output. Thus the current sinks described above affect dc levels from the Channel Switch stage to the input of U1082.

HORIZONTAL CHANNEL SELECTOR

The Horizontal Channel Selector stage interfaces the Channel Switch stage, U962, to the logic signals arriving from the Main Interface (diagram 3). The Channel Switch stage requires two pairs of complementary control voltages, one pair for each channel. A HI control signal is +3.3 volts (emitter voltage of Q914). The complementary LO control signal is about +1.9 volts. To select a channel, the HI voltage is applied to the On input of U962 (pin 2 for Ch A, pin 12 for Ch B), and the LO voltage to the Off input (pin 1 for Ch A, pin 11 for Ch B).

When the HORIZONTAL MODE switch is set to B, the Display B line is HI (+1.1 V). This voltage is applied to one input, Q924C, of the differential pair (Q924C and Q924D) controlling the channel A input. Transistor Q924C is turned on and Q924D is turned off thereby inhibiting channel A. The LO level at the collector of Q924C turns Q924E off and Q924B on, turning on channel B. When channel A is selected the Display B line is LO (-0.6 V), the opposite transistor in the two differential pairs above are on, and channel A is turned on, with channel B inhibited.

When the HORIZONTAL MODE switch is set to ALT or CHOP, the Display B signal switches between the HI and LO levels, at a rate determined by the Horizontal Binary stage in the Logic circuit (diagram 4). The X-Y Inhibit signal from the Readout System, diagram 6, applied to pin 7 of P882 has absolute control over the Horizontal Channel Selector stage. Quiescently, this signal is LO to allow the signal from the selected horizontal unit to pass to the output. However, when the Readout System displays infomation on the crt, this signal goes HI to block the signals from both horizontal compartments.

A AND B CHANNEL FEEDBESIDE

The operation of the A and B Channel Feedbeside stages are identical. Therefore, only a discussion of the A Channel Feedbeside is given.

The function of the A Channel Feedbeside stage is to compensate for low-frequency imperfections in the frequency response of the Channel Switch stage, U962. Self heating of the transistor base-emitter junction, in some transistors within U962, causes the low-frequency gain to appear larger than the midband gain. To correct this, a portion of the input signal is picked off through R942 and R941 and applied to U944. The differential signal is converted to a single-ended signal and distributed into four RC (resistive-capacitive) networks, each having a different time constant. Resistors R945, R950, R952, R955, and R958 are adjusted to provide an accumulated waveform. This waveform is converted to a paraphase signal by Q962 and Q964, and is then injected into U962 through pins 6 and 4, where it is subtracted from the signal entering U962 at pins 7 and 9. Proper adjustment results in a flat-frequency response and optimum-transient response at the output, pins 3 and 13.

11

HORIZONTAL AMPLIFIER

The Horizontal Amplifier circuit amplifies the push-pull horizontal deflection signal from the plug-in unit installed in either horizontal compartment and connects it to the horizontal deflection plates of the crt.

A schematic diagram of the Horizontal Amplifier is given on diagram 11, in Section 8 of this manual (Diagrams and Circuit Board Illustrations). The schematic is divided by a gray shaded line separating the circuitry into major stages. These stages aid in locating components mentioned here. Sub-headings in the following discussion use the stage names to further identify portions of the circuitry on diagram 11.

READOUT POSITIONING

When readout is displayed, the X Readout signal is applied to the Horizontal Amplifier through P882. At the same time, the X-Y Inhibit signal (HI) causes Q1022 to conduct, turning Q1024 off. This action enables the horizontal readout center (R.O. CTR) adjustment R1025. Ungrounding the center tap allows R1025 to horizontally position the readout display on the crt.

OUTPUT AMPLIFIER

The Output Amplifier stage is a parallel path amplifier, having a fast path and a slow path. The fast path is a non-feedback amplifier, with 50 Ω impedance throughout, except at the output. The slow path is a feedback amplifier, used to correct thermal gain errors in the fast path, and also to inject the readout signal.

Fast Path

The fast path consists primarily of U1082 (the driver) and U1094 (the output amplifier).

The differential signal is applied to pins 7 and 9 of U1082. The input is 50 Ω push-pull (100 Ω differential). The gain of U1082 is set by the HF Gain adjustment R1082 providing a nominal current gain of about 3. The output of U1082 is applied to the input of U1094, the output stage. This stage has a 50 Ω push-pull input. Accordingly, the voltage gain through the driver will be about 3, since it has equal input and output resistances.

The output stage, U1094, has a current gain of about 3.3, and has a differential load impedance of 365 Ω. The voltage gain of the stage is then 12 (the current gain times the resistance gain).

The crt has a distributed horizontal deflection structure with a differential impedance of about 365 Ω. The crt horizontal deflection structure is connected to the amplifier output and to the horizontal terminator resistor via the 365 Ω flexible transmission lines. The termination board (A20) is adjustable to match the crt impedance.

Slow Path

The slow path is a feedback amplifier, and is used for correction of thermal errors inherent in the fast path. The slow path can be considered to be an operational amplifier, and will be described as such.

The input for the slow path is from R1044 and R1064 which picks off a fraction of the output signal from the Input Clamp stage. The input signal is amplified by Q1046 and Q1066 and injected into the operational amplifier summing nodes (base of Q1052 and Q1072). The output signal at the crt is picked off by a pair of 20 kilohm resistors within U1094. This signal is applied through R1034 and R1037 to the summing nodes. Any error signal at the summing nodes is amplified by the differential transistor pair Q1052 and Q1072 and further amplified by the differential transistor pair Q1058 and Q1078. The amplified signal is then injected into the fast path via pins 1 and 5 of U1082, to correct the signal applied to the crt.

The gain of the slow path is set with the LF Gain adjustment, R1062, independent of the fast path gain. The step response of the slow path is adjusted using the Delay adjustment (C1036) and S.P. Damp (R1073), the slow path damping adjustment.

Since the slow path is a feedback circuit, it can cause difficulties in locating problems in the Output Amplifier circuit. The feedback path can be disabled by removing Q1052 and Q1072, and then shorting the emitter run to collector run on the circuit board for each transistor. This can be done by inserting a U-shaped wire, the same diameter as the transistor leads, in the emitter and collector sockets. With the feedback path open, the amplifier will operate as before, with two exceptions. First, thermal errors will not be corrected; and secondly, readout is disabled since it is injected into the slow path. All dc voltages will remain essentially unchanged. This will simplify troubleshooting the Horizontal Amplifier.

INPUT CLAMP

The Input Clamp prevents the Ouput Amplifier stage from being overdriven. Signal limiting occurs in the Input

Clamp stage when the + and - horizontal signal, applied to pins 5 and 6 of U1018, approaches a level which will overdrive the transistors within U1094. The Input Clamp requires about 75 milliamperes from pin 16 to pin 5 and from pin 13 to pin 8 for proper operation. This current is supplied by the Channel Switch stage on diagram 10. Pins 13 and 16 are normally about +7.0 volts, and pins 5 and 8 about +6.2 volts.

The voltage at pin 6 of U1018 is set with the Clamp Adj adjustment R1005 at about 0.3 volts more positive than pins 5 and 8. Now, assume a differential signal is applied to pins 5 and 8 of the Input Clamp stage, with pin 5 going negative, and pin 8 going positive; clamping occurs when pin 5 goes negative enough to turn on the transistor inside U1018 with its emitter tied to pin 5. The signal from pin 5 flows through the transistor to pin 13, effectively shunting the excess signal to the other side of the differential line. In a like manner, the other transistor causes clamping when pin 5 is positive-going and pin 8 is negative-going. Note that both transistors are never on at the same time.

The Input Clamp stage output common-mode voltage is sensed at pin 15 of U1018 and applied to U1006. This causes the voltage at pin 6 to track the common-mode voltage in the Input Clamp stage, so that the clamping point does not change as the common-mode voltage changes.

The BEAMFINDER input goes from 15 volts to ground when the BEAMFINDER button is depressed. This raises the voltage at pin 6 of U1018 to cause the horizontal signal to be confined to the crt screen.

12

INTENSITY LIMITER AND Z-AXIS

A schematic diagram of the Intensity Limiter and Z-Axis is given on diagram 12, in Section 8 of this manual (Diagrams and Circuit Board Illustrations). The schematic is divided by gray shaded lines separating the circuitry into major stages. These stages aid in locating components mentioned here. Sub-headings in the following discussion use the stage names to further identify portions of the circuitry on diagram 12.

INTENSITY LIMITER

The gain of the microchannel plate is reduced in proportion to the logarithm of the charge output. In the area of sustained trace operation this gain reduction manifests itself as reduced writing speed. The Intensity Limiter stage limits the crt screen current and prevents long-term on-screen trace operation. Even with the Intensity Limiter stage, it is possible to incur distinguishable display gain loss, depending on the use of the instrument. For more information on proper usage see the Operating Instructions in this manual under: Reduction of Display Gain With Display Output Charge.

The Screen I Sense output from the CRT Protection circuit (diagram 13) carries a current that is equal to the amount of current supplied to the MCP. Operational amplifier U1952 with the 1 megohm feedback resistor R1951 converts this current to a voltage at the rate of 1 volt per microampere of average screen current. A divider string formed by R1952, R1959 and R1960 biases the inverting input of the operational amplifier U1958B at 25 mV. When the average screen current is larger than 25 nA the noninverting input of the operational amplifier U1958B is greater than 25 mV and its output, TP1962, goes positive. This turns on the yellow LED, DS1970, through R1975 to indicate limited viewing time. Also, Q1974 is turned on, allowing C1971 to charge. In addition to this, the 3 hertz oscillator is started. Time U1968 and its associated external components is set up such that it oscillates at a frequency of 3 hertz. When the output of operational amplifier U1958 goes positive, pin 4 of U1968 goes positive starting the oscillator.

Operational amplifier, U1970, with C1971 form an integrator, integrating the current through R1958. This resistor is connected to the output of operational amplifier U1952 so the current through R1958 is proportional to the screen current. The output of U1970 ramps down from ground. When the amplitude reaches -10 volts, the timer U1986 starts. How fast the output reaches -10 volts depends on the average screen current. As will be seen later, the average screen current cannot exceed 1.8 microamperes. At this level the ouput of the integrator reaches the -10 volt output level in about 1 minute. Below average screen currents of 25 nA. Q1974 is off to prevent the integrator from operating. At an average screen current of 25 nA the integrator reaches the -10 volt level in about 1 hour. If the output of the integrator has not reached the -10 volt level and the average screen current crops below 0.2 microamperes, Q1974 turns off and C1971 discharge through R1971 to R1974 giving the integrator a fresh start when the screen current again goes over the threshold.

When the output of the integrator reaches -10 volt and pin 2 of timer U1986 reaches about +2 volts the timing starts. The ouput, pin 3 of U1986, goes high but drops low again after 10 seconds when the timer has timed out. Capacitor C1986 determines the period of the timer.

When the timer starts (pin 3 goes high), the following occurs: With pin 3 of U1986 low, diode CR1991 clamps the drive of the red LED (DS1994) to ground. When pin 3 goes high, the red LED receives its current through R1969 and CR 1993, and blinks at a 3 hertz rate to indicate that shutdown will occur in about 10 seconds.

Integrator capacitor C1971 is discharged, through divider R1988 and R1989 and the base of Q1980 is held at +2.4 volts. If pin 3 of U1986 is LO, Q1982 conducts and the collector voltage of Q1982 is too positive for transistor Q1978 to conduct. When pin 3 of U1986 goes high, Q1982 ceases to conduct and Q1978 turns on to discharge capacitor C1971, which allows the integrator a fresh start. The waveform at pin 8 of U1986 is differentiated by C1993 and inverted by Q1997. Flip-flop U1992 is triggered on a positive going pulse, so, at the end of the 10 second timing interval U1992 is triggered and the output at pin 8 goes HI.

This output goes high to cause the following to occur:

(1) The Z-Axis turns off.

(2) The red LED is turned on steady, to indicate the shutdown of the Z-Axis system. Transistor Q1994 turns off when the Z-Axis Off signal goes HI and the red LED DS1944 is turned on steady from the +15 volt supply through R1994. Pin 2 of U1986 goes HI to inhibit the 10 second timer.

The Intensity Limiter stage can be reset several ways:

(1) By either pressing the RESET button S1988 before shutdown occurs, or by reducing the display intensity so that the average screen current is less than 25 nA.

If the RESET button is pressed before shutdown occurs, the base of Q1980 is shorted to ground, Q1982 turns off, and Q1978 conducts to discharge timing capacitor C1971.

If the screen current is below 25 nA, the output of the operational amplifier U1958B goes LO and Q1974 turns off, thereby discharging timing capacitor C1971 through R1974 and R1971.

(2) By either pressing the RESET button S1988 during the 10 second delay before shutdown (when the red LED is flashing), or by reducing the intensity so that the average screen current is below 25 nA.

If the RESET button is pressed during the 10 second delay before shutdown occurs, the 10 second timer U1986 is reset and the reset pin of flip-flop U1992 is held low preventing Z-Axis shutdown.

If the screen current goes below 25 nA during the 10 second delay before shutdown occurs, the output of operational amplifier U1958B goes LO, the base of Q1998 is pulled LO, Q1998 conducts and Q1999 is saturated. The saturation of Q1999 has the same effect as pressing the RESET button.

(3) By pressing the RESET button S1988 after shutdown occurs, the 10 second timer is reset. Also, flip-flop U1992 is reset and the Z-Axis Off signal goes LO turning the Z-Axis back on.

If the average screen current exceeds 1.8 microamperes the output of operational amplifier U1952 exceeds 1.8 volts. Since the noninverting input of U1958A is biased at 1.8 volts, the output of this operational amplifier goes positive and diode CR1963 conducts. The current through Q1956 will increase and the voltage level of the intensity reference at TP1956 will increase from -10 volts to a more positive value. The intensity reference is connected to the A and B INTENSITY control network (see Mode Switch and Calibrator, diagram 2). If this reference goes more positive the input drive to the Z-Axis logic is reduced. Therefore, the beam current of the crt is reduced which results in a lower average screen current. If this feedback loop reaches equilibrium, then the voltage level of the intensity reference is such that the average screen current equals 1.8 microamperes. Singleshot screen currents are not limited to 1.8 microamperes since the feedback loop has a long time constant.

When the intensity limiter is limiting the average screen current to 1.8 microamperes the output of U1958A is high, with the result that Q1970 is driven into saturation. This causes the yellow LED to flash (indicates that the intensity is limited).

Figure 3-23 illustrates two operating conditions of the Intensity Limiter. The maximum viewing time period (approximately 1 hour) is shown in Figure 3-23A; this condition occurs with the minimum average screen current of 25 nA required to actuate the limited viewing time circuitry. The minimum viewing time (approximately 1 minute) is shown in Figure 3-23B; this condition occurs when the intensity is limited to an average screen current of 1.8 microamperes.

Diodes are connected to the A and B INTENSITY controls to prevent interaction between the intensity controls when the HORIZONTAL MODE switch is set for ALT or CHOP operation (see Mode Switch and Calibrator, diagram 2). This interaction may occur when the display is alternating between time-base units. If either diode CR2019 or CR2009 is shorted, the following will occur: If the A INTENSITY control is advanced to the point where the Intensity Limiter stage limits the average screen current to 1.8 microamperes, the voltage level of the intensity reference becomes more positive than -10 volts. Also, the B intensity level is reduced. In the extreme case the reduction of the B intensity could be such that the B trace is not visible. Present limiting of the B intensity will only occur if diode CR2019 conducts. Diode CR2019 will conduct if the B intensity level is set high enough that the cathode of CR2019 is more negative than the intensity reference voltage level at the anode of CR 2019.

Z-AXIS AMPLIFIER

The Z-Axis Amplifier stage controls the crt display intensity by varying the crt grid drive. The Logic circuit and the Readout System provide input signals to the Z-Axis Amplifier at J1606 and J 1632 respectively.

The Z-Axis Amplifier consists of three stages; an impedance matching stage, a preamplifier, and output driver. The impedance matching stage consists of Q1618 and Q1608. This stage provides isolation between the

Readout and Logic inputs in addition to providing termination of the input coax cables. The collector current out of this stage is fed to the Auto Focus amplifier through R1606, developing a voltage signal to drive the Z-Axis preamplifier. Transistor Q1626 limits the voltage drive to the preamplifier by clamping the output of Q1608 at a level determined by Clamp Level adjustment R1226.

The Z-Axis preamplifier, a transconductance amplifier, consists of Q1632, Q1648, and Q1652, which provides a current drive for the output stage. Z-Axis Gain adjustment, R1637, sets the gain of this stage and is used to set the gain for the entire Z-Axis system. Adjustments R1635, C1635, and R1651 provide current peaking to the output stage for optimum transient response. The Z-Axis Level adjustment R1645 is used to adjust the Z-Axis baseline to the proper level. The preamplifier is disabled by a shutdown signal from the Intensity Limiter circuit, which saturates Q1644.

The output driver is a shunt feedback stage with gain set by R1660. Q1658, Q1668, Q1666 and Q1676 form a direct coupled amplifier with a high open loop gain; thus the input at the base of Q1658 is a virtual ground. These transistors are capable of providing high speed transitions in the negative going direction only. Fast positive transistions are achieved by peaking the base of Q1676 via Q1664 and T1664. Capacitor C1663 adjusts the drive to Q1676 for optimum response. Transistor Q1672 establishes the collector voltage supply for Q1676. VR1671, R1677, CR1675, and CR1678 provide protection from high transient voltages.

AUTO FOCUS

The Auto Focus stage maintains optimum focus of the crt display over a range of sweep speeds. The crt needs focus correction only at high Z-Axis drive conditions. Consequently, the output of the Auto Focus amplifier is ac coupled to the focus grid. The collector current of Z-Axis impedance matching stage, which consists of Q1618 and Q1608, is fed to the input of the Auto Focus amplifier, Q1603. The emitter voltage of emitter follower Q1607 is held steady at -8.6 volts. At zero volts, drive of the Z-Axis the collector current of Q1603 is maximum (8 milliamperes) which causes clamping diode CR1609 to conduct. At midrange Z-Axis drive, the collector current of Q1603 drops to 6 milliamperes and the voltage at the anode of CR1609 is -8.0 volts which causes the clamping diode CR1609 to barely conduct. For a Z-Axis drive over midrange, diode CR1609 becomes reverse biased and a negative going signal appears at the base of Q1617. The amplifier, consisting of Q1617 and Q1620, is noninverting and has a voltage gain of approximately four. The negative going signal at the collector of Q1620 is connected to emitter follower Q1629 and then ac coupled through C1628 to the focus grid.

CRT CIRCUIT 13

A schematic diagram of the CRT Circuit is given on diagram 13, in Section 8 of this manual (Diagrams and Circuit Board Illustrations). The schematic is divided by gray shaded lines separating the circuitry into major stages. These stages aid in locating components mentioned here. Sub-headings in the following discussion use the stage names to further identify portions of the circuitry on diagram 13.

CONTROL GRID DC RESTORER

The purpose of the Control Grid DC Restorer stage is to elevate the two low voltage grid control signals to a large negative potential. These inputs are the output signal from the Z-Axis amplifier, coupled through R1680 to the first input of the Control Grid DC Restorer stage and the crt grid bias (with its associated crt grid cut off warmup compensation circuit) coupled through R1748 to the second input of the Control Grid DC Restorer stage.

The Control Grid DC Restorer stage is current driven from the square wave at the high voltage winding through R1788, R1789, R1812, and R1811. When the voltage at terminal 9 of transformer T1770 goes positive diode CR1749 conducts at the voltage determined by the first input, the Z-Axis amplifier output level. This clamping action establishes the positive swing of the dc restorer drive. On the negative swing of T1770 diode CR1747 conducts at the voltage determined by the second input; the crt grid bias voltage. This clamping action establishes the negative swing of the dc restorer drive. The ac swing of the dc restorer is coupled from the low voltage section to the high voltage section by capacitor C1793. On the negative swing of the dc restorer drive, the high voltage end of C1793 is clamped to the -2400 volt supply by CR1794. On the positive swing of the dc restorer drive, CR1792 changes the high voltage end of C1792 to a voltage more positive than the -2400 volt supply by an amount equal to the sum of the absolute value of the voltages of the two inputs; the Z-Axis amplifier output voltage level and the grid bias voltage level.

The crt cathode voltage is 135 volts more positive than the -2400 volt supply, as determined by the Grid Bias Supply stage. Therefore, the grid is negative with respect to the cathode by 135 volts (minus the sum of the absolute values of the voltages of the Z-Axis amplifier output voltage level and the crt grid bias voltage level). The CRT Grid Bias adjustment R1746 is set with the Z-Axis amplifier output at the low level for the proper crt cutoff voltage. The CRT Grid Bias adjustment has a range of 50 volts.

The Grid Bias Supply stage not only helps to protect the crt during turn-on of the instrument (see description of the Grid Crow Bar circuit) but also when a malfunction of the Control Grid DC Restorer stage occurs. In the case of a malfunction, the grid will become more negative than the cathode, thereby turning the crt off.

Neons DS1792 and DS1794 as well as the various resistors in series with the diodes provide protection (voltage and current limiting) to the components of the Control Grid DC Restorer stage during turn-on and turn-off of the instrument, as well as protection from short circuits. Capacitor C1681 provides fast ac coupling between the Z-Axis Amplifier stage and the crt grid. The slower ac path is by way of R1680 and C1792.

FOCUS GRID DC RESTORER

The purpose of the Focus Grid DC Restorer stage is to elevate the low voltage focus control to a high negative potential.

The Focus Grid DC Restorer stage is current driven from the square wave at the high voltage winding through R1788, R1789, R1813 and R1814. When the voltage at terminal 9 of T1770 goes positive, CR1820 conducts at the voltage determined by the setting of FOCUS control R2005. This clamping action establishes the positive swing of the Focus Grid DC Restorer drive. On the negative swing of T1770, CR1816 conducts at ground. This clamping action establishes the negative swing of the Focus Grid DC Restorer drive. The ac swing of the Focus Grid DC Restorer is coupled from the low voltage section to the high voltage section by C1819. On the positive swing of the Focus Grid DC Restorer drive signal, the high voltage end of C1819 is clamped to the Focus Preset adjustment voltage by CR1819. During the negative swing of the Focus Grid DC Restorer drive, CR1818 charges C1818 to a voltage more negative than the Focus Preset voltage by an amount equal to the voltage set by the FOCUS control.

Neons DS1818, DS1819, and DS1820 and the resistors in series with the various diodes provide protection (voltage and current limiting) to the components of the Focus Grid DC Restorer stage during turn-on and turn-off of the instrument as well as short circuit protection.

The voltage from the FOCUS control passes through the BEAMFINDER switch. When this switch is depressed the input to the Focus Grid DC Restorer stage is grounded, thereby defocusing the display.

HIGH-VOLTAGE TRANSFORMER

High-Voltage Transformer T1770 provides pre-regulated voltages for the +2400 volt and -2400 volt high-voltage supplies, and 6.3 volts rms for the crt heater. The crt heater is elevated to the cathode potential through R1848. The high-voltage winding of T1770 also provides the drive to the Anode Voltage Multiplier, Focus-Grid DC Restorer and the Control-Grid DC Restorer stage.

ANODE VOLTAGE MULTIPLIER

Positive accelerating potential for the crt anode is supplied by the five-times voltage multiplier contained within U2012. The applied voltage to the input of U1700 from the high voltage secondary of T1770 is about 2500 volts peak-to-peak. This results in an output voltage of about 12.5 kilovolts at the crt anode. The output resistance of this supply is about 100 megohms and may be subject to meter loading when measured.

CRT PROTECTION

The small board A22-A1 mounted on the A22 board contains the CRT Protection circuitry that supplies the MCP beam current and generates the Screen I Sense signal for the Intensity Limiting circuitry (diagram 12). The MCP and MCP power supply have a common ground that is isolated from the chassis ground.This common ground point is connected to the input of U1720B. The MCP strip current and MCP supply regulation current flowing into this virtual ground point are offset by the MCP power supply charge current supplied by CR1710 and T1708. U1720B supplies the MCP beam current through R1704. An equal current is supplied to the Intensity Limit circuit (diagram 12) through R1701.

U1720A is a buffer amp that maintains MCP supply regulation while keeping stray regulator currents from affecting the operation of the MCP protection circuit.

GRID BIAS SUPPLY

The Grid Bias Supply is a 135 volt power supply connected between the crt cathode and the -2400 Volt Supply. The polarity is such that the cathode is at a more positive potential (-2365 volts). The purpose of the cathode supply is explained in the Grid Crowbar circuit description.

The -2400 Volt Supply holds the current in the thick film high-voltage resistor R1802 constant at approximately 100 microamperes. The voltage developed across R1802C is 100 volts and is used as the voltage reference for the cathode supply. The comparator consisting of Q1835 and Q1838 requires both bases to be at the same potential. This condition is satisfied if there is 135 volts across the voltage divider of R1839 and R1840. If the voltage across the voltage divider R1839-R1840 is higher than 135 volts, the base voltage of Q1830 exceeds the base voltage of Q1835. Q1838 turns on harder; this in turn increases the current in the series regulator Q1842. This reduces the current through the voltage divider R1839 and R1840 lowering the voltage until it is 135 volts. The cathode supply furnishes current to the cathode, to the focus string, and to the resistor string which supplies the negative voltages to the scan expansion lens. Protection neons DS1842, DS1844 and DS1846 limit the maximum voltage across the supply.

MICROCHANNEL PLATE SUPPLY

The MCP (Microchannel Plate) Supply receives a 25 kilohertz square-wave signal of about 54 volts peak from the Control Rectifier circuit (diagram 14). If pin 1 of the transformer T1708 was grounded, the transformer would step this voltage up to 625 volts peak. Components C1711, CR1710, CR1711 and C1710 form a voltage doubler to develop 1250 volts dc at TP1175.

Assume that by some means the collector of Q1708 would be held at a +20 volt level. The 25 kilohertz square-wave signal is clipped by diode CR1708 to a maximum of +20.6 volts and clipped by diode CR1707 to a minimum of -0.6 volt at the cathode of diode CR1707. With the circuit in equilibrium the average current in capacitor C1707 must be zero. This is reached when C1707 is charged up to 10 volts. This means that a 25 kilohertz square-wave signal of 10.6 volts peak is on pin 1 of transformer T1708. This voltage is subtracted from the 54 volt peak drive at pin 2 of T1708, so the primary of the transformer is driven by a voltage of 43.4 volts peak. The dc output voltage is then reduced to about 1000 volts.

Components U1714A and Q1708 regulate the dc output voltage of T1175. Pin 2 of U1714A is at ground potential and is the current summing point for the regulator. If

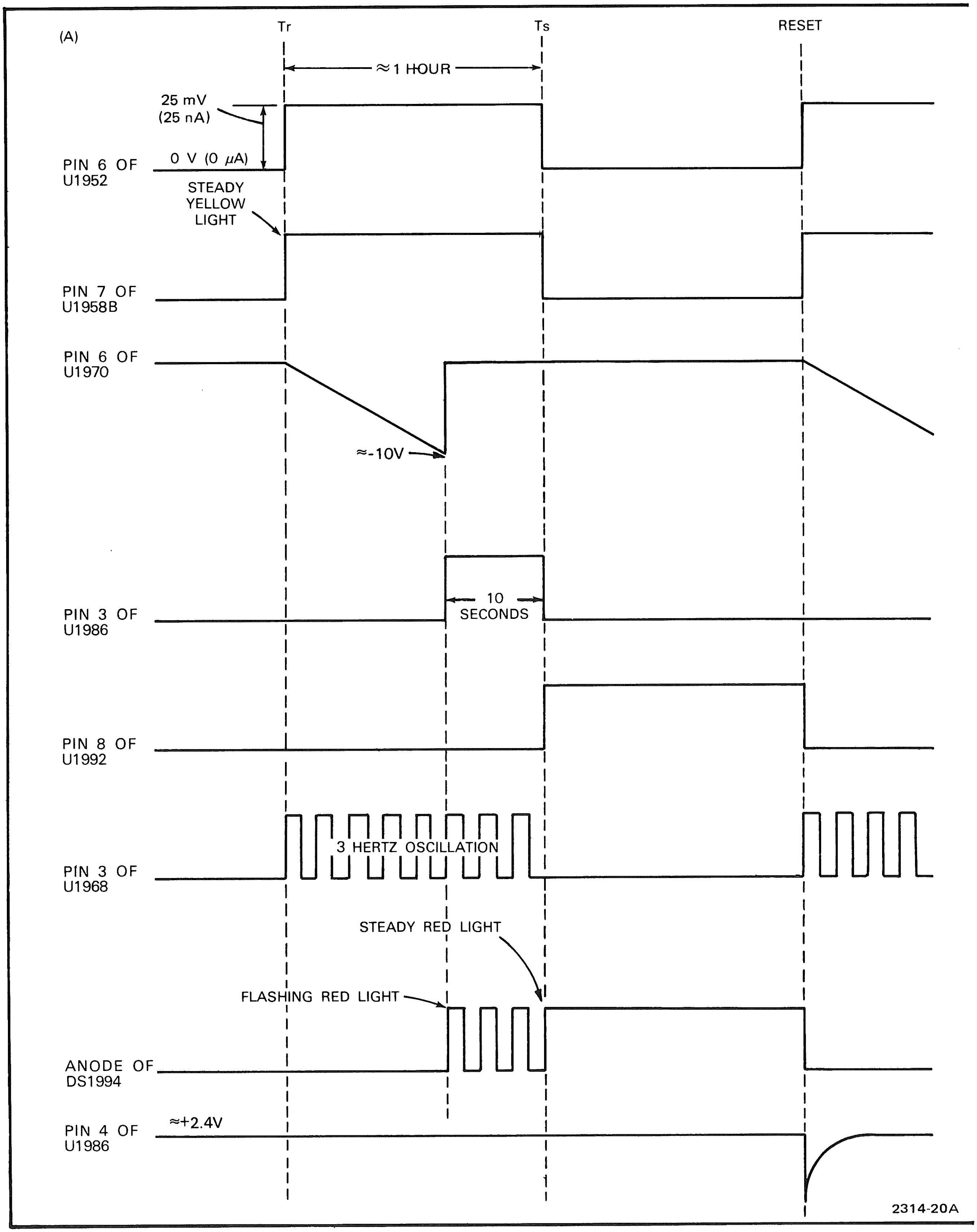

Figure 3-23. Theoretical timing diagrams for the Intensity Limiting stage.

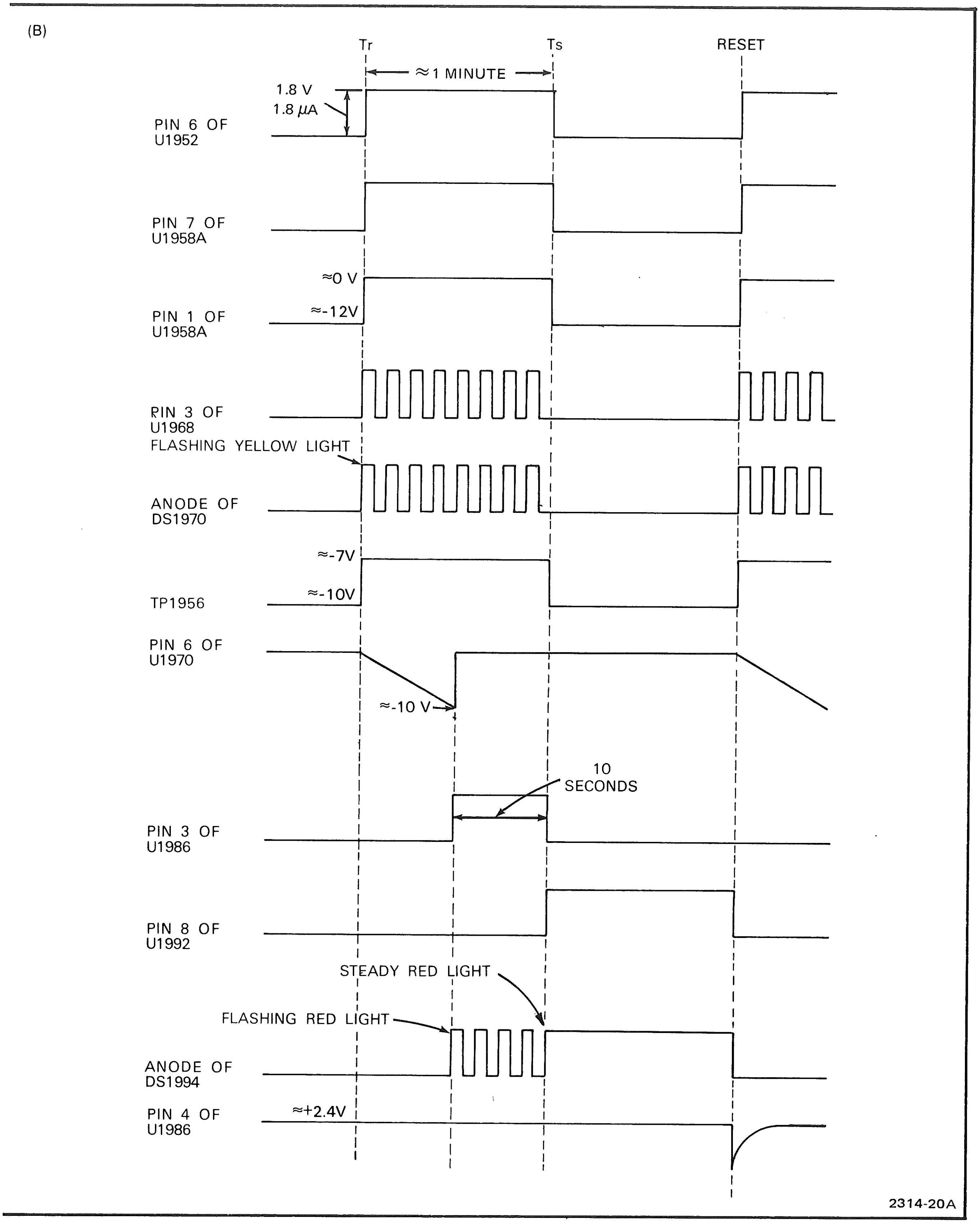

Figure 3-23. Theoretical timing diagrams for the Intensity Limiting stage (continued).

there is zero current in R1722 and R1719, pin 2 of U1714A can only be at ground potential; when the dc output voltage at TP1171 is +562.5 volts. If pin 2 is above ground, the output of operational amplifier U1714A will go negative, turning off Q1708, this will charge C1708 more positive and reduce the primary drive of the transformer. This will result in a reduced dc output voltage at TP1175 until the voltage on pin 2 of U1714A returns to ground. Resistor R1722 carries the Intensity Sense current developed by the MCP Intensity Tracking stage on the Logic Schematic, diagram 4.

The Intensity Sense current varies between 0 and 36 microamperes depending on the setting of the INTENSITY control and gives the MCP Supply voltage a maximum increase of 275 volts. The higher the voltage across the MCP the greater the gain of the MCP (electrons out for electrons in) which results in a brighter crt display (this is needed at faster sweep speeds to obtain writing rate). MCP Gain adjustment R1720 sets the output voltage at TP1775; its range is 400 volts.

MCP Gain adjustment R1720 controls the writing speed of the instrument. At the factory this adjustment is set so that a single shot, 1 gegahertz sinewave with an amplitude of 7.5 divisions is visible when photographed using type 107 3000 ASA polaroid film (camera setting is f 1.9 at a reduction ratio of 1:0.85). If the MCP output voltage is set higher both the visual as well as the photographic writing rate increase, however a background scintillation of the MCP may appear on photographs. This effect randomly covers the photographs with small bright spots.

Depending on instrument use, increased MCP output voltage may reduce the display gain. Refer to: Reduction of Display Gain With Display Output Charge in the Operating Instructions section of this manual.

When the INTENSITY control is advanced, the MCP output voltage increases to produce a brighter crt display. This also causes the Readout display to be brighter which is undesirable. The purpose of U1714B is to prevent this. When the Intensity Sense current increases from 0 to 36 microamperes, the voltage at pin 5 of U1714B increases from 0 to 0.72 volt. The voltage at the emitter of Q1724 follows this voltage at pin 5 of U1714B. Therefore, the collector current of Q1724 (Aux RO Intensity current) increases from 0 to approximately 0.17 milliampere. Aux RO intensity current is subtracted from the Readout Intensity current to reduce the readout intensity current while the MCP output voltage increases. This results in a constant intensity of the readout display.

GRID BIAS

The Grid Bias stage provides a dc reference voltage to the Control Grid DC Restorer stage. This reference level is adjustable by means of the CRT Grid Bias adjustment R1746, which sets the grid cutoff voltage of the crt. The grid cutoff voltage drifts during warmup of the instrument; the purpose of U1736 and Q1742 is to compensate for this. Initially, at instrument turn on, capacitor C1736 is discharged, both inputs of the operational amplifier U1736 are at +7.0 volts, and a small current flows through R1733 which begins to charge capacitor C1736. The output of the operational amplifier U1736 is initially at +7.3 volts but gradually, after about 10 minutes, increases to +12.5 volts. Transistor Q1742 conducts until the voltage level at the output of the operational amplifier U1736 has increased to +12.5 volts. The current from Q1742 develops a voltage drop across R1747. Emitter follower Q1748 provides a voltage source reference for R1747. During warmup of the instrument the dc reference voltage to the Control Grid DC Restorer gradually becomes more negative and compensates for the grid cutoff voltage drift of the crt. When the instrument is turned off capacitor C1736 discharges with the same time constant (diode CR1736 prevents a fast discharge). If, after a few minutes the instrument is turned on again, less warmup compensation is required. This is accomplished by not allowing capacitor C1736 to discharge fast.

-2400 VOLT SUPPLY

Components C1750, CR1762, CR1763, and C1764 form a voltage doubler. A 1250 volt peak square wave is applied to the input of this doubler. The dc voltage at TP1844 is about -2500 volts if the voltage at the collector of Q1784 (TP2784) is near ground. Components U1802 and Q1784 form the regulator for the -2400 Volt Supply. Under nominal conditions the voltage at TP1784 is 100 volts. Diodes CR1776 and CR1778 alternately clip the waveform at pin 7 of the secondary winding of T1770 between the 100 volt level and ground level. The voltage across the secondary of T1770 is 1250 volts peak. With the waveform at pin 7, the voltage at pin 9 switches between 1250 and -1150 volts. This charges C1750 to 1250 volts and C1764 (at TP1844) to -2400 volts. To maintain equilibrium, the average current through C1788 must be zero. During one half of the cycle CR1778 conducts and draws current through C1778; during the other half CR1776 conducts, and CR1778 is turned off. The collector current from Q1784 that flows through C1778 is such that the total average current in C1778 equals zero. The voltage at TP1784 can only be pulled down by Q1784. The zener diode VR1784 limits the voltage at this test point to a maximum of 200 volts. This would happen if transistor Q1784 is removed.

Pin 3 of the operational amplifier U1802 is at ground potential and is the current summing point. If the current in R1804 and in R1806 is zero, pin 3 can only be at ground potential if the current in the thick film high voltage resistor R1802A, R1802B and R1803C is 100 microamperes. This produces a voltage of -2400 volts at TP1844. If the voltage at TP1844 is slightly more positive than -2400 volts, pin 3 of U1802 is above ground, the output (pin 6) goes more positive, Q1784 turns on harder pulling more current through C1778 to charge capacitor C1778 less positive. The voltage at TP1784 drops and, as a result, the -2400 Volt Supply is pulled back down toward -2400 volts dc. Regulation by means of this path is slow (several cycles of the 25 kilohertz square wave are required to make a correction), and C1786 provides for faster regulation. When Q1784 is turned on hard, current flows through C1784 and pulls down the -2400 Volt Supply.

The -2265 Adjust, R1805, sets the dc high voltage. Divider network R1800, R1803, R1804 and thermistor RT1804 vary the -2400 Volt Supply with changes in temperature. This means that the velocity of the electron beam through the vertical and horizontal crt deflectors changes, which in turn changes the vertical and horizontal deflection sensitivity. The change in deflection sensitivity compensates for gain change with temperature in the vertical and horizontal amplifiers.

A regulated +2400 volt supply (TP1754) is generated for use by the scan expansion lens. The -2400 Volt Supply regulator also regulates the +2400 volt supply, but for slow changes only, as was seen in the circuit description of the -2400 Volt Supply. Under nominal conditions for the -2400 Volt Supply regulator the collector of Q1784 is at 100 volts and the voltage at pin 9 of the high voltage transformer (T1770) switches at a 25 kilohertz rate, between +1250 volts and -1150 volts resulting in -2400 volts dc at the output of the -2400 Volt Supply. The voltage at the cathode of CR1762 switches between 0 volt and -2400 volts and is the input to the +2400 volt supply voltage doubler consisting of C1752, CR1752, CR1753 and C1754) causing the output at TP1754 to be +2400 volts dc. The scan expansion lens requires a lower voltage than +2400 volts. Since the lens draws zero current, a resistive divider can be used to bring the voltage down. Capacitors C1756 and C1800 filter the scan expansion lens voltage.

A semi-regulated +105 volts is generated for use by the Z-Axis amplifier. The input signal to transformer T1770 is connected to a voltage doubler formed by C1770, CR1772, CR1771 and C1774 to generate +105 volts dc at R1771.

The +105 volt supply develops a negative voltage across R1774, if overloaded. When the +2400 volt supply or the -2400 volt supply is overloaded a negative voltage is developed across R1776. The I Sense line is connected through P1785, pin 8, to the voltage Balance Sense line of the inverter control IC, in the power supply. This is a high impedance point, and when pin 2 is pulled 100 millivolts negative or positive the inverter control IC shuts down the power supply. Under overload conditions of the above mentioned supplies, either diode CR1774 or CR1775 will turn on and shut down the power supply.

GRID CROW BAR

The Grid Crow Bar stage prevents the crt grid from becoming more positive than the cathode during turn-on of the instrument. This action is needed to protect the crt cathode during the time that the cathode and grid voltages are settling. The grid voltage is forced more negative than the cathode by connecting the -2400 Volt Supply voltage to the crt grid through VR1688, Q1688, CR1687 and R1688 (during the period of time that Q1688 is on, which is primarily determined by C1687 and R1687). Initially, C1687 has no charge. When the instrument power is turned on C1687 receives charging current from the -2400 Volt Supply through the emitter-base junction of Q1688 and R1685. Transistor Q1688 remains on as long as the charging current through R1685 is large enough to cause VR1688 to conduct.

CRT

The 7104 crt is a high resolution, high frequency, micro-channel plate crt. Transformer T1770 has a secondary winding that supplies 6.3 volts to the crt heater. The crt heater is held at the cathode potential through R1848 and DS1848. The conventional oxide structured cathode is held at -2265 volts. The Z-Axis amplifier provides a maximum of 55 volts unblanking to the grid.

The demagnification lens (which works in conjunction with the primary focus lens) is operated at the cathode potential.

Stigmator adjustment R1894 is connected to the stigmator lens and is used to adjust the axis of astigmatism for optimum spot symmetry. The primary focus lens is connected to the output of the Focus Grid DC Restorer stage which contains the Focus Preset adjustment R1825. At high voltage Z-Axis drive a focus correction is required. Capacitor C1628 couples the focus grid voltage drive to the output of the Auto Focus amplifier. The front-panel screwdriver adjustment ASTIG (R2005) applies a voltage to the astigmatism lens. The front panel ASTIG and FOCUS controls are used in conjunction with each other to obtain best overall focus.

The vertical and horizontal deflectors are traveling wave deflectors. They are helical transmission line deflectors where the velocity of the input signal along the helical conductors is equal to the speed of light. The phase velocity along the length of the helix is matched to the crt electron beam velocity as it propogates along the helix. The impedance of the vertical deflector is 200 ohms, the deflection factor is 1 volt per division and the bandwidth is about 3 gigahertz. To minimize skin effect losses, the deflector is silver plated. The impedance of the horizontal deflector is 365 ohms, the deflection factor is 2 volts per division and the bandwidth is about 1.5 gigahertz. The connections to the vertical and horizontal deflectors are made through carefully spaced neck pins. The vertical deflector also employs stripline lead-ins between the deflector and the neck pins. Both deflectors use external termination resistors.

The 7104 crt utilizes a scan expansion lens. Without this lens, to obtain the desired scan size and deflector sensitivities, the crt would have to be over seven feet in length. In operation this lens is a strong positive lens in the vertical axis and causes the beam to cross over or invert the vertical deflection to cause vertical scan expansion of 4.5 times. In the horizontal axis the lens is a negative lens, which enhances the deflection of the beam. The horizontal scan is expanded 4 times. Seven potentials are required to operate the lens. The voltages are adjustable, differentially as well as the dc level. The adjustments on diagram 13 are labeled for their primary function, however,. secondary effects are present:

Vertical Linearity adjustments, R1853 and R1856, align the overall vertical linearity of the crt display. The Vertical

Linearity imbalance adjustments, R1854 and R1855, correct any vertical imbalance. The Geometry adjustments, R1863 and R1866, align crt vertical geometry. The Vertical Keystone adjustments, R1864 and R1865, align the vertical keystone effect of the crt. Horizontal Sensitivity adjustments, R1873 and R1876, set the horizontal deflection factor. The Horizontal Linearity adjustments, R1874 and R1875, are adjusted to reduce the horizontal nonlinearity or nonuniform bowing of vertical lines.

The input of the microchannel plate (MCP) is held at ground potential and the output is connected to a variable positive supply thus providing the bias for the MCP. The higher the bias across the MCP the higher the gain or electron multiplication. Due to the MCP the instrument achieves its extremely high writing rate.

The MCP bias is adjusted with the INTENSITY controls. The bias across the MCP is held constant at INTENSITY control settings below about midrange, but it increases linearly from midrange to the fully clockwise position. Adjustment R1720 on the High Voltage board also adjusts the MCP output voltage. At the factory, this adjustment is set to achieve a photographic writing speed of 20 cm/nanosecond using a standard camera (f 1.9 lens) and standard film (Polaroid Type 107; 3000 ASA).

If the MCP output voltage adjustment is set high, both the visual as well as the photographic writing speed increase; however, on photographs a background scintillation may appear. At a high MCP bias setting the channels being excited by stray electrons can have an electron multiplication factor high enough to become visible on photographs. Depending on instrument use, increased MCP output voltage may reduce the display gain. Refer to Reduction of Display Gain With Display Output Charge in the Operating Instructions section of this manual. The MCP is located about 0.3 cm from an aluminized screen (with standard P31 phosphor crts). About 11.5 kilovolts is applied across this gap to accelerate the electrons exciting the MCP.

The orthogonality coil, wound on the crt neck at the exit of the vertical deflector, allows for correction of rotational alignment errors between the deflection axis and scan expansion lens. In addition to the orthogonality coil, a trace rotation coil is wound on the envelope of the glass ceramic interface.

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CONTROL RECTIFIER

The Control Rectifier circuit provides the operating power for this instrument from an ac line-voltage source. A schematic diagram of the Control Rectifier is given on diagram 14, in Section 8 of this manual (Diagrams and Circuit Board Illustrations). The schematic is divided by gray shaded lines separating the circuitry into major stages. These stages aid in locating components mentioned here. Sub-headings in the following discussion use the stage names to further identify portions of the circuitry on diagram 14.

LINE INPUT

Power is applied through line filter FL1200, line fuse F1200, and POWER switch S1200. The line filter is designed to keep power-line interference from entering the instrument and to keep the approximate 25-kilohertz Inverter signal from entering the power line. Components R1205, C1205, and C1206 suppress reverse-recovery transients of CR1215.

The LINE VOLTAGE SELECTOR switch S1212 allows the instrument to operate from either a 115 volt nominal or a 230 volt nominal line voltage source. In the 115 volt position, rectifier CR1215 operates as a full-wave doubler with energy-storage capacitors C1215 and C1217, so the voltage across the two capacitors in series will be the approximate peak-to-peak value of the line voltage. For 230 volt operation, CR1215 is connected as a bridge rectifier and the voltage across C1216 and C1217 will be the approximate peak value of the line voltage. Thus, the dc voltage applied to the Inverter stage is about the same for either 115 volt or 230 volt operation.

Thermistors RT1209 and RT1213 limit the surge current when the power supply is first turned on. After the instrument is in operation, the resistance of the thermistors decreases so that they have little effect on the circuit. When the instument is turned off, the Inverter Control stage turns off the Inverter which prevents it from discharging C1216 and C1217; C1216 and C1217 discharge slowly through R1221 to allow for thermistor thermal-recovery time. This ensures sufficient thermistor resistance to limit the turn-on surge current to a safe level. Since C1216 and C1217 discharge slowly, dangerous potentials exist within the power supply for several minutes after the POWER switch is turned off. The presence of voltage in the circuit is indicated by relaxation oscillator R1219, C1219, and DS1219. Neon bulb DS1219 will blink until the potential across C1216 and C1217 drops to about 80 volts.

Spark gap electrodes E1208 and E1213 are surge-voltage protectors. When the LINE VOLTAGE SELECTOR switch is in the 115 volt position, only E1208 is connected across the line input. If a peak voltage greater than 230 volts is present on the line, E1208 will conduct and quickly open line fuse F1200 to interrupt the input power before the instrument can be damaged. In the 230 volt position, E1208 and E1213 are connected in series across the line input to provide protection for peak voltages greater than 460 volts.

Transformer T1208 provides a sample of the line voltage to the plug-in connectors for triggering at line frequencies. This line frequency signal is also connected to the Inverter Control stage to sense when line voltage is present.

INVERTER START NETWORK

Network R1210, R1241, and C1242 is connected between the input line (ac) and the negative side of C1217 (through T1225). Capacitor C1242 charges on each cycle of the input line voltage. When the charge on C1242 reaches about 33 volts, zener diode VR1238 turns on and programmable unijunction transistor Q1238 starts conducting to provide base drive to turn on Q1240 through C1239. When Q1240 turns on, it shock-excites series-resonant network L1237 and C1237 to generate a damped oscillation. This damped oscillation provides the drive necessary to start the Inverter switching action. After the Inverter is operating, the recurrent waveform at the collector of Q1240 keeps C1242 discharged through CR1249, thus disabling the Inverter Start Network while the instrument is on.

INVERTER

The Inverter stage converts the dc voltage across C1216 and C1217 to a sine-wave current to drive power transformer T1310. Once the Inverter has been started by the Inverter Start Network, transformer T1230 provides feedback to the bases of Q1234 and Q1240 to sustain oscillation. These transistors ooperate at a forced beta of 4 due to the turns ratio of T1230. Also, T1230 provides a 60:1 turn center-tapped winding for pre-regulation and fault protection shut-down. The Inverter Control stage short circuits one-half of this winding to either delay the turn-on of Q1234 and Q1240 or to completely stop their switching action.

The switching action of Q1234 and Q1240 generates a square-wave voltage with an amplitude approximately equal to the dc voltage at the input to this stage. The square-wave voltage at the emitter of Q1234 supplies the drive necessary to maintain a sine-wave current in the series-resonant network of L1237 and C1237. Diodes CR1234 and CR1241 provide paths for series-resonant current when Q1234 and Q1240 are held off for pre-regulation.

To aid in understanding circuit operation, Figure 3-24A shows a representation of the Inverter stage as a switch. The three possible states of the Inverter are depicted by the three possible switch positions: Q1234 is on in position (a); Q1240 is on in position (c); or both transistors are held off for pre-regulation in position (b). In the composite current waveform of Figure 3-24B, the relative phase and amplitude of each component of I_t is shown for periods T_a, T_b, and T_c corresponding to the three switch positions. Figure 3-24C and Figure 3-24D show relationship of the Inverter voltage and primary winding voltages with respect to the current waveform.

The normal sequence of operation is as follows: Assume that I_t is passing through zero and is increasing in the direction which forward biases CR1241 to conduct I_1 as shown in Figure 3-24B. When the Inverter current crosses through zero, the Inverter Control stage holds off Q1234 and Q1240. At a time determined by the Inverter Control stage, Q1234 is allowed to conduct I_2 which reverse biases CR1241. Transistor Q1234 conducts as I_2 goes through its peak and back to zero. At zero crossing the Inverter Control stage again holds off Q1234 and Q1240. During this hold-off time, CR1234 conducts I_3. Next, Q1240 is turned on to conduct I_4 which reverse biases CR1234. Transistor Q1240 conducts as I_4 goes through its peak and back to zero. The cycle then repeats itself.

During conduction of Q1234 power is delivered to the series resonant circuit L1237-C1237, and to T1310. Part of this power, stored in the resonant circuit, is returned to the supply when diode CR1234 conducts. Pre-regulation is achieved by varying the holdoff of the inverter transistors, T_b in Figure 3-24B, thereby determining the net power delivered to T1310.

OVER-VOLTAGE STOP

Whenever the voltage across the primary of T1310 exceeds a safe level, the Over-Voltage Stop stage shuts down the Inverter to protect the Inverter components from damage. For example, this stage activates whenever the normal voltage regulating path through Q1252 and T1230 is inoperative.

Capacitor C1243 charges through CR1244 to the peak voltage across the primary of T1310. If this voltage exceeds a safe level, Q1245 conducts to cause Q1243 and Q1246 to turn on. When Q1246 turns on, the base-drive winding of T1230 is short-circuited, which stops the Inverter switching action. Since Q1243 is turned on, C1242 in the Inverter Start Network is prevented from charging to the breakdown voltage of VR1238, thus preventing the Inverter from starting. Transistors Q1245 and Q1243 continue to conduct until the discharge current of C1243 through R1243 drops below the holding current of Q1245. After Q1243 turns off, CR1249 continues to inhibit the Inverter Start Network while C1243 charges through R1244 and CR1244. When the voltage on C1243 is sufficient to turn on VR1238, the Inverter will start.

INVERTER CONTROL

The Inverter Control stage, made up of primarily U1275, provides pre-regulation and fault protection functions. For pre-regulation purposes, U1275 varies the hold-off time T_b, in Figure 3-24B of the Inverter switching transistors.

Under normal operating conditions, only the E Sense input at pin 15 controls the hold-off time. However, various fault conditions can affect hold-off time or stop Inverter operation altogether. The operation of each individual function of the Inverter Control stage is described in the following discussion.

Pre-Regulator

The Pre-Regulator operation of U1275, maintains constant voltage at the outputs of the low-voltage rectifiers. It also provides constant peak-to-peak voltage to the high-voltage supply.

Transformer T1235 provides Inverter phase information and power to U1275. The phase information is connected to pins 10 and 11 through C1277 and C1278. Bridge rectifier CR1272, CR1274, CR1276, and CR1275, provides positive and negative operating voltages to U1275. A shunt regulator in U1275 maintains the +7.5 volts at pin 6. The -2 volt (nominal) supply connected to pin 7 is unregulated. Zener diode VR1272 is for protection against open circuit conduction (U1275 removed) and is normally not conducting.

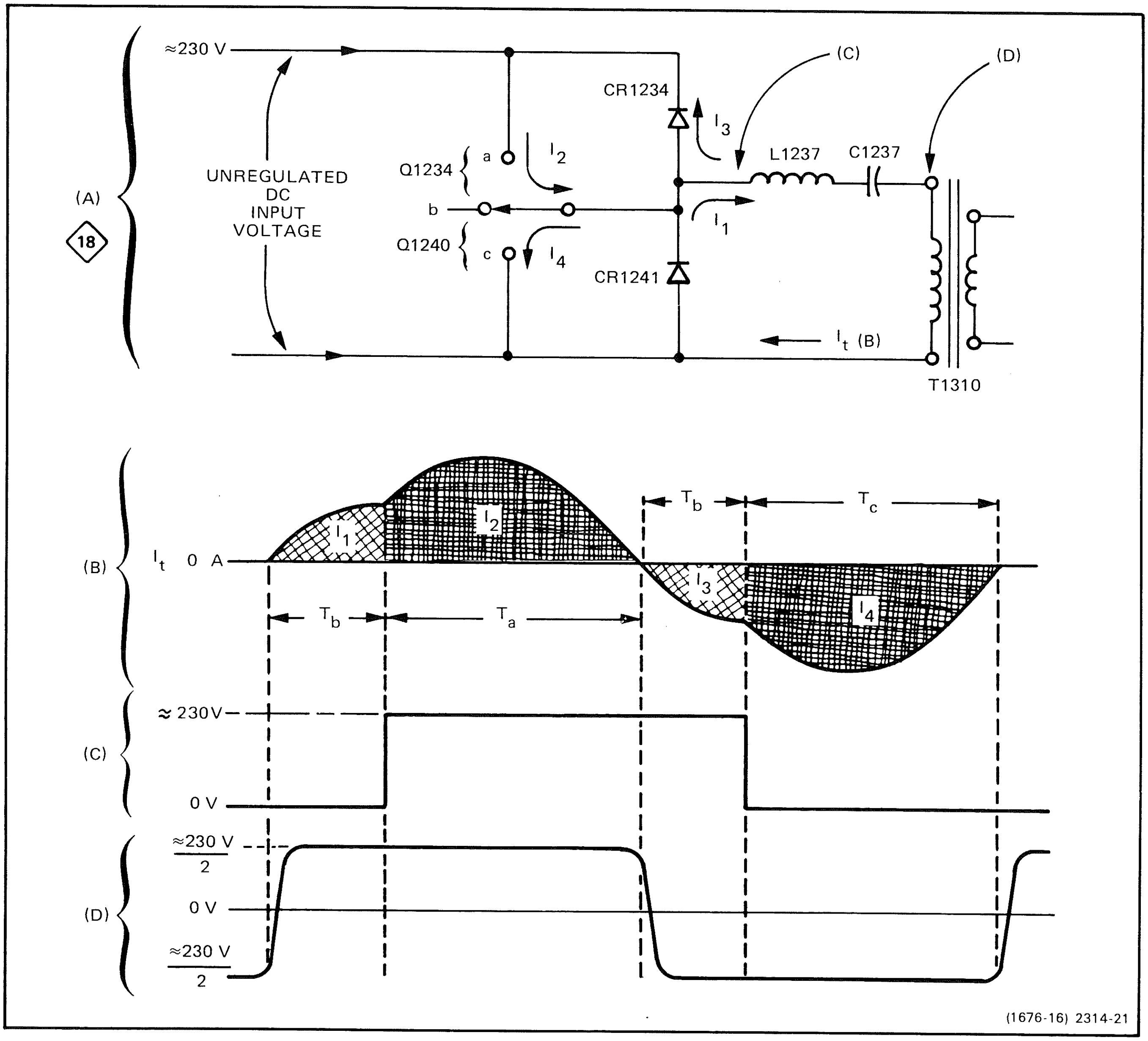

Figure 3-24. (A) Representation of Inverter stage. Idealized waveforms of (B) total inverter current, I_t, (C) voltage of CR1234 and CR1241, and (D) voltage across primary.

Pin 15 is the voltage sensing (E Sense) poinf of the Pre-Regulator circuit. Zero volts at pin 15 indicates proper regulation. Zener diode VR1288 provides a stable reference voltage for the sensing-divider resistors R1292, R1293, R1295, R1286 and R1287. Resistor R1293 in this divider adjusts the ratio of the divider to adjust the output of the +109 volt supply. Outputs of the other supplies are then set by the turns ratio of T1310.

Integrated circuit U1275 regulates the Inverter by varying the hold-off time of the switching transistors, Q1234 and Q1240. A variable pulse-width monostable multivibrator in U1275 is triggered at pins 10 and 11 whenever the Inverter current changes direction. The pulse width holds off the Inverter by turning on transistor Q1252 through pin 9 of U1275, thus shorting out the base drive to Q1234 and Q1240. The pulse width, and therefore hold-off, is controlled by a ramp at pin 12. If the voltage at the E Sense input, pin 15, is too low, the ramp is not allowed to rise very high and the pulse width and hold-off are short. As the E Sense voltage rises, the ramp is allowed to rise to a higher voltage level, increasing the hold-off time.

Fault Protection

The fault-protection portions of U1275 provide protection for the power-supply components from damage due to short circuits, turn-on surge currents, and other malfuncions. When a fault is detected at the Fault Sense input (pin 2) or I Sense input (pin 13), a current from the Fault Holdoff Time output (pin 1) charges C1264. If the detected fault lasts longer than about 10 milliseconds, C1264 will charge positive enough to initiate a positive output at pin 8. This output turns on Q1254 and Q1252 which turns off the Inverter. The Inverter will remain off while C1254 discharges through R1254 which keeps Q1254 and Q1252 turned on. The Inverter restarts in roughly 500 milliseconds when the current through R1254 is insufficient to keep Q1254 and Q1252 turned on. When the inverter restarts, C1254 is recharged through CR1259 and R1259. This cycle repeats until the fault is corrected, with the Inverter on for about 10 milliseconds, and off for about 500 milliseconds.

Inverter Current Limiter

The Inverter Current Limiter provides protection for the Inverter components from damage due to excessive current turn-on or short circuits. Operation of this stage is similar to the Pre-Regulator (voltage regulation). The Inverter Current Limiter takes control of the Inverter hold-off time whenever pin 13 starts to go negative. T1235 is a current step-down transformer. The current is rectified and flows through R1284, the current-sensing resistor. The voltage across R1284 is negative and proportional to the Inverter current. The I Sense input at pin 13 is normally held positive through divider R1281 and R1283. The Inverter Current Limiter takes control of regulation when pin 13 approaches zero volts. Peak Inverter current is limited to about 5 amperes. If the voltage at pin 13 remains near zero for more than about 10 milliseconds, pin 8 will go positive to turn off the Inverter.

Fault Sense

The Fault Sense portion of U1275 provides overload protection for those supplies on the LV Regulator schematic, diagram 15, and other supplies generated throughout the instrument. Resistive networks from supplies are connected to the Fault Sense input at pin 2 of U1275. During normal operation, the voltage at the Fault Sense input remains near zero. If one of the inputs changes sufficiently to cause this voltage level to vary 200 millivolts (positive or negative) for more than 10 milliseconds, a positive output is produced at pin 8 of U1275 to stop the Inverter.

Line Stop

The Line Stop portion of U1275 stops the Inverter when the POWER switch is turned off. The Line Stop stage will also stop the Inverter if the ac line voltage falls below a minimum value.

The line-frequency signal from transformer T1208 is connected to pin 4, the Line Stop Sense input of U1275. During normal operation, the line-frequency signal causes the Line Stop Timer terminal (pin 3) to periodically discharge to ground. When the line-frequency signal is interrupted or falls below a minimum value, C1267 will charge to approximately +0.7 volt causing the Line Stop stage to produce a positive output at pin 8 of U1275 to stop the Inverter.

POWER ON LOGIC

When the instrument is first turned on, the Power On Logic circuit produces a LO output on Pin 6 of U1374B for about 2 seconds, after which time, a HI is produced, indicating that power is on. Pin 6 of U1374B goes HI after C1371 charges sufficiently to reduce the voltage on pin 13 of U1374 to the LO state.

When the instrument is turned off this circuit produces a LO output before the regulated power supply voltages begin to drop. The Inverter Stop signal, pin 8 of U1275, goes HI allowing Q1362 to produce a LO at pin 6 of U1374B. The Power On Logic circuit is not used by the 7104.

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LV REGULATOR

A schematic diagram of the Low-Voltage Regulators is given on diagram 15, in Section 8 of this manual (Diagrams and Circuit Board Illustrations). The schematic is divided by gray shaded lines separating the circuitry into major stages. Sub-headings in the following discussion use the stage names to further identify portions of the circuitry on diagram 15.

The Low-Voltage Regulators convert semi-regulated voltages from the Control Rectifier circuit to stabilized low-ripple output voltages. The regulators are series type, using the +50 volt supply as a reference.

OPERATIONAL AMPLIFIER POWER SUPPLIES

The operational amplifiers, used to regulate the +50, +15, +5, -50, and -15 volt supplies, require that four special voltages be generated for their operation:

(1) The +22 volt supply is generated from the semi-regulated +54 volts by reference zener diode VR1432 and emitter follower Q1434.

(2) The -22 volt supply is generated from the semi-regulated -54 volts by reference zener diode VR1435 and emitter follower Q1438.

(3) The +5.6 volt supply is generated from the semi-regulated +17 volts by zener diode VR1552.

(4) The -5.6 volt supply is generated from the semi-regulated -17 volts by zener diode VR1556.

+50 VOLT SUPPLY

Semi-regulated +54 volts from the Control Rectifier circuit provides the unregulated voltage source for this supply. Operational amplifier U1415 is connected as a differential amplifier to compare the feedback voltage at pin 2 against the reference voltage at pin 3. The error output at pin 6 of U1415 reflects a difference between these two inputs. Zener diode VR1412 sets a reference level of about +9 volts at pin 3 of U1415. A sample of the output voltage from the +50 Volt Supply is connected to pin 2 of U1415 through divider network R1416, R1415, and R1414. Resistor R1415 in this divider is adjustable to set the output level of this supply. Notice that the feedback voltage of this divider is obtained from a line labeled +50 V Sense. If the feedback voltages were obtained at the supply, the voltage at the load would not stay constant, due to the inherent resistance of the interconnecting cable between the supply and its load. The Sense configuration overcomes this problem by sensing the voltage at the load. Since the current in the Sense line is small and constant, the load voltage is held constant regardless of the load current.

Regulation of voltage occurs as follows: If the output level of this supply decreases (becomes less negative) due to an increase in load or a decreased input voltage (as a result of line-voltage change or ripple) the voltage across divider R1416, R1415, and R1414 decreases also. This results in a less positive level at pin 2 of U1415 than that established by zener diode VR1412 at pin 3 of U1415. This decreases the current through CR1415 and VR1417, causing a successive increase in current through the base-emitter junction of Q1428. This results in increased conduction of Q1428, the +50 volt series regulator. The load current increases and therefore the voltage across the load also increases (becomes more positive) sufficiently to balance the input into differential amplifier U1415. The +50 Volt adjustment, R1415, sets the output level of this supply.

Current limiting is provided for the +50 Volt Supply if excessive current is demanded from the supply. Since the load is connected to this supply through R1428, all current from the +50 Volt Supply must flow through this resistor. Under normal operation there is insufficient voltage drop across R1428 to turn Q1422 off. However, when excessive current is demanded from the +50 volt series regulator (Q1428) due to a short circuit or similar malfunction at the output of this supply, the voltage drop across R1428 increases until it is sufficient to reverse bias Q1422. The reduced collector current of Q1422 results in a reduction of current through Q1428. This current limiting protects Q1428 from damage due to excessive power dissipation.

Several protection diodes are also included in this circuit. Diode CR1428 prevents the output of this supply from going more negative than about -0.6 volt if it is shorted to a negative supply. Zener diode VR1410 and diode CR1410 supply a turn-on voltage for U1415 to start the +50 Volt Supply when the instrument is first turned on. As soon as the +50 Volt Supply turns on, CR1410 stops conducting.

-15 VOLT SUPPLY

Basic operation of all stages in the -15 Volt Supply is the same as for the +50 Volt Supply. The reference level for this supply is established to ground through R1482 at pin 5 of U1484B. The divider ratio of R1480 and R1481 sets a level of zero volts at pin 6 of U1484B. The level on the +50 V Sense line is held stable by the +50 Volt Supply. Any change at the output of the -15 Volt Supply appears at pin 5 of U1484B as an error signal. The output voltage is regulated in the same manner as described for the +50 Volt Supply. Diode CR1496 limits the output of this supply from going more positive than about +0.6 volt if it is shorted to one of the more positive supplies. Operational amplifier U1484A provides short circuit protection for Q1494 by monitoring the voltage drop across R1495. When too much current is demanded from the supply the increased voltage drop across R1495 allows U1484A to turn Q1488 off, in turn reducing the current through Q1494.

+5 VOLT SUPPLY

The operation of the +5 Volt Supply is basically the same as described for previous supplies. Error voltage to pin 2 of U1514A is provided through R1531 to pin 2 of U1514A; pin 3 is referenced to the +50 V Sense line. The divider ratio of R1513 and R1514 is 10:1, so pin 3 of U1514A is at +5 volts when the supply is operating normally. The level on the +50 V Sense line is held stable by the +50 Volt Supply. Therefore, any change at the output of the +5 Volt Supply appears at pin 2 of U1514A as an error signal. The output voltage is regulated in the manner described previously for the +50 Volt Supply. Diode CR1532 limits the output of this supply to about -0.6 volt if it is shorted to one of the negative supplies.

The +5 volt current limiting is accomplished by U1514B, which protects this supply from excessive output current damage. With normal supply current through R1533 and R1534, the voltage drop is such that the base of Q1518 is biased on. If the current through R1533 and R1534 increases above a safe level, pin 7 of U1514B reduces the forward bias current to Q1518. Now, the base current of Q1522 is reduced which decreases the voltage on the base of Q1526. This limits the conduction of Q1526 to a safe current level.

+15 VOLT SUPPLY

The +15 Volt Supply regulates in the same manner as the +50 Volt Supply; current limiting operates in the manner described for the +5 Volt Supply. Error feedback voltage to pin 2 of U1464A is provided through R1469. Pin 3 of U1464A is referenced to the +50 V Sense line. The divider ratio of R1461 and R1462 sets pin 3 of U1514 at +15 volts. Any change in the output level of the +15 Volt Supply appears at pin 2 of U1464A as an error signal. This results in an opposite change at the output (pin 1 of U1464A) which is conveyed to the +15 volt series regulator (Q1474 through CR1464 and Q1468) to correct the error in the output voltage of the supply. Diode CR1476 limits the output of this supply to about -0.6 volt if it is shorted to one of the negative supplies.

-50 VOLT SUPPLY

Operation of the -50 Volt Supply is basically the same as described for the +50 Volt Supply; current limiting operates in a similar manner as described for the +50 Volt Supply. Error voltage to pin 2 of U1445 is provided by divider R1445-R1446, and is referenced to the -50 V Sense line, from the +50 V Sense line. The divider ratio of R1445 and R1446 sets the level at pin 2 of U1445 at zero volts when the output of this supply is correct. Protection diode CR1458 limits the output voltage of this supply to +0.6 volt should the supply be shorted to a positive supply.

FAN CIRCUIT (SN B059999 & Below)

The fan motor used in this instrument is a brushless dc motor, using Hall Effect devices. The 2 Hall Effect devices sequentially drive the 4 transistors (U1690 A, B, C, and D) which, in turn, control the current flow through the 4 field windings. The fan motor speed is regulated by limiting the current flow through Q1698. Diodes CR1691, CR1692, CR1694, and CR1696 rectify the back emf produced by the 4 field windings. This voltage is applied to the base of Q1698 through resistive divider network R1697, R1695, RT1696 and R1698; the voltage developed by this circuit is proportional to the motor speed. If the motor speed starts to increase, the current drive to the base of Q1698 will decrease, reducing the current to the motor, thus maintaining a constant motor speed. As the temperature increases the value of thermistor R1696 decreases reducing the base voltage of Q1698; Q1698 then conducts more current and the speed of the motor is increased.

FAN CIRCUIT (SN B060000 & Up)

Current for fan B1690 is provided by the +5 V supply through P1490 on Low Voltage Regulator board A25. The fan's 12 volt operating level is achieved by dropping approximately 3 volts across R1690.

GRATICULE-LIGHT SUPPLY

The Graticule-Light Supply provides power to illuminate the graticule lights. The front-panel GRAT ILLUM controls the output of this supply to set the brightness of the graticule lights. Transistors Q1544, Q1548, and diode CR1548 form a pseudo-differential amplifier. The output voltage at the collector of Q1548 follows the voltage set at the base of Q1544 by the divider made up of R1542, R1541, R1543 and the GRAT ILLUM control R1900 (see diagram 7). Resistor R1548 limits the output current from this supply to protect Q1548 from damage due to a short circuit.

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DELAY COMP (OPTION 2)

A schematic diagram of the Delay Compensation circuit is given at the rear of Section 8 in this manual (Diagrams and Circuit Board Illustrations). The X-Y Delay Compensation network (Option 2 only) provides a delay for the horizontal (X) signal from the B HORIZ plug-in compartment to match the delay of the vertical (Y) signal due to the Delay Line (see diagram 8). The Horizontal (X) signal from the A HORIZ plug-in compartment is coupled directly to the horizontal channel switch, diagram 9, without a delay compensation network.

TIME-BASE OPERATION

When the plug-in unit installed in the B HORIZ compartment is operated as a standard time-base unit to produce a horizontal sweep for deflection of the crt beam, the Delay Compensation network is effectively disabled. The X Compensation Inhibit (B) line is open (through pin 5 of P984); relays K1112-K1162 are not actuated. Therefore, the relay contacts remain in the normally-closed position so the horizontal signal passes directly through this network to the Horizontal Channel Switch.

X-Y OPERATION

If the time-base unit installed in the B HORIZ compartment is operated as an amplifier, or if an amplifier unit is installed in the B HORIZ compartment, the X-Compensation Inhibit (B) line, through pin 5 of P984 is held at ground. This actuates relays K1112-K1162 to connect the delay compensation network into the circuit. The B horizontal signal then passes through the X-Y Delay Compensation circuit and through the Delay Line. The horizontal signal is delayed to match the vertical signal, and the losses in the Delay Line are compensated for on the X-Y Delay Compensation circuit board.

As the B horizontal signal passes through the X-Y Delay Compensation stage, U1140 provides gain and frequency compensation. Gain of the stage is determined by R1120. Components R1110, R1112, R1113, R1114 and C1114 are adjusted for optimum step response. Centering adjustment R1105 balances the dc level of the signal. The front corner of the step response is adjusted with R1157. Standing current for U1140 is provided by the +15 Volt Supply through R1152, R1150, and R1161. The current is returned through emitter long tail resistor R1103 and R1104. Operational amplifier U1166A is a +3 volt supply for the output bases of U1140. Operational amplifier U1166B and transistor Q1166 form a regulator which holds the common-mode output voltage of the amplifier at zero volts.

The X-Y Delay Compensation network is an optional feature. For instruments which are not equipped with this feature, the B horizontal signal from the B HORIZ plug-in compartment is connected directly to the Horizontal Channel Switch through the Horizontal Interconnect board.

MAINTENANCE

This section of the manual contains information for performing preventive maintenance, troubleshooting, and corrective maintenance for the 7104 Oscilloscope mainframe.

PREVENTIVE MAINTENANCE

Preventive maintenance, when performed on a regular basis, can prevent instrument breakdown and may improve the reliability of the instrument. The severity of the environment to which the instrument is subjected will determine the frequency of maintenance. A convenient time to perform preventive maintenance is preceding electrical adjustment of the instrument.

CABINET 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, top, and bottom cabinet panels provide protection to personnel from operating potentials present within the instrument. In addition, they reduce radiation of electromagnetic interference from the instrument. The cabinet panels are held in place by slotted fasteners. To remove the panels, turn each fastener counterclockwise a quarter turn with a large screwdriver. Lift the panels away. Operate the instrument with the panels in place to protect the interior from dust.

CLEANING

The 7104 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 reduce the amount of dust reaching 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. Exercise care when cleaning Hypcon connectors; see cleaning instructions under Hypcon Connectors in this section. Use a nonresidue type of cleaner, preferably isopropyl alcohol, totally denatured ethyl alcohol, or a Freon TF cleaner such as Spray-On #2002. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

EXTERIOR

Loose dust accumulated on the outside of the instrument 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, implosion shield, and the crt faceplate with a soft, lint-free cloth dampened with denatured alcohol.

The crt mesh filter (furnished with Option 3 only) can be cleaned as follows:

l. 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

Cleaning the interior of the instrument should only be occasionally necessary. The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air (approximately 5 lb/in^2). 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 more delicate circuit components.

CAUTION

Circuit boards and components must be dry before applying power to prevent damage from electrical arcing.

The high-voltage circuits should receive special attention. Excessive dirt in this area may cause high-voltage arcing and result in improper instrument operation.

VISUAL INSPECTION

The 7104 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 parts are found. Overheating usually indicates other trouble in the instrument; therefore, correcting the cause of overheating is important to prevent recurrence of the damage.

SEMICONDUCTOR CHECKS

Periodic checks of semiconductors are not recommended. The best check of semiconductor performance is actual operation in the instrument. More details on semiconductors are given under Troubleshooting later in this section.

PERIODIC ELECTRICAL ADJUSTMENT

To ensure accurate measurements, check the electrical adjustment of this instrument after each 1000 hours of operation, or every six months if used infrequently. In addition, replacement of components may necessitate adjustment of the affected circuits. Complete adjustment instructions are given in Section 5, Calibration. This procedure can be helpful in localizing certain troubles in the instrument, and in some cases, may correct them.

TROUBLESHOOTING

The following information is provided to facilitate troubleshooting of the 7104 Oscilloscope mainframe. Information contained in other sections of this manual should be used in conjunction with the following data to aid in locating a defective component. An understanding of the circuit operation is helpful in locating troubles. See Section 3, Theory of Operation, for this information.

TROUBLESHOOTING AIDS

DIAGRAMS

Complete schematic diagrams are given on the pullout pages in Section 8, Diagrams and Circuit Board Illustrations. The component number and electrical value of each component in this instrument are shown on these diagrams. (See the first page of the Diagrams and Circuit Board Illustrations section for definitions of the reference designators and symbols used to identify components in this instrument.) Important voltages and numbered waveform test points are also shown on the diagrams. Important waveforms, and the numbered test points where they were obtained, are located adjacent to each diagram. The portions of circuits mounted on circuit boards are enclosed with heavy solid-black lines.

CIRCUIT BOARD ILLUSTRATIONS

To aid in locating circuit boards, a circuit board location illustration appears on the back of the pullout page facing the schematic diagram. In addition, an illustration of the circuit board(s) is included here, with the physical location of the components and waveform test points that appear on the schematic diagram identified. Each circuit board illustration is arranged in a grid locator with an index to facilitate rapid location of components contained in the schematic diagrams.

TROUBLESHOOTING CHART

A troubleshooting chart is given in Section 8, Diagrams and Circuit Board Illustrations to aid in locating a defective circuit. The shaded blocks on the Troubleshooting Chart indicate circuit(s) that may cause the indicated malfunction. The circuits listed are discussed in detail in Section 3, Theory of Operation.

ADJUSTMENT AND TEST POINT LOCATIONS

To aid in locating test points and adjustable components called out in the various portions of the Calibration procedure, the Adjustment and Test Point Locations pullout pages are provided in Section 8, Diagrams and Circuit Board Illustrations.

COMPONENT COLOR CODING

The instrument contains brown composition resistors, some metal-film resistors, and some wire-wound resistors. The resistance values of wire-wound resistors are usually printed on the component body. The resistance values of composition resistors and metal-film resistors are color coded on the components using the 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. 4-1). Metal-film resistors have five stripes consisting of three significant figures, a multiplier, and a tolerance value.

The values of common disc capacitors and small electrolytics are marked on the side of the component body. The white ceramic and epoxy-coated tantalum capacitors used in the instrument are color coded using a modified EIA code (see Fig. 4-1).

The cathode end of glass-encased diodes is indicated by a stripe, a series of stripes, or a dot. The cathode and anode ends of metal-encased diodes can be identified by the diode symbol marked on the body.

SEMICONDUCTOR LEAD CONFIGURATIONS

Lead configurations for semiconductor devices used in the 7104 Oscilloscope are shown in Figure 4-2.

MULTI-PIN CONNECTORS

Pin 1 on multi-pin connectors is designated with a triangle. A triangle, dot or square printed on circuit boards denotes pin 1. When a connection is made to a circuit board, the orientation of the triangle on the multi-pin holder is determined by the index (triangle, dot or square) printed on the circuit board (see Fig. 4-3). Some multi-pin connectors are keyed with a plastic pin that protrudes through a hole on the circuit board. Proper mating with the multi-pin connector and the pin(s) on the circuit board cannot be accomplished unless this pin is aligned with the hole on the circuit board.

Some multi-pin connectors are equipped with a locking mechanism to more readily secure the connector to the circuit board. To remove these connectors, grasp the connector body and pull perpendicular to the circuit board. They should not be removed by pulling on the wire leads; this causes the locking mechanism to clamp onto the circuit board pins.

TROUBLESHOOTING EQUIPMENT

The following equipment is useful for troubleshooting the 7104 Oscilloscope mainframe:

1. Transistor Tester

   Description: Dynamic-type tester.

   Purpose: Test semiconductors.

   Recommended type: TEKTRONIX 577/177 Curve Tracer, TEKTRONIX 576 Curve Tracer, 7CT1N Curve Tracer plug-in unit and a 7000-series oscilloscope system, or a 5CT1N Curve Tracer plug-in unit and a 5000-series oscilloscope system.

2. Digital Multimeter

   Description: 10 megohm input impedance and 0 to 1 kilovolt range, ac and dc; ohmmeter, accuracy, within 0.1%. Test probes must be insulated to prevent accidental shorting.

   Purpose: Check voltages and resistances.

   Recommended type: TEKTRONIX DM 501 Digital Multimeter.

3. Test Oscilloscope

   Description: Frequency response, dc to 100 megahertz minimum; deflection factor, 5 millivolts to 5 volts/division and 1 milliampere to 1 ampere/division. A 10X, 10-megohm voltage probe should be used to reduce circuit loading for voltage measurements. For current waveforms, use a TEKTRONIX P6021 Current Probe with passive termination, or the equivalent.

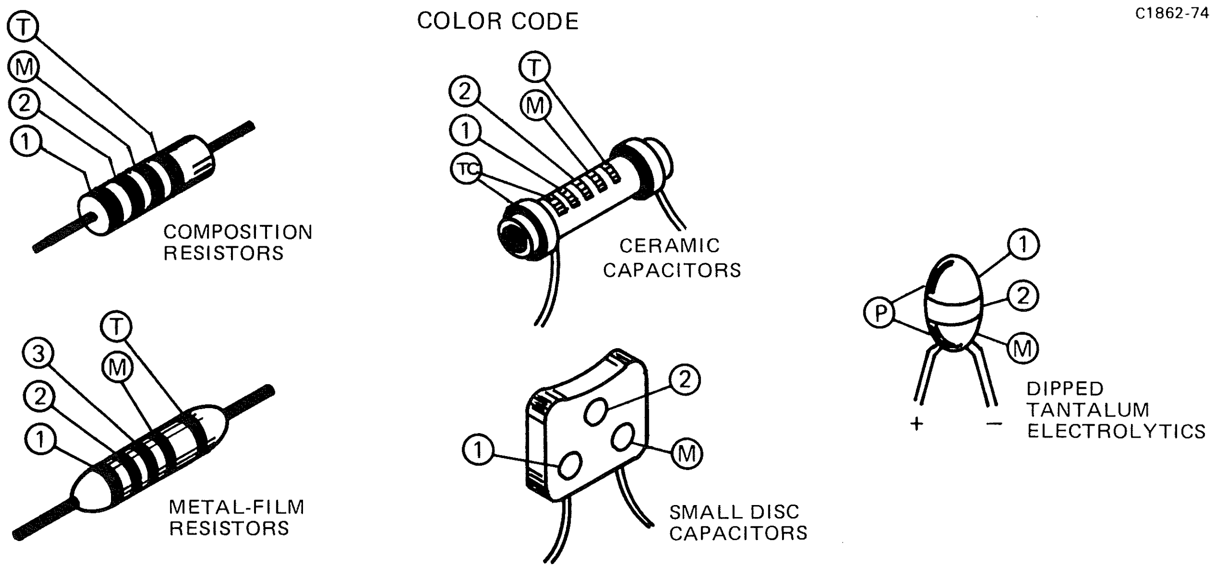
   Purpose: Check operating waveforms.

   Recommended type: Refer to the Tektronix Products catalog for applicable oscilloscope system.

4. Variable Autotransformer

   Description: Output variable from 0 to 140 volts, 10 amperes minimum rating. Must have three-wire power cord, plug, and receptacle.

COLOR CODE



(1) (2) and (3) - 1ST, 2ND, AND 3RD SIGNIFICANT FIGS.
(M) - MULTIPLIER (T) - TOLERANCE;
(TC) - TEMPERATURE COEFFICIENT.

(T) AND/OR (TC) COLOR CODE MAY NOT BE PRESENT ON SOME CAPACITORS;
(P) - POLARITY AND VOLTAGE RATING

COLOR	SIGNIFICANT FIGURES	RESISTORS		CAPACITORS			DIPPED TANTALUM VOLTAGE RATING
		MULTIPLIER (OHMS)	TOLERANCE	MULTIPLIER (pF)	TOLERANCE		
					OVER 10pF	UNDER 10pF	
BLACK	0	1	---	1	±20%	±2pF	4VDC
BROWN	1	10	±1%	10	±1%	±0.1pF	6VDC
RED	2	10^2 or 100	±2%	10^2 or 100	±2%	---	10VDC
ORANGE	3	10^3 or 1 K	±3%	10^3 or 1000	±3%	---	15VDC
YELLOW	4	10^4 or 10K	±4%	10^4 or 10,000	+100% −0%	---	20VDC
GREEN	5	10^5 or 100 K	±1/2%	10^5 or 100,000	±5%	±0.5pF	25VDC
BLUE	6	10^6 or 1 M	±1/4%	10^6 or 1,000,000	---	---	35VDC
VIOLET	7	---	±1/10%	10^7 or 10,000,000	---	---	50VDC
GRAY	8	---	---	10^{-2} or 0.01	+80% −20%	±0.25pF	---
WHITE	9	---	---	10^{-1} or 0.1	±10%	±1pF	3VDC
GOLD	---	10^{-1} or 0.1	±5%	---	---	---	---
SILVER	---	10^{-2} or 0.01	±10%	---	---	---	---
NONE	---	---	±20%	---	±10%	±1pF	---

Figure 4-1. Color code for resistors and capacitors.

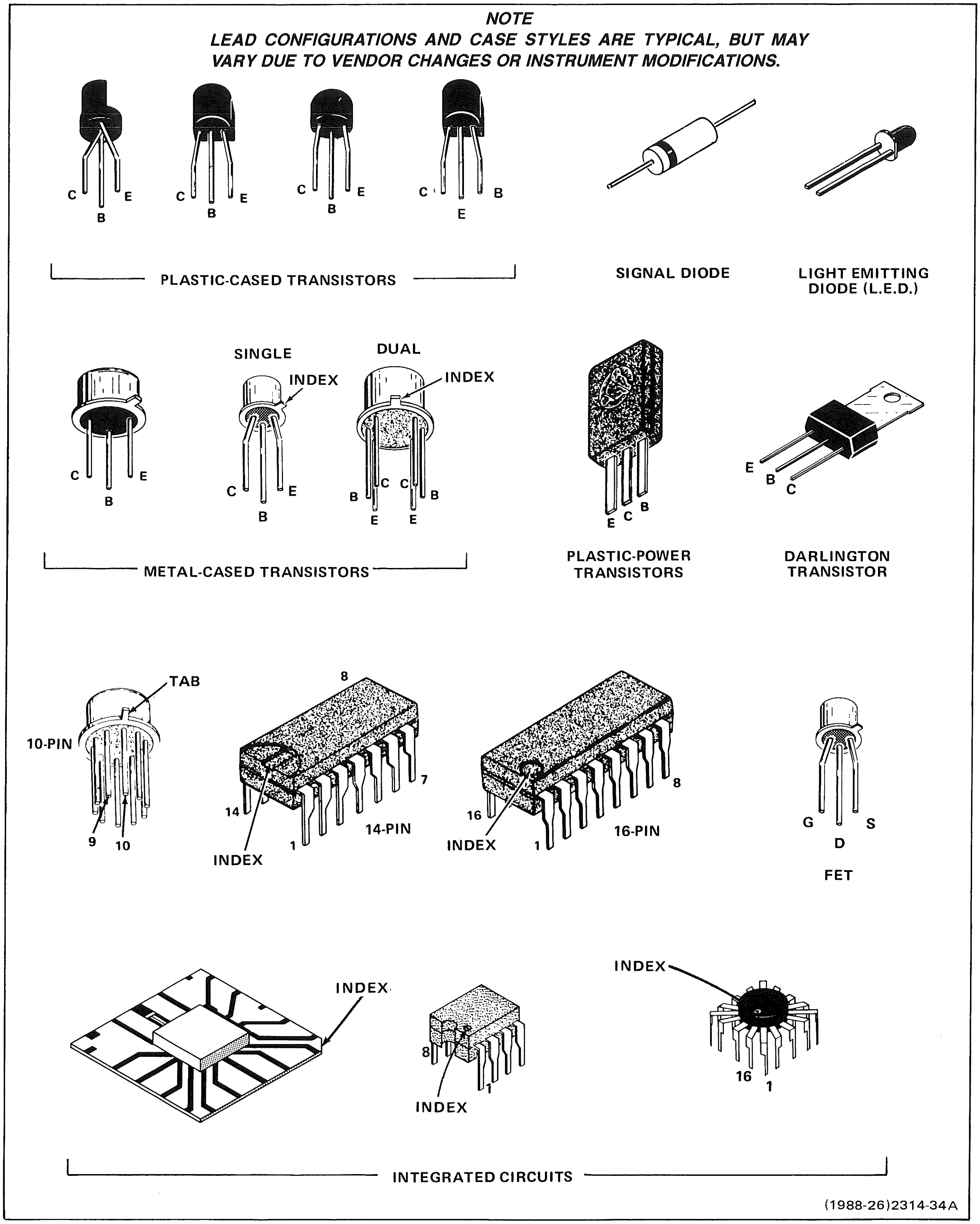


Figure 4-2. Semiconductor lead configurations.

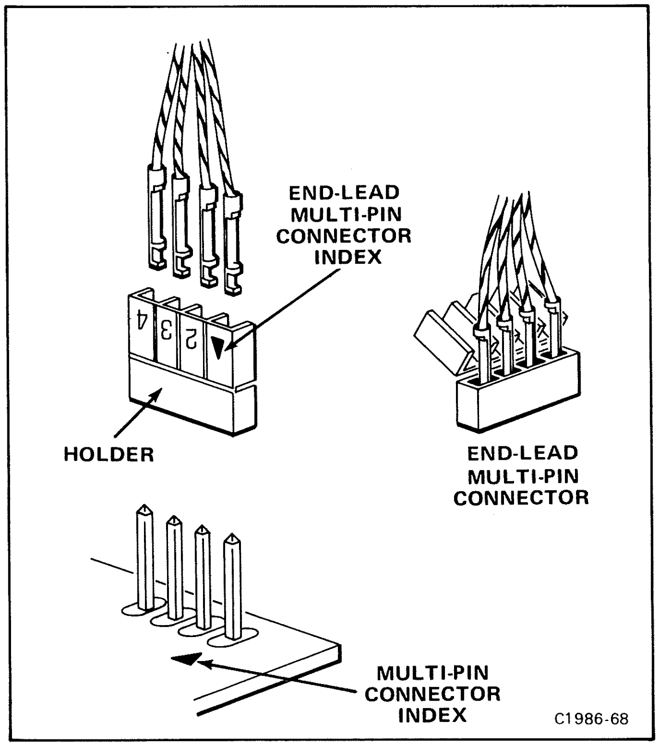


Figure 4-3. Orientation of multi-pin connectors.

Purpose: Vary input line voltage when troubleshooting in the power-supply unit.

Recommended type: General Radio W10MT3W Variac Autotransformer.

5. Isolation Transformer

Description: 1:1 turns ratio, 500 volt-amperes minimum rating, 50-60 cycle. Must have three-wire power cord, plug, and receptacle with ground connection carried through from input to output.

Purpose: To isolate 7104 from line potential when troubleshooting power supply.

Recommended type: Stancor #P6298 (for 115-volt line only) modified to include three-wire power cord, plug, and receptacle.

TROUBLESHOOTING TECHNIQUES

This troubleshooting procedure is arranged to check the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks ensure proper connection, operation, and adjustment. If the trouble is not located by these checks, the remaining steps aid in locating the defective component. When the defective component is located, replace it 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 on the 7104, refer to Section 2, Operating Instructions.

2. CHECK ASSOCIATED EQUIPMENT

Before proceeding with troubleshooting, check that the equipment used with this instrument is operating correctly. Also, check that the input signals are properly connected and that the interconnecting cables are not defective. Check the line-voltage source.

3. VISUAL CHECK

Visually check that portion of the instrument in which the trouble is located. Many troubles can be found by visible indications, such as unsoldered connections, loose cable connections, broken wires, damaged circuit boards, and damaged components.

4. CHECK INSTRUMENT ADJUSTMENT

Check the electrical adjustment of this instrument, or of the affected circuit if the trouble appears in one circuit. The apparent trouble may only be a result of misadjustment. Complete adjustment instructions are given in Section 5, Calibration.

5. ISOLATE TROUBLE TO A CIRCUIT

To isolate trouble to a particular circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. When trouble symptoms appear in more than one circuit, check the affected circuits by taking voltage and waveform measurements. Also check for the correct output signals at the front- and rear-panel output connectors with a test oscilloscope. If the signal is correct, the circuit is working correctly up to that point. For example, correct sawtooth output indicates that the time-base unit and sawtooth output portion of the Output Signals circuit is operating correctly. If a malfunction in the Readout System is suspected of causing trouble to appear in the Z-Axis Amplifier, Vertical Amplifier, or Horizontal Amplifier circuits, the trouble can be localized by removing the Readout System circuit board. This board can be removed without significantly affecting the operation of other circuits in the instrument.

Incorrect operation of all circuits often indicates trouble in the power supply. Check first for correct voltage of the individual supplies. However, a defective component elsewhere in the instrument can appear as a power-supply trouble and may also affect the operation of other circuits. If incorrect operation of the power supplies is suspected, refer to Troubleshooting the High-Efficiency Power-Supply Unit given later in this section.

The 7104 Troubleshooting Chart in the Diagrams and Circuit Board Illustrations, Section 8, provides a guide for locating defective circuits. Start at the top of the chart and perform the checks given on the left side of the page until a step is found that does not produce the indicated results. Further checks, or the circuit in which the trouble is probably located, are listed to the right of the step. This chart does not include checks for all possible defects; use steps 6 and 7 in such cases.

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 voltages or waveforms in the circuit. Typical voltages and waveforms are given in Section 8, Diagrams and Circuit Board Illustrations.

NOTE

Voltages and waveforms given in Section 8, Diagrams and Circuit Board Illustrations, are not absolute and may vary slightly between 7104 Oscilloscope mainframes. To obtain operating conditions similar to those used to take these readings, see the appropriate schematic.

7. CHECK INDIVIDUAL COMPONENTS

The following procedures describe methods of checking individual components in the 7104. Components which are soldered in place are best checked by first disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

WARNING

To avoid electric-shock hazard, always disconnect the 7104 from the power source before removing or replacing components.

Fuses

Check for open fuses by checking continuity with an ohmmeter.

Transistors

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 previously checked). 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

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 ciruits are given in Section 3, Theory of Operation and Section 8, Diagrams and Circuit Board Illustrations. Use care when checking voltages and waveforms around the integrated circuits so that adjacent leads are not shorted together. A convenient means of clipping a test probe to the in-line, multi-pin integrated circuits is with an integrated-circuit test clip. This device also doubles as an integrated-circuit extraction tool.

Diodes

A diode can be checked for an open or shorted condition by measuring the resistance between terminals with an ohmmeter on a scale having a low internal source current, such as the R X 1k scale. The resistance should be very high in one direction and very low when the meter leads are reversed.

CAUTION

When checking diodes, do not use an ohmmeter scale that has a high internal current, since high currents may damage the diodes under test.

Resistors

Check the resistors with an ohmmeter. Resistor tolerances are given in Section 7, Replaceable Electrical Parts. Normally, resistors do not need to be replaced unless the measured value varies widely from the specified value.

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 ADJUST THE CIRCUIT

If any defective parts are located, follow the replacement procedures given under Component Replacement in this section. Check the performance of any circuit that has been repaired or that has had any electrical components replaced. Adjustment of the circuit may be necessary.

TROUBLESHOOTING THE HIGH-EFFICIENCY POWER-SUPPLY UNIT

GENERAL

The following information is provided to facilitate troubleshooting the high-efficiency power-supply unit. Information contained in other sections of this manual should be used in conjunction with this procedure to aid in locating a defective component. An understanding of the circuit operation is valuable in locating troubles. See

Section 3, Theory of Operation, for this information. Specifications for the troubleshooting equipment referred to in this procedure are given earlier in this section under Troubleshooting Equipment.

WARNING

Extreme caution must be used when troubleshooting in the power-supply unit due to the line voltage and the high-voltage/high-current potentials present in the unit.

When a fault condition occurs which is not of sufficient magnitude to open the line fuse, power-supply protection circuitry will cause the inverter to operate in a pulse mode. In this mode the inverter will turn on for a short period of time, and then turn off for a longer period of time. This cycle repeats until the malfunction is corrected. This pulse mode causes either a "ticking" or a "chirping" sound. Whenever either of these sounds is heard, turn off the 7104 and proceed with the Preliminary Procedure given below.

PRELIMINARY PROCEDURE

WARNING

To avoid electric shock, always disconnect the instrument from the power source before removing or replacing components or plug-in units.

l. Remove all plug-in units from the mainframe.

2. Set the CONTROL ILLUMINATION switch on the rear panel to the OFF position, and the GRAT ILLUM switch on the front panel to the fully clockwise position.

3. Remove the power-supply unit from the mainframe following the procedure given later in this section under Component Removal and Replacement.

4. Connect the power-cord plug of the 7104 to the output of a variable autotransformer which is set for 115 volts. Connect the autotransformer to an isolation transformer and plug the isolation transformer into a 115-volt power source.

5. Push the 7104 POWER button in (to turn the instrument on) and note the trouble symptoms.

6. Turn the 7104 off and proceed to the appropriate step in the Troubleshooting Procedure as indicated by the Trouble Symptoms column in Table 4-1.

TROUBLESHOOTING PROCEDURE

Step A: Check Line Fuse

To check the line fuse, perform the following procedure:

1. Check the line fuse (F1200), located on the rear panel of the power-supply unit, for continuity and proper rating as given in Section 7, Replaceable Electrical Parts.

TABLE 4-1
Recommended Power Supply Troubleshooting Sequence

Trouble Symptom	Procedure	Proceed to Troubleshooting Step:
7104 inoperative; no pulse mode.	1. Check line fuse.	A
7104 inoperative; no pulse mode; line fuse open.	1. Check line input circuit.	D
	2. Check LV rectifier circuit.	H
	3. Check inverter circuit.	G
7104 inoperative; no pulse mode; line fuse normal.	1. Check inverter circuit.	G
7104 operating in the pulse mode.	1. Isolate malfunction from the mainframe circuitry.	B
	2. Check pre-regulated power supplies.	C
	3. Check crt and high-voltage circuits.	E
	4. Check inverter control circuit.	F
	5. Check inverter circuit.	G

@

2. If the line fuse is open, replace with a new one of proper rating.

Step B: Isolate Malfunction from the Mainframe Circuitry

To isolate the malfunction perform the following procedure:

WARNING

Use extreme caution when troubleshooting in the power-supply unit, to avoid electric shock. Stored dc potentials on the A23-Inverter circuit board remain long after the instrument is disconnected from the power source. Verify that the power-cord plug is disconnected and that the line storage capacitors (C1216 and C1217) are completely discharged before attempting any repairs or ohmic measurements. (A warning-indicator neon bulb, located on the A23-Inverter board, flashes when this stored voltage exceeds about 80 volts. However, simply because the neon bulb is not flashing does not mean that the capacitors are fully discharged.)

1. Remove the 7104 power-cord plug from the power source.

2. Remove the protective cover from the power-supply unit following the procedure under Access to Components in the Power-Supply Unit.

3. Manually discharge the line-storage capacitors using the procedure given, later in this section, under Access to Components in the Power-Supply Unit.

4. Check the resistance of the power supplies at the test points given in Table 4-2.

NOTE

Place the common lead of the ohmmeter to ground when measuring power-supply resistance.

5. If any of the resistance readings are significantly lower than that listed, remove the electrical connections between the mainframe and the power-supply unit. Disconnect P1417, P1482, P1483 on the A25-Low-Voltage Regulator board. This isolates the circuitry in the mainframe from the power-supply unit. Recheck the resistance. If the readings remain low, the malfunction is located within the mainframe circuits. If the readings increase to normal or above, the malfunction is in the power supplies.

6. Replace all electrical connections which were disconnected in part 5.

TABLE 4-2
Typical Power-Supply Resistance

Power Supply	Test Point	Ohmmeter Scale	Typical Resistance Reading
+50 V	TP891	2k	≥ 1.05 kΩ
+15 V	TP893	2k	≈ 0.115 kΩ
+5 V	TP895	2k	≈ 0.005 kΩ
-15 V	TP897	2k	≈ 0.19 kΩ
-50 V	TP899	2k	≥ 0.59 kΩ

Step C: Check the Pre-Regulated Power Supplies

To check the pre-regulated power supplies, perform the following procedure:

1. Connect a 10X voltage probe from the test oscilloscope to resistor R1284 on the A24-Rectifier board. Set the test oscilloscope vertical deflection factor as necessary for an on-screen display; set the horizontal sweep rate for 2 milliseconds/division.

2. Set the variable autotransformer for 115 volts. Connect the 7104 power-cord plug to the variable autotransformer; turn on the 7104.

3. Compare the waveform on the test oscilloscope to those shown in Figure 4-4. If the waveform resembles that of Figure 4-4A, proceed to Step E of this procedure. If it resembles that of Figure 4-4B, proceed with part 4 of this step.

4. Remove the 10X voltage probe from R1284. Set the test oscilloscope vertical coupling to dc and the horizontal sweep rate to 10 milliseconds/division.

5. Connect the 10X probe to each power supply at the test points given in Table 4-3. Note the polarity, amplitude, and shape of the waveform present at each test point. (Adjust the vertical deflection factor of the test oscilloscope as necessary to maintain an on-screen display.)

NOTE

Look for a power supply where the burst voltage is very low in relation to the specified supply voltage.

6. When a low supply voltage is found, disconnect the 7104 from the power source and discharge the line-storage capacitors following the procedure given under Access to Components in the Power-Supply Unit. Check for shorted components in the suspected power supply; also check the filter capacitors for leakage.

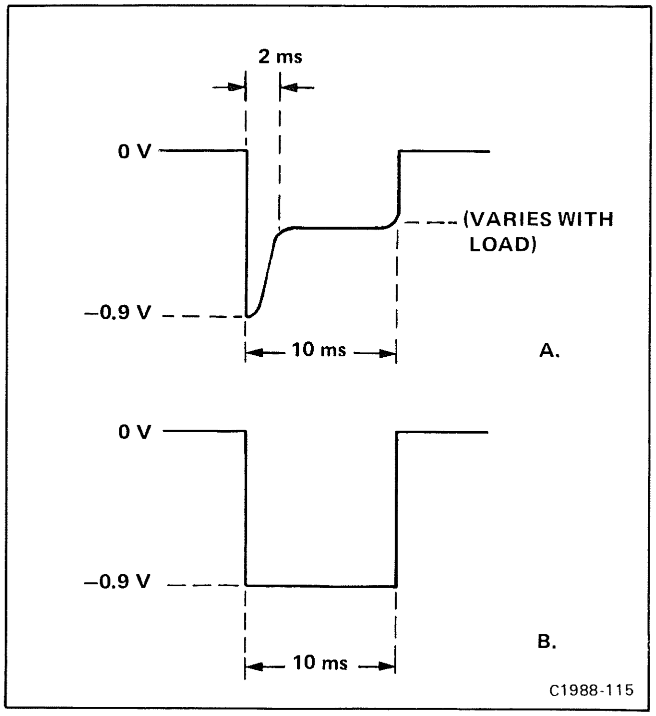


**Figure 4-4. Current sensing waveform at R1284 showing:
A. Power supplies not in current limit operation.
B. Power supplies in current limit operation.**

TABLE 4-3
Burst Voltage Test Points

Pre-Regulated Power Supply	Test Point Located on Rectifier Board
+109 V	TP1326
+54 V	Pin 4 of P1452
+17 V	Pin 6 of P1452
-17 V	Pin 2 of P1452
+8 V	Pin 7 of P1450
-54 V	Pin 3 of P1452
+5 V Lights	Pin 6 of P1450

Step D: Check Line Input Circuit

To check the input circuit, perform the following procedure:

1. Disconnect the 7104 from the variable autotransformer and discharge the line-storage capacitors following the procedure given under Access to Components in the Power-Supply Unit.

2. Replace the line fuse.

3. Check diode bridge CR1215 on the A23-Inverter board and the associated line input circuit for a shorted component. If the circuit appears normal, connect the power-cord to the variable autotransformer.

4. Attach a 10X voltage probe from the test oscilloscope to one of the screws used to discharge C1216 and C1217 (see Fig. 4-5). Set the variable autotransformer for 20 volts and turn the 7104 on. Set the test oscilloscope for line triggering.

5. Check for an ac waveform on the test oscilloscope (see Fig. 4-6). Note the amount of dc the waveform is offset. Move the probe tip to the other capacitor screw. Check for an ac waveform which is both offset an equal amount of dc, and is opposite in polarity, from the previous waveform. (This checks the condition of the line-storage capacitors.)

Step E: Check Crt and High-Voltage Circuit

To check the crt circuitry, perform the following procedure:

1. Disconnect the 7104 from the power source and discharge the line-storage capacitors following the procedure given under Access to Components in the Power-Supply Unit.

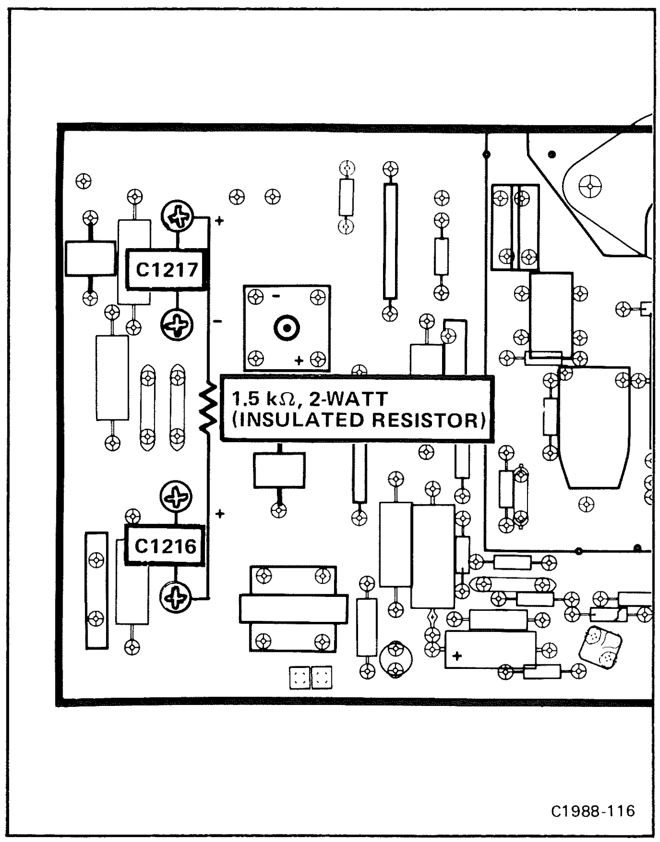
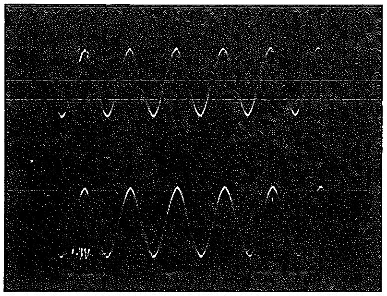


Figure 4-5. Location of line storage capacitor screws used for manually discharging C1216 and C1217.



1988-102

Figure 4-6. Typical waveforms on C1216 and C1217 with the line voltage set to about 20 volts.

2. Remove multi-lead cable P1440 from the A24-Rectifier board.

3. Set the variable autotransformer for 115 volts. Connect the 7104 power-cord plug to the variable autotransformer; turn the 7104 on.

4. Check for stable operation (no pulse mode) of the power supplies. If the power supplies operate properly, a crt failure or malfunction in the high-voltage circuitry is indicated.

Step F: Check the Inverter Control Circuit

To check the inverter control circuit, perform the following procedure:

1. Disconnect the 7104 from the power source and discharge the line-storage capacitors following the procedure given under Access to Components in the Power-Supply Unit.

2. Remove Q1254 from the A24-Rectifier board.

3. Connect the 7104 power-cord plug to the variable autotransformer. Turn the 7104 on and apply 115 volts from the variable autotransformer. If the power supplies stabilize, check the inverter control circuit for a malfunction. If the 7104 continues in pulse mode, proceed to part 4 of this step.

4. Repeat part 1 of this step. Then remove Q1252 from the A24-Rectifier board.

5. Set the variable autotransformer to 0 volts. Connect the 7104 power-cord plug to the variable autotransformer. Turn the 7104 on. While monitoring the +109 V test point on the A25-Low-Voltage Regulator board with a voltmeter, slowly increase the output of the variable autotransformer until the voltmeter just reads +109 volts.

NOTE

If the variable autotransformer's output is increased past the point where the voltmeter just reaches a reading of +109 volts, the 7104 will switch to pulse mode.

6. If the power supplies stabilize, check U1275 and the inverter control circuit for a malfunction. If the 7104 continues in the pulse mode, proceed to Step G of this procedure.

Step G: Check Inverter Circuit

To check the inverter circuit, perform the following procedure:

1. Disconnect the 7104 power-cord plug from the power source and discharge the line-storage capacitors following the procedure given under Access to Components in the Power-Supply Unit.

2. Remove Q1234, Q1240, CR1234, and CR1241 on the A23-Inverter board and check the characteristics of each with a curve tracer. Install the checked or replaced components in the A23-Inverter board. Replace the line fuse, if it is open.

3. If the faulty component was not found, check Q2143, Q2145, and VR1245 with a curve tracer.

NOTE

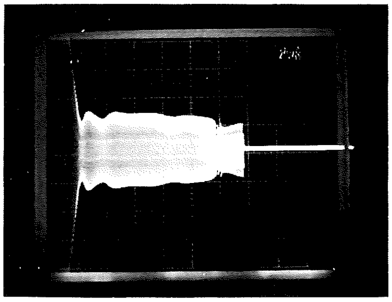
A shift in the zener voltage of VR1245 can cause erratic operation of the inverter circuit.

4. If the 7104 continues in the pulse mode or continues to open the line fuse, check the current waveform through T1230. To do this, first repeat part 1 of this step. Then connect a current probe from the test oscilloscope to the gray lead that passes through toroid transformer T1230. Set the test oscilloscope for a vertical deflection factor of about 1 volt/division and a horizontal sweep rate of 2 milliseconds/division. Connect the 7104 power-cord plug to the variable auto transformer which is set for 0 volt. Turn the 7104 on and slowly increase the variable autotransformer's output to about 60 volts. Check for a burst waveform on the test oscilloscope (similar to that shown in Fig. 4-7).

NOTE

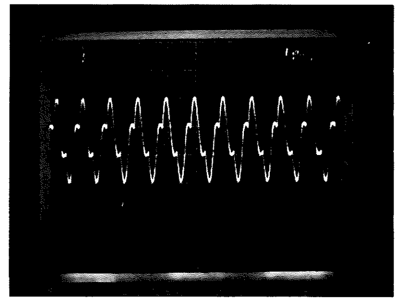
The burst waveform indicates that the inverter circuit is attepting to start. If no burst waveform occurs, proceed to part 6; if a burst waveform is obtained, proceed to part 5.

5. If a burst waveform was obtained in part 4 above, check for stable inverter operation when the line input voltage is increased to about 85 volts. Figure 4-8 shows



1988-103

Figure 4-7. Current waveforms of T1230 showing burst operation at line voltage of about 60 volts.

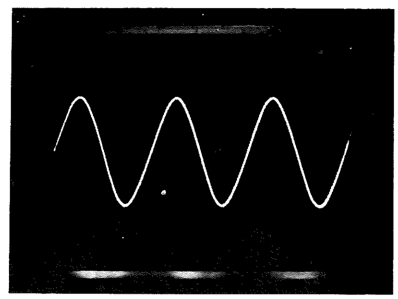


1988-104

Figure 4-8. Current waveform at T1230 for normal inverter operation at line voltage of 115 volts.

the current waveform at T1230 for normal inverter operation at a line source of 115 volts. (NOTE: The test oscilloscope horizontal sweep rate has been changed to about 50 microseconds/division for Fig. 4-8.)

6. If no burst waveform occurred in part 4, repeat part 1 of this step. Then remove the current probe from the 7104 and the test oscilloscope. Connect a 10X voltage probe from the test oscilloscope to TP1234 on the A23-Inverter board. Set the variable autotransformer for 20 volts and check for a line-ripple waveform which is about dc centered (see Fig. 4-9). If the waveform is not centered check Q1246, CR1232, CR1240, CR1249, and CR1245 for shorts or leakage.



1988-105

Figure 4-9. Waveform at TP 1234 on the power-supply Inverter board with the line voltage at about 20 volts.

Step H: Check LV Rectifier Circuit

1. Disconnect the 7104 power-cord plug from the power source and discharge the line-storage capacitors in the power-supply unit, following the procedure given under Access to Components in the Power-Supply Unit. Inspect the A24-Rectifier board and connecting cables for shorts and damaged components.

2. Remove dual diode CR1351 from the A24-Rectifier board and check with a curve tracer. Reinstall tested or replaced parts, making certain that the case is not shorted to the heat sink.

3. Lift one leg each of CR1340, CR1341, CR1342, and CR1343 and check with a curve tracer. Reconnect tested or replaced parts.

4. Lift one leg each of CR1330, CR1331, CR1332, CR1333, CR1350, and CR1353 and check with a curve tracer. Reconnect tested or replaced parts.

5. Check the electrolytic capacitors which filter the supplies, including C1354 (under the board) for shorts.

TROUBLESHOOTING THE CRT AND ASSOCIATED CIRCUITRY

The following information is provided to facilitate troubleshooting the crt connections and associated circuitry, and is designed to eliminate unnecessary crt replacement. Information contained in other sections of this manual should be used in conjunction with this procedure to aid in locating troubles. See Section 3, Theory of Operation, for this information.

WARNING

Extreme caution must be used when troubleshooting the crt and associated circuitry due to the high voltage present in this area of the instrument.

CRT DISPLAY SYMPTOM CHECKOUT PROCEDURE

Perform the following procedure to determine the display symptoms associated with a crt circuit failure. Then proceed to the appropriate step in the CRT Circuit Troubleshooting Procedure as indicated by the Trouble Symptom column of Table 4-4.

Preliminary Setup:

1. Set the 7104 front-panel controls as follows:

POWER	OFF
A INTENSITY	Counterclockwise
FOCUS	Midrange
B INTENSITY	Counterclockwise
READOUT	OFF
VERTICAL MODE	RIGHT
HORIZONTAL MODE	A
BEAMFINDER	Pushbutton in

2. Connect the 7104 to a power source that meets the voltage and frequency requirements of the instrument.

3. Install a Tektronix 7A-series amplifier unit in the RIGHT VERT compartment.

4. Install a Tektronix 7B-series time-base unit in the A HORIZ compartment and set it to 1 ms/div. Set triggering controls for a free-running sweep.

5. Press the POWER switch to the ON (locked in) position. If a trace appears on the crt, turn the POWER switch OFF and disconnect P1702 (crt heater). See Trouble Symptom #1 in Table 4-4.

6. Rotate the A INTENSITY and READOUT INTENSITY controls clockwise to about midrange.

a. If no display appears on the crt, turn the POWER switch OFF and disconnect P1702 (crt heater). Refer to Trouble Symptom #2 in Table 4-4.

b. If only the readout portion of the display appears on the crt, refer to Trouble Symptom #3 in Table 4-4.

c. If the intensity of the displayed trace appears to change during warmup, refer to Trouble Symptom #6 in Table 4-4.

d. If the displayed trace appears dim with the A INTENSITY control set fully clockwise, refer to Trouble Symptom #5 in Table 4-4.

7. Set the time-base unit to 5 μs/div. Adjust the A INTENSITY control for a visible display. Set the time-base to 2 ns/div. If the display disappears and cannot be obtained with the A INTENSITY control, refer to Trouble Symptom #4 in Table 4-4.

8. Rotate the A INTENSITY control. If a charging phenomena appears on the display, refer to Trouble Symptom #8 in Table 4-4.

9. Perform the Geometry procedure in Section 5, Calibration. If the crt geometry or linearity is unsatisfactory, refer to Trouble Symptom #7 in Table 4-4.

10. Perform the Photographic Writing-Rate procedure in Section 5, Calibration.

a. If the waveform and readout display focuses at different positions of the FOCUS control, refer to Trouble Symptom #9 in Table 4-4.

b. If the photographic writing rate is unsatisfactory, refer to Trouble Symptom #10 in Table 4-4.

c. If the photograph indicates background scintillation, refer to Trouble Symptom #11 in Table 4-4.

CRT CIRCUIT TROUBLESHOOTING PROCEDURE

Step A: Check Anode Voltage Multiplier

1. Check that the anode lead is properly installed.

2. Turn all INTENSITY controls counterclockwise.

3. Turn the instrument off, disconnect the anode lead. Watch for an arc while you short the anode lead to the chassis. An arc indicates that the Anode Voltage Multiplier is at least partially working.

NOTE

If the crt anode is open, the screen capacitance will not be charged and an arc will not be drawn when the anode is discharged to ground.

4. Turn the instrument on and measure the anode voltage. The voltage should measure approximately 12.5 kV.

TABLE 4-4
Recommended CRT Circuitry Troubleshooting Sequence

Trouble Symptom	Recommended Procedure	Proceed to Step:
1. Bright display; no response with INTENSITY controls.	1. Check CRT Grid; pin 3.	R
	2. Check Grid Bias Supply circuit.	E
	3. Check Control Grid DC Restorer circuit.	G
	4. Check Z-Axis Amplifier circuit.	I
2. No waveform or readout display.	1. Check Anode Voltage Multiplier output.	A
	2. Check CRT Heater supply.	B, T
	3. Check Microchannel Plate Supply circuit.	C
	4. Check -2400 Volt Supply circuit.	D
	5. Check Grid Bias Supply circuit.	E
	6. Check Z-Axis Amplifier circuit.	I
	7. Check Intensity Limiter circuit.	J
	8. Check Grid Crowbar circuit.	F
	9. Check Control Grid DC Restorer circuit.	G
	10. Check CRT First Anode, Second Section.	P
3. No waveform display; readout display only.	1. Check Intensity Limiter circuit.	J
4. Display only at sweep speeds below 5 μs/div.	1. Check CRT Grid, pin 3.	R
5. Dim display.	1. Check Microchannel Plate Supply circuit.	C
	2. Check Grid Crowbar circuit.	F
	3. Check Z-Axis Amplifier circuit.	I
	4. Check Intensity Limiter circuit.	J
	5. Check Grid Bias Supply circuit.	E
	6. Check Anode Voltage Multiplier output.	A
	7. Check First Anode, First Section.	U
6. Display intensity varies during warmup.	1. Check Grid Bias circuit.	L
7. Geometry or linearity unsatisfactory.	1. Check CRT Scan Expansion Lens.	O
8. Focusing problems; charging phenomena may be observed.	1. Check Focus Grid DC Restorer circuit.	H
	2. Check following CRT pin connections:	
	a. Astigmatism, pin 10.	X
	b. Stigmator, pin 11.	V
	c. First Anode, First Section, pin 7.	U
	d. D1-D2 Shield, P1813-pin 5.	W
	e. Focus Electrode, pin 4.	Q

TABLE 4-4 (CONT.)
Recommended CRT Circuitry Troubleshooting Sequence

Trouble Symptom	Recommended Procedure	Proceed to Step:
8. Focusing problems; charging phenomena may be observed (cont.).	2. Check following CRT pin connections (cont.):	
	f. Spot Demagnification Lens, pin 5.	Y
	g. Cathode, pin 2.	S
	h. Isolation Shield, P1813-pin 6.	N
9. Waveform and readout displays do not focus simultaneously.	1. Check Auto Focus circuit.	K
10. Low writing rate.	1. Check Microchannel Plate Supply circuit.	C
	2. Check Grid Bias Supply circuit.	E
	3. Check Anode Multiplier circuit.	A
11. Unacceptable background scintillation appears in photographs.	1. Check Microchannel Plate Supply circuit.	C
12. Display present with background glow.	1. Check CRT Exit Electrode.	M

NOTE

The output impedance of the anode supply is 100 MΩ. When measuring the anode voltage the loading of the voltmeter should be taken into account. Due to the 100 MΩ output impedance, the Anode Voltage Multiplier is short-proof.

5. Check the input voltage to the Anode Voltage Multiplier at R1750. This should be a square-wave signal roughly centered about ground with an amplitude of 2500 volts peak-to-peak and a frequency of approximately 25 kHz. If this voltage is correct, turn the instrument off and remove the High Voltage board (see Fig. 8-1 for the board location). Check to see if the input and ground leads of the Anode Voltage Multiplier are connected.

6. Replace the High Voltage board.

Step B: Check CRT Heater Supply

1. Visually check for loose connections to the crt. Then check to see if the heater glows.

WARNING

Potential shock hazard exists when measuring the heater supply. The heater supply is elevated to -2565 volts.

2. Disconnect harmonica P1702 and measure the heater voltage with a true rms voltmeter. The voltage should be 6.3 volts rms; frequency about 25 kHz. If a low reading of the supply is obtained, the high voltage transformer may be defective.

3. Turn the instrument off. Check for continuity between pins 1 and 2 of P1702, and between pins 1 and 14 of the crt.

Step C: Check Microchannel Plate (MCP) Supply

WARNING

Potential shock hazard exists: the MCP voltage can be as high as +1200 volts.

1. Visually check for loose connections on the High Voltage board. (See Fig. 8-1 for board location.)

2. Turn all INTENSITY controls counterclockwise. Measure the MCP output voltage at TP1775 and note the reading.

3. Turn R1720 (MCP Gain) clockwise. The voltage reading should be about 860 volts. Turn R1720 counterclockwise. The voltage reading should be about 460 volts. Reset R1720 to the voltage reading noted in part 2.

a. If the MCP voltage at TP1775 is low, ground TP1707 and again note the MCP voltage reading. If the voltage now reads about 1250 volts: check components Q1708, U1714A, CR1707, CR1708, C1707 and C1708. If the voltage is still low, check components CR1710, CR1711, C1710, and C1711.

NOTE

With TP1707 grounded, the voltage at the secondary of the MCP transformer should be a square wave of about 625 volts peak.

Remove the ground from TP1707.

4. Remove the plug-ins from the horizontal compartments. Set the HORIZONTAL MODE switch to A and turn the A INTENSITY control fully clockwise. The MCP output voltage (at TP1775) should increase by about 350 volts. With the HORIZONTAL MODE switch in CHOP, ALT, or B, turn the B INTENSITY control fully clockwise. The MCP output voltage should increase by about 350 volts. If the MCP output voltage does not increase, check for continuity of the Intensity Sense line to the Logic board (P1785 pin 7), and check U1714.

5. If the MCP voltage measurements are correct, check for a loose connection to the microchannel plate at the crt (P1819, pins 3 and 7). This can be done without removing the crt by connecting a DVM across resistors R1725 and R1726 to check for about 10 volts. Typically, the voltage reading is around 10 volts, corresponding to a current of 50 μA. If no current flows, remove the crt and check for open connections.

Step D: Check -2400 Volt Supply

WARNING

To avoid electric shock, use extreme caution when troubleshooting the -2400 Volt Supply.

1. Check the voltage at TP1844 on the High Voltage board.

a. If the reading is -2400 volts, within 5 volts, the supply is operating properly.

b. If the reading is more than 5 volts from -2400 volts, check the cathode supply at TP1846 for -2265 volts. If necessary, adjust R1805 (-2265 V Adjust) to -2265 volts. If the adjustment has no effect, check the high-voltage regulator Q1784 (see below). If the adjustment has some effect but fails to obtain -2265 volts at TP1846, the Grid Bias Supply may not be functioning properly. (See Step E: Check Grid Bias Supply.)

c. If the reading is near ground, check:

(1) For a 2500 volt (p-p) square-wave signal at the junction of R1750 and pin 9 of T1770 with the other end of the winding (pin 7) held near ground. If the appropriate signal is not obtained, check diodes CR1776, CR1778, and CR1784.

(2) Check the voltage doubler by removing regulator transistor Q1784. The dc voltage at TP1844 should be approximately -2300 volts. If not, check diodes CR1762, CR1763 and capacitors C1750 and C1764.

(3) Check the regulator transistor Q1784 and zener diode VR1784. With transistor Q1784 removed, the voltage at TP1784 should be 200 volts dc.

(4) Check operational amplifier U1802.

(5) Check the -2265 Adjust, R1805. Remove the regulator transistor Q1784 and connect a DVM to TP1806. Moving R1805 throughout its range should cause a dc voltage change of about 200 mV at TP1806. If not, lift diodes CR1803 and CR1804 and repeat the measurement. Check for shorted or opened resistors if the 200 mV change is not obtained.

(6) Check the thick-film high-voltage resistor R1802.

Step E: Check Grid Bias Supply

WARNING

Potential shock hazard exists when measuring the Grid Bias Supply; the DVM is elevated to -2400 volts.

1. Place a voltmeter between TP1846 (-2265 volts) and TP1844 (-2400 volts). Check for a reading of 137 volts, within 5 volts.

a. If the voltage is low (approximately 60 to 70 volts), check Q1838, Q1842, and C1846 for a shorted condition. Then check Q1835 for an open junction.

b. If the voltage is high (approximately 200 volts), check Q1842 and Q1838 for an open junction.

c. If the voltage is more than 5 volts from 37 volts, check transistors Q1835, Q1838, and Q1842 on a curve tracer. Check capacitor C1846 for leakage by lifting one end of the capacitor from the circuit board and remeasuring the Grid Bias Supply voltage.

Step F: Check Grid Crowbar Circuit

WARNING

Potential shock hazard exists when working on the Grid Crowbar circuit since it is elevated to -2400 volts.

1. Remove transistor Q1687 and check for a display. If a display is obtained, check Q1687 on a curve tracer. If a display is not obtained, check C1687 for leakage.

CAUTION

To ensure crt cathode protection, check the Grid Crowbar circuit for proper operation.

Step G: Check Control Grid DC Restorer

WARNING

To prevent shock hazard, turn instrument power off before working on high-voltage circuits.

1. Set the time-base unit for a 20 μs/div, free-running mode.

2. Check that the waveform at the junction of R1811 and CR1747 is similar to that shown in Figure 4-10.

NOTE

A typical waveform at this junction is a square wave with a frequency of about 25 kHz. The positive level should not exceed +50 volts and the negative level should be more positive than -50 volts.

If the waveform is not like that of Figure 4-10, check the Z-Axis Amplifier by increasing the A INTENSITY setting; the positive level of the square wave should also increase until the Intensity Limiter limits the Z-Axis drive. Then check the Grid Bias circuit by changing the setting of CRT Grid Bias adjustment R1746; the negative level of the square wave should also change.

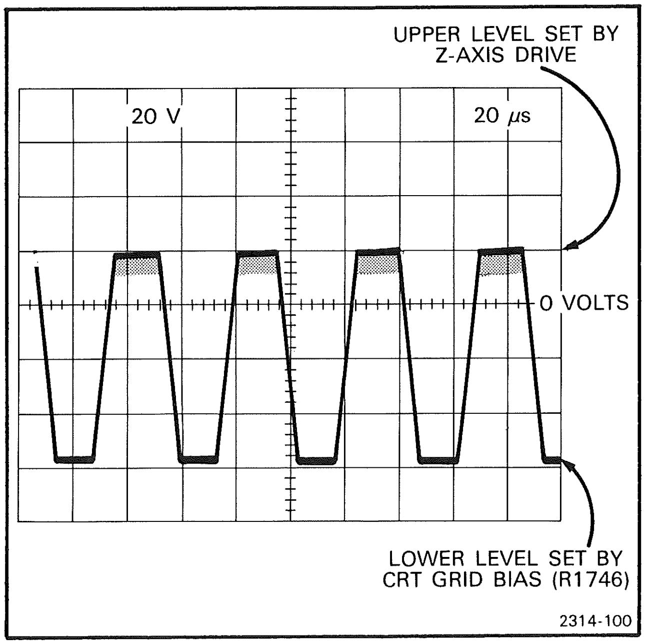


Figure 4-10. Typical waveform at junction of R1811 and CR1747 on the High Voltage circuit board.

a. If the square wave appears normal, but the display is bright and not controllable with the INTENSITY controls, check for an open crt grid.

b. If the positive level of the square wave exceeds +50 volts and the display is bright regardless of the INTENSITY controls, the low-frequency signal from the Z-Axis Amplifier is disconnected from the Control Grid DC Restorer. Check diode CR1749 for an open, then check for loose connections.

c. If the negative level of the square wave is more negative than -50 volts and the display is bright regardless of the INTENSITY control, the Grid Bias circuit is disconnected from the Control Grid DC Restorer. Check CR1447 for an open.

d. If the square wave appears normal, but no display can be obtained, check CR1792, CR1794, and C1793 for an open.

e. If the waveform is only a dc level which varies as the Z-Axis Amplifier output varies and no display can be obtained, check CR1794 for a short.

f. If the square wave amplitude is only about 10 to 20 volts and can be positioned with the CRT Grid Bias adjustment, R1746, but no display can be obtained, check CR1747 for a short.

g. If the square-wave amplitude is only about 10 to 20 volts, and cannot be positioned with CRT Grid Bias adjustment or the INTENSITY controls, and no display can be obtained, check CR1792 and CR1794 for a short.

h. If the square wave appears normal but the INTENSITY controls have no effect on its positive level, check the Z-Axis Amplifier circuit.

i. If the square wave appears normal but a display can only be obtained with the INTENSITY controls fully clockwise, the Grid Bias circuit is not functioning. Check transistors Q1748 and Q1742.

j. If the waveform is not normal and no display can be obtained, the high-voltage transformer is not driving the Control Grid DC Restorer. Check the resistor string of R1811, R1812, R1788, and R1789.

Step H: Check Focus Grid DC Restorer

WARNING

To prevent shock hazard, turn instrument power off before working on high-voltage circuits.

1. Check that the waveform at the junction of R1814 and CR1816 is similar to that shown in Figure 4-11.

NOTE

A typical waveform is a square wave of about 25 kHz. The negative level should be -0.7 volt. The positive level is determined by the setting of the front-panel FOCUS control and varies between +0.7 volt and +50 volts.

a. If the negative level of the waveform is more negative than -50 volts, check diode CR1816 for an open.

b. If the positive level of the waveform exceeds +50 volts, check diode CR1820 for an open.

c. If the amplitude of the waveform is small and the FOCUS control has no effect on the positive level of the waveform, check diode CR1816 for a short.

d. If the amplitude of the waveform is small but the FOCUS control varies the positive level from 0 to +50 volts, check diode CR1820 for a short.

e. If the waveform is not as shown in Figure 4-11 and the dc level is above ground with the FOCUS control at midrange, check diode CR1818 or CR1819 for a short.

f. If the waveform does not appear as shown in Figure 4-11, the Focus Grid DC Restorer may not be receiving drive signal from the high voltage transformer. Check resistors R1788, R1789, R1813, and R1814.

g. If the waveform appears normal but the display has focusing problems, check for an open crt focus electrode. Then check for proper adjustment of the Focus Preset and for defective resistors in the focus string. Check CR1819, CR1818, and C1819 for an open.

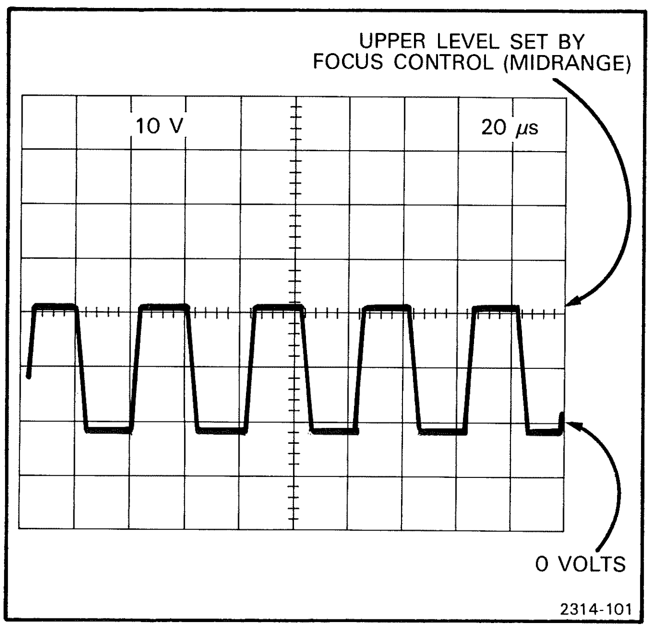


Figure 4-11. Typical waveform at junction of R1814 and CR1816 on the High Voltage circuit board.

NOTE

The focus-preset voltage, across C1820, ranges from about -1385 volts to -1560 volts as determined by R1825.

Step I: Check Z-Axis Amplifier

1. Check TP1678, on the Z-Axis board, for a waveform with a baseline at +8 volts, within 1 volt, and an amplitude of at least 55 volts above the baseline.

NOTE

To obtain maximum Z-Axis drive without engaging the Intensity Limiter, set the time-base time/division switch fully clockwise and position the trace off the crt screen. Refer to Z-Axis and Display in Section 5, Calibration, to properly adjust the Z-Axis Amplifier.

2. Check the dc voltage at TP1672. The voltage should be +75 volts, within 5%. If it is not, check transistor Q1672 and zener diode VR1671.

3. If the voltage at TP1672 is about +60 volts and the display intensity is high, check the voltage at the collector of Q1608: the baseline should be at +1.6 volts, and the signal amplitude should be about 700 mV.

a. If the conditions in part 3 are met, check transistors Q1648, Q1668, and Q1676.

b. If the conditions in part 3 are not met, check transistors Q1608 and Q1618 for a short.

4. If the voltage at TP1678 is at ground and no display can be obtained, the Intensity Limiter may be inhibiting the Z-Axis Amplifier by saturating Q1644, or Q1644 may be shorted.

a. If the baseline voltage at the collector of Q1608 is not at +1.6 volts and the signal amplitude is not about 700 mV, check Q1626, Q1608, Q1632, and Q1203.

b. If the signal is correct, check transistors Q1668 and Q1644 for a short.

Step J: Check Intensity Limiter

CAUTION

To prevent damage to the MCP when troubleshooting the Intensity Limiter circuit, flood the crt display with many cycles of a large amplitude sine wave.

1. If the Intensity Limiter is inhibiting the Z-Axis Amplifier, check the Z-Axis Off signal at TP1992. On a

properly operating instrument the signal level at TP1992 is +120 mV; on an instrument which is shutdown the signal level is +3.4 volts.

a. If the signal at TP1992 is +120 mV, the fault is in the Z-Axis Amplifier. (Refer to Step I: Check Z-Axis Amplifier.)

b. If the reading is +3.4 volts, check pin 2 of U1992 (the flip-flop may not be receiving a reset). Check U1992 by replacement.

2. Check that operational amplifier U1952 converts the average screen current to a dc voltage at a rate of 1 μA/volt. With all INTENSITY controls turned fully counterclockwise, the voltage at TP1952 should be zero volts and should increase as the INTENSITY controls are advanced. If this does not occur, check the Screen I Sense connection to the Anode Voltage Multiplier. (When the INTENSITY control is advanced, a negative voltage should be measured at pin 8 of P1904. If zero volts is measured here, either the connection is open or the Anode Voltage Multiplier is defective.) Also check U1952.

3. Increase the INTENSITY controls until the LIMITED VIEWING TIME indicator turns steadily on, and observe that this occurs when the voltage at TP1952 is approximately 25 mV dc (25 nA of average screen current).

a. If the condition in part 3 is not met, check that the voltage at pin 6 of U1958B is 25 mV dc. Measure the voltage at TP1962; with zero screen current the reading should be about -12 volts. When the INTENSITY control is advanced and the average screen current exceeds 25 nA, the reading should be about +12 volts. If the readings are much different, check operational amplifier U1958 by replacement.

b. If the condition in part 3 is not met, check for a loose connection to LED DS 1970. Check LED DS1970.

c. If the LIMITED VIEWING TIME indicator is on continuously (at zero screen current) and starts flashing at an average screen current above 25 nA, transistor Q1970 is shorted.

4. Increase the INTENSITY setting until the LIMITED VIEWING TIME indicator starts flashing, and observe that this occurs when the voltage at TP1952 is approximately 1.8 volts dc, or 1.8 μA average screen current. If this does not occur, check the following:

a. Check the 3 Hz Oscillator U1968; at zero screen current the voltage at TP1968 is about +12 volts, but will oscillate between ground and +12 volts when the INTENSITY control is advanced to the limited-viewing condition (LIMITED VIEWING TIME indicator is on steadily). If no oscillation occurs, check U1968 by replacement.

b. The voltage at pin 2 of U1958A should be 1.8 volts dc.

c. Measure the voltage at TP1958, with zero screen current the reading should be about -12 volts. When the INTENSITY control is advanced and the average screen current is 1.8 μA, the voltage reading should have increased to at least -8.0 volts dc. If the readings are much different, check operational amplifier U1958 by replacement.

d. Check transistor Q1970 for conduction.

5. Increase the INTENSITY setting until the LIMITED VIEWING TIME indicator just starts to flash. Observe that further advance of the INTENSITY control does not increase the display intensity and that limiting is taking place. (With proper limiting, the voltage at TP1956 is -10.6 volts and increases towards ground when limiting occurs.) If this does not occur, check the following:

a. Check transistor Q1956 for a short.

b. Check for proper connection of the Intensity Reference Line (pin 4 of P1904) to diodes CR2009 and CR2019 on the Display Control board. (See Fig 8-1 for location of the Display Control board.)

c. Check diodes CR2009 and CR2019 for opens.

6. Increase the INTENSITY setting until the LIMITED VIEWING TIME indicator flashes. Check that after approximately two minutes the SHUTDOWN indicator starts to flash. If this does not occur:

a. Check integrator U1970. With zero screen current, the voltage at TP1970 should be at ground or is moving toward ground. Observe that when the INTENSITY setting is increased until the LIMITED VIEWING TIME indicator is steadily on, the voltage starts moving toward -10 volts. If the INTENSITY is further increased, the slew rate of the voltage should increse. The slew rate is maximum when limiting occurs (LIMITED VIEWING TIME indicator is flahing) and should be about 10 volts/minute. If this does not occur, one of the following failures may have occurred:

(1) The base of Q1980 is held at ground by either a shorted RESET button or by a shorted or saturated Q1999.

(2) Transistor Q1982 is not conducting.

(3) Transistor Q1978 is shorted.

(4) Operational amplifier U1970 is defective.

(5) Field-effect transistor Q1974 is not conducting. This causes the voltage at TP1970 to stop at about -2.0 or -3.0 volts instead of -10 volts.

(6) Capacitor C1971 is leaking. The symptoms are similar to those for an open field-effect transistor. Press the RESET button, then increase the INTENSITY setting until limiting occurs. After approximately one minute, the voltage at TP1970 should be -10 volts. If this differs significantly, replace C1971.

(7) Check the 10-second delay timer. The voltage at TP1986 should measure zero volts at zero screen current. When the INTENSITY setting is increased and the output of the integrator has reached about -10 volts, the voltage at TP1986 should jump to about +3.6 volts. After approximately 10 seconds, the voltage should drop back to ground level. If this does not occur, check U1986 by replacement.

(8) Check SHUTDOWN LED DS1994 for loose connections or failure.

7. Increase the INTENSITY setting until limiting occurs, and wait approximately one minute until the SHUTDOWN indicator starts flashing. After approximately 10 seconds, the indicator should be on steadily and the display should shut down. If this does not occur:

a. Check transistor Q1995. This transistor should momentarily go out of saturation when timer U1986 has timed out.

b. Check the flip-flop U1992. The voltage at TP1992 should increase from 0.1 volt to about +3.4 volts when timer U1986 has timed out.

c. Check transistor Q1994.

d. Check for a loose connection of the Z-Axis Off line (pin 1 of P1904) to the Z-Axis Amplifier.

e. Check transistor Q1644.

8. When the instrument is shut down, the voltage at TP1992 is about +3.4 volts dc. If pressing the RESET button at this time does not restore the display, check the following:

a. Check the RESET switch. The voltage at the base of Q1980 should be +2.3 volts and should drop to +0.2 volt when the RESET button is pressed.

b. Check flip-flop U1992 by replacement.

9. With the SHUTDOWN indicator flashing, shutdown can be prevented by reducing the average screen current to below 25 nA (LIMITED VIEWING TIME indicator off). If this does not occur, check the following:

a. Transistors Q1998 and Q1999.

b. 10-second delay timer U1986 if it does not reset.

Step K: Check Auto Focus Amplifier

1. Check the dc voltage at the emitter of Q1607. The voltage should be about -8.5 volts. If the voltage reading differs by more than 0.2 volt, check transistor Q1607 and diode CR1607.

2. Obtain a full-drive crt display that is not intensity limited. The front-panel LIMITED VIEWING TIME indicator should not flash.

3. Check the auto-focus signals at the collector of Q1603. With the INTENSITY control fully counterclockwise, the signal is clamped by diode CR1609 to a voltage of -7.9 volts. At about midrange of the INTENSITY control, diode CR1609 ceases to conduct. With the INTENSITY control fully clockwise, the waveform at the collector of Q1603 should have an amplitude of 0.9 volt. If not, check transistor Q1603 and diode CR1609.

4. Check the auto-focus signal at TP1628. With the INTENSITY control fully clockwise, the amplitude of the signal should be about 7 volts (depending upon the focus gain adjustment). If not, check transistors Q1629, Q1620, and Q1617.

5. Check the connection to the crt focus electrode.

Step L: Check Grid Bias Compensation

1. Turn the instrument off and discharge capacitor C1753.

2. Connect a DVM to TP1736 and turn the instrument on. The voltage should be approximately +7.1 volts and should increase to +12.5 volts in 10 minutes. If the voltage is different, check the following:

a. Check operational amplifier U1736 by replacement.

b. Check CR1736.

c. Check C1736 for leakage.

d. Check Q1742.

Step M: Check CRT Exit Electrode

1. The best way to detect an open exit electrode is with a magnified sweep and maximum Z-Axis drive. The duty cycle should be such that the LIMITED VIEWING TIME indicator stays lit.

2. Position the trace vertically and horizontally and look for a background glow. This glow indicates an open exit electrode.

Step N: Check CRT Isolation Shield (P1813, Pin 6)

1. Obtain a focused display, then turn the instrument off and disconnect pin 6 of P1813.

2. Turn the instrument back on; if the isolation shield is open, the display will now be out of focus.

Step O: Check CRT Scan Expansion Lens (P1810, P1819 Pin 10)

WARNING

To prevent electric shock, turn the instrument off before attempting to work on the High-Voltage board.

NOTE

The scan-expansion lens is connected to seven different high potentials. Six are negative, one is positive. If any of these elements are floating, obtaining a focused display is still possible. In addition to a focused trace, the display can show geometry problems, linearity problems, and low vertical or horizontal gain.

Since the lens does not draw any current, detecting an open element is difficult. To detect an open connection to the Horizontal Bowing element, adjust Horizontal Bowing and observe that the display is not affected. This is the only case where the voltage varies on only one element; the other elements are adjusted in pairs.

1. To detect an open scan-expansion lens, lift the 160-ohm series resistors on the High Voltage board one at a time and look for a change in the display. No change in the display indicates an open connection.

Step P: Check CRT First Anode, Second Section (Pin 8, CRT Socket)

An open first anode, second section, will result in no display. Some display flashing may be observed as the INTENSITY control is advanced.

Step Q: Check CRT Focus Electrode (Pin 4, CRT Socket)

When the crt focus electrode is open, the display is very badly defocused and the FOCUS control has no effect.

Step R: Check CRT Grid (Pin 3, CRT Socket)

The display is always bright and the Z-Axis has no control when the crt grid is open. Check the connection to pin 3 of the crt.

Step S: Check CRT Cathode (Pin 2, CRT Socket)

With an open crt cathode, the display defocuses when the Z-Axis drive is changed.

Step T: Check CRT Heater (Pins 1 and 14, CRT Socket)

No display is obtained if the crt heater is open. Turn off the instrument and check for continuity between pins 1 and 2 of P1702, then between pins 1 and 14 of the crt socket.

Step U: Check First Anode (Pin 7, CRT Socket)

If the first anode is open, the display is very badly defocused and is dim. Charging can be observed when changing the Z-Axis drive. If the anode is not open, a waveform can be observed at the junction of R1895 and R1897 which is related to the Z-Axis drive. The front-panel +GATE waveform is useful for establishing a time relationship to the Z-Axis drive.

Step V: Check CRT Stigmator (Pin 11, CRT Socket)

If the crt stigmator is open, the display cannot be focused. If the instrument has been off for a few minutes and is then turned on with the INTENSITY control at midrange, the display at first is severely defocused and then slowly changes to a defocused display. The stigmator is open if adjusting R1894 on the High Voltage board has no effect on the display.

Step W: Check CRT D1-D2 Shield (Pin 5, P1813)

If the D1-D2 shield is open, the display cannot be focused and charging effects are not noticeable. The D1-D2 shield is open if adjusting R1892 on the High Voltage board has no effect on the display.

Step X: Check CRT Astigmatism (Pin 10, CRT Socket)

With an open crt astigmatism element the display cannot be focused, but charging may be observed. The front-panel ASTIG screwdriver adjustment has no effect. Turn the FOCUS control to midrange, slowly turn the INTENSITY control to about midrange. The trace initially is defocused, then goes into focus and defocuses again. If the instrument has been off for some time, turn the FOCUS and INTENSITY controls to midrange, and turn on the instrument. Initially the display is very badly defocused then slowly drifts into focus and finally defocuses again.

Step Y: Check Spot Demagnification Lens (Pin 5, CRT Socket)

If the crt spot demagnification lens is open, the display is badly defocused and the FOCUS control has no effect.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in the 7104 Oscilloscope mainframe are given here.

OBTAINING REPLACEMENT PARTS

Most electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, you should be able to obtain many of the standard electronic components from a local commercial source in your area. Before you purchase or order a part from a source other than Tektronix, Inc., please check the electrical parts list for the proper value, rating, tolerance and description.

NOTE

When selecting replacement parts, remember that the physical size and shape of a component may affect its performance in the instrument. All replacement parts should be direct replacements unless you know that a different component will not adversly affect instrument performance.

Some parts are manufactured or selected by Tektronix, Inc. to satisfy particular requirements, or are manufactured for Tektronix, Inc. to our specifications. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. To determine manufacturer of parts, refer to Parts List, Cross Index Mfr. Code Number to Manufacturer.

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

To avoid electric-shock hazard, 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.

CAUTION

Several of the circuit boards in the 7104 are multi-layer type boards with a conductive path laminated between the top and bottom board layers. All soldering on these boards should be done with extreme care to prevent breaking the connections to this center conductor. Only experienced maintenance personnel should attempt repair of these boards: A6-Main Interface, A13-Logic, A14-Trigger Selector, and A21-Z-Axis.

Do not allow solder or solder flux to flow under printed circuit board switches. The printed circuit board is part of the switch contacts, intermittent switch operation can occur if contaminated.

Soldering in the area of HYPCON connectors requires special precautions, see the discussion of HYPCON Connectors under Semiconductors in this section.

When soldering on circuit boards or small wiring, use only a 15-watt, pencil-type soldering iron. A higher wattage soldering iron can cause the etched circuit wiring to separate from the board base material and melt the insulation from small wiring. Always keep the soldering-iron tip properly tinned to ensure the best heat transfer to the solder joint. Apply only enough heat to remove the component or to make a good solder joint. To protect heat-sensitive components, hold the component lead with a pair of long-nose pliers between the component body and the solder joint. Use a solder-removing wick to remove excess solder from connections or to clean circuit board pads.

The following technique should be used to replace a component on any of the circuit boards not mentioned in the preceding Caution. Most components can be replaced without removing the board(s) from the instrument.

I. Touch the soldering iron to the lead at the solder connection. Never place the iron directly on the board, as this may damage the board.

2. Melt a small amount of solder onto the component lead connection. This replaces the flux, which may have been removed during instrument cleaning, and facilitates removal of the component.

3. Grip the component lead with a pair of long-nose pliers. When the solder begins to flow, gently pull the component lead from the board. If unable to separate the lead from the board, try removing the other end of the component.

NOTE

Some components are difficult to remove from the circuit boards due to a bend placed in each lead during machine insertion of the component. The purpose of the bent leads is to hold the component in position during a flow-solder manufacturing process which solders all components at once. To make removal of machine inserted components easier, straighten the leads of the component on the back of the circuit board, using a small screwdriver or pliers, while heating the soldered connection.

4. Bend the leads of the replacement component to fit the holes in the circuit board. If the component is replaced while the board is mounted in the instrument, cut the leads so they will just protrude through the board. Insert the leads into the holes in the board so that the component is firmly seated against the board, or as originally positioned.

5. Touch the iron to the connection and apply enough solder to make a firm solder joint.

6. Cut off any excess lead protruding through the board (if not clipped in step 4).

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

COMPONENT REMOVAL AND REPLACEMENT

WARNING

To avoid electric-shock hazard, always disconnect the instrument from the power source before removing or replacing components or plug-in units.

The exploded-view drawings associated with the Replaceable Mechanical Parts list (located at the rear of this manual) may be helpful in the removal or disassembly of individual components or sub-assemblies.

DISPLAY UNIT KICKSTAND

The Display unit of the 7104 Oscilloscope mainframe is equipped with a kickstand for easier access to interior components of the instrument. To use the kickstand feature, disconnect the power-cord plug from the power source. Then remove the side and top panels as described under Cabinet Panel Removal. Remove the two screws on each side of the 7104 which connect the two units. The two units can now be separated at the front of the instrument (the kickstand will hold the units apart). To assemble the units, disengage the kickstand and reverse the disassembly procedure.

POWER-SUPPLY UNIT REMOVAL

The power-supply unit can be slid out of the rear of the 7104 to gain better access to the A13-Logic board, A14-Trigger Selector board, A25-Low-Voltage Regulator board, or for power-supply maintenance and troubleshooting. To remove the power-supply unit from the mainframe, first remove the four screws which hold the power-supply unit to the rear frame of the instrument (see Fig. 4-12). Slide the power-supply unit out of the mainframe until it can be set down on the work surface (be sure to guide the interconnecting cables so they do not catch on other parts of the instrument). The power-supply unit remains electrically connected to the rest of the instrument in this position, allowing for troubleshooting. If it is necessary to operate this instrument with the power-supply unit removed for a

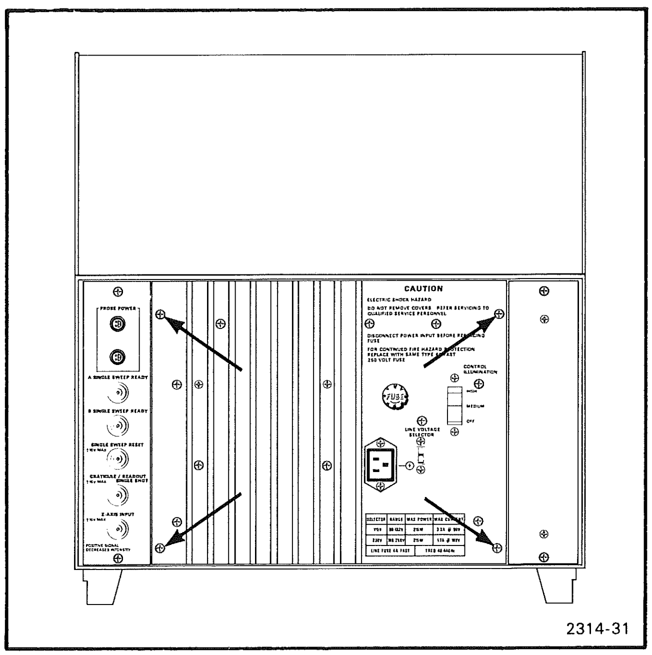


Figure 4-12. Power supply unit securing screws.

period of time, we recommend that the power-supply unit be secured to the instrument with spacers between the rear frame and the power-supply unit.

Reverse the above procedure when placing the power-supply unit into the mainframe of the instrument; be careful not to pinch the interconnecting cables when replacing the unit. Be sure that all the securing screws are tight enough to hold the power-supply unit properly in place.

Access to Components in the Power-Supply Unit

To reach the components located inside the power-supply unit for maintenance or repair, use the following procedure:

WARNING

Disconnect the instrument from the power source and allow the line-storage capacitors to discharge, before removing the power-supply unit. cover. The line-storage capacitors remain charged with high voltage dc for several minutes after the line power is disconnected unless they are manually discharged. A warning-indicator (neon bulb) located on the A23-Inverter board, flashes when this stored voltage exceeds about 80 volts. Do not remove the power-unit cover while this light is flashing.

1. Slide out the power unit as previously described.

2. Remove the four small screws that secure the cover to the rear heatsink.

3. Remove the 9 screws that attach the sides of the cover to the power unit chassis.

4. Disconnect the two coaxial connectors from P1440 on A24-Rectifier board.

5. Remove the cover from the power-supply unit.

6. The power-supply unit is now open for maintenance or repair. If the 7104 is to be operated with the cover removed, first reconnect the coaxial cables to the A24-Rectifier board.

7. Reverse the order of removal to replace the power-unit cover.

Before performing maintenance or taking ohmic measurements in the power-supply unit, manually discharge the line-storage capacitors (C1216 and C1217) as follows:

1. Remove the protective cover from the power-supply unit following the preceding procedure.

2. Apply a 1.5-kilohm, 2-watt, insulated resistor across the capacitor screws as indicated in Figure 4-5.

CATHODE-RAY TUBE REMOVAL

NOTE

Before removing the crt be certain that removal is necessary, see troubleshooting the CRT and Associated Circuitry.

Remove the cathode-ray tube (crt) as follows:

WARNING

The crt may retain a dangerous electrical charge. Before removing the crt, the anode must be fully discharged by shorting the anode lead from the crt to the chassis. Wait approximately ten minutes and again firmly short this lead to the chassis. Then remove the crt.

Use care when handling a crt. Breakage of the crt causes a high-velocity scattering of glass fragments (implosion). Protective clothing and safety glasses should be worn. Avoid striking the crt 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.

1. Remove the rear panel and the A21-Z-Axis board, directly behind the crt base.

2. Remove the crt base-pin socket from the rear of the crt.

3. Loosen the two srews located above and below the crt base pins until the tension of the springs on these screws is released. Then, press in upon the screws to be certain that the crt clamp inside the crt shield is loose.

4. Disconnect the two vertical deflection-plate connectors from the left side of the crt.

5. Disconnect the two horizontal deflection-plate connectors from the top of the crt.

6. Disconnect the crt anode lead from the jack located at the high-voltage on the right of the instrument (on Option 2 instruments remove the X-Y delay line to gain access to crt anode lead). Ground this lead to the chassis to dissipate any stored charge remaining in the crt.

7. Remove the plastic A22-High Voltage board shield on the right side of the instrument.

8. Disconnect P1811, P1810, and P1813 from the A22-High Voltage board.

9. Remove the plastic mask which covers the crt bezel.

10. Remove the four screws securing the crt bezel to the front panel. Remove the bezel while disconnecting the three-pin connector from the left rear of the bezel.

11. Remove the plastic faceplate protector, the graticule light assembly, and the gray crt faceplate mask. (The graticule light assembly need not be unsoldered from its leads.)

12. Hold one hand on the crt faceplate and gently push forward on the crt base with the other. Slowly pull the crt out from the front of the instrument while guiding the cable connected to P1811, P1810, and P1813, and the crt anode lead, through the holes in the crt shield.

CATHODE-RAY TUBE REPLACEMENT

Replace the cathode-ray tube (crt) as follows:

1. Insert the crt into the shield, guiding the crt anode plug and the cables connected to P1811, P1810, and P1813 through the holes in the crt shield and vertical delay line assembly. Set the crt firmly against the front-panel casting.

2. Clean the crt faceplate, plastic faceplate protector, and the light filter with denatured alcohol.

3. Place the gray crt mask over the faceplate. Reconnect the multi-pin connector to the crt bezel (align the arrow on the connector with the arrow on the bezel).

4. Hold the faceplate protector in position and replace the crt bezel, graticule light assembly, light filter frame, and light filter. Firmly tighten the four screws making sure that the light filter is properly aligned.

5. Gently push forward on the crt base to ascertain 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.

6. Place the crt base-pin socket on the crt base pins.

7. Reconnect the crt anode plug.

8. Carefully reconnect all cables and crt neck-pin connectors.

9. Replace the plastic crt bezel mask.

10. Replace the A21-Z-Axis board and rear panel.

NOTE

The replacement of the crt will require that the instrument be re-adjusted. Refer to Section 5, Calibration.

CIRCUIT BOARDS

If a circuit board is damaged beyond repair, replace the entire board assembly. Part numbers are given in Section 7, Replaceable Electrical Parts, for completely wired boards.

The pin connectors, except for coaxial-type connectors, used for interconnection between circuit boards are color-coded to aid in identification and circuit tracing. The color of the connector body matches the resistor color-code for the last digit of the connector circuit number; e.g., P602 is red, P603 is orange, etc.

Most of the circuit boards in this instrument are mounted on the chassis; pin connectors are used for electrical interconnection with chassis mounted components and other circuit boards. Several boards plug onto the rear of the A6-Main Interface board; feed-thru connectors connect the plug-on board to the A6-Main Interface board.

Chassis-Mounted Boards

Remove and replace all chassis-mounted circuit boards as follows:

1. Disconnect all pin connectors attached to the board, or which connect the board to other parts of the instrument.

2. Remove the securing screws.

3. Remove the chassis-mounted board.

4. Replace chassis-mounted boards in the reverse order of removal. Match the index arrow on the multi-pin connectors to the corresponding arrow on the board. Correct location of the pin connectors is shown on the circuit board illustration in Section 8, Diagrams and Circuit Board Illustrations.

Plug-On Boards

Remove and replace the plug-on boards as follows:

1. Remove the power-supply unit (see Power-Supply Unit Removal) as necessary to gain access to the boards mounted on the rear of the A6-Main Interface board.

2. Disconnect any end-lead coaxial connectors located on the front of the board, or those which pass across a portion of the board.

3. Loosen all of the board's securing screws.

4. Keeping the board parallel to the A6-Main Interface board, gently pull out on the edges of the board until the feed-thru terminals are cleared.

5. To replace a plug-on circuit board, position the board parallel to the A6-Main Interface board so that all feed-thru pins are properly aligned with their sockets.

6. Gently press the circuit board against the mounting surface. Be sure that all feed-thru pins and sockets mate properly.

7. Uniformly tighten the securing screws (recommended torque: four to six inch-pounds).

A5-Mode Switch Circuit Board

Remove or replace the A5-Mode Switch circuit board as follows:

CAUTION

Do not allow solder or solder flux to flow under printed circuit board switches. The printed circuit board is part of the switch contacts, and intermittent switch operation can occur if contaminated.

1. Separate the Display Unit from the Acquisition Unit as previously described under Display Unit Kickstand.

2. Remove the VERT TRACE SEPARATION (B) knob.

3. Disconnect the pin connectors and remove the 5 screws holding the board to the chassis.

NOTE

When removing wires from a circuit board, always tag the wire and the corresponding connection point on the circuit board.

4. Slide the board toward the rear of the instrument until the front-panel pushbuttons clear the chassis.

5. Lift the board from the instrument.

6. Replace the board by reversing the order of removal. Match the index arrow on the pin connectors to the corresponding arrow on the board. Correct location of the pin connectors is shown on the circuit board illustration in Section 8, Diagrams and Circuit Board Illustrations.

A6-Main Interface Circuit Board

Remove and replace the A6-Main Interface circuit board as follows:

1. Remove the plug-in units and the power-supply unit (see Power-Supply Unit Removal).

2. Disconnect all connectors from the A6-Main Interface board. Note the location of the connectors so they can be correctly replaced.

3. Remove the screws from inside each plug-in compartment which hold the plug-in interface connectors to the chassis (see Fig. 4-13). Also remove the screws which hold the ground straps to the chassis.

4. Slide the Main Interface board assembly to the rear of the instrument and remove it.

5. Replace the A6-Main Interface circuit board in the reverse order of removal. Match the index arrow on the pin connectors to the corresponding arrow on the board. Correct location of the pin connectors is shown in the circuit board illustrations in Section 8, Diagrams and Circuit Board Illustrations.

A7/A8/A9/A10/A11/A12-Follower Circuit Boards

Follower circuit boards with four or six interface contacts are used in the plug-in interface connectors to provide optimum signal connections between the plug-in units and the 7104. Each Follower board is held in place by a spring so that the board can move back and forth within the interface connector to compensate for length differences between plug-in units. If a contact on a Follower board is damaged, the entire board with contacts and interconnecting cables is replaced as a unit.

Remove a Follower circuit board as follows:

1. Disconnect the instrument from the power source and remove any plug-in units.

2. Remove the power-supply unit (see Power-Supply Unit Removal).

3. Remove the metal shields in front of the A6-Main Interface board.

4. Disconnect the coaxial leads of the Follower board from the A16-Vertical Channel Switch board, A19-Horizontal Amplifier or A14-Trigger Selector board. Note the location of the connectors so they may be correctly replaced.

5. Using long-nose pliers, disengage the spring from the Follower board (spring is in front of A6-Main Interface board).

6. Remove the Follower board with interconnecting cables from the rear of the interface connector, through the hole in the A6-Main Interface board.

To replace a Follower circuit board, a folded length of very thin shim stock as wide as the Follower board is required to compress the contacts while the board is inserted into the interface connector. Proceed as follows:

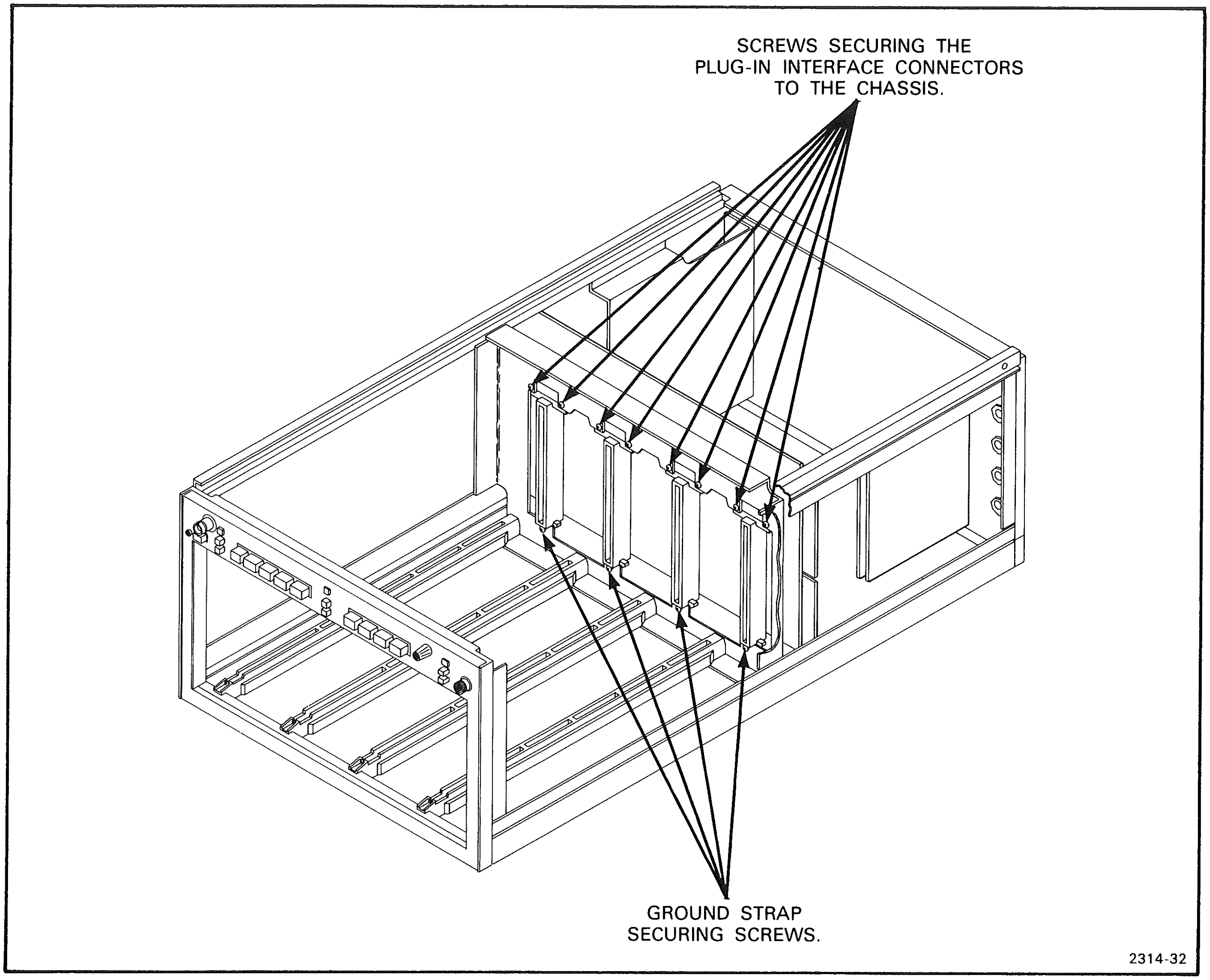


Figure 4-13. Location of securing screws for the A6-Main Interface board.

1. Hold the Follower board between the ends of the shim stock with the fold directly in front of the contacts. With the shim stock held against the sides of the board, the contacts on the sides of the board should be pressed together.

2. Insert the folded end of the shim stock (with the Follower board) into the rear of the interface connector through the hole in the A6-Main Interface board. When the Follower board contacts are almost fully inserted into the connector, hold the board in place and remove the shim stock through the front of the interface connector while fully inserting the Follower board.

3. Secure the Follower board with the spring.

4. Reconnect the Follower board coaxial leads to the A16-Vertical Channel Switch or A19-Horizontal Amplifier board and the A14-Trigger Selector board.

5. Replace the power supply unit.

6. Replace the metal shields.

A26-Fan Motor Circuit Board (SN B059999 & Below)

The exhaust fan and A26-Fan Motor circuit board are removed as a unit. Remove and replace the Fan assembly as follows:

1. Remove the A22-High Voltage board.

2. Remove the two screws which mount the fan housing assembly to the 7104 chassis.

3. Disconnect the pin connector from the board.

4. Remove the Fan assembly from the instrument.

5. To replace the Fan assembly, first place the two screws through the holes in the chassis and secure the fan housing assembly to the chassis.

6. Replace the pin connector matching the index arrow with the arrow on the circuit board.

7. Replace the A22-High Voltage board.

A25-Low-Voltage Regulator Circuit Board

Remove and replace the A25-Low-Voltage Regulator circuit board as follows:

1. Slide the power-supply unit out of the instrument (see Power-Supply Unit Removal).

2. Disconnect the multi-pin connectors from the board (two of the multi-pin connectors are self-locking; see the discussion on Multi-Pin Connectors in this section). Note the location of the pin connectors so they may be correctly replaced.

NOTE

If the A25-Low-Voltage Regulator board is to be removed to allow access to other parts of the power-supply unit, proceed with steps 3 and 4 only. If the board is to be removed from the instrument, proceed with the remaining steps of the procedure.

3. Remove the 2 screws located in the access holes under the A25-Low-Voltage Regulator board. These screws secure the chassis.

4. Remove the 3 screws securing the Low-Voltage Regulator chassis to the rear heatsink. Remove the board with attached chassis.

5. Remove the mounting hardware securing the plastic-cased power transistors to the rear heatsink (see Fig. 4-14). Note the position of the lockwashers so they can be correctly replaced.

6. Remove the 5 securing screws and lift the board with attached power transistors from the chassis.

7. To replace the A25-Low-Voltage Regulator board, first apply a thin coat of silicone grease to the back (mounting surface) of each power transistor.

WARNING

Handle silicone grease with care. Avoid getting silicone grease in your eyes. Wash hands thoroughly after use.

8. Place the A25-Low-Voltage Regulator board on the chassis. Replace, but do not tighten, the securing screws.

9. Check that the power transistors are aligned with their mounting screws and that the insulating washers are in place between the transistor cases and the rear heatsink.

10. Secure the transistors with the mounting hardware. Do not over-tighten the nuts; recommended torque is four to six inch-pounds.

11. Tighten the screws holding the A25-Low-Voltage Regulator board to the chassis.

12. Install the chassis on the power-supply unit.

13. Connect the multi-pin connectors to the board. Match the index arrow on the pin connectors to the corresponding arrow on the board. Correct location of the pin connectors is shown in the circuit board illustration in Section 8, Diagrams and Circuit Board Illustrations.

14. Replace the power-supply unit in the instrument.

A24-Rectifier Circuit Board

An exploded-view drawing of the power-supply unit is given in Section 9, Replaceable Mechanical Parts, at the rear of this manual. To remove the A24-Rectifier board, use the following procedure:

1. Slide the power-supply unit out of the instrument (see Power-Supply Unit Removal).

2. Remove the A25-Low-Voltage Regulator board with attached chassis as described under the A25-Low-Voltage Regulator Circuit Board.

3. Remove the 4 screws securing the power transformer to the bracket.

4. Remove the protective cover from the power-supply unit (see Access to Components in the Power-Supply Unit).

5. Disconnect the multi-pin connectors from the A24-Rectifier board. Note the location of the pin connectors so they can be correctly replaced.

6. Remove the 2 plastic screws which hold the circuit-board shield to power-supply A23-Inverter board.

7. Unsolder the 3 power-transformer leads from the power-supply A23-Inverter board. Remove the excess solder from the board pads with a vacuum-type desoldering tool.

8. Remove the 5 securing screws from the A24-Rectifier board.

9. Lift the circuit board and attached power transformer from the instrument.

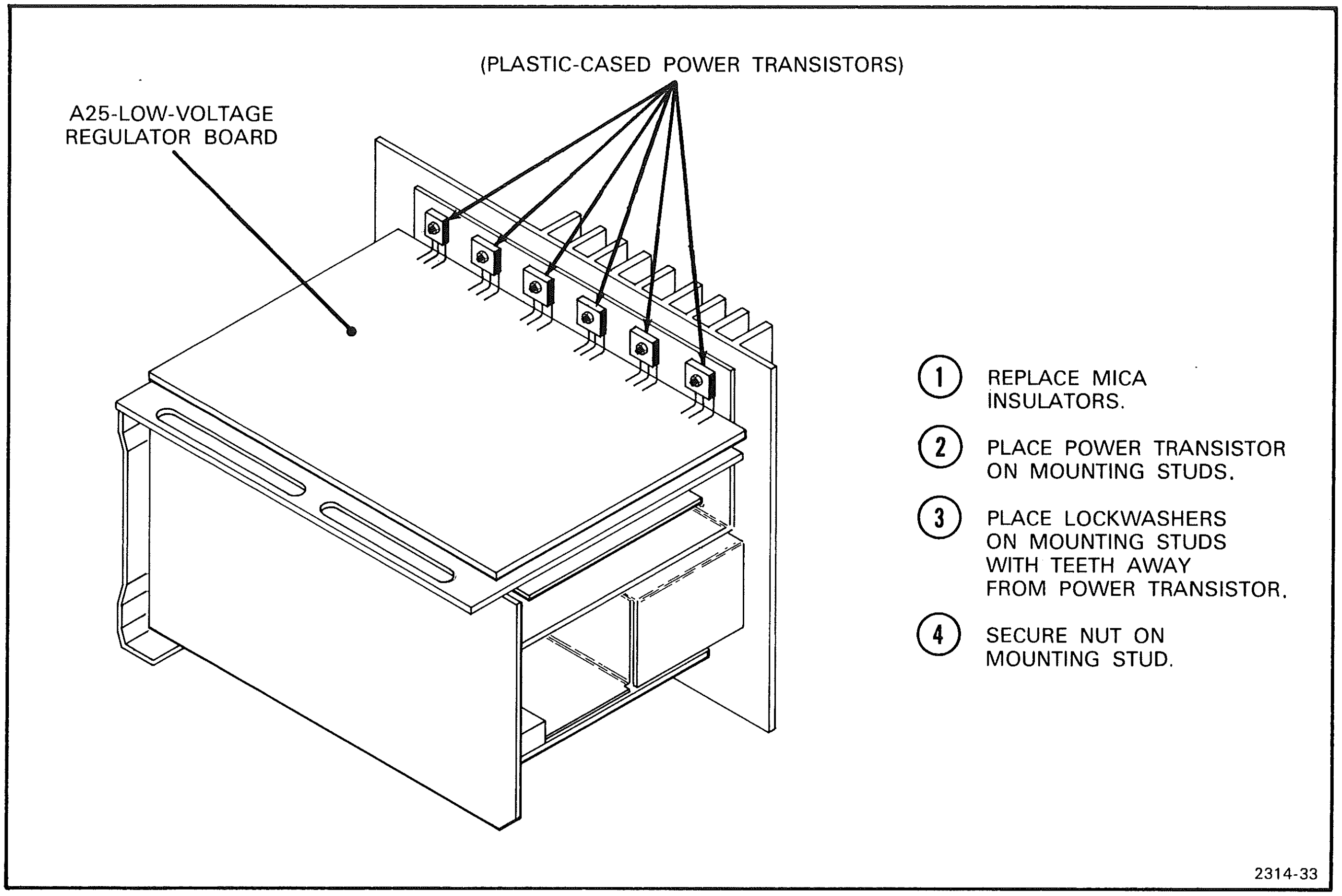


Figure 4-14. Correct placement of power transistor and mounting hardware on rear heatsink.

10. To replace the A24-Rectifier board, reverse the order of removal. Match the index arrow on the pin connectors to the corresponding arrow on the board. Correct location of the pin connectors is shown on the circuit board illustration in Section 8, Diagrams and Circuit Board Illustrations.

A23-Inverter Circuit Board

An exploded-view drawing of the power-supply unit is given in Section 9, Replaceable Mechanical Parts, at the rear of this manual. Remove and replace the power-supply A23-Inverter board as follows:

WARNING

The power-supply unit has been tested at the factory to ensure safe operation. Improper repair of this unit can result in hazardous potentials on the instrument chassis. Do not remove the plate insulator, block insulator, or transistor shield from the heatsink. (See the exploded-view drawing of the power-supply unit for the location of the components.)

1. Slide the power-supply unit out of the instrument (see Power-Supply Unit Removal).

2. Remove the protective cover from the power-supply unit (see Access to Components in Power-Supply Unit).

3. Remove A24-Rectifier board using the previous procedure.

4. Remove the 3 securing screws from A23-Inverter board.

5. Unsolder the line-input leads from the circuit board. Remove the excess solder from these circuit board pads with a vacuum-type desoldering tool.

6. Remove the two metal-cased power transistors by removing the securing nuts and pulling the transistors from their sockets.

7. Move the A23-Inverter board away from the heatsink shield until the transistor mounting studs clear the heatsink shield. Remove the board from the power-supply unit.

8. To replace the A23-Inverter board, reverse the order of removal. Match the index arrow on the pin connectors to the corresponding arrow on the board. Correct location of the pin connectors is shown on the circuit board illustration in Section 8, Diagrams and Circuit Board Illustrations.

PLUG-IN INTERFACE CONNECTORS

The individual contacts of the plug-in interface connectors can be replaced. However, we recommend replacing the entire A6-Main Interface board if a large number of the contacts are damaged. An alternative solution is to refer the maintenance of the damaged A6-Main Interface board to your local Tektronix Field Office. Use the following procedure to remove and replace an individual contact of the plug-in interface connectors:

NOTE

The plug-in interface contacts which are mounted on the Follower circuit boards cannot be replaced. A Follower board with contacts and interconnecting cables is replaced as a unit. See Circuit Boards.

1. Remove the A6-Main Interface circuit board from the instrument as previously described.

2. Snap the white plastic connector cover off the side of the damaged plug-in interface connector.

3. Unsolder and remove the damaged contact.

4. Install the replacement contact. Carefully position it to fit against the connector body.

5. Snap the white plastic connector cover back onto the plug-in interface connector. Check that the replaced contact is aligned with the other contacts.

6. Replace the A6-Main Interface board.

DELAY LINE REMOVAL

The vertical delay line is carefully matched at the factory. Therefore, it is not recommended that repair be attempted in the field. Instead, contact your local Tektronix Field Office.

The horizontal delay line (Option 2) is carefully matched electrically from side to side and to the electrical length of the vertical delay line. Therefore, it is not recommended that repair be attempted in the field. Instead, contact your local Tektronix Field Office.

SEMICONDUCTORS

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 adjustment of the instrument. When semiconductors are replaced, check the operation of circuits which may be affected.

WARNING

To avoid electric shock hazard, always disconnect the 7104 from the power source before removing or replacing components.

Replacement semiconductors should be of the original type or a direct replacement. Lead configurations of the semiconductors used in this instrument are shown in Figure 4-2. Some plastic case transistors have lead configurations which do not agree with those shown. 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 standard basing as used for metal-cased transistors. When removing soldered-on transistors, use a solder-removing wick to remove the solder from the circuit board pads. Transistors which have heat radiators or are mounted on the chassis use silicone grease to increase heat transfer. Replace the silicone grease on both sides of the insulating washer when replacing these transistors.

WARNING

Handle silicone grease with care. Avoid getting the silicone grease in your eyes. Wash hands thoroughly after use.

To replace one of the power transistors mounted on the heatsink at the rear of the power-supply unit, first remove the mounting hardware. Then, unsolder and remove the defective transistor. When replacing the transistor, be sure to install the insulating washer between the transistor and the heatsink (use silicone grease as previously described). Tighten the mounting nut just tight enough to hold the transistor in place. Then solder the replacement transistor to the A25-Low-Voltage Regulator board.

An extracting tool should be used to remove the in-line integrated circuits to prevent damaging the pins. This tool is available from Tektronix, Inc.; order Tektronix Part 003-0619-00. If an extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the integrated circuit. Try to avoid one end disengaging from the socket before the other end.

HYPCON Connectors

The HYPCON (hybrid-printed connector) connector is a precision-made connector designed to provide low loss electrical and/or thermally efficient connection between the printed circuit board and hybrid integrated circuit. An exploded view of the HYPCON connector is shown in

Figure 4-15. Care must be taken when replacing the hybrid IC's not to touch the elastomer gold-plated contacts with the fingers or to use a cleaner which will degrade contact reliability. The HYPCON connector and hybrid IC should be removed if it becomes necessary to use a cleaning solvent near the connector when replacing adjacent (within 1/2") circuit board components. IMPORTANT: Remove all traces of solder flux or foreign material contamination from the circuit board contact area before replacing the connector. Contamination usually takes place during the soldering and cleaning process. Even when the soldering is done carefully, flux, oil, or other contaminants can be carried under the connector during the cleaning operation. When the solvent evaporates, nonconductive contaminants may remain on or near the contact interfaces.

The cleaning process (either hand cleaning with a solvent or machine cleaning in an automatic detergent wash) is not recommended for boards containing HYPCON connectors.

If a component adjacent to a HYPCON connector must be replaced, the following steps are recommended:

1. Remove the hybrid IC and HYPCON connector (see Disassembly and Removal instructions) before any soldering or cleaning and store in a dirt-free covered container. When several hybrids and HYPCON connectors are to be removed, keeps parts together and replace as sets; do not interchange parts.

2. Hand soldering:

   a. Use small diameter solder (0.030"-0.040").

   b. Use low wattage soldering irons (15-20 watts).

   c. Use care with solder amount and placement.

3. Remove solder flux and contact contamination with isopropyl alcohol, denatured ethyl alcohol, or a Freon TF cleaner such as Spray-On #2002.

4. Flush the hybrid and HYPCON connector mounting area with isopropyl alcohol. Do not scrub with a cotton-tipped applicator, as cotton fibers will adhere to edges and surfaces of contact areas and cause open or intermittent connections. The elastomer should be examined under light for dust, hair, etc., before it is re-installed. If the etched circuit board surfaces require more cleaning, scrub with a soft rubber eraser and blow or vacuum clean while dusting surface with a small clean brush.

5. If the hybrid IC and elastomer contact holder are contaminated, clean the contact holder and hybrid by flushing or spraying with alcohol and oven dry at 50° C. Do not scrub with a cotton-tipped applicator or similar device. If the contact holder is excessively contaminated, replace it with a new one.

Two inch-pounds of torque should be applied to the mounting screws to secure the HYPCON to the circuit board.

Make sure that the elastomer is properly seated in the contact holder before remounting the assembly to circuit board. Exercise care when mounting the frame-elastomer connector holder-hybrid IC assembly to the circuit board to prevent misalignment between the connector and board.

CAUTION

Because of close tolerances involved, special care must be taken to assure correct index alignment of each HYPCON part during reassembly. Failure to do so can result in a cracked hybrid substrate. See Figure 4-15A for the index locations.

If your instrument contains both the flush and stepped type of HYPCON connectors be careful not to mix the elastomer contact holders during reassembly. The flush HYPCON connectors have green elastomer contact holders and the plastic frame is marked FLUSH. The stepped HYPCONS have neutral-colored elastomer contact holders with a slight ridge or step on the contact surface; the large frames are marked STEPPED. The registration pins on the stepped plastic frame are slightly longer than those on the flush frame. The elastomer contact holder in the small stepped connectors is indexed differently than the large connectors. Look for a small gold arrow in one corner of the holder instead of a flat corner. Match this corner arrow with the pointed corner of the plastic frame. Give close attention to this indexing, as it is easy to insert the elastomer contact holder incorrectly.

Differences also exist between the large flush and large stepped HYPCON circuit board receptables. Figure 4-15A shows the cross-sectional differences which must be observed when working with an instrument that contains both types of HYPCON connectors.

CAUTION

Damage to the elastomer contact holder can result if the connectors are not mated properly with the board receptacle.

When replacing the hybrid, insert it into the board opening and then position the HYPCON connector in the board registration holes for perfect alignment. The outer portion of the HYPCON frame should be flush with the circuit board before the four mounting screws are tightened. Avoid touching the hybrid and elastomer contact holder with your fingers; finger oils can degrade reliability.

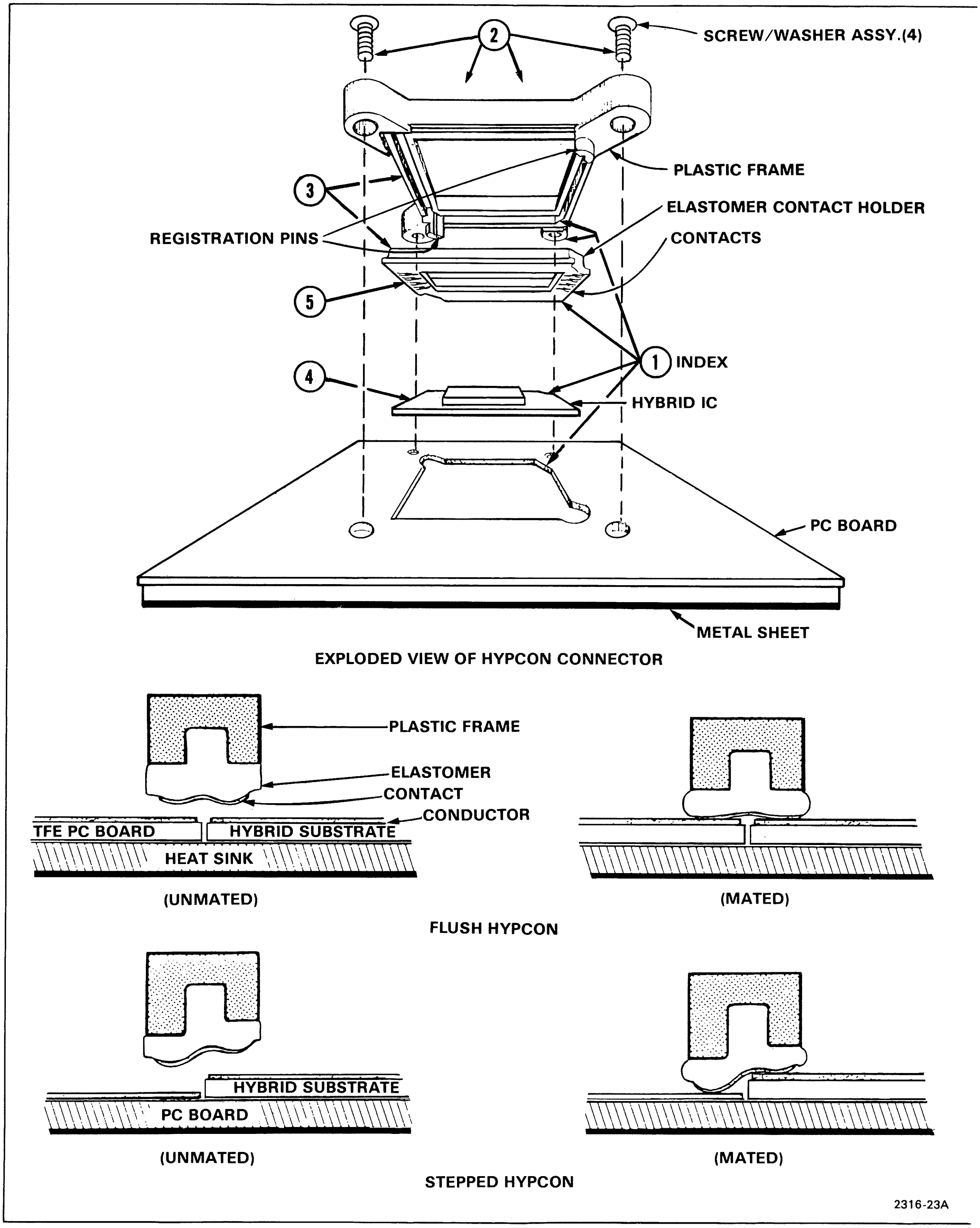


Figure 4-15. HYPCON assembly removal and replacement.

DISASSEMBLY AND REMOVAL

1. Note index on circuit board (arrow, triangle, or dot) and HYPCON plastic frame (pointed mounting ear).

2. Unscrew and remove the 4 screw/washer assemblies. Where the HYPCON connector serves to heatsink the hybrid to the chassis, 2 of the 4 screws are longer. Note the location of the yellow tinted screws for proper replacement.

3. Lift HYPCON connector from board.

4. Note index location of hybrid and remove from board with tweezers.

5. Note index location of elastomer contact holder and remove by grasping a corner of the contact holder with tweezers and lifting up. Do not touch the gold-plated contacts with your fingers.

REASSEMBLY AND REPLACEMENT

Grasp corner of elastomer contact holder with tweezers and place in plastic frame slot being careful to match the flat contact holder with the flat frame corner. Place a clean plastic envelope over finger and press with finger to seat contact holder into the frame. The contact holder must be evenly seated on all four sides.

Flush HYPCON: Match hybrid flat corner with board receptable flat corner and place hybrid in receptable. Match pointed mounting ear of HYPCON connector with flat corner of receptacle and guide registration pins into the board hold.

Stepped HYPCON: Using tweezers, match the hybrid corner index with the elastomer contact holder index and insert between the registration pins. Turn the assembly over, grasp the hybrid "hat" with the tweezers, and guide the registration pins into the board holes. Match the plastic frame pointed mounting ear with the circuit board arrow.

Insert mounting hardware and apply 2 inch-pounds of torque to secure the connector assembly.

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Figure 4-15. HYPCON assembly removal and replacement (continued).

A procedure for removal and replacement is included in Figure 4-15.

Hybrid substrate contact numbers 1 and 20 are printed on the substrate at the index corner. See Figure 4-2, Semiconductor Lead Configurations.

INTERCONNECTING PINS

Two methods of interconnection are used in this instrument to electrically connect the circuit boards with other boards and components. When the interconnection is made with a coaxial cable, a special end-lead connector plugs into a socket on the board. Other interconnections are made with a pin soldered 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 removal and replacement procedure for the various types of interconnecting methods.

Coaxial-Type End-Lead Connectors

Replacement of the coaxial-type end-lead connectors requires special tools and techniques; only experienced maintenance personnel should attempt to remove or replace these connectors. We recommend that the damaged cable or wiring harness be replaced as a unit. For cable or wiring harness part numbers, see Section 9, Replaceable Mechanical Parts. An alternative solution is to refer the replacement of the defective connector to your local Tektronix Field Office or representative. Figure 4-16 gives an exploded view of a coaxial end-lead connector assembly.

Circuit-Board Pins

A circuit-board pin replacement kit (including necessary tools, instructions, and replacement pins with attached ferrules) is available from Tektronix, Inc. Order Tektronix Part 040-0542-00. Replacing circuit-board pins on multi-layer boards is not recommended. (The multi-layer boards in this instrument are listed under Soldering Techniques in this section.)

To replace a damaged pin, first disconnect any pin connectors. Then unsolder the damaged pin and pull it from the board with a pair of pliers, leaving the ferrule (see Fig. 4-17) in the circuit board if possible. If the ferrule remains in the circuit board, remove the spare ferrule from the replacement pin and press the new pin into the hole in the circuit board. If the ferrule is removed with the damaged pin, clean out the hole using a solder-removing wick and a scribe. Then press the replacement pin, with attached spare ferrule, into the circuit board. Position the replacement pin in the same manner as the original. Solder the pin to the circuit board on each side of the board. If the original pin was bent at an angle to mate with a connector, carefully bend the new pin to the same angle. Replace the pin connector.

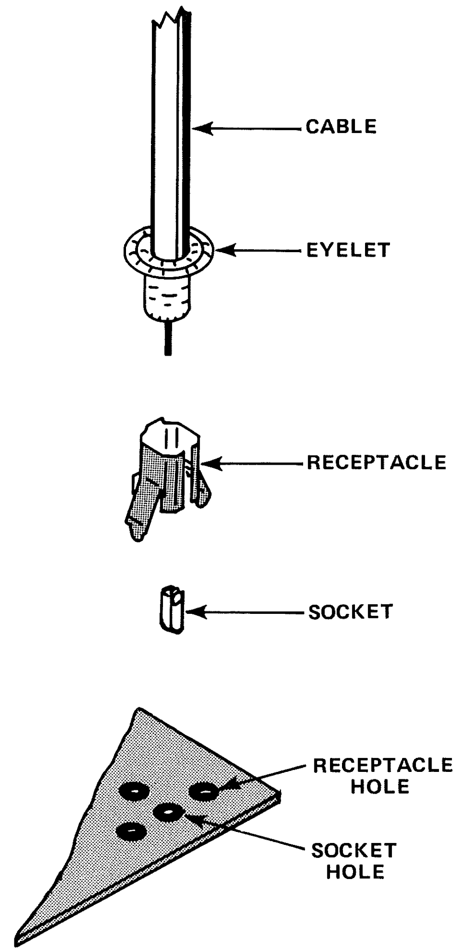


Figure 4-16. Coaxial end-lead connector assembly.

Circuit-Board Pin Sockets

The pin sockets on the circuit boards are soldered to the back of the board. To remove or 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 the socket from the board. Place the new socket in the circuit board hole and press the tabs down against the board. Solder the tabs of the socket to the circuit board; be careful not to get solder inside 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.

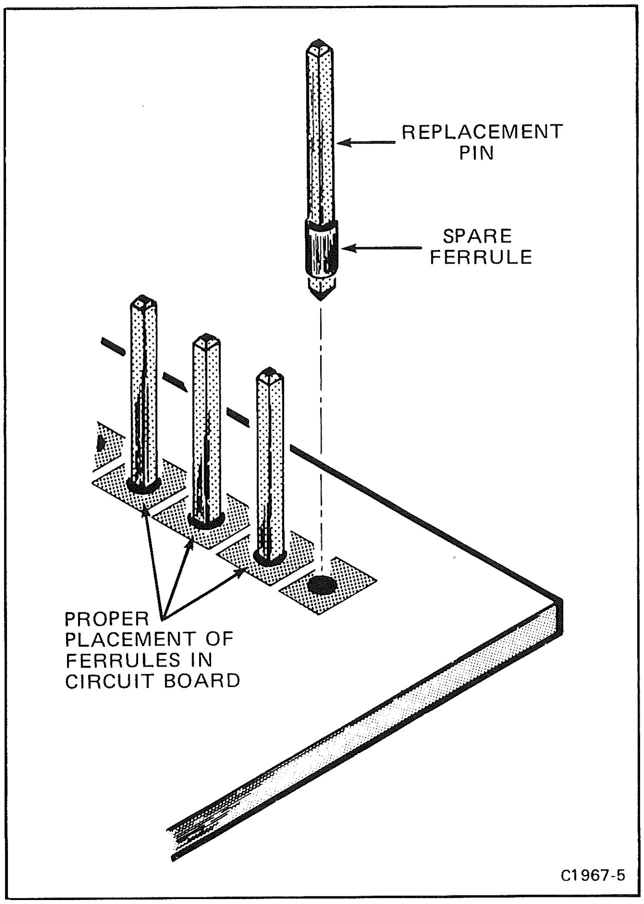


Figure 4-17. Exploded view of circuit-board pin and ferrule.

Multi-Pin Connectors

The pin connectors used to connect the wires to the interconnecting pins are clamped to the ends of the associated leads. To remove or replace damaged multi-pin connectors, remove the old pin connector from the end of the lead and clamp the replacement connector to the lead.

NOTE

Some multi-pin connectors are equipped with a special locking mechanism. These connectors cannot be removed by pulling on the wire(s). To remove the connectors from the pin(s) grasp the plastic holder and pull.

To remove an individual wire from the holder insert a scribe in the hole on the side of the holder and slide the extended portion under the holder. This will allow the wire to be removed from the holder.

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 (see Troubleshooting Aids). If the individual end-lead pin connectors are removed from the plastic holder, note the order of the individual wires for correct replacement in the holder.

PUSHBUTTON SWITCHES

The pushbutton switches used on the 7104 Oscilloscope mainframe are circuit board mounted. First remove the associated circuit board following the procedure given under Circuit Boards in this section. Figure 4-18 gives removal and replacement instructions for the pushbutton switches.

GRATICULE LIGHT BULBS (FOR SN B021449 & BELOW)

To remove or replace the graticule light bulbs, first remove the plastic crt mask, light filter, and metal light shield. Pull on the white tabs to remove the graticule lamp assembly. Next, slide the retaining strip off to the side of the damaged bulb base. Pull the bulb out of the circuit board. Reverse the order of removal for replacement.

GRATICULE LIGHT BULBS (FOR SN B021450 & UP)

To remove or replace the graticule light bulbs, first remove the plastic crt mask, light filter, and metal shield. Pull on the white tabs to remove the graticule lamp assembly. Next unsolder the leads of the damaged bulb and pull the bulb out of the circuit board. Pre-form the leads of the replacement bulb and insert it into the circuit board and re-solder. Now reverse the order of removal for replacement of the entire crt graticule lamp assembly.

TRIGGER SOURCE LIGHT BULBS

1. Separate the Display Unit from the Acquisition Unit as previously described under Display Unit Kickstand.

2. Remove the VERT TRACE SEPARATION (B) knob.

3. Disconnect pin connectors P346, P366, P308, and J396 and remove the five screws holding the board to the chassis.

4. Slide the board toward the rear of the instrument until the front panel pushbuttons clear the chassis.

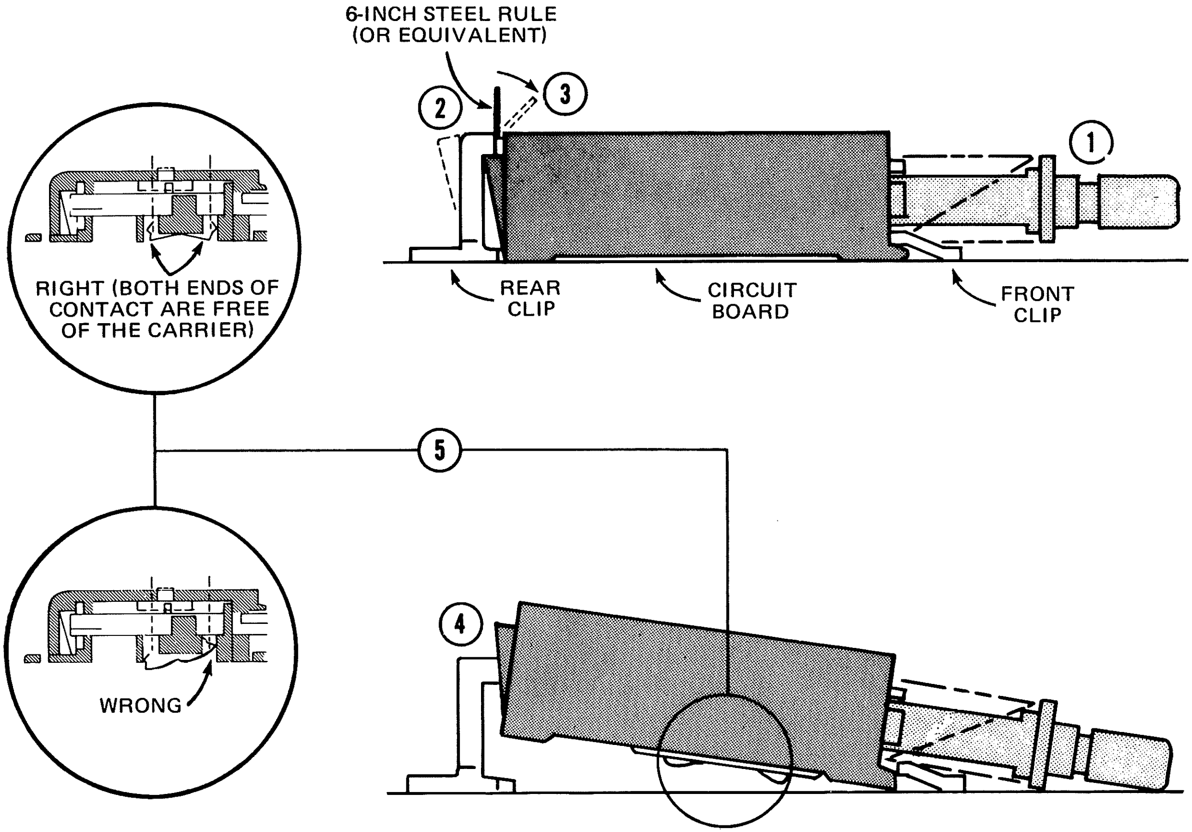
5. Remove the five screws holding the front panel of the Acquisition Unit and remove the front panel. (Note that the EMI strips are held in place by the front panel).

6. Remove the two screws holding the trigger light holder.

7. Lift the trigger light holder from the instrument.

8. Remove the trigger light board from the trigger light holder.

9. Replace the light bulb and replace the board by reversing the order of the removal procedure.



(1) Make sure that all switch shafts are in the OUT position to clear the rear clip.

(2) Place the long edge of a six-inch rule or similar thin straight edge between the top edge of the rear clip and the switch body.

(3) Carefully pry the rear clip back just far enough to push the steel rule down between the clip and switch body.

CAUTION

When the switch is removed, the contacts may drop free and be damaged or lost. Body salts or acids can contaminate the switch contacts. Wear cotton gloves to prevent touching the contacts in the switch or on the board with bare hands.

(4) Pull the rear of the switch up, remove the steel rule, and pull the switch out of the front clip.

(5) To replace the switch, first check that the slide contacts are properly installed in the carrier. Then, place the front of the switch into the front clip and push the rear of the switch down until the rear clip catches and holds the switch in place.

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Figure 4-18. Removal procedure for pushbutton switches.

POWER TRANSFORMER

Replace the power transformer only with a direct replacement Tektronix transformer. Remove and replace the power transformer as follows:

1. Remove the A24-Rectifier board as described under Circuit Boards in this section.

2. Remove the bracket which holds the transformer to the rear heatsink.

3. Unsolder the transformer leads from the circuit boards. Remove the excess solder from the circuit-board pads (see Soldering Techniques). Note the position of the transformer leads so they may be correctly replaced.

4. Place the new transformer in position but do not yet solder the leads to the circuit-board pads.

5. Secure the bracket to the A24-Rectifier board and attach the transformer to the bracket with the 4 securing screws.

6. Reposition the A24-Rectifier board and secure with 3 screws. Attach the bracket securely to the rear heatsink.

7. Solder the transformer leads to the circuit-board pads.

8. Continue replacing the A24-Rectifier board.

LINE FUSE

The line fuse used in this instrument is located on the rear panel of the power-supply unit. Replace the line fuse (F1200) only with one of proper type and rating.

NOTE

The line voltage fuse F1200 is used for both 110 volt and 220 volt operation. No change in the fuse is necessary when switching the LINE VOLTAGE SELECTOR switch between 110 volts and 220 volts.

ADJUSTMENT AFTER REPAIR

After any electrical component has been replaced, the adjustment of that particular circuit should be checked, as well as the adjustment of any closely related circuits. Since the low-voltage supplies affect all circuits, adjustment of the entire instrument should be checked if component replacements have been made in these supplies or if the power transformer has been replaced. See section 5 for a complete adjustment procedure.

SELECTED COMPONENT CRITERIA

During initial adjustment, selected values of components listed in Table 4-5 may have been installed to meet certain performance requirements for this instrument. The criteria in Table 4-5 should be used if it is determined that any of these components need replacement during adjustment following corrective maintenance or hours-of-service performance checks.

TABLE 4-5
SELECTED COMPONENT CRITERIA

Component	Nominally Installed	Selectable Values	Effects/Symptoms
C483 and C493[1]	10 pF	7-18 pF	Selected for optimum bandwidth and pulse flatness.
L486	510 nH	113 nH, 360 nH	

[1] **Lead length affects capacitance. Nominal lead length is approximately 1/4".**

CALIBRATION

This section provides procedures for calibrating this instrument. These procedures are designed to compare the performance of this instrument with other measurement instruments of known accuracy to detect, correlate, or eliminate by adjustment, any variation from the electrical specifications. These procedures also verify that the controls function properly.

This section is divided into two parts: Part I—Performance Check is provided for those who wish to verify that this instrument meets the applicable electrical specifications in section 1 without making internal adjustments. Part II—Adjustment and Performance Check provides a complete calibration procedure that includes adjustments and performance checks in addition to verifying that the controls function properly. The procedures in Part I and Part II are written so that the entire instrument or any major circuit or part of a circuit can be checked or adjusted.

Table 5-1, Calibration Procedure Electives, lists the choices available and instructions for performing complete or partial calibration procedures. Also refer to page 5-2, Using These Procedures, for more detailed information.

TABLE 5-1
Calibration Procedure Electives

Electives	Procedure
Functional Check	Perform Power-Up Sequence in Part II—Adjustment and Performance Check. Then proceed sequentially through subsections (A, B, C, etc.) to end. If a functional check only is desired, perform the Operators Checkout Procedure in Section 2.
Performance Check Only	Perform Power-Up Sequence in Part I—Performance Check. Then proceed sequentially through subsections (A, B, C, etc.) to end.
Complete Calibration (Part II—Adjustment and Performance Check)	Perform Power-Up Sequence in Part II—Adjustment and Performance Check. Then proceed sequentially through subsections (A, B, C, etc.) to end.
Partial Part I—Performance Check or Part II—Adjustment and Performance Check by Subsection (A, B, C, etc.)	Perform Power-up Sequence for Part I—Performance Check or Part II—Adjustment and Performance Check. Perform **Before You Begin** and Preliminary Control Settings instructions for the desired subsection. Then proceed sequentially through the procedures in desired subsection.
Partial Part I—Performance Check or Partial II—Adjustment and Performance Check by Step (A1, A2, B1, B2, etc.) within Subsection (A, B, C, etc.)	Perform Power-Up Sequence for Part I—Performance Check or Part II—Adjustment and Performance Check. Perform **Before You Begin** and Preliminary Control Settings instructions for subsection (A, B, C, etc.) containing the desired step (A1, A2, B1, B2, etc.). Then proceed through the instructions (a, b, c, etc.) in the desired step. **NOTE** *Although a partial adjustment procedure may be done, we recommend that the entire subsection procedure be performed if any adjustments are made.*

USING THESE PROCEDURES

NOTE

In these procedures, capital letters within the body of the text are used to identify front-panel controls, indicators and connectors on the 7104 (e.g., READOUT). Initial capitalizing is used to identify controls, indicators, and connectors (e.g., Position) on associated test equipment (used in this procedure). Initial capitalizing is also used to identify adjustments internal to the 7104 (e.g., Vert Gain).

These procedures are divided into subsections by major functional circuits (e.g., A. Z-Axis And Display, B. Calibrator And Output Signals, etc.). The order in which the subsections and procedures appear is the recommended sequence for a complete performance check or calibration of the instrument.

Each step contains the Setup Conditions which, if applicable, include control settings for this instrument, a test setup illustration, and test equipment control settings. The Setup Conditions are written so that, if desired, each subsection (A, B, C, etc.) or step (A1, A2, B1, B2, etc.) can be performed separately.

A heading system is provided to readily identify the steps (A1, A2, B1, B2, etc.) that contain performance check and/or adjustment instructions. For example, if CHECK is the first word in the title of a step, an electrical specification is checked. If ADJUST is the first word in the title, the step concerns one or more internal adjustments. And if CHECK/ADJUST appears in the title, the step involves electrical specification checks and related adjustments. If EXAMINE is the first word in the step title, the step concerns measurement limits that indicate whether the instrument is operating properly; these limits are not to be interpreted as electrical specifications.

The alphabetical insructions under each step (a, b, c, etc.) may contain CHECK, EXAMINE, ADJUST, or INTERACTION as the first word of the instruction. These terms are defined as follows:

1. **CHECK**—indicates the instruction accomplishes an electrical specification check. Each electrical specification checked is listed in Table 5-2, Performance Check Summary (see Performance Check Summary discussion for more information).

2. **EXAMINE**—usually precedes an ADJUST instruction and indicates that the instruction determines whether adjustment is necessary. If no ADJUST instruction appears in the same step, the EXAMINE instruction concerns measurement limits that do not have a related adjustment. Measurement limits following the word EXAMINE are not to be interpreted as electrical specifications. They are provided as indicators of a properly functioning instrument and to aid in the adjustment process.

3. **ADJUST**—describes which adjustment to make and the desired result. We recommend that the adjustments not be made if a previous CHECK or EXAMINE instruction indicates that no adjustment is necessary.

4. **INTERACTION**—indicates that the adjustment described in the preceding instruction interacts with other circuits. The nature of the interaction is described and reference is made to the step(s) affected.

PERFORMANCE CHECK SUMMARY

Table 5-2, Performance Check Summary, lists the electrical specifications that are checked in Part I and Part II of this section. Table 5-2 is intended to provide a convenient means for locating the procedures in Part I and Part II that check and/or adjust the instrument to meet the applicable electrical specifications. For example: If the A25 Low-Voltage Regulator board had been repaired or replaced, use Table 5-2 to locate the electrical specifications affected by the repair or replacement. Then, note the title of the procedure in Part I or Part II in which those specifications are checked and/or adjusted. Use the index provided at the front of Part I and Part II to determine the page number of the desired procedures.

ADJUSTMENT INTERVAL

To maintain instrument accuracy, check performance every 1000 hours of operation, or every 6 months if used infrequently. Before complete adjustment, thoroughly clean and inspect this instrument as outlined in the Maintenance section.

TEKTRONIX FIELD SERVICE

Tektronix Field Service Centers and the Factory Service Center provide instrument repair and adjustment services. Contact your Tektronix Field Office or representative for further information.

TABLE 5-2
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
VERTICAL SYSTEM			
Deflection Factor	Compatible with all 7000-series plug-in units.	Implicitly checked in step E1. Check Vertical Amplifier Gain.	Implicitly checked in step F2. Check/Adjust Vertical Amplifier Gain.
Difference Between Vertical Compartments	1% or less.		
Low-Frequency Linearity	0.1 div or less compression or expansion of a center-screen 2 div signal positioned anywhere vertically within the graticule area.	E2. Check Vertical Low-Frequency Linearity.	F3. Check Vertical Low-Frequency Linearity.
Frequency Response		Implicitly checked in step E3. Check Vertical Amplifier 1 GHz Gain.	Implicitly checked in step F6. Check Vertical Amplifier 1 GHz Gain.
Step Response	Varies with plug-in unit selected. See 7104 Oscilloscope Vertical System Specification, Table 1-7.	Does not normally require customer verification. However, risetime can be calculated from the Vertical Bandwidth.	
Isolation Between Vertical Compartments (8 Div Signal)		E4. Check Vertical Channel Isolation.	F7. Check Vertical Channel Isolation.
LEFT, RIGHT, ALT Modes	At least 160:1 from dc to 100 MHz and at least 80:1 from 100 MHz to 1 GHz.		
Delay Line	Permits viewing the leading edge of triggering signal.	Checked throughout procedure where single pulse is displayed on crt.	
Difference in Signal Delay Between Vertical Compartments	50 ps or less.	Does not normally require customer verification; substantiated at the factory.	
Vertical Display Modes	Selected by front-panel Vertical Mode switch.	E5. Check Vertical Display Modes.	F8. Check Vertical Display Modes.

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Vertical Display Modes (Continued)		E5. Check Vertical Display Modes.	F8. Check Vertical Display Modes.
LEFT	Left vertical unit displayed.		
ALT	Display alternates between Left and Right vertical units at rate determined by Horizontal plug-in units.		
ADD	Display is algebraic sum of Left and Right vertical units.		
CHOP	Display chops between Left and Right vertical units asynchronously to horizontal plug-in unit(s).		
Repetition Rate	1 MHz within 20%.	Does not normally require customer verification. Satisfactory operation is substantiated by other tests.	
RIGHT	Right vertical unit displayed.	E5. Check Vertical Display Modes.	F8. Check Vertical Display Modes.
"SLAVED ALT"	Slaved operation occurs if: (1) VERT MODE switch set to ALT, (2) HORIZ MODE switch set to ALT or CHOP, (3) time-base unit is installed in each horizontal compartment and (4) the A time-base unit operates in INDEPENDENT mode. When in slaved operation the display alternates between: (1) the trace produced by the LEFT VERT unit displayed at the sweep rate of B time-base unit and (2) the trace produced by the RIGHT VERT unit displayed at the sweep rate of A time-base unit. **NOTE** *The VERT TRACE SEPARATION (B) control is inoperative in "Slaved Alt" Mode.*	"SLAVED ALT" is verified in the Operators Checkout Procedure in Section 2, Operating Instructions.	
VERTICAL TRACE SEPARATION (B)	Positions "B" trace at least 4 div above and below "A" trace, when 7104 operates in ALT or CHOP horizontal modes. See note concerning "Slaved Alt" Vertical Mode.	E6. Check Vertical Trace Separation Operation.	F9. Check Vertical Trace Separation Operation.

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
TRIGGERING SYSTEM			
A and B TRIGGER SOURCE	Selected by front-panel switches. Lights behind the pushbuttons are illuminated to indicate the trigger source.	C2. Check Trigger Selector Operation.	D4. Check Trigger Selector Operation.
VERT MODE	The trigger source is controlled by the VERT MODE selector. The source (sources) is (are) shown by the illumination of the LEFT and RIGHT trigger source buttons. The source follows (is same as) the Vert Display with the following two exceptions: VERT MODE — Trigger Source CHOP — LEFT "SLAVED ALT" — RIGHT for A TRIG, LEFT for B TRIG See Vertical Display Modes for slaved operation.		
LEFT	Trigger source: LEFT vertical unit; LEFT trigger source button illuminated.		
RIGHT	Trigger source: RIGHT vertical unit; RIGHT trigger source button illuminated.		
HORIZONTAL SYSTEM			
Deflection Factor	Compatible with all 7000-series plug-in units.	D1. Check Horizontal Amplifier Gain.	E1. Check/Adjust Horizontal Amplifier Gain.
Gain Differences Between Horizontal Compartments	1% or less.		
DC Linearity	0.05 division or less error at each graticule line after adjusting for no error at the second and tenth graticule line.		
Fastest Calibrated Sweep Rate	200 ps/division.	D2. Check High-Frequency Timing.	E2. Check/Adjust High-Frequency Timing.

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Horizontal Display Modes	A: A horizontal unit only. ALT: Dual-sweep, alternates between horizontal units. CHOP: Dual-sweep, chops between horizontal units. B: B horizontal unit only.	Checked in Operators Checkout Procedure, in section 2.	
Chopped Mode		Does not normally require customer verification. Satisfactory operation is substantiated by other tests.	
Repetition Rate	200 kHz within 20%.		
Phase Shift Between Vertical and Horizontal Systems	2° or less from dc to at least 50 kHz.	Satisfactory operation substantiated at the factory.	
With Option 2 (B HORIZ Compartment Only)		D3. Check X-Y Compensation (Option 2 only).	E3. Check/Adjust X-Y Compensation (Option 2 only).
With 7A19's or 7A29's at least one of which has the Variable Delay Option	2° or less from dc to 50 MHz after adjusting variable delay for balance at 25 MHz. Phase balance can be obtained at any frequency up to 250 MHz.		
Bandwidth (Option 2 Only)	350 MHz.	D4. Check Horizontal Bandwidth.	E4. Check Horizontal Bandwidth.

CALIBRATOR

Wave Shape	Square wave.	B3. Check Calibrator Rise Time, Fall Time, and Duty Cycle.	C3. Check Calibrator Rise Time, Fall Time, and Duty Cycle.
Polarity	Positive going with base line at 0 volt.		
Output Resistance	450 Ω.	Satisfactory operation substantiated at the factory.	
Output Voltage	Selected by front-panel CALIBRATOR switch .	B1. Check Calibrator Output Voltage.	C1. Check/Adjust Calibrator Output Voltage.
Into 100 kΩ or Greater	40 mV, 0.4 V, 4 V.		
Into 50 Ω	4 mV, 40 mV, 0.4 V.	Satisfactory operation substantiated at the factory.	

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TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Output Current	40 mA available through CALIBRATOR output with optional bnc to current loop adaptor. CALIBRATOR switch must be set to 4 V for calibrated output.	Satisfactory operation substantiated at the factory.	
Amplitude Accuracy (P-P Voltage)	Within 1%.	B1. Check Calibrator Output Voltage.	C1. Check/Adjust Calibrator Output Voltage.
Repetition Rate	1 kHz within 0.25%.	B3. Check Calibrator Rise Time, Fall Time, and Duty Cycle.	C3. Check Calibrator Rise Time, Fall Time, and Duty Cycle.
Duty Cycle	49.8% to 50.2%.		
Rise Time and Fall Time	500 nsec or less into 100 pF or less.		
SIGNAL OUTPUTS			
+ SAWTOOTH OUT		B4. Check A and B Sawtooth Output Signals.	C4. Check A and B Sawtooth Output Signals.
Source	Selected by front panel switch. A: A HORIZ time-base unit. B: B HORIZ time-base unit.		
Polarity	Positive-going with baseline at 0 V within 1 V into 1 MΩ.		
Output Voltage		Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
Rate of Rise			
Into 50 Ω	50 mV/unit of time selected by the time-base unit time div switch, within 15%, 100 ns/div maximum sweep rate.		
Into 1 mΩ	1 V/unit of time selected by the time-base unit time div switch, within 10%, 1 μsec/div maximum sweep rate.	B4. Check A and B Sawtooth Output Signals.	C4. Check A and B Sawtooth Output Signals.
Output Resistance	Approximately 950 Ω.	Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
+ GATE OUT		B5. Check A and B Gate Output Signals.	B5. Check A and B Gate Output Signals.
Source	Selected by front-panel switch. A: A Gate, derived from A HORIZ time-base unit main gate. B: B Gate, derived from B HORIZ time-base unit main gate.		
Polarity	Positive-going with baseline at 0 V within 1.0 V into 1 MΩ.		

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
+GATE OUT (cont.)		Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
Output Voltage			
Into 50 Ω	0.5 V within 10%.		
Into 1 MΩ	10 V within 10% (up to 1 sec/div sweep rate).		
Rise Time into 50 Ω	5 nsec or less.		
Fall Time into 50 Ω	15 nsec or less.		
Output Resistance	Approximately 950 Ω.		
SIG OUT	Selected by B TRIGGER SOURCE switch.	C2. Check Trigger Selector Operation.	D4. Check Trigger Selector Operation.
Source	Same as B TRIGGER SOURCE.		
Output Voltage		Satisfactory operation substantiated at the factory.	
Into 50 Ω	25 mV/div or vertical deflection within 25%.		
Into 1 MΩ	For a maximum output of ±2 V; 0.5 V/div of vertical deflection within 25%.		
Bandwidth into 50 Ω	Varies with vertical plug-in selected. See 7104 Oscilloscope Vertical System Specification, Table 1-7.		
DC Centering	0 V within 1 V into 1 MΩ.	C1. Check Vertical Signal Out DC Centering.	D3. Check/Adjust Vertical Signal Out DC Centering.
Aberrations	15% or less peak-to-peak within 20 ns of step.	Satisfactory operation substantiated at the factory.	
Output Resistance	Approximately 950 Ω.		

READOUT DISPLAY

Readout Modes		F1. Check Readout Modes.	G4. Check Readout Modes.
Free-Run (Not Labeled)	Continuously displayed.		
PULSED	Single-shot operation.		
Pulse Source	Selected by front-panel switches. + GATE: Triggered by the trailing edge of the + GATE selected by the front-panel switch.		

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TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Readout Modes (cont.) Pulse Source (Continued)	EXT: Controlled through rear-panel remote control connector. MAN: Manual trigger, independent of other pulse sources.	F1. Check Readout Modes.	G4. Check Readout Modes.

DISPLAY

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Graticule Type	Internal, illuminated with variable edge lighting.	B6. Check Graticule Illumination Operation.	C6. Check Graticule Illumination Operation.
Lighting Normal	Continuously lighted.		
PULSED	Single-shot operation. Lights are pulsed on for approximately 0.5 seconds.		
Pulse Source	Selected by front-panel switches. + GATE: Triggered by the trailing edge of the + GATE selected by the front-panel switch. EXT: Controlled through rear-panel remote control connector. MAN: Manual trigger, independent of other pulse sources.		
Area	8 x 10 div 0.85 cm/div.	Checked at the factory.	
Phosphor	P31.		
Vertical and Horizontal Resolution	17 lines/div.		
Limited Viewing Time Indicator Steady Yellow	Crt display time is limited to ≤ 20 minutes.	Checked in the Operators Checkout Procedure, in section 2.	
Flashing Yellow	Crt display time is limited to 2 minutes or less and Intensity is being limited.		
Geometry	Within 0.1 div of vertical and horizontal graticule lines.	A2. Check Geometry.	B5. Check/Adjust Geometry.
BEAMFINDER	When actuated limits the display within the graticule area and defocuses the display.	Checked in the Operators Checkout Procedure in section 2.	

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Minimum Photographic Writing Speed	20 cm/nsec (without blue filter). Phosphor: Standard P31. Camera: Tektronix C53; f/1.9 1:0.85 lens. Film: Polaroid Type 107; 3000 ASA.	G1. Check Photographic Writing Rate.	H1. Check/Adjust Photographic Writing Rate.
REMOTE CONNECTORS AND SWITCHES			
Control Illumination	High, medium and off. (Three position switch located on rear panel of power supply).	Checked in the Operators Checkout Procedure in section 2.	
Camera Power	3-contact connector compatible with Tektronix C-50 series cameras.	Implicitly checked in step G1. Check Photographic Writing Rate.	Implicitly checked in step H1. Check/Adjust Photographic Writing Rate.
Bottom Pin	Ground.		
Center Pin	Single sweep reset.		
Top Pin	+15 V.		
REMOTE RESET INPUT	Input to reset single-sweep function of time-base units installed in A and B HORIZ compartments.	Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
Signal Required	Closure to ground or switching from the high level (+50 V to +10 V; sink less than 40 μA) to the low level (+0.5 V to -5 V; sink less than 12 mA) in less than 1 msec, resets the sweep. Compatible to 15 V open collector TTL source.		
Minimum Pulse Width	10 μsec at 50% amplitude points.		
Maximum Safe Input Voltage	50 V to -5 V (dc + peak ac).		
A SINGLE SWEEP READY	Bnc connector on rear panel. Remote ready indicator for A HORIZ time-base unit.		
Output Signal	Open when not ready. +5 V at 47 Ω source impedance when ready. Output will light a No. 49 bulb.		
B SINGLE SWEEP READY	Bnc connector on rear panel. Remote ready indicator for B HORIZ time-base unit.		
Output Signal	Open when not ready. +5 V at 47 Ω source impedance when ready. Output will light a No. 49 bulb.		

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
GRAT/READOUT SINGLE SHOT	Bnc connector on rear panel. Switching to the low level (+ 1 V) to -5 V; sink less than 2 mA) from the high level (+10 V to +15 V; sink less than 0.3 mA), in less than 1 μsec, triggers the Readout to display one complete readout frame and the GRAT ILLUM (to be displayed for approximately 0.5 sec). Compatible to 15 V open collector TTL Source.	Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
Maximum Open Circuit Voltage	+15 V.		
Maximum Safe Input Voltage	+15 V to -5 V (dc plus peak ac).		
Probe Power	Two probe power connectors on rear panel.		
Pin 1	+5 V.		
Pin 2	Chassis Ground.		
Pin 3	-15 V.		
Pin 4	+15 V.		
EXTERNAL Z-AXIS INPUT	Bnc connector on rear panel.	A3. Check External Z-Axis Operation.	B7. Check External Z-Axis Operation.
Polarity and Sensitivity	Positive 2 V provides complete blanking from maximum intensity condition. Negative 2 V provides complete unblanking from minimum intensity condition.		
Low Frequency Limit	Dc.	Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
Input Resistance	Approximately 500 ohm.		
Input Capacitance	Less than 50 pF.		
Open Circuit Voltage	0 V.		
Maximum Safe Input Voltage	15 V, dc plus peak ac.		
Maximum Repetition Rate	1 MHz.		

POWER SOURCE

Characteristic	Performance Requirement	Part I / Part II Procedure Title
Voltage Range (AC, RMS)	Selected rear-panel LINE VOLTAGE SELECTOR switch.	Does not normally require customer verification. Satisfactory operation substantiated by other tests.
115 V Rated	From 90 V to 132 V.	
230 V Rated	From 180 V to 250 V.	

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Line Frequency	From 48 Hz to 440 Hz.	Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
Maximum Power Consumption	215 W.		
Maximum Current	3.3 A at 60 Hz, 90 V line. 1.7 A at 60 Hz, 180 V line.		
Fuse Data			
Line (F1200)	4 A fast blow. (For both line voltage selector ranges.)		

TEST EQUIPMENT REQUIRED

The test equipment listed in Table 5-3 is required for a complete Adjustment and Performance Check of the instrument. If only Part I—Performance Check is to be performed, the items required for Part II—Adjustment and Performance Check are not required and are indicated by footnote 1. The remaining test equipment is common to both procedures.

The specifications for test equipment, given in Table 5-3 are the minimum required to meet the performance requirements. Detailed operating instructions for test equipment are omitted in these procedures. Refer to the test equipment instruction manual if more information is needed.

SPECIAL FIXTURES

Special fixtures are used only where they facilitate instrument adjustment. These fixtures are available from Tektronix, Inc. Order by part number from Tektronix Field Offices or representatives.

TEST EQUIPMENT ALTERNATIVES

All of the listed test equipment is required to completely calibrate this insrument. However, complete checking or adjusting may not always be necessary or desirable. You may be satisfied with checking only selected characteristics, thereby reducing the amount of test equipment actually required.

The calibration procedures in Part I and Part II are based on the first item of equipment given as an example. When other equipment is substituted, control settings or setups may need to be altered. If the exact item of equipment given as an example in Table 5-3 is not available, first check the Minimum Specifications column carefully to see if any other equipment might suffice. Then check the Purpose column to see what this item is used for. If used for a performance check or adjustment that is of little or no importance for your measurement requirements, the item and corresponding step(s) can be deleted.

TABLE 5-3
Test Equipment

Description	Minimum Specifications	Purpose	Examples of Applicable Test Equipment
1. Test Oscilloscope	Bandwidth, dc to 200 megahertz, minimum deflection factor 10 millivolts/division; accuracy, within 3%. Dual-channel with an inverting input and both added and alternate vertical modes.	Used throughout calibration procedure.	a. TEKTRONIX 7704A Oscilloscope System with 7A18 and 7A29 Amplifier; 7B80 or 7B10 Time Base, and P6053B Probe. b. TEKTRONIX 475 Oscilloscope with P6053B Probe. c. Refer to the Tektronix Products catalog for compatible oscilloscope system.
2. Amplifier Unit (Two Required, One with Variable Delay)	Tektronix 7A-series plug-in unit.	Used throughout procedure to provide vertical input to the instrument under adjustment.	a. TEKTRONIX 7A29 Amplifier, and TEKTRONIX 7A29 AMPLIFIER (Option 4).
3. Amplifier Unit (Dual Trace)	Any 7A-series dual display amplifier unit.	Used to check position and operation of read-out display.	a. Any 7A-series dual amplifier unit (may be shared with a 7000-series test oscilloscope).
4. Time-Base Unit (Two Required)	Sweep rate 200 pico seconds/div.	Used throughout procedure to provide sweep.	a. TEKTRONIX 7B15 Time Base. b. TEKTRONIX 7B10 Time Base.
5. Signal Standardizer (Two Required)	Produces gain-check and pulse-response waveforms.	Used throughout procedure to standardize instrument so plug-in units can be interchanged without complete readjustment and to adjust crt geometry.	a. Tektronix Calibration Fixture 067-0587-02. b. 7000-series plug-in units with suitable signal sources may be substituted if lower performance is acceptable.
6. Plug-In Extender[1] (Rigid Calibration Fixture)	Provides access to power supply voltages.	Power Supply Voltage, Trigger System check and adjustment.	a. Tektronix Part 067-0589-00.
7. Camera	f/1.9, 1:0.85 lens.	Photographic writing rate.	a. TEKTRONIX C-53 Oscilloscope Camera.
8. Precision DC Voltmeter (DVM)	Range, −75 to +200 volts; accuracy, within 0.1%.	Check and adjustment of calibrator output accuracy, power supply voltages and Z-axis display voltages.	a. TEKTRONIX DM 501 Digital Multimeter with power module. b. Fluke Model 825A Differential DC Voltmeter.
9. DC Voltmeter (VOM) With Test Leads	Range, to −2500 volts; accuracy, checked to within 1% at −2265 volts.	High-voltage power supply adjustment and geometry.	a. Valhalla Model 4500 H.V. Digital Multimeter Tektronix Part 003-0120-00

[1]Used for Part II—Adjustment and Performance Check only; NOT used for Part I—Performance Check.

TABLE 5-3 (CONT.)
Test Equipment

Description	Minimum Specifications	Purpose	Examples of Applicable Test Equipment
10. Time-Mark Generator	Marker outputs, 1 nanosecond to 0.1 second; marker accuracy, within 0.1%; trigger output, 1 millisecond.	Check and adjustment of horizontal timing, and calibrator frequency.	a. TEKTRONIX TG 501 Time-Mark Generator with power module.
11. Low-Frequency Sine-Wave Generator	Frequency, 250 kilohertz to 250 megahertz; output amplitude, variable from 50 millivolts to 3 volts into 50 ohms.	Check and adjust horizontal bandwidth and external Z-axis input.	a. TEKTRONIX SG 503 Leveled Sine-Wave Generator with power module. b. General Radio 1310-B Oscillator.
12. High-Frequency Sine-Wave Generator	Frequency 245 megahertz to 1 gigahertz; reference frequency, 20 megahertz or lower; output amplitude, variable from 0.5 to 4 volts into 50 ohms.	Check and adjustment of vertical bandwidth and vertical channel isolation.	a. TEKTRONIX SG 504 Leveled Sine-Wave Generator. b. Wiltron Model 610C Swept Frequency Generator with Model 61083C, 10 to 1220 megahertz plug-in.
13. 10X Passive Probe[1]	Compatible with test oscilloscope to be used.	Used to check signals out, calibrator and Z-axis adjustment.	a. TEKTRONIX P6053B or P6054A Probe.
14. 100X Probe	Compatible with test oscilloscope to be used; impedance, 5 kilohms.	Used to check Z-axis adjustment.	a. TEKTRONIX P6057 Probe.
15. Coaxial Cable (Two of Each Length Required)	Impedance, 50 ohms; type, RG-58/U; length, 18 and 42 inches; connectors, bnc.	Signal interconnection.	a. Tektronix Part 012-0076-00 (18 inches) and Tektronix Part 012-0057-01 (42 inches).
16. 2X Attenuator	Impedance, 50 ohms; 2X accuracy, within 2%, connectors, bnc.	Output termination for signal generators, if amplifier unit is not 50-ohm input impedance.	a. Tektronix Part 011-0069-02.
17. T Connector	Bnc-to-bnc.	Used to check external Z-axis operation and X-Y compensation.	a. Tektronix Part 103-0030-00.
18. Nylon Tuning Tool[1]	1-inch shaft.	Vertical high-frequency compensation.	a. Tektronix Part 003-0675-00.
19. Low-Capacitance Screwdriver[1]	1-inch shaft.	Used throughout adjustment procedure to adjust variable components.	a. Tektronix Part 003-0000-00.
20. Screwdriver[1]	Three-inch shaft, 3/32-inch bit.	Used throughout procedure to adjust variable resistors.	a. Xcelite R-3323.

[1] **Used for calibration only; NOT used for performance check.**

PART I—PERFORMANCE CHECK

The following procedure (Part I—Performance Check) verifies electrical specifications without removing instrument covers or making internal adjustments. All tolerances given are as specified in the Specification tables (section 1) in this manual.

Part II—Adjustment and Performance Check provides the information necessary to: (1) verify that the instrument meets the electrical specifications, (2) verify that the controls function properly, and (3) perform all internal adjustments.

A separate Operators Checkout Procedure is provided in section 2 for familiarization with the instrument and also to verify that the controls function properly.

See Table 5-1, Calibration Procedure Electives, at the beginning of this section, for information on performing a Partial Part I—Performance Check procedure.

INDEX TO PERFORMANCE CHECK PROCEDURE

PERFORMANCE CHECK POWER-UP SEQUENCE

NOTE

The performance of this instrument can be checked at any ambient temperature from 0° to +50° C unless otherwise stated. Adjustments must be performed at an ambient temperature from +20° to +30° C for specified accuracies.

1. Check that the LINE VOLTAGE SELECTOR switch is set for the correct input line voltage.

2. Connect the instrument power cord to the power source.

3. Turn the instrument POWER switch on and allow at least 20 minutes before proceeding.

A. Z-AXIS AND DISPLAY

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

1. Test oscilloscope
4. Time-base unit
15. 50-ohm cables (two required)
17. T connector (bnc)

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

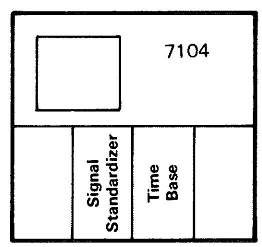
Z-AXIS AND DISPLAY PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
VERTICAL MODE .... RIGHT
A TRIGGER SOURCE .... VERT MODE
A INTENSITY .... Fully counterclockwise
HORIZONTAL MODE .... A
B INTENSITY .... Fully counterclockwise
B TRIGGER SOURCE .... VERT MODE
FOCUS .... Midrange
READOUT INTENSITY .... OFF (in detent)
GRAT ILLUM .... Midrange
BEAMFINDER .... Pushbutton out

A1. CHECK TRACE ALIGNMENT

A1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Signal Standardizer
Test Selector Switch .... Vert or Horiz Aux In

Time Base
Triggering .... Auto, AC, Internal
Sweep Rate .... 1 ms/div
Magnifier X1

a. Set the A INTENSITY control for a visible trace. Set the FOCUS and ASTIG controls for a well-defined trace.

b. Position the trace to the center graticule line.

c. **CHECK**—Trace parallels the center graticule line within 0.1 division.

d. **ADJUST**—TRACE ROTATION adjustment to align the trace with the vertical center graticule line.

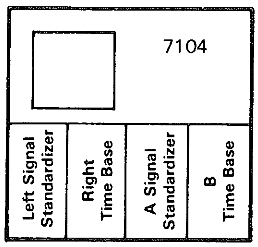
A2. CHECK GEOMETRY

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

A2. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... ALT
HORIZONTAL MODE .... ALT



Test Equipment Controls:
Left Signal Standardizer
Test Selector Switch .... Vert or Horiz Gain
Rep Rate .... 100 kHz

A Signal Standardizer
Test Selector Switch .... Vert or Horiz Gain
Rep Rate .... 100 kHz

Right Time Base
Sweep Rate .... 2 μs/div
Triggering .... Auto, AC, External

B Time Base
Sweep Rate .... 2 μs/div
Triggering .... Auto, AC, External

a. Set the B INTENSITY control for a visible display.

b. Set the FOCUS and ASTIG controls for a well defined display.

c. **CHECK**—For crosshatch pattern lines that parallel the graticule lines within 0.1 division.

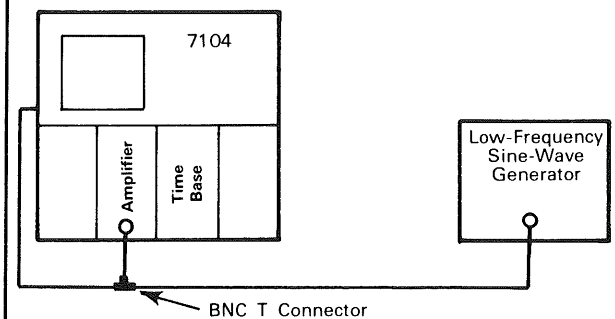
A3. CHECK EXTERNAL Z-AXIS OPERATION

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

A3. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE .... A
VERTICAL MODE .... RIGHT



Test Equipment Controls:
Amplifier Unit
Deflection Factor .... 0.5 V/div
Time Base
Sweep Rate .... 20 μs/div
Triggering .... Auto, AC, Internal

a. Set the A INTENSITY control for a dim display.

b. Connect the output of the low-frequency sine-wave generator to the amplifier unit input (use a T connector, bnc, at the amplifier input).

c. Set the low-frequency sine-wave generator for a four-division display at 50 kilohertz (one volt above and below ground).

d. Connect the signal from the output of the T connector at the amplifier input to the Z-AXIS INPUT connector on the rear panel.

e. **CHECK**—Positive portion of the displayed waveform is blanked out.

B. CALIBRATOR AND OUTPUT SIGNALS

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

1. Test oscilloscope
4. Time-base unit
10. Time-mark generator
15. Coaxial cable (one 18-inch, two 42-inch required)
17. T connector

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

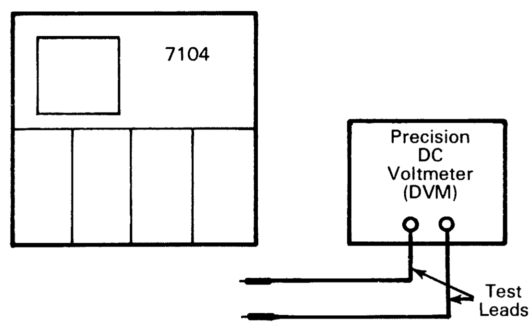
CALIBRATOR AND OUTPUT SIGNALS PRELIMINARY CONTROL SETTINGS:

POWER switch ....On
VERTICAL MODE............................RIGHT
A TRIGGER SOURCE................. VERT MODE
A INTENSITY................Fully counterclockwise
HORIZONTAL MODE .... A
B INTENSITY.............. Fully counterclockwise
B TRIGGER SOURCE................. VERT MODE
READOUT INTENSITY...............OFF (in detent)
GRAT ILLUM.............................Midrange
BEAMFINDER ....Pushbutton out
CALIBRATOR................... 4 V pushbutton in

B1. CHECK CALIBRATOR OUTPUT VOLTAGE

B1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Precision DC Voltmeter (DVM)
Voltage Range .... Appropriate range for voltage to be measured.

a. Set both the 4 V and 0.4 V CALIBRATOR pushbuttons to the depressed position.

b. Connect the precision dc voltmeter to the CALIBRATOR output connector.

c. **CHECK**—Meter reading for 0.4008 volt within the limits of 0.4004 to 0.4012 volt.

B2. CHECK CALIBRATOR 1 kHz REPETITION RATE

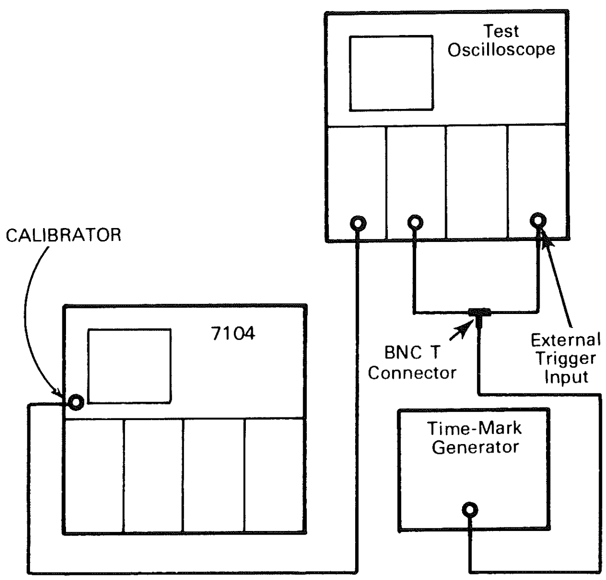
NOTE

A frequency counter with an accuracy of at least 0.1% may be used to adjust the calibrator repetition rate.

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

B2. SETUP CONDITIONS

7104 Controls:
CALIBRATOR .... 4 V pushbutton in



Test Equipment Controls:
Time-Mark Generator........................ 1 ms markers

Test Oscilloscope
Triggering .... Auto, AC, External
Input Coupling.................................... DC
Sweep Rate .... 1 ms/div
Vertical Mode .... Add

a. Connect 1-millisecond time-markers to the test oscilloscope external trigger input and to the noninverting vertical channel of the test oscilloscope (use a T connector). Connect the 7104 CALIBRATOR output to the inverting input of the test oscilloscope.

b. Set the test oscilloscope triggering level for a stable time-mark display.

c. Set the test oscilloscope vertical deflection factors to display 2 divisions of CALIBRATOR signal and 1 division of time-marker signal.

d. Set the test oscilloscope sweep rate for 0.2 second/division.

e. **CHECK**—The time required for the 1-millisecond time marks to drift from the positive level of the CALIBRATOR signal to the negative level, and back to the positive level must be more than 0.4 second (2 divisions). This time can be measured directly from the display by observing the number of divisions that the markers move across the display area before it returns to the positive level.

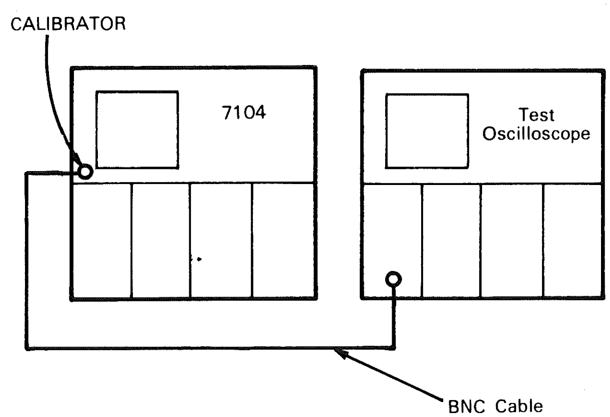
B3. CHECK CALIBRATOR RISE TIME, FALL TIME, AND DUTY CYCLE

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

B3. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Test Oscilloscope
Sweep Rate .... 0.1 μs/div
Triggering .... Auto, AC, Internal

a. Connect the CALIBRATOR output to the inverting vertical input of the test oscilloscope.

b. Set the test oscilloscope vertical deflection to display 4 divisions of CALIBRATOR signal.

c. Set the test oscilloscope for a stable display, triggered on the rising portion of the CALIBRATOR signal.

d. **CHECK**—Displayed waveform for not more than 5 divisions horizontally between the 10% to 90% points of the waveform (rise time, 0.5 microsecond or less).

e. Set the test oscilloscope for a stable display triggered on the falling portion of the waveform.

f. **CHECK**—Displayed waveform for not more than 5 divisions between the 90% and 10% points (fall time, 0.5 microsecond or less).

g. Set the test oscilloscope triggering for positive slope and auto mode with ac coupling from the internal source at a sweep rate of 0.1 millisecond/division. Set the triggering controls so that the display starts at the 50% point on the rising edge of the waveform.

h. Set the test oscilloscope sweep magnifier to X10. Then, position the display horizontally so the falling edge of the waveform aligns with the center vertical graticule line.

i. Set the test oscilloscope vertical to invert the display.

NOTE

The display is triggered on the opposite slope, even though the display appears the same.

j. **CHECK**—The 50% point on the falling edge of the waveform now displayed is within 0.2 divisions horizontally of the center line. (Indicates duty cycle of 50% within 0.2%.)

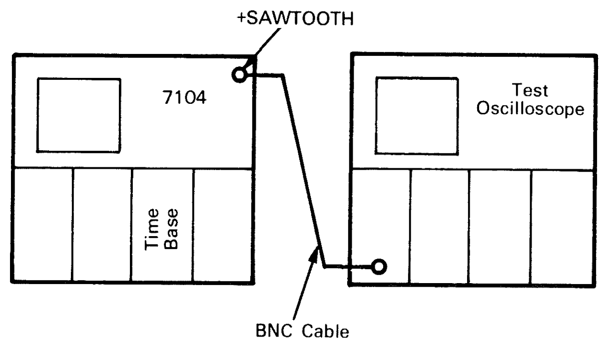
B4. CHECK A AND B SAWTOOTH OUTPUT SIGNALS

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

B4. SETUP CONDITIONS

7104 Controls:
+SAWTOOTH A or B switch .... A



Test Equipment Controls:
Test Oscilloscope
Sweep Rate .... 2 ms/div
Vertical Deflection .... 2 V/div

Time Base
Sweep Rate .... 0.1 ms/div
Triggering .... Auto

a. Connect the +SAWTOOTH output connector to the test oscilloscope channel 1 vertical input (1 megohm input).

b. **CHECK**—That the slope of the test oscilloscope display is 2 volts/division within 10% (10 volt sawtooth display for 10 division sweep on 7104 crt screen) and that the sawtooth baseline is within one volt of ground.

c. Move the time-base unit to the B HORIZ compartment.

d. Set the +SAWTOOTH selector switch to the B position.

e. **CHECK**—Test oscilloscope display for 2 volts/division of sweep within 10% (10 volt sawtooth display for 10 division sweep on the 7104 crt screen) and that the sawtooth baseline is within one volt of ground.

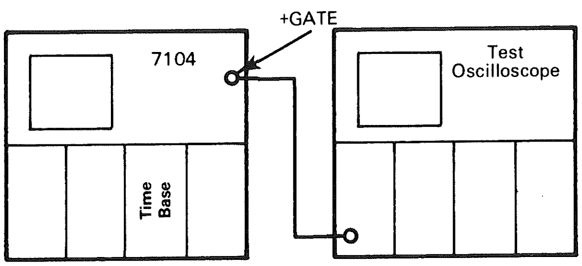
B5. CHECK A AND B GATE OUTPUT SIGNALS

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

B5. SETUP CONDITIONS

7104 Controls:
+GATE A or B Switch .... A



Test Equipment Controls:
Test Oscilloscope
Vertical Deflection Factor .... 2 V/div
Sweep Rate .... 2 ms/div

Time-Base
Mode .... Delaying
Triggering .... Auto, AC, Internal
Sweep Rate .... 0.5 ms/div

a. **CHECK**—Test oscilloscope display for a gate waveform 5 divisions in amplitude within 10% and a baseline at zero volts within one volt.

b. Move the time-base unit to the B HORIZ compartment.

c. Set the +GATE selector switch to the B position.

d. **CHECK**—Test oscilloscope display for a gate waveform 5 divisions in amplitude within 10% and a baseline at zero volts within one volt.

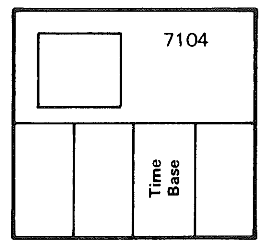
B6. CHECK GRATICULE ILLUMINATION OPERATION

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

B6. SETUP CONDITIONS

7104 Controls:
GRAT ILLUM +GATE or EXT switch............................+GATE
+GATE A or B switch..A
HORIZONTAL MODE...A



Test Equipment Controls:
Time Base
Sweep Rate.. 0.2 s
Triggering...Auto, AC, Internal

a. **CHECK**—Rotate the GRAT ILLUM control throughout its range and notice that the illumination of the graticule varies.

b. Set the GRAT ILLUM control fully clockwise to the PULSED detent position.

c. Set the A INTENSITY control for a visible display.

d. **CHECK**—Graticule illumination occurs only after the time-base unit has completed a sweep (adjust GRAT ILLUM PRESET, if necessary).

e. Set the GRAT ILLUM +GATE or EXT switch to EXT.

f. **CHECK**—Press the GRAT ILLUM MAN pushbutton and check for one momentary illumination of the graticule.

g. Set the GRAT ILLUM control to midrange (out of the PULSED detent position).

C. TRIGGER SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

1. Test oscilloscope
3. Amplifier unit (dual trace)
4. Time-base unit (two required)
5. Signal standardizer
15. Coaxial cable (one 18-inch, two 42-inch required)

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

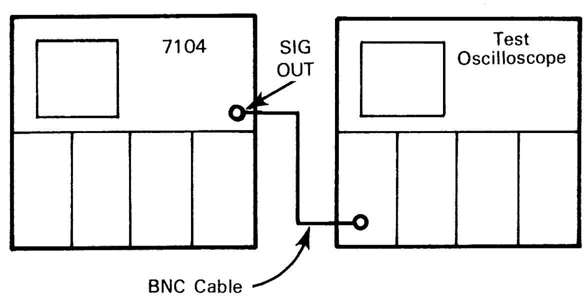
TRIGGER SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
VERTICAL MODE .... RIGHT
A TRIGGER SOURCE .... VERT MODE
A INTENSITY .... Fully counterclockwise
HORIZONTAL MODE .... A
B INTENSITY .... Fully counterclockwise
B TRIGGER SOURCE .... VERT MODE
FOCUS .... Midrange
READOUT INTENSITY .... OFF (in detent)
GRAT ILLUM .... Midrange
BEAMFINDER .... Pushbutton out

C1. CHECK VERTICAL SIGNAL OUT DC CENTERING

C1. SETUP CONDITIONS

7104 Controls:
No change in setting.



Test Equipment Controls:
Test Oscilloscope
Input Coupling .... Gnd or Off
Vertical Deflection .... 1 V/div
Sweep Rate .... 1 ms/div

a. Establish a ground reference for the test oscilloscope by positioning the trace to the graticule center line. Do not change the test oscilloscope position control after setting this ground reference.

b. Connect the front-panel SIG OUT connector to the vertical input of the test oscilloscope with the 42-inch, 50-ohm bnc cable.

c. Set the test oscilloscope input coupling switch to dc.

d. **CHECK**—Test oscilloscope display for a dc level within 1 division of the ground reference established in part a.

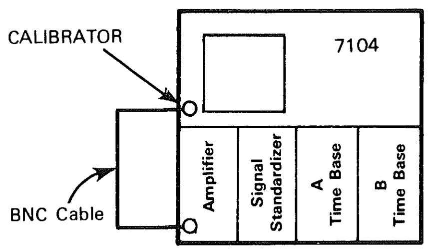
C2. CHECK TRIGGER SELECTOR OPERATION

NOTE

If the preceding step was not performed, first refer to the Trigger System Preliminary Control Settings, then proceed with the following instructions.

C2. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... LEFT
HORIZONTAL MODE .... A
A TRIGGER SOURCE .... VERT MODE
B TRIGGER SOURCE .... VERT MODE



Test Equipment Controls:
Signal Standardizer
Test Selector Switch .... Vert or Horiz +Step Resp
Rep Rate .... 10 kHz

A Time Base
Sweep Rate .... 0.2 ms/div
Triggering .... Auto, AC, Internal
Magnifier X1
Mode .... Independent

B Time Base
Sweep Rate .... 0.2 ms/div
Triggering .... Auto, AC, Internal
Magnifier X1
Mode .... Independent

a. Connect the CALIBRATOR 4 V output to the amplifier unit (use 18-inch bnc cable). Set the A INTENSITY control for a visible display. Set the amplifier for a 2-division display in the upper half of the graticule area. Use the A time-base unit trigger level to trigger the display.

b. Set the VERTICAL MODE switch to RIGHT.

c. Set the signal standardizer Amplitude and Position controls for a 2-division display in the lower half of the graticule area.

d. Set the VERTICAL MODE switch to ALT.

e. **CHECK**—The crt display for 1-kHz and 10-kHz triggered waveforms (adjust the time-base unit trigger level controls as necessary).

f. Set the VERTICAL MODE switch to ADD.

g. **CHECK**—For a triggered waveform.

h. Set the VERTICAL MODE switch to CHOP.

i. **CHECK**—For a stable display of only the 1-kHz waveform.

j. Set the A TRIGGER SOURCE switch to LEFT VERT.

k. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 1-kHz waveform.

l. Set the A TRIGGER SOURCE switch to RIGHT VERT.

m. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 10-kHz waveform.

n. Set the VERTICAL MODE switch to ALT, the HORIZONTAL MODE switch to B, and the B INTENSITY control for a visible display.

o. **CHECK**—Crt display for 1-kHz and 10-kHz triggered waveforms.

p. Set the VERTICAL MODE switch to ADD.

q. **CHECK**—For a stable display.

r. Set the VERTICAL MODE switch to CHOP.

s. **CHECK**—For a stable display of only the 1-kHz waveform.

t. Set the B TRIGGER SOURCE switch to LEFT VERT.

u. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 1-kHz waveform.

v. Set the B TRIGGER SOURCE switch to RIGHT VERT.

w. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 10-kHz waveform.

x. Set the VERTICAL MODE switch to ALT, the HORIZONTAL MODE switch to ALT, and the A and B TRIGGER SOURCE switches to VERT MODE.

y. **CHECK**—Vary the time-base unit's Trigger Level control. The B HORIZ time-base unit should be triggered on the 1-kHz waveform; the A HORIZ time-base unit should be triggered on the 10-kHz waveform.

D. HORIZONTAL SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

2. Amplifier unit (two required, one with variable delay)
4. Time-base unit
5. Signal standardizer
10. Time-mark generator
11. Low-frequency sine-wave generator
15. Coaxial cable (one 18-inch, one 42-inch)
17. T connector

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

HORIZONTAL SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
VERTICAL MODE .... RIGHT
VERT TRACE SEPARATION (B) .... Midrange
A TRIGGER SOURCE .... VERT MODE
A INTENSITY .... Fully counterclockwise
HORIZONTAL MODE .... A
B INTENSITY .... Fully counterclockwise
B TRIGGER SOURCE .... VERT MODE
FOCUS .... Midrange
READOUT INTENSITY .... OFF (in detent)
GRAT ILLUM .... As desired
BEAMFINDER .... Pushbutton out
X-Y Z-Axis .... X-Y DC Controlled Z-Axis (see note below)

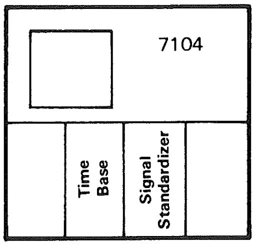
NOTE

The X-Y Z-Axis Selector is an internal switch located on the Logic board (A13). Refer to Figure 8-29, Test Point and Adjustment Locations E, in section 8 of this manual. When the X-Y Z-Axis Selector switch is set to the X-Y DC Controlled Z-Axis position, control of the Z-Axis drive signal to the crt is determined by the horizontal plug-in unit selected by the HORIZONTAL MODE switch. When the X-Y Z-Axis Selector is set to the X-Y Time Base Controlled Z-Axis position, and an amplifier unit is installed in one of the horizontal compartments, control of the Z-Axis drive signal to the crt is determined by a time-base unit installed in the other horizontal compartment. Return the X-Y Z-Axis Selector to the X-Y Time Base Controlled Z-Axis position after performing all or part of the D. Horizontal System procedure.

D1. CHECK HORIZONTAL AMPLIFIER GAIN

D1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Signal Standardizer
Test Selector Switch .... Vert or Horiz Com Mode
Rep Rate .... 1 MHz

Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

a. Set the A INTENSITY control for a visible trace.

b. Set the signal standardizer Test Selector switch to Vert or Horiz Gain and the Rep Rate switch to 1 MHz. Align the bright vertical trace with the center vertical graticule line using the signal standardizer Position control.

c. **CHECK**—For 8 divisions of deflection between the center nine traces within 0.08 division. Note the exact error for comparison in part h.

d. **CHECK**—That the other vertical traces align with their respective graticule lines within 0.05 division.

e. Move the signal standardizer to the B HORIZ compartment.

f. Set the HORIZONTAL MODE switch to B.

g. Set the B INTENSITY control for a visible display.

h. **CHECK**—For 8 divisions of deflection between the center nine traces within 0.08 division of the error noted in part c, and that the other vertical traces align with their respective graticule lines within 0.05 division (specified at the center graticule line).

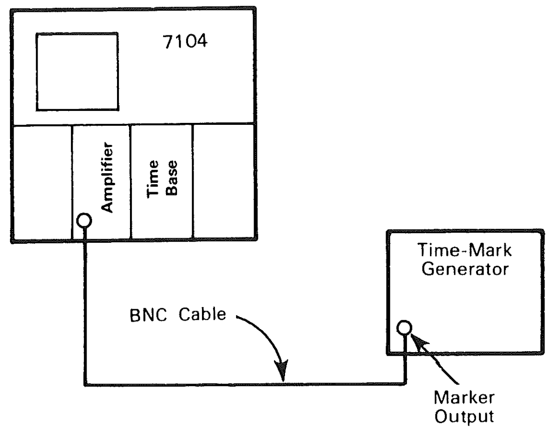
D2. CHECK HIGH-FREQUENCY TIMING

NOTE

If the preceding step was not performed, first refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

D2. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE .... A



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal
Mode .... Independent

Amplifier
Deflection Factor .... 0.5 V/div
Input Coupling .... DC

Time-Mark Generator .... 1 ms markers

a. Connect 1-millisecond markers from the time-mark generator to the amplifier unit input and adjust the amplifier unit deflection factor for about 2 divisions of display. Set the A INTENSITY control for a visible display, if necessary.

b. Set the time-base unit triggering controls for a stable display.

c. Position the first marker to the extreme left line on the graticule.

d. Set the time-base unit sweep calibration control for 1 marker at each major graticule division between the second and tenth graticule lines (center 8 divisions).

e. **CHECK**—Refer to the time-base unit instruction manual for performance check or calibration procedures for checking high-frequency timing and linearity.

D3. CHECK X-Y COMPENSATION (OPTION 2)

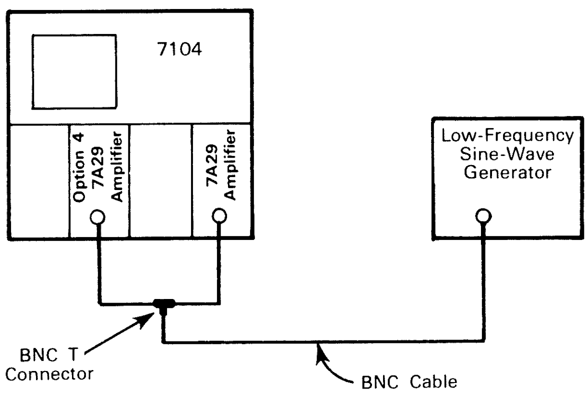
NOTE

If the instrument under test does not contain Option 2, omit the remainder of this step.

If the preceding step was not performed, refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

D3. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE .... B



Test Equipment Controls:
7A29 Amplifier Option 4
Deflection Factor .... 0.1 V/div
Input Coupling .... DC
Polarity .... + UP

7A29 Amplifier
Deflection Factor .... 0.1 V/div
Input Coupling .... DC
Polarity .... + UP

a. Set the low-frequency sine-wave generator for eight divisions of vertical and horizontal deflection at 25 megahertz.

b. Set the variable delay control on the 7A29 Option 4 Amplifier unit to minimize the separation on the Lissajous display.

c. Set the low-frequency sine-wave generator to 50 megahertz.

d. **CHECK**—Crt Lissajous display for a separation of 0.28 division or less (indicates 2 degrees or less phase shift).

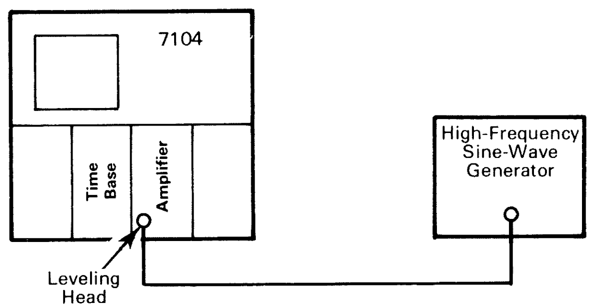
D4. CHECK HORIZONTAL BANDWIDTH

NOTE

If the preceding step was not performed, refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

D4. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE .... A



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, External

Amplifier
Deflection Factor .... 50 mV
Input Coupling .... DC

a. Set the high-frequency sine-wave generator for 8 divisions of displayed signal on the 7104 crt at the generator's reference frequency (6 megahertz).

b. Set the high-frequency sine-wave generator output frequency to 350 megahertz.

c. **CHECK**—Displayed 350 MHz amplitude is at least 5.7 divisions.

E. VERTICAL SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

2. Amplifier unit
4. Time-base unit (two required)
5. Signal standardizer
11. Low-frequency sine-wave generator
12. High-frequency sine-wave generator

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

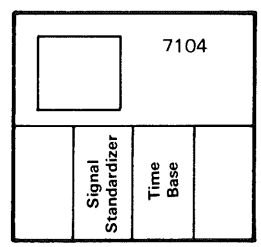
VERTICAL SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
VERTICAL MODE .... RIGHT
VERT TRACE SEPARATION (B) .... Midrange
A TRIGGER SOURCE .... VERT MODE
A INTENSITY .... Midrange
HORIZONTAL MODE .... A
B INTENSITY .... Midrange
B TRIGGER SOURCE .... VERT MODE
FOCUS .... Midrange
READOUT INTENSITY .... OFF (in detent)
GRAT ILLUM .... As desired
BEAMFINDER .... Pushbutton out

E1. CHECK VERTICAL AMPLIFIER GAIN

E1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, External

Signal Standardizer
Test Selector Switch .... Vert or Horiz Gain
Rep Rate .... 100 kHz

a. Position the signal standardizer display to align the bright center trace with the graticule center line.

b. **CHECK**—For one trace per graticule division within 0.06 division over the center 6 graticule divisions. Note the exact error for comparison in part e.

c. Remove the signal standardizer from the RIGHT VERT compartment and install it in the LEFT VERT compartment.

d. Set the VERTICAL MODE switch to LEFT.

e. **CHECK**—For one trace per graticule division within 0.06 division of the error noted in part b, over the center 6 graticule divisions.

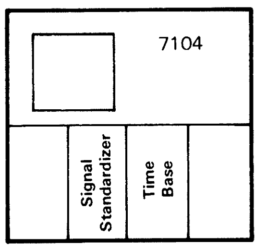
E2. CHECK VERTICAL LOW-FREQUENCY LINEARITY

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

E2. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

Signal Standardizer
Test Selector Switch .... Vert or Horiz +Step Resp
Rep Rate .... 1 kHz

a. Set the signal standardizer Amplitude and Position controls so the display is exactly two divisions in amplitude in the center of the graticule area.

b. **CHECK**—Position the two-division display vertically and check for not more than 0.1 division of compression or expansion anywhere within the graticule area.

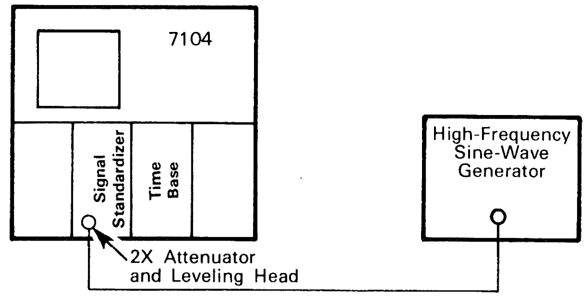
E3. CHECK VERTICAL AMPLIFIER 1 GHz GAIN

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

E3. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate .... 0.1 ms/div
Triggering .... Auto, AC, External

Signal Standardizer
Test Selector Switch .... Vert or Horiz Freq Resp

High-Frequency Sine-Wave Generator
Reference Frequency .... 6 MHz

a. Set the signal standardizer Amplitude control fully clockwise.

b. Connect the high-frequency sine-wave generator to the signal standardizer Aux In CW In (Freq Resp) input with a 2X attenuator.

c. Set the high-frequency sine-wave generator for a 10-division display at the reference frequency (between 6 and 50 megahertz) centered on the graticule. (To obtain a 10-division display, first set for 8 divisions, then vertically position the display 1 division down and set the sine-wave generator to return the top of the display to the top of the graticule.)

d. Set the signal standardizer Amplitude control for a 6-division display, centered on the graticule. (The CW Leveled indicator should be lit.)

e. Without changing the output amplitude, increase the sine-wave generator frequency until the displayed amplitude is reduced to 5 divisions. If the CW Leveled indicator goes off, increase the amplitude of the sine-wave generator signal until the light just turns on.

NOTE

The signal standardizer CW Leveled light must be on and the sine-wave generator must be properly connected for a valid check. Refer to the signal standardizer and high-frequency sine-wave generator manuals.

f. **CHECK**—Sine-wave generator frequency is 1 gigahertz or higher (verifies 1 gigahertz gain).

g. Move the signal standardizer to the LEFT VERT compartment (leave signal connected) and set the VERTICAL MODE switch to LEFT.

h. **CHECK**—Repeat parts d through g for the LEFT VERT compartment.

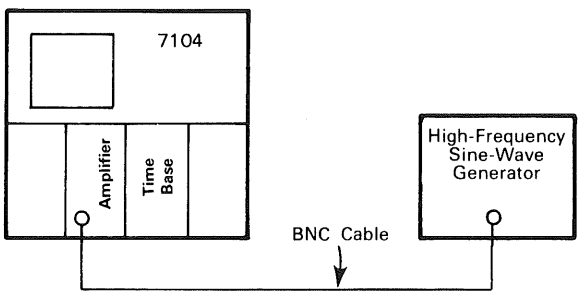
E4. CHECK VERTICAL CHANNEL ISOLATION

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

E4. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

Amplifier
Input Coupling .... DC

High-Frequency Sine-Wave Generator .... 1 GHz

a. Connect the output of the high-frequency sine-wave generator to the amplifier unit input.

b. Set the output of the high-frequency sine-wave generator and the amplifier unit deflection factor for 8 divisions of deflection at 1 gigahertz.

c. Set the VERTICAL MODE switch to LEFT.

d. **CHECK**—Crt display amplitude for 0.1 division less of the 1-gigahertz signal (verifies isolation at least 80:1 at 1 gigahertz).

e. Move the amplifier unit to the LEFT VERT compartment without disturbing the set-up.

f. Set the VERTICAL MODE switch to RIGHT.

g. **CHECK**—Crt display amplitude for 0.1 division or less of the 1 gigahertz signal (verifies isolation at least 80:1 at 1 gigahertz).

h. Set the VERTICAL MODE switch to LEFT.

i. Connect the low-frequency sine-wave generator to the amplifier input.

j. Set the low-frequency sine-wave generator for 8 divisions of deflection at 100 megahertz.

k. Set the VERTICAL MODE switch to RIGHT.

l. **CHECK**—Crt display amplitude for 0.05 division or less of 100 megahertz signal (verifies 100 megahertz isolation at least 160:1).

m. Move the amplifier unit to the RIGHT VERT compartment without disturbing the set-up.

n. Set the VERTICAL MODE switch to LEFT.

o. **CHECK**—Crt display amplitude for 0.05 division or less of 100 megahertz signal (verifies isolation at least 60:1 from dc to 100 megahertz).

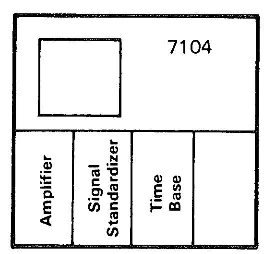
E5. CHECK VERTICAL DISPLAY MODES

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

E5. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

Amplifier
Deflection Factor .... 0.1 V/div
Input Coupling .... DC

Signal Standardizer
Test Selector Switch .... Vert or Horiz Aux In

a. Position the trace to the upper half of the graticule area with the right-vertical unit position control.

b. Set the VERTICAL MODE switch to LEFT and position the trace to the lower half of the graticule area with the left-vertical unit position control.

c. **CHECK**—Crt display for two traces in the ALT and CHOP positions of the VERTICAL MODE switch.

d. Set the VERTICAL MODE switch to ADD.

e. **CHECK**—Crt display for a single trace that can be positioned vertically with either the left or right vertical-unit position control.

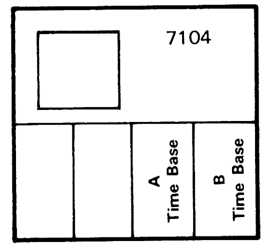
E6. CHECK VERTICAL TRACE SEPARATION OPERATION

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

E6. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE .... CHOP
VERTICAL MODE .... ADD



Test Equipment Controls:
A Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

B Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

a. **CHECK**—Rotate the VERT TRACE SEPARATION (B) control throughout its range and check that the trace produced by the B time-base unit can be positioned at least 4 divisions above and below the trace produced by the A time-base unit. Also, check with the HORIZONTAL MODE switch set to ALT.

F. READOUT SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

3. Amplifier unit (dual trace)

4. Time-base unit

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change information at the rear of this manual for any modifications which may affect this procedure.

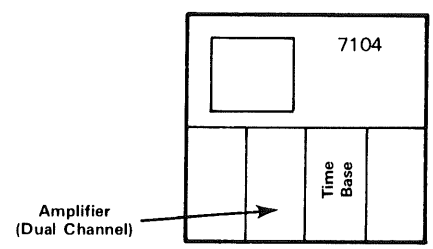
READOUT SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
VERTICAL MODE .... RIGHT
VERT TRACE SEPARATION (B) .... Midrange
A TRIGGER SOURCE .... VERT MODE
A INTENSITY .... Midrange
HORIZONTAL MODE .... A
B TRIGGER SOURCE .... VERT MODE
B INTENSITY .... Midrange
READOUT INTENSITY .... OFF (in detent)
GRAT ILLUM .... Midrange
BEAMFINDER .... Pushbutton out

F1. CHECK READOUT MODES

F1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

Amplifier
Mode .... Dual trace

a. Set the READOUT INTENSITY control for a visible display.

b. **CHECK**—Set the time-base unit to several sweep rates throughout the time/division switch range and check that the readout characters are displayed independently of the sweep.

c. Set the READOUT +GATE or EXT switch to +GATE and the READOUT INTENSITY control to PULSED.

d. Set the +GATE mode switch to A.

e. Set the READOUT PRESET control for a visible readout display.

f. Set the time-base unit for a free-running (not triggered) sweep at a rate of 0.2 second/division.

g. **CHECK**—The readout characters are blanked out while the sweep is running, and are displayed immediately after the end of the sweep; each character encoded by the plug-in units is displayed only once for each sweep.

h. Set the READOUT +GATE or EXT switch to EXT.

i. **CHECK**—Press the READOUT MAN pushbutton and notice that one frame of readout is displayed.

G. PHOTOGRAPHIC WRITING RATE

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

2. Amplifier unit
4. Time-base unit
7. Camera
12. High-frequency sine-wave generator

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

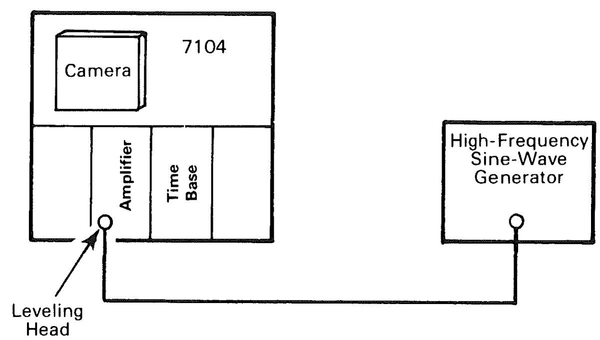
PHOTOGRAPHIC WRITING RATE PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
VERTICAL MODE .... RIGHT
A TRIGGER SOURCE .... VERT MODE
A INTENSITY .... Counterclockwise
HORIZONTAL MODE .... A
B INTENSITY .... Counterclockwise
B TRIGGER SOURCE .... VERT MODE
READOUT INTENSITY .... OFF (in detent)
GRAT ILLUM .... PULSED
BEAMFINDER .... Pushbutton out

G1. CHECK PHOTOGRAPHIC WRITING RATE

G1. SETUP CONDITIONS

7104 Controls:
GRAT ILLUM +GATE or EXT .... +GATE
+GATE A or B .... A



Test Equipment Controls:
Amplifier
Deflection Factor .... 0.5 V/div
Input Coupling .... DC

Time Base
Sweep Rate .... 2 ns
Magnifier X1
Triggering .... Auto, AC, Internal

High-Frequency Sine-Wave Generator
Frequency .... 1 GHz

Camera
Mode .... Time
Aperature f/1.9

NOTE

Section 2, Operating Instructions, contains helpful information on obtaining waveform photographs; see Graticule Illumination, Light Filter, Readout Display and Display Photography.

a. Remove the blue crt filter.

b. Set the A INTENSITY control for a visible display.

c. Set the time-base unit sweep magnifier to X10.

d. Set the high-frequency sine-wave generator output amplitude to display a 7.5 division signal on the 7104 crt.

e. Set the time-base unit triggering controls for a stable display.

f. Set the FOCUS and ASTIG controls for a well-defined display.

g. Set the time-base unit to single-sweep mode.

h. Sequentially press the time-base unit single sweep reset control and set the GRAT ILLUM PRESET control to illuminate the graticule.

i. Focus the camera.

j. Install 3000 ASA film in the camera and close the camera viewing port.

k. Rotate the A INTENSITY control fully clockwise.

l. Press the camera shutter button.

m. Press the time-base single sweep reset button.

n. Press the camera shutter button.

o. Develop film.

p. **CHECK**—Photograph should show the 1 GHz sine-wave signal clearly (see Fig. 5-1 for typical photograph).

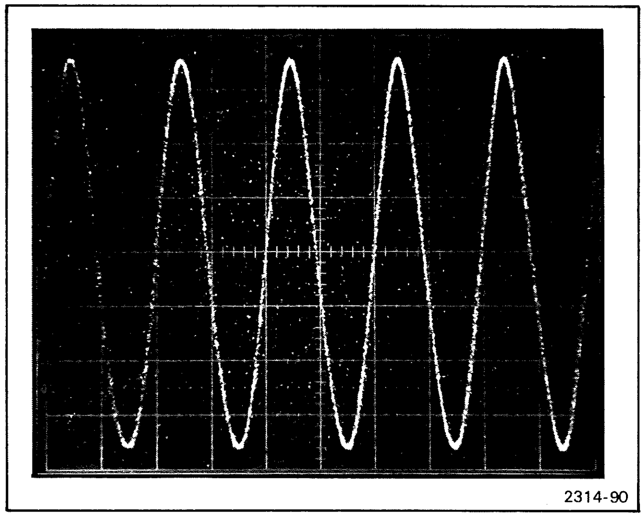


Figure 5-1. Typical 7104 Photographic Writing Rate.

See Table 5-1, Calibration Procedure Electives, at the beginning of this section, for information on performing a Partial Part II—Adjustment and Performance Check procedure.

This concludes the Performance Check of the 7104.

PART II—ADJUSTMENT AND PERFORMANCE CHECK

The following procedure (Part II—Adjustment and Performance Check) provides the information necessary to: (1) verify that the instrument meets the electrical specifications, (2) verify that all controls function properly, and (3) perform all internal adjustments.

Part I—Performance Check verifies electrical specifications without removing instrument covers or making internal adjustments. All tolerances given are as specified in the Specification tables (section 1) in this manual.

A separate Operators Checkout Procedure is provided in the Operators Manual for familiarization with the instrument and also to verify that the controls, indicators, and connectors function properly.

See Table 5-1, Calibration Procedure Electives at the beginning of this section, for information on performing a Partial Part II—Adjustment and Performance Check procedure.

INDEX TO ADJUSTMENT AND PERFORMANCE CHECK PROCEDURE

ADJUSTMENT AND PERFORMANCE CHECK POWER-UP SEQUENCE

NOTE

The performance of this instrument can be checked at any ambient temperature from 0° to +50° C unless otherwise stated. Adjustments must be performed at an ambient temperature from +20° to +30° C for specified accuracies.

1. Check that the LINE VOLTAGE SELECTOR switch is set for the correct input line voltage.

2. Remove cabinet panels to gain access to internal adjustments and test points.

3. Turn the instrument POWER switch on and allow at least 20 minutes warmup before proceeding.

A. POWER SUPPLY

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

8. Precision dc voltmeter (DVM)

20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the Test Point and Adjustment Locations A foldout page in Section 8, Diagrams and Circuit Board Illustrations.

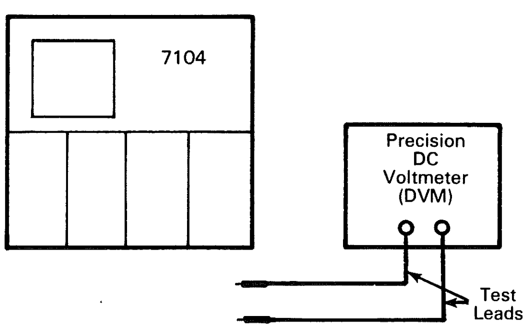
POWER SUPPLY PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
READOUT INTENSITY .... OFF (in detent)
GRAT ILLUM .... Counterclockwise
BEAMFINDER .... Pushbutton out
All other controls .... No change

A1. ADJUST +50 VOLT POWER SUPPLY (R1415)

A1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Precision DC Voltmeter (DVM)
Voltage Range .... Appropriate range for voltage to be measured.

WARNING

Extreme caution must be used when operating the 7104 with the power unit removed due to the line voltage, high voltage, and high current potentials present.

NOTE

The Power Supply voltages can be checked without removing the power unit by using the 7000-series plug-in extender (rigid), Tektronix part 067-0589-00.

a. Set POWER switch to OFF and disconnect the line cord from the power source. Remove any plug-in units from the plug-in compartments. Expose the 7104 power supply adjustments and test points by removing the power unit from the rear of the 7104 (interconnecting cables remain connected). See the Maintenance section in this manual for power unit removal instructions.

b. Connect the line cord to the power source and press the POWER button in.

c. Connect the precision dc voltmeter between TP -50 V Sense and TP Ground Sense on the Low-Voltage Regulator circuit board.

d. **EXAMINE**—The meter reading for -50 volts, within the limits of -49.8 to -50.2 volts.

e. **ADJUST**—The +50 V adjustment R1415 for a meter reading of -50 volts within 0.1 volt.

f. **INTERACTION**—Any change in the setting of R1415 may affect the operation of all circuits in the instrument.

@

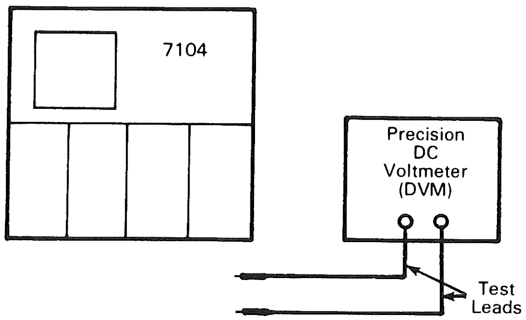
A2. ADJUST INVERTER CONTROL (R1293)

NOTE

If the preceding step was not performed, first refer to the Power Supply Preliminary Control Settings, then proceed with the following instructions.

A2. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Precision DC Voltmeter (DVM)
Voltage Range .... Appropriate range for voltage to be measured.

a. Connect the precision dc voltmeter between TP1326 and chassis ground.

b. **EXAMINE**—Meter reading for +109 volts within the limits of +108.5 to +109.5 volts. If the meter reading is within the given tolerance, proceed to step A3.

c. **ADJUST**—The Pre Reg Adj, adjustment R1293 for a meter reading of +109 volts within 0.5 volt.

d. **INTERACTION**—Any change in the setting of R1293 may affect the adjustment of R1415 given in step A1.

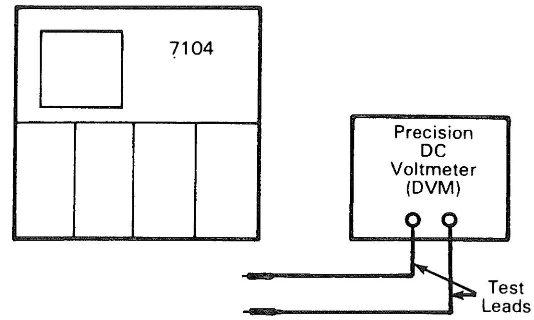
A3. EXAMINE POWER-SUPPLY VOLTAGES

NOTE

If the preceding step was not performed, first refer to the Power Supply Preliminary Control Settings, then proceed with following instructions.

A3. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Precision DC Voltmeter (DVM)
Voltage Range .... Appropriate range for voltage to be measured.

a. **EXAMINE**—Table 5-4 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 common lead to TP Ground Sense.

b. **INTERACTION**—If the power supplies are not within the tolerances given in Table 5-4, repeat steps A1 and A2.

TABLE 5-4
Power Supply Tolerance

Power Supply	Output Voltage Limits
TP −50 V Sense	−49.8 to −50.2 volts
TP −15 V Sense	−14.85 to −15.15 volts
TP +5 V Sense	+4.9 to +5.1 volts
TP +15 V Sense	+14.85 to +15.15 volts
TP +50 V Sense	+49.5 to +50.5 volts

c. Disconnect the precision dc voltmeter.

NOTE

Regulation of the individual power supplies can be checked using the procedure given under Troubleshooting Techniques in the Maintenance section.

d. Disconnect the line cord from the power source.

e. Install the power unit and connect the line cord.

B. Z-AXIS AND DISPLAY

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

1. Test oscilloscope
2 or 3. Amplifier unit (two required)
4. Time-base unit (two required)
5. Signal standardizer (two required)
8. Precision dc voltmeter (DVM)
9. DC voltmeter (VOM)
11. Low-frequency sine-wave generator
12. High-frequency sine-wave generator
13. 10X passive probe
14. 100X probe
15. Coaxial cable (two 42-inch required)
16. 2X attenuator
17. T connector
19. Low-capacitance screwdriver
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the Test Point and Adjustment Locations B foldout page in Section 8, Diagrams and Circuit Board Illustrations.

(4) Remove the blue rear-panel cabinet cover (secured by 4 screws).

Z-AXIS AND DISPLAY PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
VERTICAL MODE .... RIGHT
VERT TRACE SEPARATION (B)............. Midrange
A TRIGGER SOURCE................... VERT MODE
A INTENSITY .... Fully counterclockwise
HORIZONTAL MODE .... A
B INTENSITY .... Fully counterclockwise
B TRIGGER SOURCE................... VERT MODE
FOCUS.................................. Midrange
READOUT INTENSITY .... OFF (in detent)
GRAT ILLUM .... Midrange
BEAMFINDER .... Pushbutton out
X-Y Z Axis Selector .... X-Y Time Base Controlled Z-Axis (see following note)

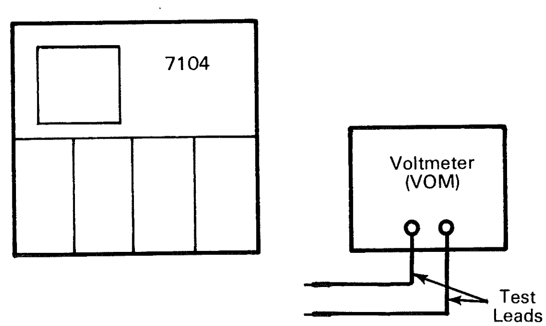
NOTE

The X-Y Z-Axis Selector is an internal switch located on the Logic board (A13). Refer to Figure 8-29, Test Point and Adjustment Locations E, in section 8 of this manual. When the X-Y Z-Axis Selector is set to the X-Y DC Controlled Z-Axis position, control of the Z-Axis drive signal to the crt is determined by the horizontal plug-in unit selected by the HORIZONTAL MODE switch. When the X-Y Z-Axis Selector is set to the X-Y Time Base Controlled Z-Axis position (In) and an amplifier unit is installed in one of the horizontal compartments, control of the Z-Axis drive signal to the crt is determined by a time-base unit installed in the other horizontal compartment. Return the X-Y Z-Axis Selector to the X-Y Time Base Controlled Z-Axis position (In) after performing all or part of this procedure.

B1. ADJUST HV SUPPLY (R1805)

B1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Voltmeter (VOM)
Range .... Appropriate range for voltage to be measured.

@

a. Set the POWER switch to OFF.

b. Connect the dc voltmeter (VOM), set to measure at least -2500 volts (accuracy check to within 1%), between TP1846 (-2265 volt test point), and TP1756 (ground). (Test points located on the A22 High Voltage board.)

c. Set the POWER switch to on.

d. **EXAMINE**—Meter reading; -2265 volts within the limits of -2243 to -2287 volts.

e. **ADJUST**—The HV Adjust, adjustment R1805, for a meter reading of -2265 volts.

f. Set the POWER switch to OFF.

WARNING

Shock hazard exists while performing parts g through n; VOM elevated to 2.4 kV.

g. Connect the dc voltmeter (VOM), set to measure 150 volts, between TP1844 (-2400 volts) and TP1846 (-2265 volts).

h. Set the POWER switch to on.

i. **EXAMINE**—Meter reading for 137 volts within the limits of 132 volts to 142 volts. If meter reads outside limits, corrective maintenance is required to prevent deterioration of the crt cathode.

j. Set the POWER switch to OFF and disconnect the voltmeter.

k. Remove the shield from the Z-Axis board.

l. Connect the dc voltmeter (VOM), set to measure 600 millivolts dc, across R1688 on the Z-Axis board A21 (connect VOM common test lead to junction of CR1687 and R1688 and the other lead to pin 6 of P1602).

m. Set the POWER switch to on.

n. **EXAMINE**—Meter reading for a momentary deflection of at least 10 millivolts; if meter reading is less, corrective maintenance is required to prevent deterioration of the crt cathode.

o. Set the POWER switch to OFF and disconnect the dc voltmeter.

p. Replace the shield on the Z-Axis board.

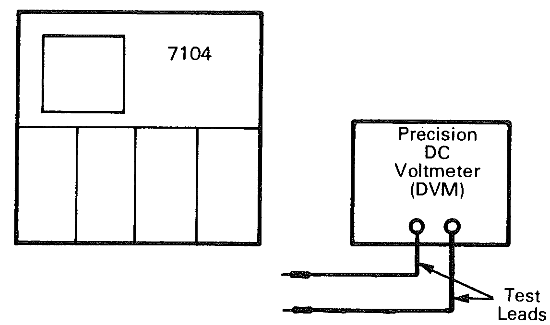
B2. ADJUST CRT GRID BIAS (R1746)

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

B2. SETUP CONDITIONS

7104 Controls:
POWER switch .... ON



Test Equipment Controls:
Precision DC Voltmeter (DVM)
Range .... Approprite range for voltage to be measured.

a. Connect the precision dc voltmeter (DVM) between test point TP1678 and chassis ground.

b. **EXAMINE**—The DVM reading for 8 volts within 1 volt.

c. **ADJUST**—Set the Z-Axis Level adjustment R1645 for 8 volts.

d. Install an amplifier unit in the A HORIZ and B HORIZ compartments, and midrange the B HORIZ amplifier unit Position control.

e. Rotate the B INTENSITY control clockwise until the DVM reads 13 volts.

f. **ADJUST**—The Grid Bias adjustment R1746 so that the dot displayed on the crt is just extinguished.

NOTE

The instrument has to be on for at least 20 minutes to allow for stabilization of the crt grid cutoff voltage.

g. Disconnect the DVM test leads.

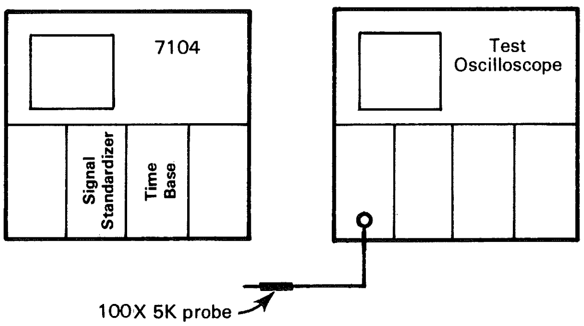
B3. ADJUST Z-AXIS AMPLIFIER (R1626, R1637, R1635, C1635, C1651, AND C1663)

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

B3. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Signal Standardizer
Test Selector Switch .... Vert or Horiz +Step
Rep Rate .... 1 kHz

Time Base
Sweep Rate .... 0.2 ms/div
Triggering .... Auto, AC, Internal

a. Set the A INTENSITY control for a visible display.

b. Set the time-base unit triggering controls for a stable display.

c. Rotate the signal standardizer Amplitude and Position controls fully counterclockwise.

d. Connect the 100X 5-kilohm probe to the input of the test oscilloscope. Note that a 50-ohm system is needed for the 100X 5-kilohm probe.

e. Set the test oscilloscope for dc input coupling with a vertical deflection factor of 0.1 volts/division (10 volts/division at the probe tip) and a sweep rate of 1 millisecond/division.

f. Connect the probe tip to TP1678. Connect the probe ground to chassis ground with a short grounding strap.

g. Set the time-base unit sweep rate to 0.1 microsecond/division and the magnifier to X10.

h. Set the test oscilloscope sweep rate to 1 microsecond/division.

i. Set the Clamp Level adjustment R1626 fully clockwise.

j. Set the A INTENSITY control fully clockwise.

k. Set the Z-Axis Gain adjustment R1637 for a pulse amplitude (indicated on the test oscilloscope) of 70 volts above ground.

l. Set the Clamp Level adjustment R1626 for a pulse amplitude of 63 volts above ground.

m. Rotate the A INTENSITY control counterclockwise until the pulse amplitude displayed on the test oscilloscope is 33 volts above ground.

n. Set the time-base unit Time/Div switch to 2 nanoseconds/division and trigger source to External.

o. Set the signal standardizer Rep Rate to 100 kHz.

p. Set the test oscilloscope deflection factor to 50 millivolts/division (5 volts at probe tip), sweep rate to 10 nanoseconds/division and magnifier to X1.

q. **EXAMINE**—The test oscilloscope display for aberrations of less than 4%, rise time of less than 6.5 nanoseconds, and fall time of less than 12 nanoseconds.

NOTE

Use test oscilloscope X1 magnifier for checking aberrations and X10 magnifier for checking rise time.

r. **ADJUST**—Z-Axis compensations #1, #2, #3, and #4 adjustments R1635, C1635, C1651, and C1663 to minimize the aberrations and rise time of the pulse displayed on the test oscilloscope.

NOTE

Use test oscilloscope X1 magnifier for checking aberrations and X10 magnifier for checking rise time.

s. Disconnect the test oscilloscope probe.

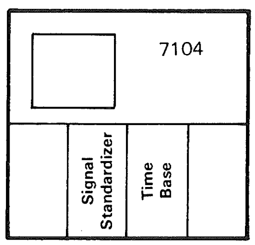
B4. CHECK/ADJUST TRACE ALIGNMENT (R1888)

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

B4. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Signal Standardizer
Test Selector Switch .... Vert or Horiz Aux In

Time Base
Triggering .... Auto, AC, Internal
Sweep Rate .... 1 ms/div
Magnifier X1

a. Set the A INTENSITY control for a visible trace. Set the FOCUS and ASTIG controls for a well-defined trace.

b. Position the trace to the center graticule line.

c. **CHECK**—Trace parallels the center graticule line within 0.1 division.

d. **ADJUST**—TRACE ROTATION adjustment to align the trace with the center graticule line.

e. Move the signal standardizer to the A HORIZ compartment and the time-base unit to the RIGHT VERT compartment.

f. Install an amplifier unit in the B HORIZ compartment.

g. Set the B INTENSITY control for a visible trace and with the signal standardizer Position control, position the trace to the center graticule line.

h. **CHECK**—Trace parallels the center graticule line within 0.1 division.

i. **ADJUST**—Y Alignment (Ortho) adjustment R1888 (on the A22 High-Voltage board) so trace parallels the center graticule line.

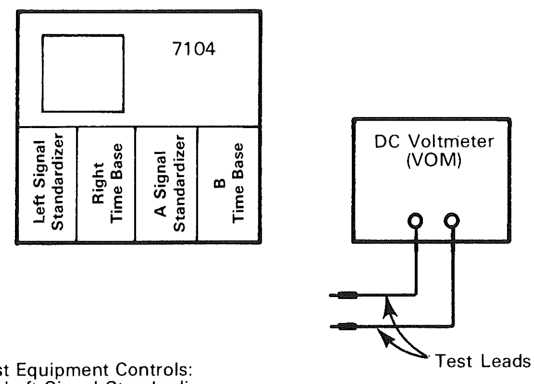
B5. CHECK/ADJUST GEOMETRY (R740, R830, R1030, R1888, R1062, R1853-R1856, R1883, R1825, R1891, R1873-R1876, R1874-R1875, R1894, R1864-R1865, R1863-R1866, R1854-R1855)

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

B5. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... ALT
HORIZONTAL MODE .... ALT



Test Equipment Controls:
Left Signal Standardizer
Test Selector Switch .... Vert or Horiz Gain
Rep Rate .... 100 kHz

A Signal Standardizer
Test Selector Switch .... Vert or Horiz Gain
Rep Rate .... 100 kHz

Right Time Base
Sweep Rate .... 2 μs/div
Triggering .... Auto, AC, External

B Time Base
Sweep Rate .... 2 μs/div
Triggering .... Auto, AC, External

VOM .... Appropriate range for voltage to be measured.

a. Set the B INTENSITY control for a visible display.

b. Set the FOCUS control to midrange.

c. **ADJUST**—Stigmator adjustment R1894, Focus Preset adjustment R1825 and the front-panel ASTIG control for best overall focus of the crosshatch display.

d. **CHECK**—For crosshatch pattern lines that parallel graticule lines within 0.1 division.

e. **INTERACTION**—Performing the adjustments in the remainder of this procedure (B5) may uncalibrate the vertical and horizontal amplifiers, particularly the crt centering adjustments. It will therefore be necessary to perform procedures E. Horizontal System, and F. Vertical System in this section.

f. Set both signal standardizer Test selector switches to Vert or Horiz Com Mode.

g. Move jumper P1062 (on the A19 Horizontal Amplifier board) to short together the two pins nearer the left side of the 7104.

NOTE

Adjustment and Test Point Locations B shows correct position of P1062 located by dotted lines.

h. **EXAMINE**—The displayed trace should align with the center graticule line typically within 0.8 division.

i. **ADJUST**—Ctr (center) adjustment R1030 (Horizontal board) to position the trace to the graticule *center* line.

j. Return jumper P1062 to the storage pins.

k. **EXAMINE**—The displayed horizontal trace should align with the center graticule line typically within 1.0 division.

l. **ADJUST**—MVA (main vertical amplifier) Center adjustment R740 to position the horizontal trace to the graticule *center* line.

m. Set the TRACE ROTATION control so that the horizontal trace is parallel to the center graticule line.

n. **ADJUST**—Y Alignment (Ortho) adjustment R1888 so that the vertical trace is parallel to the center graticule line.

WARNING

Shock hazard exists while performing parts o through y; VOM elevated to 2.4 kV.

o. Connect the test leads of the VOM, set to measure 200 volts dc, between TP1850 and TP1852.

p. Preset the Vertical Linearity Imbalance adjustment R1854-R1855 so that zero volts is indicated on the VOM.

q. Move the VOM test leads to TP1860 and TP1862.

r. Preset the Vertical Keystone adjustment R1864-R1865 so that zero volts is indicated on the VOM.

s. Move the VOM test leads to TP1870 and TP1872.

t. Preset the Horizontal Linearity adjustment R1874-R1875 so that zero volts is indicated on the VOM.

u. Disconnect the VOM test leads.

v. Mechanically midrange the Horizontal Bowing adjustment R1883, Vertical Linearity adjustment R1853-R1856, Geometry adjustment R1863-R1866, and Horizontal Sensitivity adjustment R1873-R1876.

NOTE

A DVM equipped with a high-impedance probe (at least 1,000 megohms) can be used to preset the adjustments in part w more effectively, using the voltages listed on the label attached to the crt shield.

w. Connect the VOM between TP1813 and ground.

x. **ADJUST**—D1-D2 Shield adjustment R1891 so that the meter reads the voltage listed for TP1813 on the label attached to the crt shield. (If no label, mechanically midrange R1891.)

y. Disconnect the VOM test leads.

z. Set the Test selector switches of both signal standardizers to Vert or Horiz Gain.

aa. Set the B INTENSITY control for a visible crosshatch display.

bb. **ADJUST**—FOCUS and ASTIG controls, and Stigmator adjustment R1894 for best overall focus of the crosshatch pattern.

cc. **ADJUST**—D1-D2 Shield adjustment R1891 for sharply focused outer vertical traces.

NOTE

As this control is adjusted, the top and bottom portions of the vertical traces become more or less focused. This is the control's primary function. Due to interaction effects, the display will also change height and show vertical pin cushion or barrel distortions. These effects are corrected later.

dd. **ADJUST**—Vertical Linearity adjustment R1853-R1856 for best overall vertical linearity (expand crosshatch display until best linearity is achieved).

NOTE

There may be some imbalance (i.e., compression at top and expansion at bottom) which should be averaged out so that the errors are of the same magnitude. As the Vertical Linearity adjustment is adjusted, the display will either shrink and become barreled vertically, or expand and become pin-cushioned vertically. These effects will be corrected later.

ee. **ADJUST**—If any vertical linearity imbalance is observed in previous steps, adjust the Vertical Linearity Imbalance adjustment R1854-R1855 to correct this condition (i.e., place each horizontal line coincident with a graticule line). As this control is adjusted, vertical lines will become keystoned. This effect will be corrected later.

ff. **ADJUST**—Geometry adjustment R1863-R1866 for straight vertical traces (aim for straightness without keystone).

NOTE

As R1863-R1866 is adjusted, the display will also expand or contract horizontally. This effect will be corrected later.

gg. **ADJUST**—If any vertical keystone is present on the display, it should be corrected by adjusting the Vertical Keystone adjustment R1864-R1865.

hh. **ADJUST**—Horizontal Bowing adjustment R1883 to obtain straight horizontal lines at the top and bottom of the crt screen.

NOTE

As this control is adjusted, the display will shrink or expand horizontally. This effect will be compensated for later. The line straightening effect of this control is very slight.

ii. Set the signal standardizer installed in the A HORIZ compartment to Aux In.

jj. Set the HORIZONTAL MODE switch to A. Rotate the A HORIZ signal standardizer Position control to align the trace with the third graticule line from the left side of the crt screen.

kk. With a precision dc voltmeter, measure the differential voltage on the crt horizontal deflection plates. Note this voltage.

ll. Rotate the A HORIZ signal standardizer Position control to align the trace with the eighth graticule line from the left side of the crt screen.

mm. With the precision dc voltmeter, measure the differential voltage on the crt horizontal deflection plates. Note this voltage.

nn. **EXAMINE**—The sum of the absolute voltages measured in parts jj and ll should be 9.4 volts within 0.94 volt (1.88 volts/division of deflection within 10%).

oo. **ADJUST**—Horizontal Sensitivity adjustment R1873-R1876 to obtain a crt horizontal sensitivity that is 1.88 volts/division, within 10% (9.4 volts within 0.94 volt for 5 divisions of deflection).

NOTE

If this adjustment is moved an appreciable amount, it may be necessary to readjust the Geometry adjustment R1863-R1866 to compensate for the slight pin cushion or barrel distortion of the vertical lines. If the crt horizontal sensitivity of 1.88 volts/division within 10% cannot be achieved with the Horizontal Sensitivity adjustment R1873-R1876, it may be corrected by adjusting the Horizontal Bowing adjustment R1883 slightly at the expense of minor horizontal line bowing.

pp. Set the HORIZONTAL MODE switch to ALT.

qq. Set the signal standardizer installed in the A HORIZ compartment to Vert or Horiz Gain.

rr. **ADJUST**—If horizontal nonlinearity or nonuniform bowing of vertical lines is observed on the display, adjust the Horizontal Linearity adjustment R1874-R1875 to correct the nonlinearity.

ss. **ADJUST**—FOCUS control, ASTIG control and Stigmator adjustment R1894 for best overall focus of crosshatch pattern.

tt. **EXAMINE**—Displayed crosshatch pattern should align with the vertical and horizontal graticule lines within 0.1 division everywhere on the graticule.

uu. **ADJUST**—Vert Gain adjustment R830 (on A17 Vertical Amplifier board) and LF Gain adjustment R1062 (on A19 Horizontal Amplifier board) so that the vertical and horizontal traces of the crosshatch display align with the vertical and horizontal graticule lines within 0.1 division.

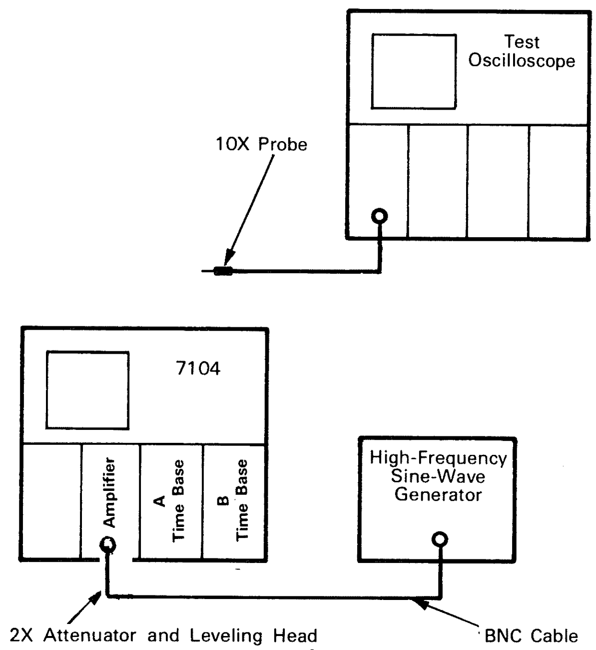
B6. ADJUST AUTO FOCUS (R1622)

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

B6. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... RIGHT
HORIZONTAL MODE .... A



Test Equipment Controls:
Test Oscilloscope
Deflection Factor .... 0.2 V/div
Sweep Rate .... 20 ns/div
Triggering .... Negative slope

High-Frequency Sine-Wave Generator
Frequency .... 250 MHz

A Time Base
7B15
Sweep Rate .... 5 μs/div
Triggering .... Auto, AC, Internal
Magnifier X1
B Delay Mode .... B Triggerable After Dly
Trace Sep .... OFF

B Time Base
7B10
Sweep Rate .... 5 ns/div
Triggering .... Auto, AC, Internal
Magnifier X1

Amplifier
Deflection Factor .... 0.2 V/div
Input Coupling .... DC

a. Connect the high-frequency sine-wave generator to the amplifier input connector.

b. Set the A INTENSITY control as desired.

c. Set the high-frequency sine-wave generator Amplitude control for a 2 division display.

d. Set the HORIZONTAL MODE switch to B.

e. Set both time-base triggering levels for a triggered light.

f. Set the B INTENSITY control for a low-intensity display.

g. Set the FOCUS control and ASTIG adjustment for a well-defined display.

h. Connect the 10X probe from the test oscilloscope to TP1628 on the A21 Z-Axis board.

i. Rotate the amplifier unit Position control to move the displayed waveform off the crt screen.

j. Set the B INTENSITY control fully clockwise.

k. **ADJUST**—The Focus Gain adjustment R1622 for maximum pulse amplitude displayed on the test oscilloscope.

l. **EXAMINE**—The pulse displayed on the test oscilloscope should be at least 6 volts with a pulse leading-edge fall time of 20 nanoseconds or less with less than 25% aberrations.

m. Remove test oscilloscope 10X probe.

n. Set the A HORIZ time-base unit sweep rate to 0.1 millisecond/division.

o. Set the READOUT INTENSITY control for a visible readout display.

p. Set the FOCUS control for optimum focus of the readout display.

q. Rotate the amplifier Position control to move the sine wave to the crt screen center.

r. **EXAMINE**—Rotate the FOCUS control and check that the sine wave and readout displays focus at the same point on the FOCUS control.

s. **ADJUST**—The Focus Gain adjustment R1622 for optimum focus of the displayed sine-wave signal.

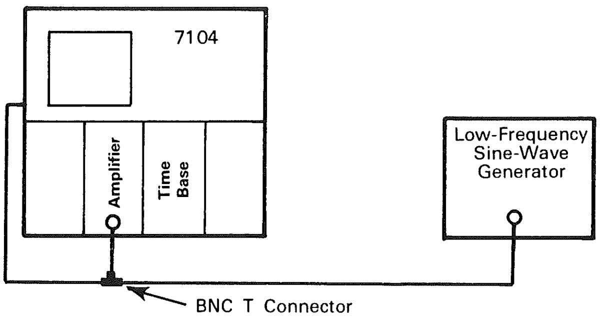
B7. CHECK EXTERNAL Z-AXIS OPERATION

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

B7. SETUP CONDITIONS

7104 Controls:
READOUT INTENSITY .... OFF
HORIZONTAL MODE .... A



Test Equipment Controls:
Amplifier Unit
Deflection Factor .... 0.5 V/div
Time Base
Sweep Rate .... 20 μs/div
Triggering .... Auto, AC, Internal

a. Set the A INTENSITY control for a dim display.

b. Connect the output of the low-frequency sine-wave generator to the amplifier unit input (use a bnc T connector at the amplifier input).

c. Set the low-frequency sine-wave generator for a four-division display at 50 kilohertz (one volt above and below ground).

d. Set the A INTENSITY control for a dim display.

e. Connect the signal from the output of the T connector at the amplifier input to the Z-AXIS INPUT connector on the rear panel.

f. **CHECK**—Positive portion of the displayed waveform is blanked out.

C. CALIBRATOR AND OUTPUT SIGNALS

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

1. Test oscilloscope
4. Time-base unit
8. Precision dc voltmeter (DVM)
10. Time-mark generator
15. Coaxial cable (one 18-inch, two 42-inch required)
17. T connector
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the Test Point and Adjustment Locations C foldout page in Section 8, Diagrams and Circuit Board Illustrations.

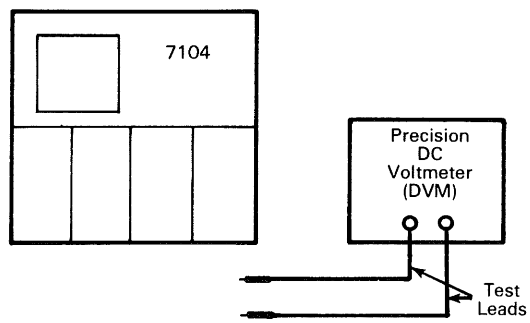
CALIBRATOR AND OUTPUT SIGNALS PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
VERTICAL MODE .... RIGHT
VERT TRACE SEPARATION (B) .... Midrange
A TRIGGER SOURCE .... VERT MODE
A INTENSITY .... Fully counterclockwise
HORIZONTAL MODE .... A
B INTENSITY .... Fully counterclockwise
B TRIGGER SOURCE .... VERT MODE
READOUT INTENSITY .... OFF (in detent)
GRAT ILLUM .... Midrange
BEAMFINDER .... Pushbutton out
CALIBRATOR .... 4 V pushbutton in

C1. CHECK/ADJUST CALIBRATOR OUTPUT VOLTAGE (R385)

C1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Precision DC Voltmeter (DVM)
Voltage Range .... Appropriate range for voltage to be measured.

a. Set both the 4 V and 0.4 V CALIBRATOR push buttons to the depressed position.

b. Connect the precision dc voltmeter to the CALIBRATOR output connector.

c. **CHECK**—Meter reading for 0.4008 volt within the limits of 0.4004 to 0.4012 volt.

d. **ADJUST**—The 0.4 V ADJ adjustment R385 for a meter reading of exactly 0.4008 volt. (Access to adjustment is through the chassis, inside the vertical compartments, near the front of the instrument and under the VERTICAL MODE switch.)

@

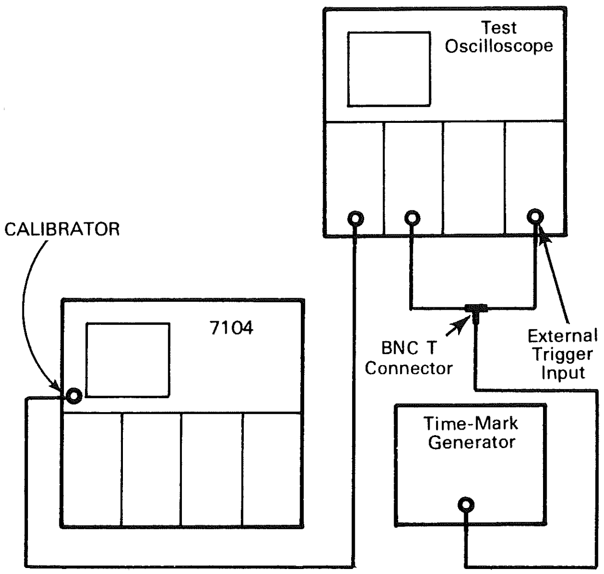
C2. CHECK/ADJUST CALIBRATOR 1 kHz REPETITION RATE (R375)

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

C2. SETUP CONDITIONS

7104 Controls:
CALIBRATOR .... 4 V pushbutton in



Test Equipment Controls:
Time-Mark Generator........................ 1 ms markers

Test Oscilloscope
Triggering .... Auto, AC, External
Input Coupling.......................................DC
Sweep Rate ....1 ms/div
Vertical Mode ....Add

NOTE

A frequency counter with an accuracy of at least 0.1% may be used to adjust the CALIBRATOR repetition rate.

a. Connect 1-millisecond time-markers to the test oscilloscope external trigger input and to the noninverting vertical channel of the test oscilloscope (use a bnc T connector). Connect the 7104 CALIBRATOR output to the inverting input of the test oscilloscope.

b. Set the test oscilloscope triggering level for a stable time-mark display.

c. Set the test oscilloscope vertical deflection factors to display 2 divisions of CALIBRATOR signal and 1 division of time-marker signal.

d. Set the test oscilloscope sweep rate for 0.2 second/division.

e. **CHECK**—The time required for the 1-millisecond time marks to drift from the positive level of the CALIBRATOR signal to the negative level, and back to the positive level must be more than 0.4 second (2 divisions). This time can be measured directly from the display by observing the number of divisions that the markers move across the display area before it returns to the positive level.

f. **ADJUST**—1 kHz adjustment R375 for minimum drift (access to the adjustment is through the chassis, inside the vertical compartment).

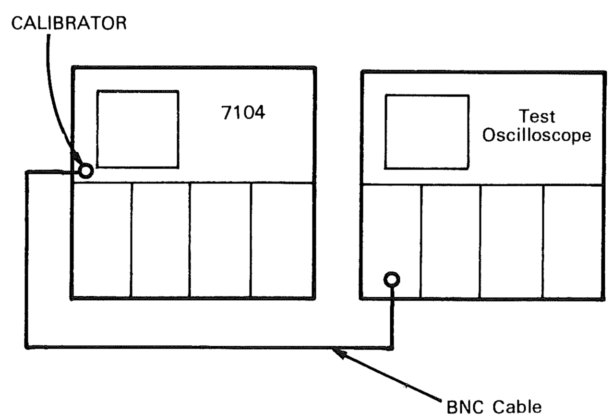
C3. CHECK CALIBRATOR RISE TIME, FALL TIME, AND DUTY CYCLE

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

C3. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Test Oscilloscope
Sweep Rate ....0.1 μs/div
Triggering .... Auto, AC, Internal

a. Connect the CALIBRATOR output to the inverting vertical input of the test oscilloscope.

b. Set the test oscilloscope vertical deflection to display 4 divisions of CALIBRATOR signal.

c. Set the test oscilloscope for a stable display, triggered on the rising portion of the CALIBRATOR signal.

d. **CHECK**—Displayed waveform for not more than 5 divisions horizontally between the 10% to 90% points of the waveform (rise time, 0.5 microsecond or less).

e. Set the test oscilloscope for a stable display triggered on the falling portion of the waveform.

f. **CHECK**—Displayed waveform for not more than 5 divisions between the 90% and 10% points (fall time, 0.5 microsecond or less).

g. Set the test oscilloscope triggering for positive slope and auto mode with ac coupling from the internal source at a sweep rate of 0.1 millisecond/division. Set the triggering controls so that the display starts at the 50% point on the rising edge of the waveform.

h. Set the test oscilloscope sweep magnifier to X10. Then, position the display horizontally so the falling edge of the waveform aligns with the center vertical graticule line.

i. Set the test oscilloscope vertical to invert the display.

NOTE

The display is triggered on the opposite slope, even though the display appears the same.

j. **CHECK**—The 50% point on the falling edge of the waveform now displayed is within 0.2 divisions horizontally of the center line. (Indicates duty cycle of 50% within 0.2%.)

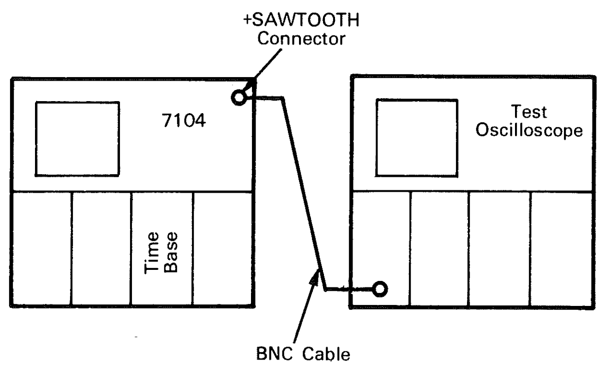
C4. CHECK A AND B SAWTOOTH OUTPUT SIGNALS

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Setting, then proceed with the following instructions.

C4. SETUP CONDITIONS

7104 Controls:
+SAWTOOTH A or B switch .... A



Test Equipment Controls:
Test Oscilloscope
Sweep Rate .... 2 ms/div
Vertical Deflection .... 2 V/div
Vertical Mode .... Channel 1

Time Base
Sweep Rate .... 0.1 ms/div
Triggering .... Auto

a. Connect the +SAWTOOTH output connector to the test oscilloscope channel 1 vertical input (1-megohm input).

b. **CHECK**—That the slope of the test oscilloscope display is 2 volts/division within 10% (10-volt sawtooth for 10 division sweep on 7104 crt screen) and that the sawtooth baseline is within one volt of ground.

c. Move the time-base unit to the B HORIZ compartment.

d. Set the +SAWTOOTH selector switch to the B position.

e. **CHECK**—Test oscilloscope display for 2 volts/division of sweep within 10% (10-volt sawtooth for 10 division sweep on the 7104 crt screen) and that the sawtooth baseline is within one volt of ground.

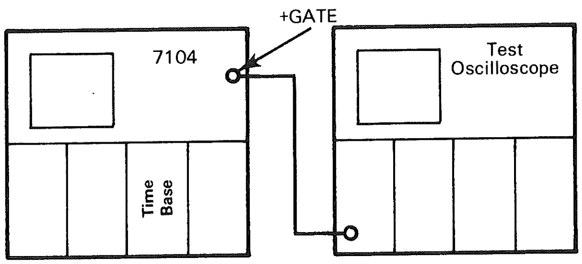
C5. CHECK A AND B GATE OUTPUT SIGNALS

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

C5. SETUP CONDITIONS

7104 Controls:
+GATE A or B Switch .... A



Test Equipment Controls:
Test Oscilloscope
Vertical Deflection Factor .... 2 V/div
Sweep Rate .... 2 ms/div

Time-Base
Mode .... Delaying
Triggering .... Auto, AC, Internal
Sweep Rate .... 0.5 ms/div

a. **CHECK**—Test oscilloscope display for a gate waveform 5 divisions in amplitude, within 10%, and a baseline at zero volts, within one volt.

b. Move the time-base unit to the B HORIZ compartment.

c. Set the +GATE selector switch to the B position.

d. **CHECK**—Test oscilloscope display for a gate waveform 5 divisions in amplitude, within 10%, and a baseline at zero volts, within one volt.

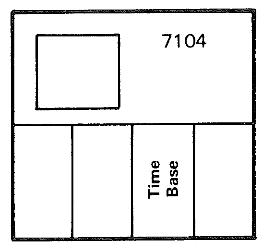
C6. CHECK GRATICULE ILLUMINATION OPERATION

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

C6. SETUP CONDITIONS

7104 Controls:
GRAT ILLUM +GATE or EXT switch.............................+GATE
+GATE A or B switch..A
HORIZONTAL MODE..A



Test Equipment Controls:
Time Base
Sweep Rate..0.2 s
Triggering...............................Auto, AC, Internal

a. **CHECK**—Rotate the GRAT ILLUM control throughout its range and notice that the illumination of the graticule varies.

b. Set the GRAT ILLUM control fully clockwise to the PULSED detent position.

c. Set the A INTENSITY control for a visible display.

d. **CHECK**—Graticule illumination occurs only after the time-base unit has completed a sweep (adjust GRAT ILLUM PRESET, if necessary).

e. Set the GRAT ILLUM +GATE or EXT switch to EXT.

f. **CHECK**—Press the GRAT ILLUM MAN pushbutton and check for one momentary illumination of the graticule.

g. Set the GRAT ILLUM control to midrange (out of the PULSED detent position).

D. TRIGGER SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

1. Test oscilloscope
2 or 3. Amplifier unit
4. Time-base unit (two required)
5. Signal standardizer
6. Plug-In extender (rigid calibration fixture)
15. Coaxial cable (one 18-inch, two 42-inch required)
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the Test Point and Adjustment Locations D foldout page in Section 8, Diagrams and Circuit Board Illustrations.

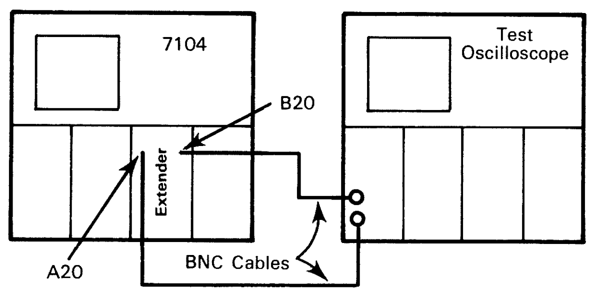
TRIGGER SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch	On
VERTICAL MODE	RIGHT
VERT TRACE SEPARATION (B)	Midrange
A TRIGGER SOURCE	VERT MODE
A INTENSITY	Fully counterclockwise
HORIZONTAL MODE	A
B INTENSITY	Fully counterclockwise
B TRIGGER SOURCE	VERT MODE
FOCUS	Midrange
READOUT INTENSITY	OFF (in detent)
GRAT ILLUM	Midrange
BEAMFINDER	Pushbutton out

D1. ADJUST A TRIGGER SELECTOR CENTERING (R255, R270, R274, AND R279)

D1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Test Oscilloscope
Vertical Deflection

Channel 1	50 mV/div
Input Coupling	Gnd or Off
Channel 2	50 mV/div
Input Coupling	Gnd or Off
Sweep Rate	1 ms/div

a. Within the plug-in extender, disconnect the top connector on the left and right sides (labeled A20 and B20). Connect each female connector to one of the test oscilloscope channels with the 42-inch 50-ohm bnc cables and 50-ohm bnc terminations (omit the 50-ohm bnc terminations if the test oscilloscope has a 50-ohm input impedance).

b. Set the test oscilloscope for differential operation between the two channels (added display mode with one channel inverted).

c. Establish a ground reference level for the test oscilloscope by positioning the trace to the center horizontal line of the graticule. Do not change the test oscilloscope position controls after setting this ground reference.

d. Set both channels of the test oscilloscope for dc input coupling.

e. **EXAMINE**—Check the test oscilloscope display a for dc level within 1 division (50 millivolts) of the ground reference level in the LEFT, RIGHT, and ADD positions of the VERTICAL MODE switch.

f. **ADJUST**—The A DC Center adjustment R255 for a dc level within 1 division (50 millivolts) of the ground reference level in the LEFT, RIGHT, and ADD positions of the VERTICAL MODE switch.

g. Install the signal standardizer in the LEFT VERT compartment.

h. Set the VERTICAL MODE switch to LEFT.

i. Set the signal standardizer Test selector switch to Trigger +Step Resp, and the Rep Rate switch to 1 kHz. Use the signal standardizer Position and Amplitude controls to center a 6 division display on the test oscilloscope. Set the test oscilloscope sweep rate to 0.5 millisecond/division.

j. **EXAMINE**—Test oscilloscope display for less than +3% and -3% aberrations.

k. **ADJUST**—The A Thermal adjustment R270 (on the A14 Trigger Selector board) for optimum square wave displayed on the test oscilloscope.

l. Set the signal standardizer Test selector switch to Trigger Gain and the Rep Rate switch to 1 MHz. Use the signal standardizer Position control to move the bright trace display on the test oscilloscope to the center graticule line.

m. **EXAMINE**—Test oscilloscope display for nine traces with six divisions of vertical deflection between the center seven traces, within 0.6 division (300 millivolts, within 20 millivolts).

n. **ADJUST**—The A Gain adjustment R274 for a test oscilloscope display of six divisions of deflection between the center seven traces, within 0.6 division (300 millivolts, within 30 millivolts).

o. Remove the signal standardizer from the LEFT VERT compartment.

p. Set the test oscilloscope to alternate between channel 1 and channel 2. Re-establish a ground reference for both channels of the test oscilloscope. Then set both channels for dc coupling.

q. **EXAMINE**—Check the test oscilloscope display for a dc level within 1 division (50 millivolts) of the established ground reference.

r. **ADJUST**—The A DC Common Mode adjustment R279 for a dc level within 1 division of ground.

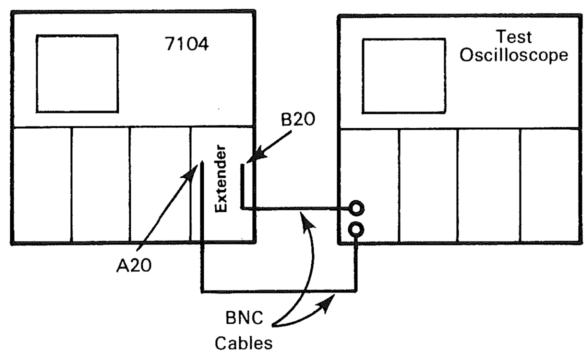
D2. ADJUST B TRIGGER SELECTOR CENTERING AND GAIN (R455, R473, R479)

NOTE

If the preceding step was not performed, first refer to the Trigger System Preliminary Control Settings, then proceed with the following instructions.

D2. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Test Oscilloscope
Vertical Deflection

Channel 1	50 mV/div
Input Coupling	Gnd or Off
Channel 2	50 mV/div
Input Coupling	Gnd or Off
Sweep Rate	1 ms/div

a. Set the test oscilloscope for differential operation between the two channels (added display mode with one channel inverted).

b. Establish a ground reference level for the test oscilloscope by positioning the trace to the center horizontal line of the graticule. Do not change the test oscilloscope position controls after setting this ground reference.

c. Within the plug-in extender, disconnect the top connector on the left and right sides (labeled A20 and B20). Connect each female connector to one of the test oscilloscope channels with the 42-inch 50-ohm bnc cables and 50-ohm bnc terminations (omit the 50-ohm bnc terminations if the test oscilloscope has a 50-ohm input impedance).

d. Set both channels of the test oscilloscope for dc input coupling.

e. **EXAMINE**—Test oscilloscope display for a dc level within 1 division (50 millivolts) of the ground reference level in the LEFT, RIGHT, and ADD positions of the 7104 VERTICAL MODE switch.

f. **ADJUST**—B DC Center adjustment R455 for a dc level within 1 division (50 millivolts) of the ground reference level in the LEFT, RIGHT, and ADD positions of the VERTICAL MODE switch.

g. Install the signal standardizer in the LEFT VERT compartment.

h. Set the VERTICAL MODE switch to LEFT.

i. Set the signal standardizer Test selector switch to Trigger Gain and the Rep Rate switch to 1 MHz. Use the signal standardizer Position control to align the bright trace displayed on the test oscilloscope with the center graticule line.

j. **EXAMINE**—Test oscilloscope display for nine traces with six divisions of vertical deflection between the center seven traces, within 0.6 division (300 millivolts, within 30 millivolts).

k. **ADJUST**—B Gain adjustment R474 for a test oscilloscope display of six divisions of deflection between the center seven traces, within 0.6 division.

l. Remove the signal standardizer from the LEFT VERT compartment.

m. Set the test oscilloscope to alternate between channel 1 and channel 2. Re-establish a ground reference for both channels of the test oscilloscope. Then set both channels for dc coupling.

n. **EXAMINE**—Test oscilloscope display for a dc level within 1 division (50 millivolts) of the established ground reference.

o. **ADJUST**—The B DC Common Mode adjustment R479 for a dc level within 1 division of ground.

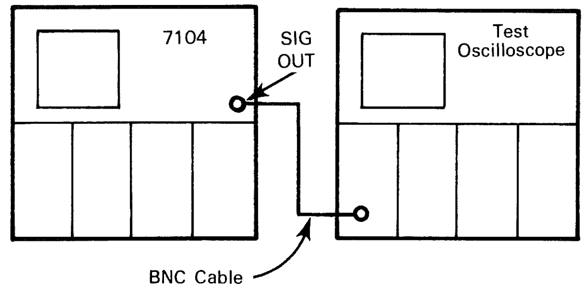
D3. CHECK/ADJUST VERTICAL SIGNAL OUT DC CENTERING (R485, R480, R490)

NOTE

If the preceding step was not performed, first refer to the Trigger System Preliminary Control Settings, then proceed with the following instructions.

D3. SETUP CONDITIONS

7104 Controls:
No change in setting.



Test Equipment Controls:
Test Oscilloscope
Input Coupling .... Gnd or Off
Vertical Deflection .... 1 V/div
Vertical Mode .... Channel 1
Sweep Rate .... 1 ms/div

a. Establish a ground reference for the test oscilloscope by positioning the trace to the graticule center line. Do not change the test oscilloscope position control after setting this ground reference.

b. Connect the front-panel SIG OUT connector to the vertical input of the test oscilloscope with the 42-inch, 50-ohm bnc cable.

c. Set the test oscilloscope input coupling switch to dc.

d. **EXAMINE**—Test oscilloscope display for a dc level within 1 division of the ground reference established in part a.

e. **ADJUST**—Signal Out DC Center adjustment R485 for a dc level within 1 division of the ground reference level.

f. Install the signal standardizer in the LEFT VERT compartment.

g. Set the Test selector switch to Trigger +Step Resp and the Rep Rate switch to 1 kHz.

h. Rotate the signal standardizer Position and Amplitude controls to display a six division triggered signal on the test oscilloscope.

i. **EXAMINE**—The test oscilloscope square-wave display for optimum flat top within 0.1 division.

j. **ADJUST**—The Signal Out Thermal 1 adjustment R480 to optimize the test oscilloscope square-wave display.

k. Set the signal standardizer Rep Rate switch to 10 kHz.

l. Set the test oscilloscope sweep rate to 0.1 millisecond/division.

m. **EXAMINE**—The test oscilloscope square-wave display for a flat top within 0.2 division.

n. **ADJUST**—The Signal Out Thermal 2 adjustment R490 to optimize test oscilloscope square-wave display.

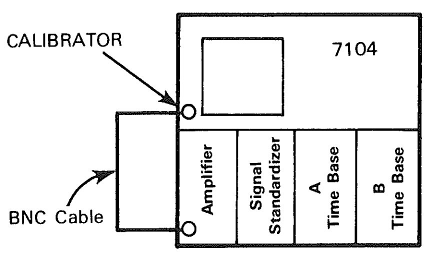
D4. CHECK TRIGGER SELECTOR OPERATION

NOTE

If the preceding step was not performed, first refer to the Trigger System Preliminary Control Settings, then proceed with the following instructions.

D4. SETUP CONDITIONS

7104 Controls:
- VERTICAL MODE .... LEFT
- HORIZONTAL MODE .... A
- A TRIGGER SOURCE .... VERT MODE
- B TRIGGER SOURCE .... VERT MODE



Test Equipment Controls:
- Signal Standardizer
  - Test Selector Switch .... Vert or Horiz +Step Resp
  - Rep Rate .... 10 kHz
- A Time Base
  - Sweep Rate .... 0.2 ms/div
  - Triggering .... Auto, AC, Internal
  - Magnifier X1
  - Mode .... Independent
- B Time Base
  - Sweep Rate .... 0.2 ms/div
  - Triggering .... Auto, AC, Internal
  - Magnifier X1
  - Mode .... Independent

a. Connect the CALIBRATOR 4 V output to the amplifier unit (use 18-inch bnc cable). Set the A INTENSITY control for a visible display. Set the amplifier for a 2 division display in the upper half of the graticule area. Use the A time-base unit trigger level to trigger the display.

b. Set the VERTICAL MODE switch to RIGHT.

c. Set the signal standardizer Amplitude and Position controls for a 2 division display in the lower half of the graticule area.

d. Set the VERTICAL MODE switch to ALT.

e. **CHECK**—For 1 kHz and 10 kHz triggered waveforms (adjust the time-base unit trigger level controls as necessary).

f. Set the VERTICAL MODE switch to ADD.

g. **CHECK**—For a triggered waveform.

h. Set the VERTICAL MODE switch to CHOP.

i. **CHECK**—For a stable display of only the 1 kHz waveform.

j. Set the A TRIGGER SOURCE switch to LEFT VERT.

k. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 1 kHz waveform.

l. Set the A TRIGGER SOURCE switch to RIGHT VERT.

m. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 10 kHz waveform.

n. Set the VERTICAL MODE switch to ALT, the HORIZONTAL MODE switch to B, and the B INTENSITY control for a visible display.

o. **CHECK**—For a 1 kHz and 10 kHz triggered waveforms.

p. Set the VERTICAL MODE switch to ADD.

q. **CHECK**—For a stable display.

r. Set the VERTICAL MODE switch to CHOP.

s. **CHECK**—Crt display for a stable display of only the 1 kHz waveform.

t. Set the B TRIGGER SOURCE switch to LEFT VERT.

u. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 1 kHz waveform.

v. Set the B TRIGGER SOURCE switch to RIGHT VERT.

w. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 10 kHz waveform.

x. Set the VERTICAL MODE switch to ALT, the HORIZONTAL MODE switch to ALT, and the A and B TRIGGER SOURCE switches to VERT MODE.

y. **CHECK**—Vary the time-base units Trigger Level controls; the B HORIZ time-base unit should be triggered on the 1 kHz waveform and the A HORIZ time-base unit should be triggered on the 10 kHz waveform.

E. HORIZONTAL SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

2. Amplifier unit (two required, one with variable delay)
4. Time-base unit
5. Signal standardizer
8. Precision dc voltmeter (DVM)
10. Time-mark generator
11. Low-frequency sine-wave generator
15. Coaxial cable (one 18-inch, two 42-inch required)
17. T connector
19. Low-capacitance screwdriver
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the **Test Point and Adjustment Locations E** foldout page in Section 8, Diagrams and Circuit Board Illustrations.

HORIZONTAL SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
VERTICAL MODE .... RIGHT
VERT TRACE SEPARATION (B) .... Midrange
A TRIGGER SOURCE .... VERT MODE
A INTENSITY .... Fully counterclockwise
HORIZONTAL MODE .... A
B INTENSITY .... Fully counterclockwise
B TRIGGER SOURCE .... VERT MODE
FOCUS .... Midrange
READOUT INTENSITY .... OFF (in detent)
GRAT ILLUM .... As desired
BEAMFINDER .... Pushbutton out
X-Y Z-Axis Selector .... X-Y DC-Controlled Z-Axis (see note below)

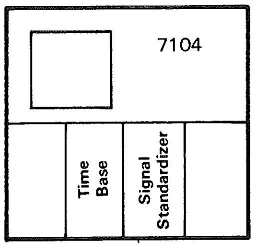
NOTE

The X-Y Z-Axis Selector is an internal switch, located on the Logic board (A13). Refer to Figure 8-29, Test Point and Adjustment Locations E, in section 8 of this manual. When the X-Y Z-Axis Selector is set to the X-Y DC Controlled Z-Axis position, control of the Z-Axis drive signal to the crt is determined by the horizontal plug-in unit selected by the HORIZONTAL MODE switch. When the X-Y Z-Axis Selector is set to the X-Y Time-Base Controlled Z-Axis position (In) and an amplifier unit is installed in one of the horizontal copartments, control of the Z-Axis drive signal to the crt is determined by a time-base unit installed in the other horizontal compartment. Return the X-Y Z-Axis Selector to the X-Y Time-Base Controlled Z-Axis position (In) after performing all or part of the E. Horizontal System procedure.

E1. CHECK/ADJUST HORIZONTAL AMPLIFIER GAIN (R1030, R995, R965, R1062)

E1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Signal Standardizer
Test Selector Switch .... Vert or Horiz Com Mode
Rep Rate .... 1 MHz

Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

a. Set the A INTENSITY control for a visible trace.

b. Move jumper P1062 to short together the two pins nearer to the outside of the 7104.

NOTE

Test Point and Adjustment Locations E (Section 8, Diagrams and Circuit Board Illustrations) illustrates the correct position of P1062 located by dotted lines.

c. **EXAMINE**—The vertical trace should be within 0.5 division of the center vertical graticule line.

d. **ADJUST**—The Ctr adjustment R1030 (on the A19 Horizontal Amplifier board) to align the displayed trace with the center vertical graticule line.

e. Return jumper P1062 to the storage pins.

f. **EXAMINE**—The vertical trace should be within 0.5 division of the center graticule line.

g. **ADJUST**—A Ctr adjustment R995 to align the trace with the center graticule line.

h. Move the signal standardizer to the B HORIZ compartment.

i. Set the HORIZONTAL MODE switch to B.

j. Set the B INTENSITY control for a visible trace.

k. **EXAMINE**—The trace should be within 0.5 division of the center graticule line.

l. **ADJUST**—B Ctr adjustment R965 to align the trace with the center graticule line.

m. Set the signal standardizer Test selector switch to Vert or Horiz Gain and the Rep Rate switch to 1 MHz. Align the bright vertical trace with the center vertical graticule line using the signal standardizer Position control.

n. **CHECK**—For 8 divisions of deflection between the center nine traces within 0.08 division. Note the exact error for comparison in part t.

o. **ADJUST**—The LF Gain adjustment R1062 for exactly 8 divisions of deflection between the center nine traces measured at the second and tenth graticule lines.

p. **INTERACTION**—If R1062 was adjusted in part o, step E2 will have to be performed.

q. **CHECK**—That the other vertical traces align with their respective graticule lines within 0.05 division. (The LF Gain adjustment R1062 should be set for optimum for valid check.)

r. Move the signal standardizer to the A HORIZ compartment.

s. Set the HORIZONTAL MODE switch to A.

t. **CHECK**—For 8 divisions of deflection between the center nine traces within 0.08 division of the error noted in part n. And, that the other vertical traces align with their respective graticule lines within 0.05 divisions. (Specified at the center graticule line.)

u. **ADJUST**—If necessary, compromise the setting of R1062 for optimum gain for both A and B HORIZ compartments. If readjustment is necessary, recheck parts a through o.

v. **INTERACTION**—If R1062 was adjusted in step E1, step E2 will have to be performed.

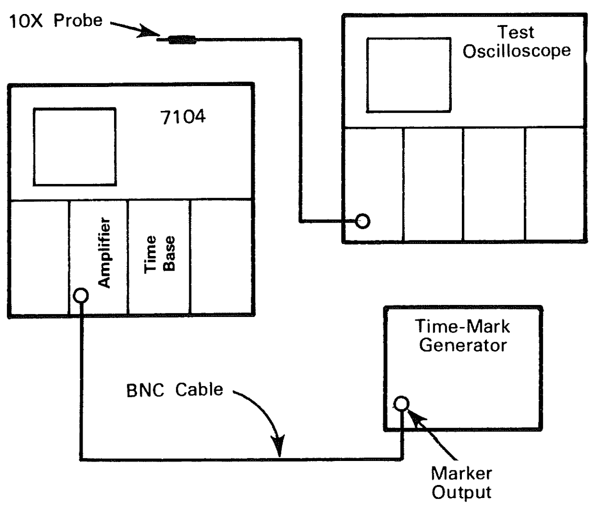
E2. CHECK/ADJUST HIGH-FREQUENCY TIMING (R1005, R1062, R975, R945, R958, R955, R952, R950, R988, R985, R982, R980, R1082, R1073, C1036, C1040, C1060, R1099)

NOTE

If the preceding step was not performed, first refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

E2. SETUP CONDITIONS

7104 Controls:
No change in setting



Test Equipment Controls:

Test Oscilloscope
- Vertical Deflection .... 0.5 V/div
- Sweep Rate .... 5 μs/div
- Input Coupling .... DC
- Triggering .... Auto, AC, Internal

Time Base
- Sweep Rate .... 1 ms/div
- Triggering .... Auto, AC, Internal
- Mode .... Independent

Amplifier
- Deflection Factor .... 0.5 V/div
- Input Coupling .... DC

Time-Mark Generator .... 1 ms markers

a. Connect 1-millisecond markers from the time-mark generator to the amplifier unit input and adjust the amplifier unit deflection factor for about 2 divisions of display. Set the A INTENSITY control for a visible display, if necessary.

b. Set the time-base unit triggering controls for a stable display.

c. Position the first marker to the extreme left line on the graticule.

d. Set the time-base unit sweep calibration control for 1 marker at each major graticule division between the second and tenth graticule lines (center 8 divisions).

e. **CHECK**—Refer to the time-base unit instruction manual for performance check or calibration procedures for checking high-frequency timing and linearity. If the given limits are met, omit the remainder of this step.

NOTE

If the instrument under test contains Option 2, disconnect P984 while performing the remainder of this step.

f. Remove the amplifier and time-base units from the 7104.

g. Install a time-base unit in the RIGHT VERT compartment and a signal standardizer in the A HORIZ compartment.

h. Set the signal standardizer Test selector switch to Vert or Horiz +Step and the Rep Rate to 1 MHz.

i. Set the time-base unit Time/Div switch to 1 millisecond/division, the magnifier to X1, and the triggering for auto mode with ac coupling from the external source.

j. Set the signal standardizer Amplitude and Position controls for a 10 division display centered on the crt.

k. Connect a 10X probe from the test oscilloscope to the horizontal crt Termination R1099 and the probe ground lead to the 7104 chassis.

NOTE

Figure 8-29, Test Point and Adjustment Locations E, in Section 8 (Diagrams and Circuit Board Illustrations) shows correct placement of the 10X probe.

l. Set the test oscilloscope variable gain control for 2 divisions of displayed waveform and set the position control so the bottom of the displayed waveform is aligned with the center graticule line on the test oscilloscope crt.

m. Rotate the signal standardizer Position control counterclockwise to align the right side of the 7104 displayed waveform with the first graticule line on the left side of the crt.

n. **ADJUST**—Clamp adjustment R1005 so that the bottom of the displayed test oscilloscope waveform aligns with the first graticule line below the center graticule line on the test oscilloscope crt.

o. Disconnect the 10X probe.

p. Preset LF Gain adjustment R1062, A LF ADJ adjustment R975, and B LF ADJ adjustment R945 to mechanical midrange. Preset Comp #1, 2, 3, 4, 5, 6, 7 and 8 (adjustments R958, R955, R952, R950, R988, R985, R982, and R980 respectively) fully clockwise.

q. Set the time-base unit Time/Div switch to 0.2 millisecond/division, the magnifier to X10 and the triggering to +Slope, Auto, ac coupling and external.

r. Connect a bnc cable from the signal standardizer Pre Trigger Out connector to the time-base unit External Trigger In connector.

s. Set the signal standardizer Position and Amplitude controls for an 8 division display at a Rep Rate of 10 kHz. (Align the waveform on the second and tenth graticule lines).

t. Set the time-base unit Time/Div switch to 0.5 microsecond/division and the signal standardizer Rep Rate to 1 MHz.

u. **ADJUST**—HF Gain adjustment R1082 so that the displayed pulse is 8 divisions wide at a point 10 nanoseconds from the leading edge.

v. **ADJUST**—SP Damp adjustment R1073 and Delay adjustment C1036 to optimize step response.

w. Set the time-base unit Time/Div switch to 20 nanoseconds/division.

x. Use the time-base unit Position and Trigger Level controls to align the leading edge of the pulse near the second graticule line from the bottom of the crt.

y. **ADJUST**—Comp #9 and #10 adjustments C1040 and LC1060 to optimize the first 2 nanoseconds of the front corner on the displayed pulse.

z. **ADJUST**—HF Gain adjustment R1082 to align the area of the pulse 3 nanoseconds from the front corner with the retrace.

NOTE

For SN B031959 & up, termination wires LR1097 and LR1098 should be dressed for the smallest aberrations, 5 nanoseconds from the front corner.

aa. **ADJUST**—Termination adjustment R1099 to align the area of the pulse 8 nanoseconds from the front corner of the pulse with the retrace.

bb. **INTERACTION**—Adjustments in parts y and z interact. Repeat as necessary.

cc. Set the time-base unit Time/Div switch to 0.5 microsecond/division and the triggering to negative slope. Use the time-base unit Position control to align the front corner of the pulse with the second graticule line from the bottom of the crt.

dd. **ADJUST**—SP Damp adjustment R1073, and Delay adjustment C1036 to optimize the front corner of the displayed pulse.

ee. Set the time-base unit Time/Div switch to 2 microseconds/division.

ff. Set the signal standardizer Position and Amplitude controls so the displayed pulse is exactly 8 divisions in amplitude (align the waveform on the second and tenth graticule lines; use the center horizontal graticule line to set 8 divisions), measured 200 nanoseconds from the front-corner of the pulse (front corner of pulse is right side of displayed waveform lower corner).

NOTE

Care should be taken not to change the signal standardizer Amplitude control throughout the remaining parts of this step.

gg. Set the time-base unit Time/Div switch to 2 millseconds/division, the magnifier to X1, and the signal standardizer Rep Rate to 100 Hz.

NOTE

Adjustments in the remainder of this step are measured and adjusted at the graticules's vertical center by vertically positioning the trace using the time-base unit Position control as needed.

hh. **ADJUST**—A LF ADJ adjustment R975 for exactly 8 divisions at the trailing edges of the displayed pulse (trailing edge of pulse is upper portion of pulse on left and right sides of waveform).

ii. Set the time-base unit Time/Div switch to 1 millisecond/division.

jj. **ADJUST**—Comp #5 adjustment, R988 for 8 divisions of pulse amplitude 0.2 millisecond from the front corner of the pulse.

kk. Set the time-base unit Time/Div switch to 0.1 millisecond/division. Set the signal standardizer Rep Rate to 1 kHz.

ll. **ADJUST**—Comp #6 adjustment R985 for 8 divisions of pulse amplitude 20 microseconds from the front corner of the pulse.

mm. Set the time-base unit Time/Div switch to 10 microseconds/division, and the signal standardizer Rep Rate to 10 kHz.

nn. **ADJUST**—Comp #7 adjustment R982 for 8 divisions of pulse amplitude 2 microseconds from the front corner of the pulse.

oo. Set the time-base unit Time/Div switch to 1 microsecond/division, and the signal standardizer Rep rate to 100 kHz.

pp. **ADJUST**—Comp #8 adjustment R980 for 8 divisions of pulse amplitude 0.2 microsecond from the front corner of the pulse.

qq. Set the time-base unit to internal triggering and the signal standardizer Test selector switch to Vert or Horiz Gain.

rr. **ADJUST**—Align the bright center trace with the center graticule line and set LF Gain adjustment R1062 for 8 divisions of deflection between the center nine traces.

ss. Set the time-base unit magnifier to X10 and the triggering to External. Set the signal standardizer Test selector switch to Vert or Horiz +Step and the Rep Rate to 1 MHz.

tt. **ADJUST**—HF Gain R1082 for a flat top.

uu. Move the signal standardizer to the B HORIZ compartment.

vv. Set the HORIZONTAL MODE switch to B.

NOTE

If the instrument under calibration contains Option 2, disconnect P984 while performing the remainder of this step.

ww. Set the signal standardizer Position and Amplitude controls so the pulse is exactly 8 divisions in amplitude measured 200 nanoseconds from the front corner (align the waveform on the second and tenth graticule lines).

NOTE

Care should be taken not to change the signal standardizer amplitude control throughout the remaining parts of this step.

xx. Set the time-base unit Time/Div switch to 2 milliseconds/division, the magnifier to X1 and the signal standardizer Rep Rate to 100 Hz.

yy. **ADJUST**—B LF ADJ adjustment R945 for exactly 8 divisions of displayed pulse at the trailing edges.

zz. Set the time-base unit sweep rate to 1 millisecond/division.

aaa. **ADJUST**—Comp #1 adjustment R958 for exactly 8 divisions of pulse amplitude 0.2 millisecond from the front corner.

bbb. Set the time-base unit Time/Div to 0.1 milliseconds/division and the signal standardizer Rep Rate to 1 kHz.

ccc. **ADJUST**—Comp #2 adjustment R955 for 8 divisions of amplitude 20 microseconds from the front corner.

ddd. Set the time-base unit sweep rate to 10 microseconds/division and the signal standardizer Rep Rate to 10 kHz.

eee. **ADJUST**—Comp #3 adjustment R952 for 8 divisions of pulse amplitude 2 microseconds from the front corner.

fff. Set the time-base unit Time/Div switch to 1 microsecond/division and the signal standardizer Rep Rate to 100 kHz.

ggg. **ADJUST**—Comp #4 adjustment R950 for 8 divisions of pulse amplitude 0.2 microsecond from the front corner.

hhh. **INTERACTION**—The adjustments in this step interact; repeat part e of this step.

NOTE

If the instrument under calibration contains Option 2 reconnect P984.

E3. CHECK/ADJUST X-Y COMPENSATION (OPTION 2 ONLY) (R1105, R1120, R1110, R1113, R1112, C1114, R1114, R1156)

NOTE

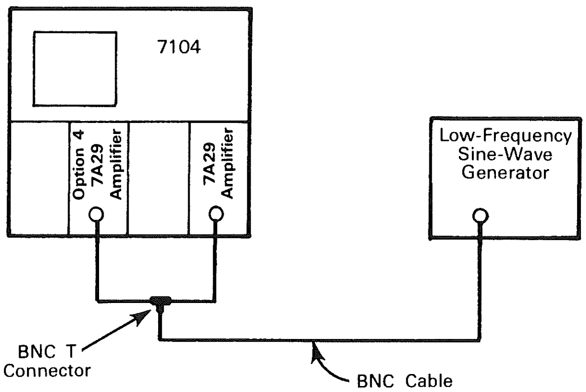
If the instrument under test does not contain Option 2, omit this step.

NOTE

If the preceding step was not performed, refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

E3. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE .... B



Test Equipment Controls:
7A29 Amplifier Option 4
Deflection Factor .... 0.1 V/div
Input Coupling .... DC
Polarity .... + UP

7A29 Amplifier
Deflection Factor .... 0.1 V/div
Input Coupling .... DC
Polarity .... + UP

a. Set the low-frequency sine-wave generator for eight divisions of vertical and horizontal deflection at 25 megahertz.

b. Set the variable delay control on the 7A29 Option 4 Amplifier unit to minimize the separation on the Lissajous display.

c. Set the low-frequency sine-wave generator to 50 megahertz.

d. **CHECK**—Crt Lissajous display for a separation of 0.28 division or less (indicates 2 degrees or less phase shift).

NOTE

If the specification in part d is met, omit the remainder of this step.

e. Remove the cables and the 7A29 Amplifier units from the RIGHT VERT and B HORIZ compartments.

f. Install a signal standardizer in the B HORIZ compartment.

g. Set the signal standardizer Test selector switch to Vert or Horiz Com Mode.

h. Install a time-base unit in the RIGHT VERT compartment.

i. Set the time-base unit Time/Div switch to 1 millisecond/division, the magnifier to X1, and the triggering to auto with ac coupling from the internal source.

j. **ADJUST**—Ctr adjustment R1105 (on the A28 X-Y Delay Compensation board) so that disconnecting and reconnecting P984 produces no trace shift.

k. Set the signal standardizer Test selector switch to Vert or Horiz Gain and use the Position control to align the bright center trace with the center graticule line.

l. **EXAMINE**—The second and tenth vertical traces should align with the second and tenth graticule lines within 0.08 division.

m. **ADJUST**—Gain adjustment R1120 so that the second and tenth vertical traces align with the second and tenth graticule lines.

n. Set the signal standardizer Test selector switch to Vert or Horiz +Step.

o. Set the signal standardizer Amplitude and Position controls for an 8 division display centered on the crt at a Rep Rate of 10 kHz.

p. Connect the signal standardizer Pretrigger Out connector to the time-base unit External Trigger In connector.

q. Set the time-base unit Time/Div switch to 20 microseconds/division and the triggering to +Slope, Auto, AC and External.

r. **ADJUST**—Comp #1 adjustment R1110 to optimize the front corner of the displayed pulse.

s. Set the time-base unit sweep rate to 2 microsecond/division.

t. Set the signal standardizer Rep Rate to 100 kHz.

u. **ADJUST**—Comp #2 adjustment R1113 to optimize the front corner of the displayed pulse.

v. Set the time-base unit magnifier to X10, and the signal standardizer Rep Rate to 1 MHz.

w. **ADJUST**—Comp #3 adjustment R1112 to optimize the front corner of the displayed pulse.

x. Set the time-base unit sweep rate to 0.1 microsecond/division.

y. **ADJUST**—Comp #4 adjustment C1114, and Comp #5 adjustment R1114 to optimize the front corner of the displayed pulse.

z. Set the time-base unit Time/Div switch to 20 nanoseconds/division.

aa. **ADJUST**—Comp #6 adjustment R1156 to optimize the displayed pulse.

bb. **INTERACTION**—Adjustments in parts q through aa interact; repeat as necessary.

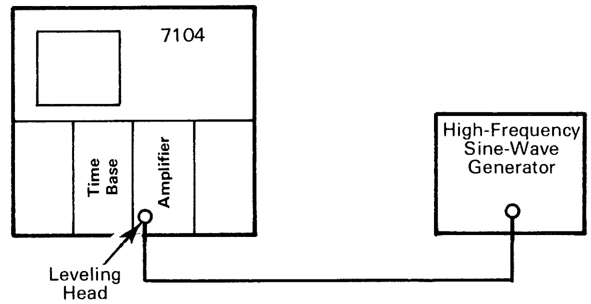
E4. CHECK HORIZONTAL BANDWIDTH

NOTE

If the preceding step was not performed, refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

E4. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE .... A



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, External

Amplifier
Deflection Factor .... 50 mV
Input Coupling .... DC

a. Set the high-frequency sine-wave generator for 8 divisions of displayed signal on the 7104 crt at the generator's reference frequency (6 MHz).

b. Set the high-frequency sine-wave generator output frequency to 350 megahertz.

c. **CHECK**—Displayed 350 MHz amplitude is at least 5.7 divisions.

F. VERTICAL SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

2. Amplifier unit
4. Time-base unit (two required)
5. Signal standardizer
11. Low-frequency sine-wave generator
12. High-frequency sine-wave generator
16. 2X attenuator
19. Low-capacitance screwdriver
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the Test Point and Adjustment Locations F foldout page in Section 8, Diagrams and Circuit Board Illustrations.

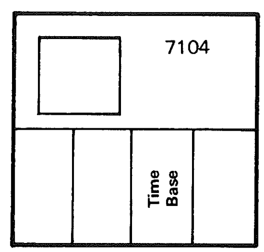
VERTICAL SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
VERTICAL MODE .... RIGHT
VERT TRACE SEPARATION (B) .... Midrange
A TRIGGER SOURCE .... VERT MODE
A INTENSITY .... Midrange
HORIZONTAL MODE .... A
B INTENSITY .... Midrange
B TRIGGER SOURCE .... VERT MODE
FOCUS .... Midrange
READOUT INTENSITY .... OFF (in detent)
GRAT ILLUM .... As desired
BEAMFINDER .... Pushbutton out

F1. ADJUST VERTICAL AMPLIFIER CENTERING (R740, R535)

F1. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... ALT



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

a. Set the A INTENSITY control as desired.

b. **EXAMINE**—The vertical position of the alternating traces (might appear as a single trace). They should be within 0.5 division of the graticule center line.

c. Set the VERTICAL MODE switch to LEFT.

d. **ADJUST**—MVA Center adjustment R740 (on the A17 Vertical Amplifier board) to align the trace with the center graticule line.

e. Set the VERTICAL MODE switch to RIGHT.

f. **ADJUST**—Right Ctr adjustment R535 (on the A16 Vertical Channel Switch board) to align the trace with the center graticule line.

f. **CHECK**—For one trace per graticule division within 0.06 division of the error noted in part b, over the center 6 graticule divisions.

g. **ADJUST**—If necessary, compromise the setting of Vert Gain adjustment R830 for optimum gain for both LEFT and RIGHT compartments.

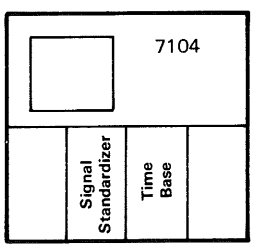
F2. CHECK/ADJUST VERTICAL AMPLIFIER GAIN (R830)

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F2. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, External

Signal Standardizer
Test Selector Switch .... Vert or Horiz Gain
Rep Rate .... 100 kHz

a. Position the signal standardizer display to align the bright center trace with the graticule center line.

b. **CHECK**—For one trace per graticule division within 0.06 division over the center 6 graticule divisions. Note the exact error for comparison in part f.

c. **ADJUST**—Vert Gain adjustment R830 for one division between each of the center 7 displayed traces, within 0.01 division.

d. Remove the signal standardizer from the RIGHT VERT compartment and install it in the LEFT VERT compartment.

e. Set the VERTICAL MODE switch to LEFT.

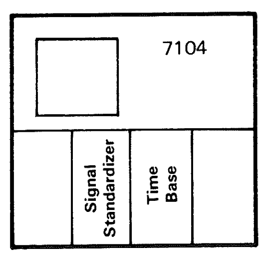
F3. CHECK VERTICAL LOW-FREQUENCY LINEARITY

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F3. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

Signal Standardizer
Test Selector Switch .... Vert or Horiz +Step Resp
Rep Rate .... 1 kHz

a. Set the signal standardizer Amplitude and Position controls so the display is exactly two divisions in amplitude in the center of the graticule area.

b. **CHECK**—Position the two-division display vertically and check for not more than 0.1 division of compression or expansion anywhere within the graticule area.

c. **ADJUST**—If the specification of part b was not met, perform steps F1, F2, F4, and F5.

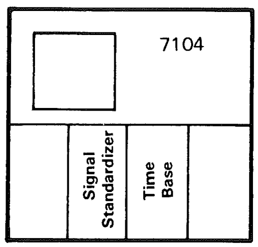
F4. ADJUST THERMAL COMPENSATIONS (C808, R785, R801, R836, R795, R806, R791, R787)

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F4. SETUP CONDITIONS

7104 Controls:
A TRIGGER SOURCE .... RIGHT VERT



Test Equipment Controls:
Time Base
Sweep Rate .... 10 μs/div
Triggering .... Auto, AC, Internal

Signal Standardizer
Test Selector Switch .... Vert or Horiz +Step Resp
Rep Rate .... 100 kHz

a. Set the signal standardizer Position and Amplitude controls for an 8 division display centered on the crt.

b. Set the VERTICAL MODE switch to CHOP.

c. Set the READOUT INTENSITY control for a visible readout display.

d. **EXAMINE**—Readout display for less than 0.05 divisions of jitter and 0.05 divisions of deviation in the center displayed trace using the time-base sweep rates and signal standardizer rep rates given in Table 5-5.

e. **ADJUST**—Thermal Compensation adjustments as given in Table 5-5 for minimum Readout display jitter and minimum deviation of the displayed center trace.

f. **INTERACTION**—The adjustment listed in Table 5-5 may interact with step F2, F3, F4, and F5; repeat as necessary.

TABLE 5-5
Vertical Compensation Adjustments
(Signal Rep Rate vs. Sweep Rate)

Adjustment	Signal Standardizer Rep Rate	Sweep Rate
Comp #1 (R785), Comp #7 (C808)	1 MHz	1 μs
Comp #8 (R836)	100 kHz	10 μs
Comp #5 (R801)	100 kHz	10 μs
Comp #4 (R795)	10 kHz	0.1 ms
Comp #3 (R791)	1 kHz	1 ms
Comp #6 (R806)	100 Hz	10 ms
Comp #2 (R787)	10 Hz	50 ms

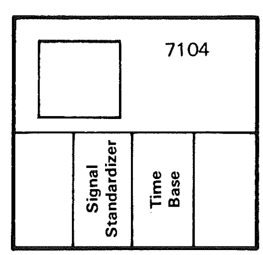
F5. ADJUST VERTICAL LOW-FREQUENCY COMPENSATION (C538, R530, R525, R520, R515, R512, C638, R630, R625, R620, R615, R612, C705)

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F5. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... RIGHT VERT
A TRIGGER SOURCE .... VERT MODE



Test Equipment Controls:
Time Base
Sweep Rate .... 2 μs/div
Triggering .... Auto, AC, Internal

Signal Standardizer
Test Selector Switch .... Vert or Horiz +Step Resp
Rep Rate .... 100 kHz

a. Set the signal standardizer Amplitude control for a 6-division display.

b. Set the time-base unit triggering and position controls for a stable display.

c. **EXAMINE**—Displayed pulse for optimum flat top within 0.06 division with the signal standardizer Rep Rate and time-base unit sweep rates given in Table 5-6A.

TABLE 5-6A
Low-Frequency Compensation
(Signal Rep Rate vs. Sweep Rate)

Adjustment	Signal Standardizer Rep Rate	Sweep Rate
Comp #14 (C538), Comp #13 (R530)	100 kHz	2.0 μs
Comp #12 (R525)	10 kHz	20.0 μs
Comp #11 (R520)	1 kHz	0.2 ms
Comp #10 (R515)	100 Hz	2.0 ms
Comp #9 (R512)	10 Hz	20.0 ms

TABLE 5-6B
Low-Frequency Compensation
(Signal Rep Rate vs. Sweep Rate)

Adjustment	Signal Standardizer Rep Rate	Sweep Rate
Comp #20 (C638), Comp #19 (R630)	100 kHz	2.0 μs
Comp #18 (R625)	10 kHz	20 μs
Comp #17 (R620)	1 kHz	0.2 ms
Comp #16 (R615)	100 Hz	2.0 ms
Comp #15 (R612)	10 Hz	20.0 ms

d. **ADJUST**—Compensation adjustments #14, #13, #12, #11, #10 and #9 (on the A16 Vertical Channel Switch board) as given in Table 5-6A for optimum flat top on the displayed waveform.

e. Move the signal standardizer to the LEFT VERT compartment.

f. Set the VERTICAL MODE switch to LEFT VERT.

g. Set the signal standardizer Rep Rate switch to 100 kHz. Set the Amplitude and Position controls for a six-division display, centered on the graticule area.

h. **EXAMINE**—Displayed pulse for optimum flat top within 0.06 division with the signal standardizer Rep Rate and the time-base unit sweep rates given in Table 5-6B.

i. **ADJUST**—Compensation adjustments #20, #19, #18, #17, #16, and #15 as given in Table 5-6B for optimum flat top on the displayed waveform.

j. Set the signal standardizer Test selector switch to Vert or Horiz +Step Resp and the Rep Rate to 1 MHz.

k. Set the time-base unit for a sweep rate of 2.0 nanoseconds/division. Set the triggering controls for a stable display triggered on the rising portion of the pulse.

l. **EXAMINE**—For optimum square corner and flat top on the displayed pulse within the following limits: Aberrations in the first 5 nanoseconds after the 50% point of the step should not exceed 0.3 division peak-to-peak. Aberrations from 5 to 10 nanoseconds after the 50% point of the step should not exceed 0.18 division peak-to-peak. Aberrations after 10 nanoseconds of the 50% point of the step should not exceed 0.06 divisions peak-to-peak except to allow 0.12 division of aberrations for delay-line termination at about 105 nanoseconds from the step. Rise time of the pulse should be 350 picoseconds between the 10% and 90% points.

m. **ADJUST**—High-frequency Comp #21 adjustment C705 for optimum rise time (less than 350 picoseconds) and flat top with minimum aberrations within the limits given in part l. Use the low-capacitance screwdriver to adjust the variable capacitors. Repeat the complete adjustment procedure as necessary to obtain optimum step response.

n. **INTERACTION**—Adjustments in step F5 interact with steps F2, F3, and F4; repeat as necessary.

o. Move the signal standardizer to the RIGHT VERT compartment and set the VERTICAL MODE switch to RIGHT.

p. **ADJUST**—If necessary, compromise the high-frequency Comp #21 adjustment C705 for optimum pulse response for both vertical compartments.

q. **EXAMINE**—For optimum square corner and flat top on the displayed pulse with aberrations within the limits given in part l.

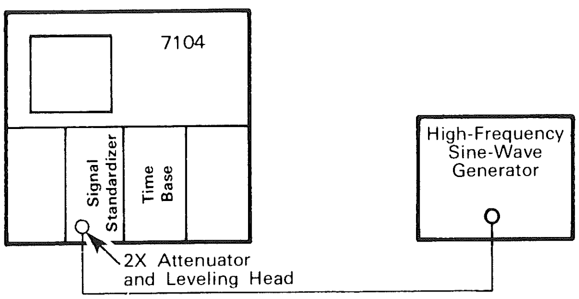
F6. CHECK VERTICAL AMPLIFIER 1 GHz GAIN (0° TO 35°C)

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F6. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate .... 0.1 ms/div
Triggering .... Auto, AC, External

Signal Standardizer
Test Selector Switch .... Vert or Horiz Freq Resp

High-Frequency Sine-Wave Generator
Reference Frequency .... 6 MHz

a. Set the signal standardizer Amplitude control fully clockwise.

b. Connect the high-frequency sine-wave generator to the signal standardizer Aux In-Cw In (Freq Resp) input with a 2X attenuator.

c. Set the high-frequency sine-wave generator for a 10-division display at the reference frequency (between 6 and 50 megahertz) centered on the graticule. (To obtain a 10-division display first set for 8 divisions, then vertically position the display 1 division down and set the sine-wave generator to return the top of the display to the top of the graticule.)

d. Set the signal standardizer Amplitude control for a 6-division display, centered on the graticule. (The CW Leveled indicator should be lit.)

e. Without changing the output amplitude, increase the generator frequency until the displayed amplitude is reduced to 5 divisions. If the CW Leveled indicator extinguishes, increase the amplitude of the sine-wave generator signal until the light just turns on.

NOTE

The signal standardizer CW Leveled light must be on and the sine-wave generator must be properly connected for a valid check. Refer to the signal standardizer and high-frequency sine-wave generator manuals.

f. **CHECK**—Sine-wave generator frequency is 1 gigahertz or higher (verifies 1 gigahertz gain).

g. Move the signal standardizer to the LEFT VERT compartment (leave signal connected) and set the VERTICAL MODE switch to LEFT.

h. **CHECK**—Repeat parts d through f for the LEFT VERT compartment.

i. **ADJUST**—If the specifications of steps f or h were not met, perform steps F1, F2, F3, F4, and F5.

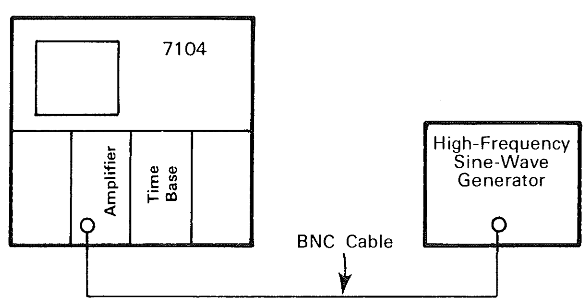
F7. CHECK VERTICAL CHANNEL ISOLATION

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F7. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

Amplifier
Input Coupling .... DC

High-Frequency Sine-Wave Generator .... 1 GHz

a. Connect the output of the high-frequency sine-wave generator to the Amplifier unit input.

b. Set the output of the high-frequency sine-wave generator and the amplifier unit deflection factor for 8 divisions of deflection at 1 gigahertz.

c. Set the VERTICAL MODE switch to LEFT.

d. **CHECK**—Crt display amplitude for 0.1 division or less of the 1 gigahertz signal (verifies isolation at least 80:1 at 1 gigahertz).

e. Move the amplifier unit to the LEFT VERT compartment without disturbing the set-up.

f. Set the VERTICAL MODE switch to RIGHT.

g. **CHECK**—Crt display amplitude for 0.1 division or less of the 1 gigahertz signal (verifies isolation at least 80:1 at 1 gigahertz).

h. Set the VERTICAL MODE switch to LEFT.

i. Connect the low-frequency sine-wave generator to the amplifier unit input.

j. Set the low-frequency sine-wave generator for 8 divisions of deflection at 100 megahertz.

k. Set the VERTICAL MODE switch to RIGHT.

l. **CHECK**—Crt display amplitude for 0.05 division or less of 100 megahertz signal (verifies 100 megahertz isolation of at least 160:1).

m. Move the amplifier unit to the RIGHT VERT compartment without disturbing the set-up.

n. Set the VERTICAL MODE switch to LEFT.

o. **CHECK**—Crt display amplitude for 0.05 division or less of 100 megahertz signal (verifies isolation of at least 160:1 from dc to 100 megahertz).

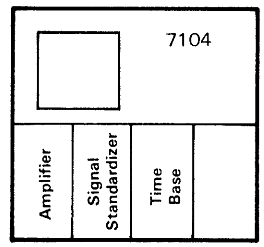
F8. CHECK VERTICAL DISPLAY MODES

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F8. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE .... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

Amplifier
Deflection Factor .... 0.1 V/div
Input Coupling .... DC

Signal Standardizer
Test Selector Switch .... Vert or Horiz Aux In

a. Position the trace to the upper half of the graticule area with the right-vertical unit position control.

b. Set the VERTICAL MODE switch to LEFT and position the trace to the lower half of the graticule area with the left-vertical unit position control.

c. **CHECK**—Crt display for two traces in the ALT and CHOP positions of the VERTICAL MODE switch.

d. Set the VERTICAL MODE switch to ADD.

e. **CHECK**—Crt display for a single trace that can be positioned vertically with either left or right vertical-unit position controls.

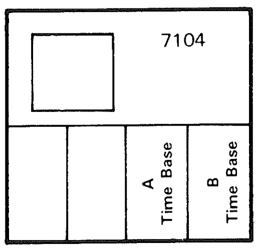
F9. CHECK VERTICAL TRACE SEPARATION OPERATION

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F9. SETUP CONDITIONS

7104 Controls:
- HORIZONTAL MODE .... CHOP
- VERTICAL MODE .... ADD



Test Equipment Controls:
- A Time Base
  - Sweep Rate .... 1 ms/div
  - Triggering .... Auto, AC, Internal
- B Time Base
  - Sweep Rate .... 1 ms/div
  - Triggering .... Auto, AC, Internal

a. **CHECK**—Rotate the VERT TRACE SEPARATION (B) control throughout its range and check that the trace produced by the B time-base unit can be positioned above and below the trace produced by the A time-base unit by at least 3.5 divisions. Repeat with the HORIZONTAL MODE switch set to ALT.

G. READOUT SYSTEM
SN B053266 & Below

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

3. Amplifier unit (dual trace)
4. Time-base unit
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the **Test Point and Adjustment Locations G** foldout page in Section 8, Diagrams and Circuit Board Illustrations.

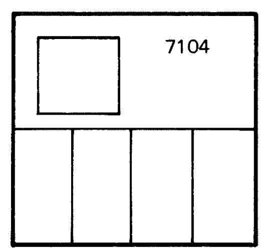
READOUT SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch	On
VERTICAL MODE	RIGHT
VERT TRACE SEPARATION (B)	Midrange
A TRIGGER SOURCE	VERT MODE
A INTENSITY	Midrange
HORIZONTAL MODE	A
B TRIGGER SOURCE	VERT MODE
B INTENSITY	Midrange
READOUT INTENSITY	OFF (in detent)
GRAT ILLUM	Midrange
BEAMFINDER	Pushbutton out
Readout Selector Switch	Free Run (see Test Point and Adjustment Locations G.)

G1. ADJUST READOUT VERTICAL SEPARATION, CENTERING AND CHARACTER HEIGHT (R2291, R701, R2273, R1025, R1035)

G1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
No equipment necessary.

a. Set the POWER switch to OFF.

b. Remove Q2225 from its socket on the Readout System board A15.

c. Set the POWER switch to on.

d. Set the READOUT INTENSITY control for visible characters (all zeros).

NOTE

The following tolerances are provided as guides to correct instrument operation and are not instrument specifications.

e. **EXAMINE**—The crt display for two rows of zeros, 40 zeros to a row with no character overlap. The two rows of zeros should be located vertically in the middle of the top and bottom divisions of the graticule (see Fig. 5-2).

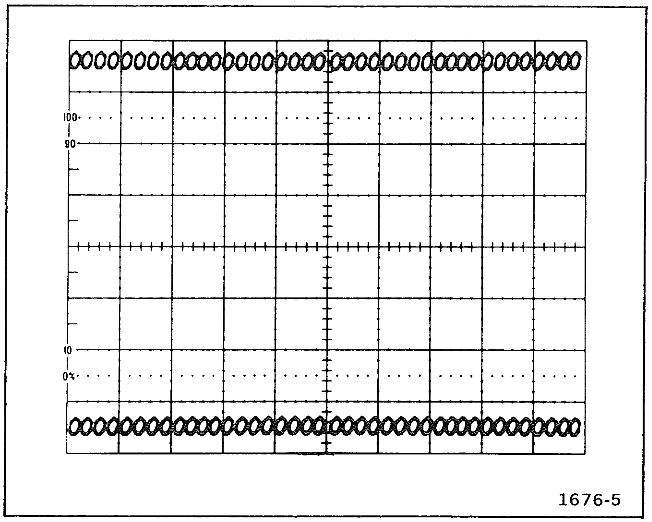


Figure 5-2. Readout display with Q2225 removed.

NOTE

The MVA (Main Vertical Amplifier) Center Adjustment R740 must be correct before making the next adjustment. Refer to F. Vertical System procedure.

f. **ADJUST**—Vertical Separation adjustment R229l, and R/O Center adjustment R701 to position the two rows of readout characters to the middle of the top and bottom divisions of the graticule. Set Character Height adjustment R2273 as desired.

g. **EXAMINE**—Display for two rows of zeros, 40 zeros to each row with no character overlap. Total length of each row of characters is between 9.5 and 10 divisions.

h. **ADJUST**—RO Ctr adjustment R1025 and RO Gain R1035 to horizontally center the zeros display and so that the length of each row of characters is between 9.5 divisions and 10 divisions.

i. Set the POWER switch to OFF and replace Q2225 in its socket.

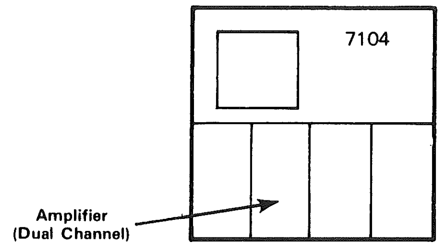
G2. ADJUST FULL CHARACTER SCAN (R2128)

NOTE

If the preceding step was not performed, first refer to the Readout System Preliminary Control Settings, then proceed with the following instructions.

G2. SETUP CONDITIONS

7104 Controls:
POWER .... On
VERTICAL MODE .... RIGHT



Test Equipment Controls:
Amplifier Unit
Deflection Factors .... 50 mV/div
Display Mode .... Dual trace

a. **EXAMINE**—The displayed characters for completeness without overscanning; overscanning causes a bright dot where traces overlap.

b. **ADJUST**—Scan adjustment R2128 for fully scanned characters without overscanning. The m and the 5 will show the most change.

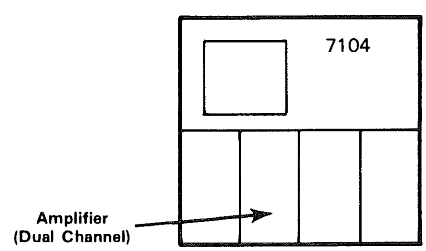
G3. ADJUST COLUMN AND ROW MATCH (R2214, R2183)

NOTE

If the preceding step was not performed, first refer to the Readout System Preliminary Control Settings, then proceed with the following instructions.

G3. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Amplifier
Display Mode .... Dual trace

a. Press and hold one of the amplifier unit trace-identify buttons.

b. **EXAMINE**—The readout display for correct indication of "IDENTIFY." If the readout display is incorrect, adjustment is required.

c. **ADJUST**—Column Match adjustment R2214, and Row Match adjustment R2183, for correct readout of "IDENTIFY." Set these adjustments to the center of the adjustment range which provides correct readout indication. Release the amplifier unit trace-identify button.

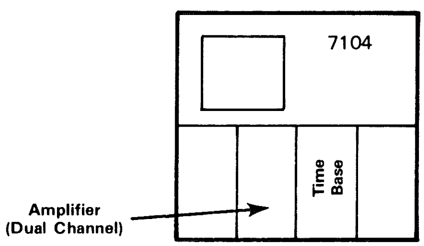
G4. CHECK READOUT MODES

NOTE

If the preceding step was not performed, first refer to the Readout System Preliminary Control Settings, then proceed with the following instructions.

G4. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE .... A



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

a. Set the READOUT INTENSITY control for a visible display.

b. **CHECK**—Set the time-base unit to several sweep rates throughout the time/division switch range and check that the readout characters are displayed independently of the sweep.

c. Set the READOUT +GATE or EXT switch to +GATE and the READOUT INTENSITY control to PULSED.

d. Set the +GATE mode switch to A.

e. Set the READOUT PRESET control for a visible readout display.

f. Set the time-base unit for a free-running (not triggered) sweep at a rate of 0.2 second/division.

g. **CHECK**—The readout characters are blanked out while the sweep is running, and are displayed immediately after the end of the sweep; each character encoded by the plug-in units is displayed only once for each sweep.

h. Set the READOUT +GATE or EXT switch to EXT.

i. **CHECK**—Press the READOUT MAN pushbutton and notice that one frame of readout is displayed.

G. READOUT SYSTEM
SN B053267 & Above

Equipment Required: (Numbers correspond to those in Table 5-3, Test Equipment.)

1. Test oscilloscope
3. Amplifier unit (dual trace)
4. Time-base unit
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-up Sequence.

(2) Refer to Section 6, Instrument Options, and other Change Information at the rear of the manual for any modifications which may affect this procedure.

(3) See the Test Point and Adjustment Locations G fold-out page in Section 8, Diagrams and Circuit Board Illustrations.

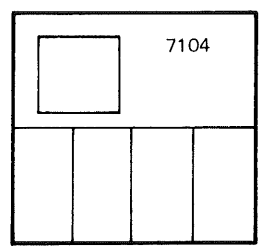
READOUT SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
VERTICAL MODE.......................... RIGHT
VERT TRACE SEPARATION (B) .... Midrange
A TRIGGER SOURCE .... VERT MODE
A INTENSITY .... Midrange
HORIZONTAL MODE.......................... A
B TRIGGER SOURCE .... VERT MODE
B INTENSITY .... Midrange
READOUT INTENSITY.............. OFF (in detent)
GRAT ILLUM .... Midrange
BEAMFINDER.................... Pushbutton out
Readout Mode Plug (P2112)... Free Run - pins 1 and 2

G1. ADJUST READOUT VERTICAL SEPARATION, CENTERING, AND VERTICAL SIZE (R2260, R701, R2210, R1025, R1035)

G1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
No equipment necessary.

a. Set the POWER switch to OFF.

b. Move plug P2184 to connect pins 2 and 3 (the arrow etched on the circuit board indicates pin 1).

c. Set the POWER switch to ON.

d. Set the READOUT INTENSITY control for visible characters (all zeros).

NOTE

The following tolerances are provided as guides to correct instrument operation and are not instrument specifications.

e. **EXAMINE**—The crt display for two rows of zeros, 40 zeros to a row with no character distortion. The two rows of zeros should be located vertically in the middle of the top and bottom divisions of the graticule.

NOTE

The MVA (Main Vertical Amplifier) Center Adjustment R740 must be correct before making the next adjustment. Refer to F. Vertical System procedure.

f. **ADJUST**—Vertical Separation adjustment R2260 and RO Center adjustment R701 to position the two rows of readout characters to the middle of the top and bottom divisions of the graticule. Set character Vertical Size R2210 as desired.

g. **EXAMINE**—Display for two rows of zeros, 40 zeros to each row. Total length of each row is between 9.5 and 10 divisions.

h. **ADJUST**—RO Ctr adjustment R1025 and RO Gain R1035 to horizontally center the zeros display and so that the length of each row of characters is between 9.5 and 10 divisions.

i. Set the POWER switch to OFF and move P2184 to connect pins 1 and 2.

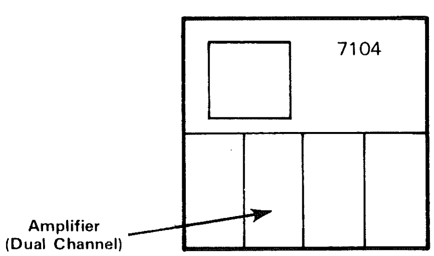
G2. ADJUST CHARACTER GENERATOR CLOCK (C2155)

NOTE

If the preceding step was not performed, first refer to the Readout System Preliminary Control Settings, then proceed with the following instructions.

G2. SETUP CONDITIONS

7104 Controls:
POWER .... On
VERTICAL MODE .... RIGHT



Test Equipment Controls:
Amplifier Unit
Deflection Factors .... 50 mV/div
Display Mode .... Dual trace

a. Connect test oscilloscope Channel 1 to pin 12 of U2202.

b. Set the test oscilloscope time base sweep rate for 5 μS/div, negative triggers.

c. Set the test oscilloscope amplifier unit Trigger Source to CH 1 and connect Channel 2 to pin 13 of U2202.

d. **ADJUST**—C2155 for seventeen positive pulses in ten divisions on the test oscilloscope.

e. Disconnect the test oscilloscope from U2202.

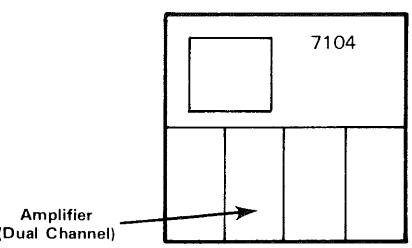
G3. ADJUST COLUMN AND ROW MATCH (R2243, R2184)

NOTE

If the preceding step was not performed, first refer to the Readout System Preliminary Control Settings, then proceed with the following instructions.

G3. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Amplifier
Display Mode .... Dual trace

a. Press and hold one of the amplifier unit trace-identify buttons.

b. **EXAMINE**—The readout display for correct indication of IDENTIFY. If the readout display is incorrect, adjustment is required.

c. **ADJUST**—Column Match R2243 and Row Match R2184 for correct readout of *IDENTIFY*. Set these adjustments to the center of the adjustment range which provides correct readout indication. Release the amplifier unit trace-identify button.

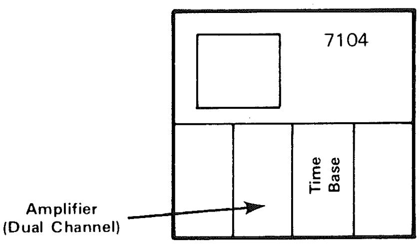
G4. CHECK READOUT MODES

NOTE

If the preceding step was not performed, first refer to the Readout System Preliminary Control Settings, then proceed with the following instructions.

G4. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE .... A



Test Equipment Controls:
Time Base
Sweep Rate .... 1 ms/div
Triggering .... Auto, AC, Internal

a. Set the READOUT INTENSITY control for a visible display.

b. **CHECK**—Set the time-base unit to several sweep rates throughout the time/division switch range and check that the readout characters are displayed independently of the sweep.

c. Set the READOUT +GATE or EXT switch to +GATE and the READOUT INTENSITY control to PULSED.

d. Set the +GATE mode switch to A.

e. Set the READOUT PRESET control for a visible readout display.

f. Set the time-base unit for a free-running (not triggered) sweep at a rate of 0.2 second/division.

g. **CHECK**—The readout characters are blanked out while the sweep is running, and are displayed immediately after the end of the sweep; each character encoded by the plug-in units is displayed only once for each sweep.

h. Set the READOUT +GATE or EXT switch to EXT.

i. **CHECK**—Press the READOUT MAN pushbutton and notice that one frame of readout is displayed.

H. PHOTOGRAPHIC WRITING RATE

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

2. Amplifier unit
4. Time-base unit
7. Camera
12. High-frequency sine-wave generator
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the **Test Point and Adjustment Locations H** foldout page in Section 8, Diagrams and Circuit Board Illustrations.

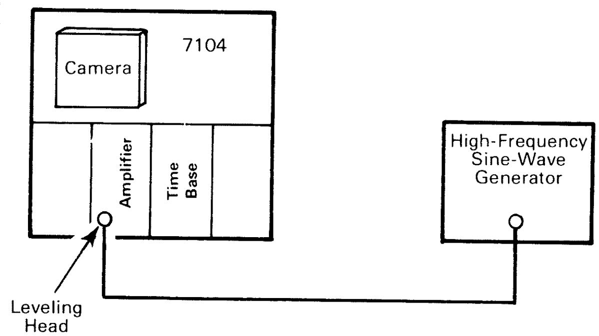
PHOTOGRAPHIC WRITING RATE PRELIMINARY CONTROL SETTINGS:

POWER switch .... On
VERTICAL MODE .... RIGHT
A TRIGGER SOURCE .... VERT MODE
A INTENSITY .... Counterclockwise
HORIZONTAL MODE .... A
B INTENSITY .... Counterclockwise
READOUT INTENSITY .... OFF (in detent)
GRAT ILLUM .... PULSED
BEAMFINDER .... Pushbutton out

H1. CHECK/ADJUST PHOTOGRAPHIC WRITING RATE

H1. SETUP CONDITIONS

7104 Controls:
GRAT ILLUM +GATE or EXT .... +GATE
+GATE A or B .... A



Test Equipment Controls:
Amplifier
Deflection Factor .... 0.5 V/div
Input Coupling .... DC

Time Base
Sweep Rate .... 5 ns
Magnifier X10
Triggering .... Auto, AC, Internal

High-Frequency Sine-Wave Generator
Frequency .... 1 GHz

Camera
Mode .... Time
Aperture f/1.9

a. Remove the blue crt filter.

b. Set the A INTENSITY control for a visible display.

c. Set the time-base unit sweep magnifier to X10.

d. Set the high-frequency sine-wave generator output amplitude to display 7.5 divisions on the 7104 crt.

e. Set the FOCUS and ASTIG controls for a well-defined display.

f. Set the time base unit to single-sweep mode.

g. Repeatedly press the time-base unit single-sweep reset control and set the GRAT ILLUM PRESET control to illuminate the graticule.

h. Focus the camera.

i. Install 3000 ASA film in camera and close the camera viewing port.

j. Rotate the A INTENSITY control fully clockwise.

k. Press the camera shutter button.

l. Press the time base single-sweep reset button.

m. Press the camera shutter button.

n. Develop film.

o. **CHECK**—Photograph should show the 1 gigahertz sine-wave clearly (see Fig. 5-3 for typical photograph).

p. **ADJUST**—Rotate the MCP Output adjustment R1720 clockwise to increase the photographic writing rate. Note that background scintillation can be reduced by rotating R1720 counterclockwise at the expense of the photographic writing rate.

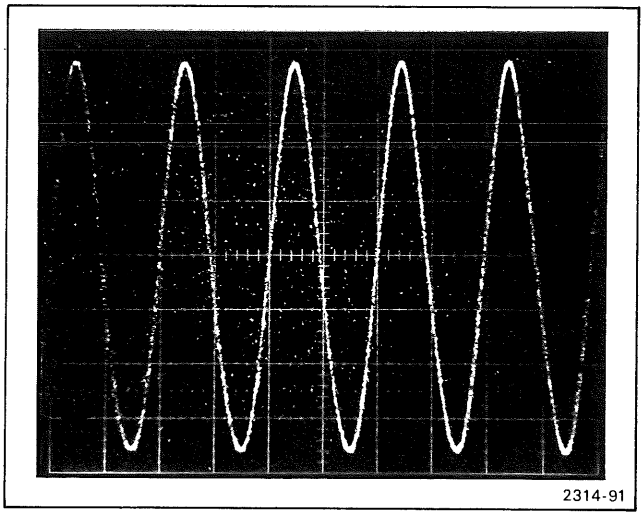


Figure 5-3. Typical 7104 Photographic Writing Rate.

This concludes the Adjustment and Performance Check of the 7104.

INSTRUMENT OPTIONS

Your instrument may be equipped with one or more instrument options. A brief description of each available option is given in the following discussion. Option information is incorporated into the appropriate sections of the manual. Refer to Table 6-1 and the Table of Contents for location of option information. For further information on instrument options, see your Tektronix Products catalog or contact your Tektronix Field Office.

WARNING

To avoid electric shock hazard, operating personnel must not remove the protective instrument covers. Component replacement and internal adjustments must be made by qualified service personnel only.

OPTION 2

Option 2 provides X-Y Mode Phase Correction. A horizontal delay line and compensation network equalizes the signal delay between either vertical compartment and the B HORIZ compartment. When this network is installed and activated, the phase shift between the vertical and B horizontal channels is adjustable to less than 2° from dc to 50 megahertz (phase balance can be obtained at any frequency up to 250 MHz). This option is factory installed.

OPTION 3

With Option 3 installed, the instrument will meet EMC (electromagnetic compatibility) specifications given in section 1. This option can be added at any time. Refer to the Tektronix Products catalog for part number.

TABLE 6-1
Option Information Locator

Instrument Options	Manual Section	Location of Information
Option 2 (Provides X-Y Delay Compensation)	1 General Information	Specification Table 1-4 contains the electrical characteristics for Option 2.
	2 Operating Instructions	Applications Provides discussion on X-Y Operation.
	3 Theory of Operation	Delay Comp (Option 2) 16 Provides discussion of circuitry.
	5 Calibration	Horizontal System E3. Check/Adjust Option 2 X-Y compensation.
	6 Instrument Options	Introductory page Includes a brief description of Option 2.
	7 Replaceable Electrical Parts	Replaceable Electrical Parts Replaceable parts unique to Option 2 are footnoted "Option 2 only".

TABLE 6-1 (CONT.)
Option Information Locator

Instrument Option	Manual Section	Location of Information
Option 2 (cont.)	8 Diagrams and Circuit Board Illustrations	Delay Comp (Option 2) 16 Diagram 16, shows circuitry unique to Option 2.
	9 Replaceable Mechanical Parts	Instrument Options (pull-out page) Provides a mechanical parts list and an exploded-view drawing unique to Option 2.
Option 3 (Provides EMC)	1 General Information	Specification Table 1-5 contains the electrical characteristics for Option 3.
	2 Operating Instructions	Detailed Operating Information Light Filter; includes basic description. Installation of Plug-In Units Refers to EMC shielded blank plug-in panel.
	6 Instrument Options	Introductory page Includes a brief description of Option 3.
	7 Replaceable Electrical Parts	Replaceable Electrical Parts Replaceable parts unique to Option 3 contain the footnote "Option 3 only".
	9 Replaceable Mechanical Parts	Instrument Options (pull-out page) Provides a mechanical parts list and an exploded-view drawing unique to Option 3.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

ABBREVIATIONS

Abbreviations conform to American National Standard Y1.1.

COMPONENT NUMBER (column one of the Electrical Parts List)

A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:

Example a.

component number

A23R1234 A23 R1234

Assembly number Circuit number

Read: Resistor 1234 of Assembly 23

Example b.

component number

A23A2R1234 A23 A2 R1234

Assembly number Subassembly number Circuit number

Read: Resistor 1234 of Subassembly 2 of Assembly 23

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

NAME & DESCRIPTION (column five of the Electrical Parts List)

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

MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

MFR. PART NUMBER (column seven of the Electrical Parts List)

Indicates actual manufacturers part number.

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00213	NYTRONICS COMPONENTS GROUP INC SUBSIDIARY OF NYTRONICS INC	ORANGE ST	DARLINGTON SC 29532
00853	SANGAMO WESTON INC COMPONENTS DIV	SANGAMO RD PO BOX 128	PICKENS SC 29671-9716
01121	ALLEN-BRADLEY CO	1201 S 2ND ST	MILWAUKEE WI 53204-2410
01281	MOTOROLA INC RF & OPTOELECTRONIC PRODUCTS DIV	14520 AVIATION BLVD	LAWNDALE CA 90260-1121
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPY PO BOX 655012	DALLAS TX 75265
02111	HAMILTON STANDARD CONTROLS INC SPECTROL DIV	17070 E GALE AVE P O BOX 1220	CITY OF INDUSTRY CA 91749
02114	AMPEREX ELECTRONIC CORP FERROXCUBE DIV	5083 KINGS HWY	SAUGERTIES NY 12477
02289	HI-G CO INC SUB OF NYTRONICS INC	101 LOCUST ST	HARTFORD CT 06114-1504
02735	RCA CORP SOLID STATE DIVISION	ROUTE 202	SOMERVILLE NJ 08876
02777	HOPKINS ENGINEERING CO	12900 FOOTHILL BLVD	SAN FERNANDO CA 91342-4928
03508	GENERAL ELECTRIC CO SEMI-CONDUCTOR PRODUCTS DEPT	W GENESEE ST	AUBURN NY 13021
03888	PYROFILM DIV DIV OF KDI ELECTRONICS INC	60 S JEFFERSON RD	WHIPPANY NJ 07981-1001
04072	BELL INDUSTRIES JW MILLER DIVISION		COMPTON CA 94539
04099	CAPCO INC	1328 WINTERS AVE PO BOX 1028	GRAND JUNCTION CO 81502
04222	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR PRODUCTS SECTOR	5005 E MCDOWELL RD	PHOENIX AZ 85008-4229
05397	UNION CARBIDE CORP MATERIALS SYSTEMS DIV	11901 MADISON AVE	CLEVELAND OH 44101
05828	GENERAL INSTRUMENT CORP GOVERNMENT SYSTEMS DIV	600 W JOHN ST	HICKSVILLE NY 11802
07263	FAIRCHILD SEMICONDUCTOR CORP NORTH AMERICAN SALES SUB OF SCHLUMBERGER LTD MS 118	10400 RIDGEVIEW CT	CUPERTINO CA 95014
07716	TRW INC TRW IRC FIXED RESISTORS/BURLINGTON	2850 MT PLEASANT AVE	BURLINGTON IA 52601
11236	CTS CORP BERNE DIV THICK FILM PRODUCTS GROUP	406 PARR ROAD	BERNE IN 46711-9506
12697	CLAROSTAT MFG CO INC	LOWER WASHINGTON ST	DOVER NH 03820
12954	MICROSEMI CORP - SCOTTSDALE	8700 E THOMAS RD P O BOX 1390	SCOTTSDALE AZ 85252
12969	UNITRODE CORP	5 FORBES RD	LEXINGTON MA 02173-7305
14193	CAL-R INC	1601 OLYMPIC BLVD PO BOX 1397	SANTA MONICA CA 90406
14433	ITT SEMICONDUCTORS DIV		WEST PALM BEACH FL
14552	MICROSEMI CORP	2830 S FAIRVIEW ST	SANTA ANA CA 92704-5948
14731	HARRIS GRAPHICS CORP PUBLICATION PRESS DIV	MECHANIC ST PO BOX 515	WESTERLY RI 02891
14752	ELECTRO CUBE INC	1710 S DEL MAR AVE	SAN GABRIEL CA 91776-3825
14859	TEXAS INSTRUMENTS INC CONTROL PRODUCTS DIV	300 NORTH MAIN	VERSAILLES KY 40383-1245
14936	GENERAL INSTRUMENT CORP DISCRETE SEMI CONDUCTOR DIV	600 W JOHN ST	HICKSVILLE NY 11802
15238	ITT SEMICONDUCTORS A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORP	500 BROADWAY PO BOX 168	LAWRENCE MA 01841-3002
15454	AMETEK INC RODAN DIV	721 N POPLAR ST	ORANGE CA 92668
15801	FENWAL ELECTRONICS DIV OF KIDDE INC	450 FORTUNE BLVD	MILFORD MA 01759
18235	KRL ELECTRONICS INC	160 BOUCHARD ST	MANCHESTER NH 03103-3315

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
18324	SIGNETICS CORP MILITARY PRODUCTS DIV	4130 S MARKET COURT	SACRAMENTO CA 95834-1222
19396	ILLINOIS TOOL WORKS INC PAKTRON DIV	1205 MCCONVILLE RD PO BOX 4539	LYNCHBURG VA 24502-4535
19701	MEPCO/CENTRALAB A NORTH AMERICAN PHILIPS CO MINERAL WELLS AIRPORT	PO BOX 760	MINERAL WELLS TX 76067-0760
20932	KYOCERA INTERNATIONAL INC	11620 SORRENTO VALLEY RD PO BOX 81543 PLANT NO 1	SAN DIEGO CA 92121
21847	FEI MICROWAVE INC	825 STEWART DR	SUNNYVALE CA 94086-4514
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS DIV MILITARY PRODUCTS GROUP	515 FISHING CREEK RD	NEW CUMBERLAND PA 17070-3007
23223	CTS CORP MICROELECTRONICS DIV	1201 CUMBERLAND AVE	WEST LAFAYETTE IN 47902
24546	CORNING GLASS WORKS	550 HIGH ST	BRADFORD PA 16701-3737
25088	SIEMENS CORP	186 WOOD AVE S	ISELIN NJ 08830-2704
25403	AMPEREX ELECTRONIC CORP SEMICONDUCTOR SOLID STATE AND ACTIVE DEVICES-ELECTRO OPTICAL DEVICES	GEORGE WASHINGTON HWY	SMITHFIELD RI 02917
27014	NATIONAL SEMICONDUCTOR CORP	2900 SEMICONDUCTOR DR	SANTA CLARA CA 95051-0606
31433	KEMET ELECTRONICS CORP NATIONAL SALES HEADQUARTERS	PO BOX 5928	GREENVILLE SC 29606
31918	ITT SCHADOW INC	8081 WALLACE RD	EDEN PRAIRIE MN 55344-2224
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507-2114
33095	SPECTRUM CONTROL INC	2185 W WEIGHT ST	ERIE PA 16505
50434	HEWLETT-PACKARD CO OPTOELECTRONICS DIV	370 W TRIMBLE RD	SAN JOSE CA 95131
50558	ELECTRONIC CONCEPTS INC	526 INDUSTRIAL WAY W	EATONTOWN NJ 07724-2212
51406	MURATA ERIE NORTH AMERICA INC HEADQUARTERS AND GEORGIA OPERATIONS	2200 LAKE PARK DR	SMYRNA GA 30080
51642	CENTRE ENGINEERING INC	2820 E COLLEGE AVE	STATE COLLEGE PA 16801-7515
51984	NEC AMERICA INC	2741 PROSPERITY AVE	FAIRFAX VA 22031-4308
52536	BECKMAN INDUSTRIAL INFORMATION DISPLAYS OPERATIONS	350 N HAYDEN RD	SCOTTSDALE AZ 85257
52763	STETCO INC	3344 SCHIERHORN	FRANKLIN PARK IL 60131
52769	SPRAGUE-GOODMAN ELECTRONICS INC	134 FULTON AVE	GARDEN CITY PARK NY 11040-5352
54473	MATSUSHITA ELECTRIC CORP OF AMERICA	ONE PANASONIC WAY PO BOX 1501	SECAUCUS NJ 07094-2917
54583	TDK ELECTRONICS CORP	12 HARBOR PARK DR	PORT WASHINGTON NY 11550
54937	DEYOUNG MANUFACTURING INC	12920 NE 125TH WAY	KIRKLAND WA 98034-7716
55112	WESTLAKE CAPACITORS INC	5334 STERLING CENTER DRIVE	WESTLAKE VILLAGE CA 91361
55292	WILBRECHT ELECTRONICS INC LEDCO DIV	240 E PLATO BLVD	ST PAUL MN 55107-1609
55680	NICHICON /AMERICA/ CORP	927 E STATE PKY	SCHAUMBURG IL 60195-4526
56289	SPRAGUE ELECTRIC CO WORLD HEADQUARTERS	92 HAYDEN AVE	LEXINGTON MA 02173-7929
56623	BABCOCK INC	1717 W COLLINS AVE	ORANGE CA 92667-5422
57668	ROHM CORP	8 WHATNEY PO BOX 19515	IRVINE CA 92713
58224	XENELL CORP	11 DUNBARTON RD PO BOX 4401	CHERRY HILL NJ 08003-2107
58854	GTE PRODUCTS CORP LIGHTING PRODUCTS GROUP	60 BOSTON ST	SALEM MA 01970-2147
59660	TUSONIX INC	7741 N BUSINESS PARK DR PO BOX 37144	TUCSON AZ 85740-7144
59821	MEPCO/CENTRALAB A NORTH AMERICAN PHILIPS CO	7158 MERCHANT AVE	EL PASO TX 79915-1207
60705	CERA-MITE CORPORATION	1327 6TH AVE	GRAFTON WI 53024-1831
71400	BUSSMANN DIV OF COOPER INDUSTRIES INC	114 OLD STATE RD PO BOX 14460	ST LOUIS MO 63178
71590	MEPCO/CENTRALAB INC A NORTH AMERICAN PHILIPS CO	HWY 20 W PO BOX 858	FORT DODGE IA 50501

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Mfr. Code	Manufacturer	Address	City, State, Zip Code
75042	IRC ELECTRONIC COMPONENTS PHILADELPHIA DIV TRW FIXED RESISTORS	401 N BROAD ST	PHILADELPHIA PA 19108-1001
75498	MULTICOMP INC	3005 SW 154TH TERRACE #3	BEAVERTON OR 97006
76493	BELL INDUSTRIES INC JW MILLER DIV	19070 REYES AVE PO BOX 5825	COMPTON CA 90224-5825
77342	AMF INC POTTER AND BRUMFIELD DIV	200 RICHLAND CREEK DR	PRINCETON IN 47670-4771
79727	C-W INDUSTRIES	130 JAMES WAY	SOUTHAMPTON PA 18966-3818
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077-0001
81073	GRAYHILL INC	561 HILLGROVE AVE PO BOX 10373	LA GRANGE IL 60525-5914
82389	SWITCHCRAFT INC SUB OF RAYTHEON CO	5555 N ELSTRON AVE	CHICAGO IL 60630-1314
83003	VARO INC	2203 W WALNUT ST PO BOX 401426	GARLAND TX 75042
84411	AMERICAN SHIZUKI CORP OGALLALA OPERATIONS	301 WEST O ST	OGALLALA NE 69153-1844
91637	DALE ELECTRONICS INC	2064 12TH AVE PO BOX 609	COLUMBUS NE 68601-3632
92966	GTE PRODUCTS CORP LIGHTING PRODUCTS GROUP HILLSBORO MINIATURE LAMP PLANT	WEST MAIN ST	HILLSBORO NH 03244
TK0213	TOPTRON CORP		TOKYO JAPAN
TK0852	A T R COIL CO INC	3895 W VERNAL PIKE	BLOOMINTON IN 47401
TK1036	E F JOHNSON CO	299 10TH AVE SW	WASECA MN 56093
TK1345	ZMAN AND ASSOCIATES	7633 S 180TH	KENT WA 98032
TK1450	TOKYO COSMOS ELECTRIC CO LTD	2-268 SOBUDAI ZAWA	KANAGAWA 228 JAPAN
TK2038	MULTICOMP INC	3005 SW 154TH TERRACE #3	BEAVERTON OR 97006
TK2042	ZMAN & ASSOCIATES	7633 S 180TH	KENT WA 98032

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1	670-4895-00	B010100	B020870	CIRCUIT BD ASSY:FRONT PANEL	80009	670-4895-00
A1	670-4895-01	B020871	B021249	CIRCUIT BD ASSY:FRONT PANEL	80009	670-4895-01
A1	670-4895-02	B021250	B063670	CIRCUIT BD ASSY:FRONT PANEL	80009	670-4895-02
A1	670-4895-03	B063671		CIRCUIT BD ASSY:FRONT PANEL	80009	670-4895-03
A2	670-5227-00	B010100	B063482	CIRCUIT BD ASSY:DISPLAY CONTROLLER	80009	670-5227-00
A2	670-5227-02	B063483		CIRCUIT BD ASSY:DISPLAY CONTROLLER	80009	670-5227-02
A3	670-4778-00	B010100	B020839	CIRCUIT BD ASSY:TRIGGER LIGHT	80009	670-4778-00
A3	670-4778-01	B020840		CIRCUIT BD ASSY:TRIGGER LIGHT	80009	670-4778-01
A4	670-4778-00	B010100	B020839	CIRCUIT BD ASSY:TRIGGER LIGHT	80009	670-4778-00
A4	670-4778-01	B020840		CIRCUIT BD ASSY:TRIGGER LIGHT	80009	670-4778-01
A5	670-4773-00	B010100	B020379	CIRCUIT BD ASSY:MODE SWITCH	80009	670-4773-00
A5	670-4773-01	B020380	B021489	CIRCUIT BD ASSY:MODE SWITCH	80009	670-4773-01
A5	670-4773-02	B021490	B021797	CIRCUIT BD ASSY:MODE SWITCH 388-5358-XX	80009	670-4773-02
A5	670-4773-03	B021798	B031995	CIRCUIT BD ASSY:MODE SWITCH	80009	670-4773-03
A5	670-4773-04	B031996		CIRCUIT BD ASSY:MODE SW	80009	670-4773-04
A6	670-4775-00	B010100	B032619	CIRCUIT BD ASSY:MAIN INTERFACE	80009	670-4775-00
A6	670-4775-01	B032620	B053419	CIRCUIT BD ASSY:MAIN INTERFACE	80009	670-4775-01
A6	670-4775-02	B053420		CIRCUIT BD ASSY:MAIN INTFC	80009	670-4775-02
A7	670-5098-00			CIRCUIT BD ASSY:TRIGGER A FOLLOWER	80009	670-5098-00
A8	670-5099-00			CIRCUIT BD ASSY:TRIGGER B FOLLOWER	80009	670-5099-00
A9	670-5617-00			CIRCUIT BD ASSY:HORIZONTAL B FOLLOWER	80009	670-5617-00
A10	670-5096-00			CIRCUIT BD ASSY:HORIZONTAL A FOLLOWER	80009	670-5096-00
A11	670-5097-00			CIRCUIT BD ASSY:VERTICAL CHANNEL FOLLOWER	80009	670-5097-00
A12	670-5097-00			CIRCUIT BD ASSY:VERTICAL CHANNEL FOLLOWER	80009	670-5097-00
A13	670-4777-00	B010100	B020599	CIRCUIT BD ASSY:LOGIC	80009	670-4777-00
A13	670-4777-01	B020600	B020954	CIRCUIT BD ASSY:LOGIC	80009	670-4777-01
A13	670-4777-02	B020955	B021446	CIRCUIT BD ASSY:LOGIC	80009	670-4777-02
A13	670-4777-03	B021447		CIRCUIT BD ASSY:LOGIC	80009	670-4777-03
A14	670-4776-00	B010100	B010229	CIRCUIT BD ASSY:TRIG SELECTOR	80009	670-4776-00
A14	670-4776-01	B010230	B031999	CIRCUIT BD ASSY:TRIG SELECTOR	80009	670-4776-01
A14	670-4776-03	B032000	B063700	CIRCUIT BD ASSY:TRIGGER SELECTOR	80009	670-4776-03
A14	670-4776-04	B063701		CIRCUIT BD ASSY:TRIGGER SELECTOR	80009	670-4776-04
A15	670-1900-03	B010100	B020359	CIRCUIT BD ASSY:READOUT	80009	670-1900-03
A15	670-1900-04	B020360	B021280	CIRCUIT BD ASSY:READOUT	80009	670-1900-04
A15	670-1900-05	B021281	B021699	CIRCUIT BD ASSY:READOUT 388-2459-XX WIRED	80009	670-1900-05
A15	670-1900-06	B021700	B049999	CIRCUIT BD ASSY:READOUT	80009	670-1900-06
A15	670-8620-00	B050000	B053266	CIRCUIT BD ASSY:READOUT	80009	670-8620-00
A15	670-8620-01	B053267	B063540	CIRCUIT BD ASSY:READOUT	80009	670-8620-01
A15	670-8620-04	B063541	B063844	CIRCUIT BD ASSY:READOUT	80009	670-8620-04
A15	670-8620-05	B063845	B063938	CIRCUIT BD ASSY:READOUT	80009	670-8620-05
A15	670-8620-06	B063939		CIRCUIT BD ASSY:READOUT	80009	670-8620-06
A16	670-4769-00	B010100	B020839	CIRCUIT BD ASSY:VERTICAL CHANNEL SWITCH	80009	670-4769-00
A16	670-4769-01	B020840	B032400	CIRCUIT BD ASSY:VERTICAL CHANNEL SWITCH	80009	670-4769-01
A16	670-4769-02	B032401		CIRCUIT BD ASSY:VERTICAL CHAN SWITCH	80009	670-4769-02
A17	670-4770-00	B010100	B020254	CIRCUIT BD ASSY:VERTICAL AMP	80009	670-4770-00
A17	670-4770-01	B020255	B020954	CIRCUIT BD ASSY:VERTICAL AMP	80009	670-4770-01
A17	670-4770-03	B020955	B021446	CIRCUIT BD ASSY:VERTICAL AMPL	80009	670-4770-03
A17	670-4770-04	B201447	B032223	CIRCUIT BD ASSY:VERTICAL AMPL	80009	670-4770-04
A17	670-4770-05	B032224	B032279	CIRCUIT BD ASSY:VERTICAL AMPLIFIER	80009	670-4770-05
A17	672-0802-01	B032280	B063648	CIRCUIT BD ASSY:VERTICAL AMPLIFIER	80009	672-0802-01
A17	672-0802-02	B063649		CIRCUIT BD ASSY:VERT AMPL	80009	672-0802-02
A18	670-4779-00			CIRCUIT BD ASSY:CRT TERM	80009	670-4779-00
A19	670-4771-00	B010100	B021049	CIRCUIT BD ASSY:HORIZONTAL AMP	80009	670-4771-00
A19	670-4771-01	B021050	B031999	CIRCUIT BD ASSY:HORIZONTAL AMPLIFIER	80009	670-4771-01
A19	670-4771-02	B032000	B032279	CIRCUIT BD ASSY:HORIZONTAL AMP	80009	670-4771-02
A19	672-0801-00	B032280	B053279	CIRCUIT BD ASSY:HORIZONTAL	80009	672-0801-00
A19	672-0801-01	B053280		CIRCUIT BD ASSY:HORIZONTAL	80009	672-0801-01
A20	670-0702-03	B010100	B021449	CIRCUIT BD ASSY:GRATICULE LAMPS	80009	670-0702-03
A20	670-0702-06	B021450		CIRCUIT BD ASSY:GRATICULE LAMPS	80009	670-0702-06
A21	670-4774-00	B010100	B010199	CIRCUIT BD ASSY:Z AXIS	80009	670-4774-00

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A21	670-4774-01	B010200	B020859	CIRCUIT BD ASSY:Z AXIS	80009	670-4774-01
A21	670-4774-02	B020860		CIRCUIT BD ASSY:Z AXIS	80009	670-4774-02
A22	670-4772-00	B010100	B020369	CIRCUIT BD ASSY:HIGH VOLTAGE #1	80009	670-4772-00
A22	670-4772-01	B020370	B020799	CIRCUIT BD ASSY:HIGH VOLTAGE #1	80009	670-4772-01
A22	670-4772-02	B020800	B063909	CIRCUIT BD ASSY:HIGH VOLTAGE #1	80009	670-4772-02
A22	670-4772-04	B063910	B073913	CIRCUIT BD ASSY:HIGH VOLTAGE #1	80009	670-4772-04
A22	670-4772-05	B073914		CIRCUIT BD ASSY:HIGH VOLTAGE	80009	670-4772-05
A22A1	670-9742-00	B073914		CIRCUIT BD ASSY:CRT PROTECTION	80009	670-9742-00
A23	670-5637-00	B010100	B021359	CIRCUIT BD ASSY:INVERTER	80009	670-5637-00
A23	670-5637-01	B021360	B031929	CIRCUIT BD ASSY:INVERTER	80009	670-5637-01
A23	670-6259-01	B031930	B039999	CIRCUIT BD ASSY:INVERTER	80009	670-6259-01
A23	670-6259-02	B040000		CIRCUIT BD ASSY:INVERTER	80009	670-6259-02
A24	670-5638-00	B010100	B020239	CIRCUIT BD ASSY:CONTROL/RECTIFIER	80009	670-5638-00
A24	670-5638-01	B020240	B020476	CIRCUIT BD ASSY:CONTROL/RECTIFIER	80009	670-5638-01
A24	670-5638-02	B020477	B020829	CIRCUIT BD ASSY:CONTROL/RECTIFIER	80009	670-5638-02
A24	670-5638-03	B020830	B021359	CIRCUIT BD ASSY:CONTROL/RECTIFIER	80009	670-5638-03
A24	670-5638-04	B021360	B021899	CIRCUIT BD ASSY:CONTROL/RECTIFIER	80009	670-5638-04
A24	670-5638-05	B021900	B031929	CIRCUIT BD ASSY:CONTROL/RECTIFIER	80009	670-5638-05
A24	670-5959-03	B031930	B053348	CIRCUIT BD ASSY:CONTROLLED RECTIFIER	80009	670-5959-03
A24	670-5959-04	B053349	B063973	CIRCUIT BD ASSY:CONTROLLED RECTIFIER	80009	670-5959-04
A24	670-5959-05	B063974		CIRCUIT BD ASSY:CONTROLLER RECTIFIER	80009	670-5959-05
A25	670-5639-00	B010100	B020639	CIRCUIT BD ASSY:REGULATOR	80009	670-5639-00
A25	670-5639-01	B020640	B031929	CIRCUIT BD ASSY:REGULATOR	80009	670-5639-01
A25	670-5960-03	B031930	B053419	CIRCUIT BD ASSY:LOW VOLTAGE REGULATOR	80009	670-5960-03
A25	670-5960-04	B053420		CIRCUIT BD ASSY:LV REGULATOR	80009	670-5960-04
A26	670-2245-01	B010100	B010189	CIRCUIT BD ASSY:FAN MOTOR	80009	670-2245-01
A26	670-2245-03	B010190	B020699	CIRCUIT BD ASSY:FAN MOTOR	80009	670-2245-03
A26	670-2245-04	B020700		CIRCUIT BD ASSY:FAN MOTOR	80009	670-2245-04
A27	670-4346-00			CIRCUIT BD ASSY:READOUT PROTECTION #1	80009	670-4346-00
A28	670-4780-00	B010100	B010164	CIRCUIT BD ASSY:X-Y DELAY COMP (OPTION 02 ONLY)	80009	670-4780-00
A28	670-4780-01	B010165		CIRCUIT BD ASSY:X-Y DELAY COMP (OPTION 02 ONLY)	80009	670-4780-01
A29	670-5093-00	B010100	B031958	CIRCUIT BD ASSY:HORIZONTAL CRT FLEX CON	80009	670-5093-00
A30	670-5094-00			CIRCUIT BD ASSY:HORIZONTAL CRT FLEX CON	80009	670-5094-00
A31	670-5616-00			CIRCUIT BD ASSY:VERTICAL CRT FLEX CON	80009	670-5616-00
A32	670-5616-00			CIRCUIT BD ASSY:VERTICAL CRT FLEX CON	80009	670-5616-00
B1690	147-0035-00			MOTOR,DC:BRUSHLESS,3000 RPM,10-15V	25088	1AD3001-0A
C2	290-0747-00	B010100	B053419	CAP,FXD,ELCTLT:100UF,+50-20%,25WVDC	54473	ECE-B25V100L
C2	290-0966-00	B053420		CAP,FXD,ELCTLT:220UF,+50-20%,25V	55680	TLB1E221TCAANA
C3	285-0674-00			CAP,FXD,PLASTIC:0.01UF,10%,100V	84411	TEK270-10391
C4	290-0747-00			CAP,FXD,ELCTLT:100UF,+50-20%,25WVDC	54473	ECE-B25V100L
C5	285-0674-00			CAP,FXD,PLASTIC:0.01UF,10%,100V	84411	TEK270-10391
C6	290-0194-00	B010100	B032619	CAP,FXD,ELCTLT:10UF,+50-10%,100V	00853	556DC100T100B
C6	290-0969-00	B032620		CAP,FXD,ELCTLT:22UF,+50-10%,100V	55680	TLB2A220TAAANA
C8	290-0194-00	B010100	B032619	CAP,FXD,ELCTLT:10UF,+50-10%,100V	00853	556DC100T100B
C8	290-0919-00	B032620		CAP,FXD,ELCTLT:470UF,+50-20%,35V	55680	UVX1V471MPA
C9	290-0747-00			CAP,FXD,ELCTLT:100UF,+50-20%,25WVDC	54473	ECE-B25V100L
C71	281-0547-00			CAP,FXD,CER DI:2.7PF,+/-0.25PF,500V	52763	2RDPLZ007 2P70CC
C85	283-0111-00			CAP,FXD,CER DI:0.1UF,20%,50V	05397	C330C104M5U1CA
C87	283-0111-00			CAP,FXD,CER DI:0.1UF,20%,50V	05397	C330C104M5U1CA
C237	283-0221-00			CAP,FXD,CER DI:0.47UF,20%,50V	04222	SR305C474MAA
C240	290-0183-00			CAP,FXD,ELCTLT:1UF,10%,35V	05397	T3228105K035AS
C250	290-0525-00			CAP,FXD,ELCTLT:4.7UF,20%,50V	05397	T368B475M050AS
C270	283-0177-00			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAA
C324	283-0002-00			CAP,FXD,CER DI:0.01UF,+80-20%,500V	59821	D103Z40Z5ULADEG
C325	283-0115-00			CAP,FXD,CER DI:47PF,5%,200V	59821	2DDT60K470J
C326	283-0002-00			CAP,FXD,CER DI:0.01UF,+80-20%,500V	59821	D103Z40Z5ULADEG

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C376	285-1006-00	B010100	B031995	CAP,FXD,PLASTIC:0.22UF,2%,50V	TK2038	285-1006-00
C376	285-1130-00	B031996		CAP,FXD,PLASTIC:0.22UF,1%,100V	50558	MH12D224F
C384	283-0115-00			CAP,FXD,CER DI:47PF,5%,200V	59821	2DDT60K470J
C386	283-0115-00			CAP,FXD,CER DI:47PF,5%,200V	59821	2DDT60K470J
C440	290-0527-00			CAP,FXD,ELCTLT:15UF,20%,20V	05397	T368B156M020AS
C447	283-0221-00			CAP,FXD,CER DI:0.47UF,20%,50V	04222	SR305C474MAA
C450	290-0488-00			CAP,FXD,ELCTLT:2.2UF,10%,20V	05397	T322B225K020AS
C483	281-0513-00	B010100	B010229	CAP,FXD,CER DI:27PF,+/-5.4PF,500V	52763	2RDPLZ007 27POMP
C483	283-0159-00	B010230	B063700	CAP,FXD,CER DI:18PF,5%,50V	04222	SR155A180JAA
C483	283-0175-00	B063701		CAP,FXD,CER DI:10PF,5%,200V (NOMINAL VALUE,SELECTED)	05397	C312C100D2G5CA 8
C483	283-0157-00	B063701		CAP,FXD,CER DI:7PF,5%,50V	05397	C315C709D5G5CA
C483	283-0159-00	B063701		CAP,FXD,CER DI:18PF,5%,50V	04222	SR155A180JAA
C483	283-0168-00	B063701		CAP,FXD,CER DI:12PF,5%,100V (C483 IS SELECTABLE)	05397	C315C120J1G5CA
C486	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C487	283-0111-00			CAP,FXD,CER DI:0.1UF,20%,50V	05397	C330C104M5U1CA
C488	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C490	283-0339-00			CAP,FXD,CER DI:0.22UF,10%,50V	05397	C330C224K5R5CA
C493	281-0513-00	B010100	B010229	CAP,FXD,CER DI:27PF,+/-5.4PF,500V	52763	2RDPLZ007 27POMP
C493	283-0159-00	B010230	B063700	CAP,FXD,CER DI:18PF,5%,50V	04222	SR155A180JAA
C493	283-0175-00	B063701		CAP,FXD,CER DI:10PF,5%,200V (NOMINAL VALUE,SELECTED)	05397	C312C100D2G5CA 8
C493	283-0157-00	B063701		CAP,FXD,CER DI:7PF,5%,50V	05397	C315C709D5G5CA
C493	283-0159-00	B063701		CAP,FXD,CER DI:18PF,5%,50V	04222	SR155A180JAA
C493	283-0168-00	B063701		CAP,FXD,CER DI:12PF,5%,100V (C493 IS SELECTABLE)	05397	C315C120J1G5CA
C505	281-0811-00			CAP,FXD,CER DI:10PF,10%,100V	04222	MA101A100KAA
C508	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C512	285-0650-00			CAP,FXD,PLASTIC:0.027UF,5%,100V	56289	192P27352M447
C515	285-0643-00			CAP,FXD,PLASTIC:0.0047UF,5%,100V	56289	192P47252R468
C520	283-0666-00			CAP,FXD,MICA DI:890PF,2%,100V	00853	D151F891G0
C525	283-0649-00			CAP,FXD,MICA DI:105PF,1%,500V	00853	D155F1050F0
C531	285-0598-00			CAP,FXD,PLASTIC:0.01UF,5%,100V	19396	DU490B103J
C538	281-0204-00			CAP,VAR,PLASTIC:2-22PF,100V	19701	2807C00222MJ02
C539	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C582	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
C583	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
C584	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
C605	281-0811-00			CAP,FXD,CER DI:10PF,10%,100V	04222	MA101A100KAA
C608	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C612	285-0650-00			CAP,FXD,PLASTIC:0.027UF,5%,100V	56289	192P27352M447
C615	285-0643-00			CAP,FXD,PLASTIC:0.0047UF,5%,100V	56289	192P47252R468
C620	283-0666-00			CAP,FXD,MICA DI:890PF,2%,100V	00853	D151F891G0
C625	283-0649-00			CAP,FXD,MICA DI:105PF,1%,500V	00853	D155F1050F0
C631	285-0598-00			CAP,FXD,PLASTIC:0.01UF,5%,100V	19396	DU490B103J
C638	281-0204-00			CAP,VAR,PLASTIC:2-22PF,100V	19701	2807C00222MJ02
C639	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C675	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C681	281-0788-00			CAP,FXD,CER DI:470PF,10%,100V	04222	SA102C471KAA
C695	290-0746-00			CAP,FXD,ELCTLT:47UF,+50-20%,16V	54473	ECE-A6V47L
C704	283-0320-00	B020255		CAP,FXD,CER DI:1PF,0.25%,50V	54583	C2012C0G1H1R0C
C705	281-0218-00			CAP,VAR,CER DI:1-5PF,+2 -2.5%,100V	59660	513-011A1-5
C730	281-0814-00	B010100	B020954	CAP,FXD,CER DI:100 PF,10%,100V	04222	MA101A101KAA
C730	281-0809-00	B020955		CAP,FXD,CER DI:200 PF,5%,100V	04222	MA101A201JAA
C751	283-0176-00			CAP,FXD,CER DI:0.0022UF,20%,50V	04222	SR205C222MAA
C762	283-0253-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	15051C103KZT6C
C780	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C782	281-0810-00			CAP,FXD,CER DI:5.6PF,+/-0.5PF,100V	04222	MA101A5R6DAA

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C783	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C787	285-0686-00			CAP,FXD,PLASTIC:0.068UF,10%,100V	19396	683K01PT605
C791	285-0643-00			CAP,FXD,PLASTIC:0.0047UF,5%,100V	56289	192P47252R468
C795	283-0666-00			CAP,FXD,MICA DI:890PF,2%,100V	00853	D151F891G0
C801	283-0649-00			CAP,FXD,MICA DI:105PF,1%,500V	00853	D155F1050F0
C806	285-0683-00			CAP,FXD,PLASTIC:0.022UF,5%,100V	19396	223J01PT485
C808	281-0204-00			CAP,VAR,PLASTIC:2-22PF,100V	19701	2807C00222MJ02
C809	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C837	283-0251-00	B020255		CAP,FXD,CER DI:87 PF,5%,100V	04222	3418 100A 870J
C838	283-0334-00	B010100	B020254	CAP,FXD,CER DI:130PF,+1-2%,500V	04222	SR207A131GAA
C838	283-0197-00	B020255		CAP,FXD,CER DI:470PF,5%,50V	04222	SR205A471JAA
C842	----- -----			(SELECTED AND ADDED IF NECESSARY)		
C852	283-0353-00			CAP,FXD,CER DI:0.1UF,10%,50V	04222	12105C104KA2075
C862	283-0353-00			CAP,FXD,CER DI:0.1UF,10%,50V	04222	12105C104KA2075
C878	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C881	283-0005-00			CAP,FXD,CER DI:0.01UF,+100-0%,250V	04222	SR303E103ZAA
C882	283-0005-00			CAP,FXD,CER DI:0.01UF,+100-0%,250V	04222	SR303E103ZAA
C885	283-0178-00			CAP,FXD,CER DI:0.1UF,20%,100V	05397	C330C104Z1U1CA
C891	290-0768-00			CAP,FXD,ELCTLT:10UF,+50-20%,100WVDC	54473	ECE-A100V10L
C893	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
C895	290-0776-00			CAP,FXD,ELCTLT:22UF,+50-20 %,10V	55680	ULA1A220TAA
C897	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
C903	283-0160-00	B010106		CAP,FXD,CER DI:1.5PF,+/-0.1PF,50V (C903, ADDED IF NECESSARY)	51642	100050NP0159B
C944	281-0808-00			CAP,FXD,CER DI:7 PF,20%,100V	04222	MA101A7R04AA
C950	283-0597-00			CAP,FXD,MICA DI:470PF,10%,300V	00853	D155F471K0
C952	285-0813-00			CAP,FXD,PLASTIC:0.0015UF,5%,100V	14752	410D1B152J
C955	285-0598-00			CAP,FXD,PLASTIC:0.01UF,5%,100V	19396	DU490B103J
C958	285-0808-00			CAP,FXD,PLASTIC:0.1UF,10%,50V	04099	EK13-16
C974	281-0808-00			CAP,FXD,CER DI:7 PF,20%,100V	04222	MA101A7R04AA
C980	283-0597-00			CAP,FXD,MICA DI:470PF,10%,300V	00853	D155F471K0
C982	285-0813-00			CAP,FXD,PLASTIC:0.0015UF,5%,100V	14752	410D1B152J
C985	285-0598-00			CAP,FXD,PLASTIC:0.01UF,5%,100V	19396	DU490B103J
C988	285-0808-00			CAP,FXD,PLASTIC:0.1UF,10%,50V	04099	EK13-16
C1001	290-0769-00			CAP,FXD,ELCTLT:10UF,+50-10%,100VDC	54473	ECEB2AV100S
C1002	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
C1003	290-0776-00			CAP,FXD,ELCTLT:22UF,+50-20 %,10V	55680	ULA1A220TAA
C1004	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
C1011	283-0110-00			CAP,FXD,CER DI:0.005UF,+80-20%,150V	59660	855-547-E-502Z
C1017	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C1019	290-0523-00			CAP,FXD,ELCTLT:2.2UF,20%,20V	05397	T368A225M020AS
C1035	281-0601-00			CAP,FXD,CER DI:7.5PF,+/-0.5PF,500V	52763	2RDPLZ007 7P50DC
C1036	281-0203-00	B010100	B053279	CAP,VAR,PLASTIC:2-10PF,100V	52769	GYA 10000
C1036	281-0204-00	B053280		CAP,VAR,PLASTIC:2-22PF,100V	19701	2807C00222MJ02
C1040	281-0122-00			CAP,VAR,CER DI:2.5-9PF,100V	59660	518-000A2.5-9
C1044	281-0592-00			CAP,FXD,CER DI:4.7PF,+/-0.5PF,500V	52763	2RDPLZ007 4P70DC
C1060	281-0122-00			CAP,VAR,CER DI:2.5-9PF,100V	59660	518-000A2.5-9
C1064	281-0592-00			CAP,FXD,CER DI:4.7PF,+/-0.5PF,500V	52763	2RDPLZ007 4P70DC
C1073	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1075	283-0299-00			CAP,FXD,CER DI:51PF,5%,500V	51642	200-500-NPO-510J
C1096	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C1098	283-0178-00			CAP,FXD,CER DI:0.1UF,20%,100V	05397	C330C104Z1U1CA
C1110	283-0180-00			CAP,FXD,CER DI:5600PF,20%,200V (C1110, OPTION 02 ONLY)	04222	3429 200E 562M
C1112	283-0107-00			CAP,FXD,CER DI:51PF,5%,200V (C1112, OPTION 02 ONLY)	04222	SR206A510JAA
C1113	283-0197-00			CAP,FXD,CER DI:470PF,5%,50V (C1113, OPTION 02 ONLY)	04222	SR205A471JAA
C1114	281-0158-00			CAP,VAR,CER DI:7-45PF,100WVDC SUBMIN CER	59660	518-006 G 7-45

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				(C1114, OPTION 02 ONLY)		
C1142	290-0512-00			CAP,FXD,ELCTLT:22UF,20%,15V	05397	T368B226M015AS
				(C1142, OPTION 02 ONLY)		
C1156	281-0619-00			CAP,FXD,CER DI:1.2PF,+/-0.1PF,500V	52763	2RDPLZ007 1P20BC
				(C1156, OPTION 02 ONLY)		
C1165	283-0191-00			CAP,FXD,CER DI:0.022UF,20%,50V	04222	SR205C223MAA
				(C1165, OPTION 02 ONLY)		
C1205	283-0022-00	B010100	B039999	CAP,FXD,CER DI:0.02UF,+100-0%,1400V	59660	3888531Z5U0203Z
C1205	119-1168-00	B040000		CAPACITOR-RES:0.1UF,20% & 22 OHM,10%,250VAC	14752	RG1782-1
C1206	283-0022-00	B010100	B039999	CAP,FXD,CER DI:0.02UF,+100-0%,1400V	59660	3888531Z5U0203Z
C1216	290-0628-00			CAP,FXD,ELCTLT:950UF,+50-10%,200V	56289	36D7560
C1217	290-0628-00			CAP,FXD,ELCTLT:950UF,+50-10%,200V	56289	36D7560
C1219	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
C1227	283-0280-00	B010100	B039999	CAP,FXD,CER DI:2200PF,10%,2000V	60705	564CBA202EH222
C1227	283-0351-00	B040000		CAP,FXD,CER DI:5000PF,20%,3000V	51406	DHR17Z5U502M3KV
C1228	283-0280-00	B010100	B039999	CAP,FXD,CER DI:2200PF,10%,2000V	60705	564CBA202EH222
C1228	283-0351-00	B040000		CAP,FXD,CER DI:5000PF,20%,3000V	51406	DHR17Z5U502M3KV
C1229	285-0939-00			CAP,FXD,PLASTIC:3UF,5%,400V	04099	TEK13-17
C1231	290-0782-00	B010100	B031929	CAP,FXD,ELCTLT:4.7UF,+75-20%,35VDC	55680	ULB1V4R7TAAANA
C1231	290-0891-00	B031930		CAP,FXD,ELCTLT:1UF,+75 -10%,50V	55680	ULA1H010TEA
C1235	283-0078-00	B010100	B010144	CAP,FXD,CER DI:0.001UF,20%,500V	59660	0801 547X5F0102M
C1235	283-0060-00	B010145		CAP,FXD,CER DI:100PF,5%,200V	59660	855-535U2J101J
C1236	283-0280-00			CAP,FXD,CER DI:2200PF,10%,2000V	60705	564CBA202EH222
C1237	285-0938-00			CAP,FXD,PLASTIC:0.03UF,5%,900V	50558	PA6-0738J
C1238	283-0279-00			CAP,FXD,CER DI:0.001UF,20%,3000V	51406	DHR12Y5S102M3KV
C1239	290-0782-00	B010100	B031929	CAP,FXD,ELCTLT:4.7UF,+75-20%,35VDC	55680	ULB1V4R7TAAANA
C1239	290-0891-00	B031930		CAP,FXD,ELCTLT:1UF,+75 -10%,50V	55680	ULA1H010TEA
C1242	283-0001-00	B010100	B031929	CAP,FXD,CER DI:0.005UF,+100-0%,500V	59821	2DDH61L502P
C1242	283-0079-00	B031930		CAP,FXD,CER DI:0.01UF,20%,250V	04222	SR503C103MAA
C1243	290-0767-00			CAP,FXD,ELCTLT:4.7UF,+75-10%,160VDC	54473	ECEA2CS4R7
C1252	283-0003-00	B010100	B053348	CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C1252	285-1340-00	B053349		CAP,FXD,MTLZD:0.01UF,10%,63V	55112	185/0.01/K/63AAA
C1254	290-0573-00			CAP,FXD,ELCTLT:2.7UF,20%,50V	05397	T368B275M050AS
C1255	283-0028-00			CAP,FXD,CER DI:0.0022UF,20%,50V	59660	0805585Y5S0222M
C1264	290-0263-00			CAP,FXD,ELCTLT:2.7UF,10%,15V	05397	T320A275K015AS
C1266	283-0003-00	B010100	B053348	CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C1266	285-1340-00	B053349		CAP,FXD,MTLZD:0.01UF,10%,63V	55112	185/0.01/K/63AAA
C1267	290-0523-00	B010100	B053348	CAP,FXD,ELCTLT:2.2UF,20%,20V	05397	T368A225M020AS
C1267	290-0573-00	B053349		CAP,FXD,ELCTLT:2.7UF,20%,50V	05397	T368B275M050AS
C1270	290-0523-00	B010100	B020476	CAP,FXD,ELCTLT:2.2UF,20%,20V	05397	T368A225M020AS
C1270	290-0522-00	B020477	B031929	CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
C1270	290-0534-00	B031930	B053348	CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
C1270	285-1338-00	B053349		CAP,FXD,MTLZD:1.0UF,10%,50V	55112	185/1.0/K/50/AGA
C1271	290-0523-00	B010100	B020476	CAP,FXD,ELCTLT:2.2UF,20%,20V	05397	T368A225M020AS
C1271	290-0522-00	B020477	B031929	CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
C1271	290-0534-00	B031930	B053348	CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
C1271	285-1338-00	B053349		CAP,FXD,MTLZD:1.0UF,10%,50V	55112	185/1.0/K/50/AGA
C1274	283-0594-00			CAP,FXD,MICA DI:0.001UF,1%,100V	00853	D151F102F0
C1277	283-0060-00	B010100	B010144	CAP,FXD,CER DI:100PF,5%,200V	59660	855-535U2J101J
C1277	283-0076-00	B010145	B020239	CAP,FXD,CER DI:27PF,10%,500V	59660	831-500S2L270K
C1277	283-0060-00	B020240	B021899	CAP,FXD,CER DI:100PF,5%,200V	59660	855-535U2J101J
C1277	283-0084-00	B021900		CAP,FXD,CER DI:270PF,5%,1000V	59660	838533X5F02715
C1278	283-0060-00	B010100	B010144	CAP,FXD,CER DI:100PF,5%,200V	59660	855-535U2J101J
C1278	283-0076-00	B010145	B020239	CAP,FXD,CER DI:27PF,10%,500V	59660	831-500S2L270K
C1278	283-0060-00	B020240	B021899	CAP,FXD,CER DI:100PF,5%,200V	59660	855-535U2J101J
C1278	283-0084-00	B021900		CAP,FXD,CER DI:270PF,5%,1000V	59660	838533X5F02715
C1280	283-0080-00	B010100	B053348	CAP,FXD,CER DI:0.022UF,+80-20%,25V	59821	2DDU60E223Z
C1286	290-0580-00			CAP,FXD,ELCTLT:0.27UF,20%,50V	05397	T368A274M050AZ
C1290	290-0778-00			CAP,FXD,ELCTLT:1UF,20%,50V,NPLZD	54473	ECE-A50N1

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C1292	285-1123-00			CAP,FXD,PLASTIC:1UF,20%,200V	14731	230B1C105M
C1294	285-0543-00	B010100	B021359	CAP,FXD,PLASTIC:0.0022UF,20%,400V	56289	192P22204
C1294	285-0695-00	B021360		CAP,FXD,PLASTIC:0.01UF,10%,200V	56289	192P10392
C1324	290-0758-00			CAP,FXD,ELCTLT:2.2UF,+50-10%,200V	56289	502D227
C1325	290-0758-00			CAP,FXD,ELCTLT:2.2UF,+50-10%,200V	56289	502D227
C1327	285-0892-00			CAP,FXD,PLASTIC:0.22UF,10%,200V	14752	650B1C224K
C1332	290-0768-00			CAP,FXD,ELCTLT:10UF,+50-20%,100WVDC	54473	ECE-A100V10L
C1333	290-0768-00			CAP,FXD,ELCTLT:10UF,+50-20%,100WVDC	54473	ECE-A100V10L
C1334	290-0768-00			CAP,FXD,ELCTLT:10UF,+50-20%,100WVDC	54473	ECE-A100V10L
C1335	290-0768-00			CAP,FXD,ELCTLT:10UF,+50-20%,100WVDC	54473	ECE-A100V10L
C1342	290-0772-00			CAP,FXD,ELCTLT:330UF,+50-10%,25VDC	54473	ECE-BIEV30S
C1343	290-0770-00			CAP,FXD,ELCTLT:100UF,+50-20%,25VDC	54473	ECE-A25V100L
C1344	290-0772-00			CAP,FXD,ELCTLT:330UF,+50-10%,25VDC	54473	ECE-BIEV30S
C1345	290-0770-00			CAP,FXD,ELCTLT:100UF,+50-20%,25VDC	54473	ECE-A25V100L
C1352	290-0771-00			CAP,FXD,ELCTLT:220UF,+50-10%,10VDC	55680	ULA1A221TPA2
C1353	290-0771-00			CAP,FXD,ELCTLT:220UF,+50-10%,10VDC	55680	ULA1A221TPA2
C1354	290-0754-00	B010100	B031929	CAP,FXD,ELCTLT:2200UF,+75%-10%,10VDC	56289	432D222010AA2
C1354	290-0898-00	B031930	B053348	CAP,FXD,ELCTLT:2600UF,+75-10%,35V	56289	602DX262G035AA2B
C1354	290-0898-01	B053349		CAP,FXD,ELCTLT:2600UF,+75 -10%,35V	56289	602DX262G035AA2P
C1355	290-0773-00			CAP,FXD,ELCTLT:1000UF,+50-10%,10VDC	54473	ECEB1AV102S
C1356	290-0771-00			CAP,FXD,ELCTLT:220UF,+50-10%,10VDC	55680	ULA1A221TPA2
C1371	290-0746-00	B010100	B031929	CAP,FXD,ELCTLT:47UF,+50-20%,16V	54473	ECE-A6V47L
C1372	290-0746-00	B031930		CAP,FXD,ELCTLT:47UF,+50-20%,16V	54473	ECE-A6V47L
C1374	283-0221-00	B010100	B031929	CAP,FXD,CER DI:0.47UF,20%,50V	04222	SR305C474MAA
C1379	283-0177-00	B031930	B053348	CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAA
C1379	285-1338-00	B053349		CAP,FXD,MTLZD:1.0UF,10%,50V	55112	185/1.0/K/50/AGA
C1383	283-0111-00	B031930	B053348	CAP,FXD,CER DI:0.1UF,20%,50V	05397	C330C104M5U1CA
C1383	285-1300-01	B053349		CAP,FXD,MTLZD:0.1UF,10%,63V	55112	185/0.1/K/63/ABA
C1408	290-0778-00			CAP,FXD,ELCTLT:1UF,20%,50V,NPLZD	54473	ECE-A50N1
C1412	290-0778-00			CAP,FXD,ELCTLT:1UF,20%,50V,NPLZD	54473	ECE-A50N1
C1413	283-0047-00	B031930		CAP,FXD,CER DI:270PF,5%,500V	59660	0831604Z5F0271J
C1415	281-0629-00			CAP,FXD,CER DI:33PF,5%,600V	52763	2RDPLZ007 33POJC
C1417	290-0778-00			CAP,FXD,ELCTLT:1UF,20%,50V,NPLZD	54473	ECE-A50N1
C1424	283-0110-00			CAP,FXD,CER DI:0.005UF,+80-20%,150V	59660	855-547-E-502Z
C1436	290-0782-00	B010100	B020639	CAP,FXD,ELCTLT:4.7UF,+75-20%,35VDC	55680	ULB1V4R7TAAANA
C1436	281-0775-00	B020640		CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C1444	283-0067-00			CAP,FXD,CER DI:0.001UF,10%,200V	59660	835-515-YSE0102K
C1445	281-0613-00	B010100	B031929	CAP,FXD,CER DI:10PF,1%,500V	59660	374-018COG0100F
C1445	281-0511-00	B031930		CAP,FXD,CER DI:22PF,+/-2.2PF,500V	52763	2RDPLZ007 22POKC
C1447	290-0778-00			CAP,FXD,ELCTLT:1UF,20%,50V,NPLZD	54473	ECE-A50N1
C1454	283-0110-00	B010100	B031929	CAP,FXD,CER DI:0.005UF,+80-20%,150V	59660	855-547-E-502Z
C1454	283-0100-00	B031930		CAP,FXD,CER DI:0.0047UF,10%,200V	04222	SR306A472KAA
C1464	281-0540-00			CAP,FXD,CER DI:51PF,5%,500V	59660	301-000U2J0510J
C1468	290-0420-00			CAP,FXD,ELCTLT:0.68UF,20%,75V	05397	T110A684M075AS
C1469	283-0067-00			CAP,FXD,CER DI:0.001UF,10%,200V	59660	835-515-YSE0102K
C1484	281-0629-00			CAP,FXD,CER DI:33PF,5%,600V	52763	2RDPLZ007 33POJC
C1488	290-0420-00			CAP,FXD,ELCTLT:0.68UF,20%,75V	05397	T110A684M075AS
C1514	281-0605-00			CAP,FXD,CER DI:200PF,10%,500V	59660	301000Y5D201K
C1535	290-0420-00	B010100	B031929	CAP,FXD,ELCTLT:0.68UF,20%,75V	05397	T110A684M075AS
C1556	290-0776-00	B010100	B031929	CAP,FXD,ELCTLT:22UF,+50-20 %,10V	55680	ULA1A220TAA
C1556	290-0745-00	B031930		CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
C1601	281-0547-00			CAP,FXD,CER DI:2.7PF,+/-0.25PF,500V	52763	2RDPLZ007 2P7OCC
C1605	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1611	281-0547-00			CAP,FXD,CER DI:2.7PF,+/-0.25PF,500V	52763	2RDPLZ007 2P7OCC
C1615	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1619	281-0562-00	B010100	B010199	CAP,FXD,CER DI:39PF,10%,500V	52763	2RDPLZ007 39POKU
C1619	281-0785-00	B010200		CAP,FXD,CER DI:68PF,10%,100V	04222	MA101A680KAA
C1620	281-0092-00	B010100	B010199	CAP,VAR,CER DI:9-35PF,200V	33095	53-717-001 D9-35

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C1623	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C1628	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1635	281-0158-00			CAP,VAR,CER DI:7-45PF,100WVDC SUBMIN CER	59660	518-006 G 7-45
C1636	283-0159-00			CAP,FXD,CER DI:18PF,5%,50V	04222	SR155A180JAA
C1638	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1642	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C1643	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
C1644	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C1645	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
C1646	290-0746-00			CAP,FXD,ELCTLT:47UF,+50-20%,16V	54473	ECE-A6V47L
C1651	281-0123-00	B010100	B020859	CAP,VAR,CER DI:5-25PF,100V	59660	518-000A5-25
C1651	281-0158-00	B020860		CAP,VAR,CER DI:7-45PF,100WVDC SUBMIN CER	59660	518-006 G 7-45
C1653	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1656	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1660	281-0557-00			CAP,FXD,CER DI:1.8PF,+/-0.1PF,500V	59660	301-080COK0189B
C1663	281-0158-00			CAP,VAR,CER DI:7-45PF,100WVDC SUBMIN CER	59660	518-006 G 7-45
C1664	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1665	281-0791-00			CAP,FXD,CER DI:270PF,10%,100V	04222	MA101C271KAA
C1671	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1672	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C1675	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1676	281-0788-00			CAP,FXD,CER DI:470PF,10%,100V	04222	SA102C471KAA
C1677	283-0346-00			CAP,FXD,CER DI:0.47UF,+80-20%,100V	20932	5034ES100RD474Z
C1680	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C1681	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1687	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1692	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1694	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1698	290-0804-00			CAP,FXD,ELCTLT:10UF,+50-20%,25V	55680	ULB1E100TAAANA
C1699	283-0060-00	B010190	B020700	CAP,FXD,CER DI:100PF,5%,200V	59660	855-535U2J101J
C1702	281-0773-00	B073914		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1704	281-0812-00	B073914		CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
C1707	290-0164-00			CAP,FXD,ELCTLT:1UF,+50-10%,150V	56289	500D105F150BA2R2
C1708	290-0164-00			CAP,FXD,ELCTLT:1UF,+50-10%,150V	56289	500D105F150BA2R2
C1710	283-0105-00			CAP,FXD,CER DI:0.01UF,+80-20%,2000V	60705	564CBA202IP203ZA
C1711	283-0105-00			CAP,FXD,CER DI:0.01UF,+80-20%,2000V	60705	564CBA202IP203ZA
C1712	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1714	283-0204-00			CAP,FXD,CER DI:0.01UF,20%,50V	04222	SR155E103MAA
C1715	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C1722	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
C1724	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C1732	281-0814-00			CAP,FXD,CER DI:100 PF,10%,100V	04222	MA101A101KAA
C1735	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C1736	285-0894-00			CAP,FXD,PLASTIC:5UF,5%,50V	14752	A650DIA505J
C1747	283-0092-00			CAP,FXD,CER DI:0.03UF,+80-20%,200V	59660	845-534Z5U0303Z
C1749	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C1750	283-0105-00			CAP,FXD,CER DI:0.01UF,+80-20%,2000V	60705	564CBA202IP203ZA
C1752	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1754	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1755	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1756	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1764	283-0272-00			CAP,FXD,CER DI:0.0068UF,30%,4000V	51406	DHR28Y5S682M-4
C1770	290-0767-00			CAP,FXD,ELCTLT:4.7UF,+75-10%,160VDC	54473	ECEA2CS4R7
C1772	283-0010-00			CAP,FXD,CER DI:0.05UF,+80-20%,50V	04222	SR305E503ZAA
C1774	290-0767-00			CAP,FXD,ELCTLT:4.7UF,+75-10%,160VDC	54473	ECEA2CS4R7
C1775	283-0177-00	B010100	B020799	CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAA
C1775	283-0203-00	B020800		CAP,FXD,CER DI:0.47UF,20%,50V	04222	SR305SC474MAA
C1776	283-0177-00			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAA

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C1778	283-0006-00			CAP,FXD,CER DI:0.02UF,+80-20%,500V	59660	0841545Z5V00203Z
C1783	283-0108-00			CAP,FXD,CER DI:220PF,10%,200V	31433	C320C221K2G5CA
C1785	283-0032-00			CAP,FXD,CER DI:470PF,5%,500V	59660	831-000-Z5E0471J
C1786	283-0272-00			CAP,FXD,CER DI:0.0068UF,30%,4000V	51406	DHR28Y5S682M-4
C1791	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C1792	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1793	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1796	283-0002-00	B010157	B073913	CAP,FXD,CER DI:0.01UF,+80-20%,500V	59821	D103Z40Z5ULADEG
C1796	283-0220-00	B073914		CAP,FXD,CER DI:0.01UF,20%,50V	04222	3429 050C 103M
C1797	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C1803	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C1807	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C1818	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1819	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1820	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1821	283-0092-00			CAP,FXD,CER DI:0.03UF,+80-20%,200V	59660	845-534Z5U0303Z
C1831	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1834	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C1839	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C1842	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C1846	283-0187-00			CAP,FXD,CER DI:0.047UF,10%,400V	04222	SR308C473KAA
C1848	283-0271-00	B010100	B010140	CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1849	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1850	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1852	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1860	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1862	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1870	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1872	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1877	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1880	283-0271-00			CAP,FXD,CER DI:0.001UF,20%,4000V	51406	DHR15Y5S102M-4KV
C1890	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C1893	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C1901	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1904	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
C1906	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
C1908	290-0187-00			CAP,FXD,ELCTLT:4.7UF,20%,35V	05397	T110B475M035AS
C1914	281-0763-00			CAP,FXD,CER DI:47PF,10%,100V	04222	MA101A470KAA
C1918	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
C1919	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1920	281-0773-00	B010100	B021249	CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1921	281-0813-00			CAP,FXD,CER DI:0.047UF,20%,50V	05397	C412C473M5V2CA
C1935	281-0797-00	B010100	B063670	CAP,FXD,CER DI:15PF,10%,100V	04222	SA106A150KAA
C1935	281-0759-00	B063671		CAP,FXD,CER DI:22PF,10%,100V	04222	MA101A220KAA
C1938	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
C1950	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C1952	281-0786-00			CAP,FXD,CER DI:150PF,10%,100V	04222	MA101A151KAA
C1953	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C1955	290-0536-00			CAP,FXD,ELCTLT:10UF,20%,25V TANTALUM	05397	T368B106M025AS
C1956	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
C1968	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
C1969	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1971	285-0913-00			CAP,FXD,PLASTIC:3UF,5%,50V	04099	TEK13-10
C1982	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C1984	281-0773-00	B010100	B021249	CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C1985	290-0529-00			CAP,FXD,ELCTLT:47UF,20%,20V	05397	T362C476M020AS
C1990	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
C1993	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA

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C1994	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C1995	290-0804-00			CAP,FXD,ELCTLT:10UF,+50-20%,25V	55680	ULB1E100TAAANA
C1996	290-0804-00			CAP,FXD,ELCTLT:10UF,+50-20%,25V	55680	ULB1E100TAAANA
C1997	290-0804-00			CAP,FXD,ELCTLT:10UF,+50-20%,25V	55680	ULB1E100TAAANA
C2101	283-0004-00	B010100	B049999	CAP,FXD,CER DI:0.02UF,+80-20%,150V	59660	855-558Z5V0203Z
C2101	281-0774-00	B500000		CAP,FXD,CER DI:0.022MFD,20%,100V	04222	MA201E223MAA
C2105	283-0108-00	B063845		CAP,FXD,CER DI:220PF,10%,200V	31433	C320C221K2G5CA
C2109	283-0003-00	B010100	B049999	CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C2109	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2112	283-0077-00	B010100	B049999	CAP,FXD,CER DI:330PF,5%,500V	59660	831-500B331J
C2112	281-0767-00	B050000		CAP,FXD,CER DI:330PF,20%,100V	04222	MA106C331MAA
C2115	290-0534-00	B010100	B021280	CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
C2115	290-0782-00	B021281	B049999	CAP,FXD,ELCTLT:4.7UF,+75-20%,35VDC	55680	ULB1V4R7TAAANA
C2115	290-0804-00	B050000		CAP,FXD,ELCTLT:10UF,+50-20%,25V	55680	ULB1E100TAAANA
C2117	290-0534-00	B010100	B021280	CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
C2117	290-0782-00	B021281	B049999	CAP,FXD,ELCTLT:4.7UF,+75-20%,35VDC	55680	ULB1V4R7TAAANA
C2117	290-0920-00	B050000		CAP,FXD,ELCTLT:33UF,+50-20%,35WVDC	55680	UVX1H330MAA
C2118	290-0804-00	B050000		CAP,FXD,ELCTLT:10UF,+50-20%,25V	55680	ULB1E100TAAANA
C2119	290-0534-00	B010100	B021280	CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
C2119	290-0782-00	B021281	B049999	CAP,FXD,ELCTLT:4.7UF,+75-20%,35VDC	55680	ULB1V4R7TAAANA
C2120	281-0862-00	B050000		CAP,FXD,CER DI:0.001UF,+80-20%,100V	04222	MA101C10ZMAA
C2121	283-0594-00	B010100	B049999	CAP,FXD,MICA DI:0.001UF,1%,100V	00853	D151F102F0
C2121	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2127	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2135	285-0698-00			CAP,FXD,PLASTIC:0.0082UF,5%,100V	80009	285-0698-00
C2140	283-0103-00	B010100	B049999	CAP,FXD,CER DI:180PF,5%,500V	59821	2DDH73L181J
C2141	281-0767-00	B063541		CAP,FXD,CER DI:330PF,20%,100V	04222	MA106C331MAA
C2144	281-0544-00	B010100	B021280	CAP,FXD,CER DI:5.6PF,+/0.5PF,500V	52763	2RDPLZ007 270PM0
C2144	281-0810-00	B021281		CAP,FXD,CER DI:5.6PF,+/-0.5PF,100V	04222	MA101A5R6DAA
C2145	290-0534-00	B010100	B021280	CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
C2145	290-0782-00	B021281	B049999	CAP,FXD,ELCTLT:4.7UF,+75-20%,35VDC	55680	ULB1V4R7TAAANA
C2154	283-0630-00	B050000		CAP,FXD,MICA DI:110PF,1%,100V (SELECTABLE)	00853	D155F111F0
C2154	283-0728-00	B050000		CAP,FXD,MICA DI:120PF,1%,500V	00853	D155F121F0
C2154	283-0796-00	B050000		CAP,FXD,MICA DI:100PF,5%,500V (SELECTABLE)	00853	D105F101J0
C2155	283-0103-00	B010100	B049999	CAP,FXD,CER DI:180PF,5%,500V	59821	2DDH73L181J
C2155	281-0158-00	B050000		CAP,VAR,CER DI:7-45PF,100WVDC SUBMIN CER	59660	518-006 G 7-45
C2157	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2161	281-0765-00	B050000		CAP,FXD,CER DI:100PF,5%,100V	04222	MA101A101JAA
C2180	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2183	283-0032-00	B010100	B049999	CAP,FXD,CER DI:470PF,5%,500V	59660	831-000-Z5E0471J
C2183	281-0788-00	B050000		CAP,FXD,CER DI:470PF,10%,100V	04222	SA102C471KAA
C2185	283-0004-00	B010100	B049999	CAP,FXD,CER DI:0.02UF,+80-20%,150V	59660	855-558Z5V0203Z
C2185	281-0774-00	B050000		CAP,FXD,CER DI:0.022MFD,20%,100V	04222	MA201E223MAA
C2186	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2187	281-0862-00	B050000		CAP,FXD,CER DI:0.001UF,+80-20%,100V	04222	MA101C10ZMAA
C2190	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2201	281-0114-00	B050000		CAP,VAR,AIR DI:1.3-5.4PF,425V	TK1036	189-0752-075
C2202	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2203	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2204	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2211	281-0762-00	B050000		CAP,FXD,CER DI:27PF,20%,100V	04222	MA101A270MAA
C2212	283-0666-00	B050000		CAP,FXD,MICA DI:890PF,2%,100V	00853	D151F891G0
C2213	283-0640-00	B050000		CAP,FXD,MICA DI:160PF,1%,500V	00853	D155F161F0
C2214	283-0032-00	B010100	B049999	CAP,FXD,CER DI:470PF,5%,500V	59660	831-000-Z5E0471J
C2221	281-0788-00	B050000		CAP,FXD,CER DI:470PF,10%,100V	04222	SA102C471KAA
C2239	281-0788-00	B050000		CAP,FXD,CER DI:470PF,10%,100V	04222	SA102C471KAA
C2242	283-0000-00	B010100	B049999	CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P

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C2243	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2244	283-0004-00	B010100	B049999	CAP,FXD,CER DI:0.02UF,+80-20%,150V	59660	855-558Z5V0203Z
C2244	281-0774-00	B050000		CAP,FXD,CER DI:0.022MFD,20%,100V	04222	MA201E223MAA
C2245	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2246	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2251	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2255	283-0000-00	B010100	B049999	CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
C2259	281-0762-00	B063541		CAP,FXD,CER DI:27PF,20%,100V (NOMINAL VALUE)	04222	MA101A270MAA
C2259	281-0798-00	B063541		CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
C2259	281-0799-00	B063541		CAP,FXD,CER DI:62PF,2%,100V	04222	MA101A620GAA
C2259	281-0808-00	B063541		CAP,FXD,CER DI:7 PF,20%,100V	04222	MA101A7R04AA
C2259	281-0811-00	B063541		CAP,FXD,CER DI:10PF,10%,100V	04222	MA101A100KAA
C2259	281-0759-00	B063845		CAP,FXD,CER DI:22PF,10%,100V	04222	MA101A220KAA
C2259	281-0763-00	B063845		CAP,FXD,CER DI:47PF,10%,100V	04222	MA101A470KAA
C2259	281-0797-00	B063845		CAP,FXD,CER DI:15PF,10%,100V	04222	SA106A150KAA
C2259	281-0819-00	B063845		CAP,FXD,CER DI:33 PF,5%,50V (C2259 IS SELECTABLE)	04222	GC105A330J
C2263	281-0773-00	B050000		CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C2276	281-0762-00	B050000		CAP,FXD,CER DI:27PF,20%,100V	04222	MA101A270MAA
C2277	283-0666-00	B050000		CAP,FXD,MICA DI:890PF,2%,100V	00853	D151F891G0
C2279	283-0640-00	B050000		CAP,FXD,MICA DI:160PF,1%,500V	00853	D155F161F0
C2281	283-0054-00			CAP,FXD,CER DI:150PF,5%,200V	59660	855-535 U2J0151J
C2284	283-0251-00	B021700		CAP,FXD,CER DI:87 PF,5%,100V	04222	3418 100A 870J
C2297	281-0762-00	B063541		CAP,FXD,CER DI:27PF,20%,100V (NOMINAL VALUE)	04222	MA101A270MAA
C2297	281-0798-00	B063541		CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
C2297	281-0799-00	B063541		CAP,FXD,CER DI:62PF,2%,100V	04222	MA101A620GAA
C2297	281-0808-00	B063541		CAP,FXD,CER DI:7 PF,20%,100V	04222	MA101A7R04AA
C2297	281-0811-00	B063541		CAP,FXD,CER DI:10PF,10%,100V	04222	MA101A100KAA
C2297	281-0759-00	B063845		CAP,FXD,CER DI:22PF,10%,100V	04222	MA101A220KAA
C2297	281-0763-00	B063845		CAP,FXD,CER DI:47PF,10%,100V	04222	MA101A470KAA
C2297	281-0797-00	B063845		CAP,FXD,CER DI:15PF,10%,100V	04222	SA106A150KAA
C2297	281-0819-00	B063845		CAP,FXD,CER DI:33 PF,5%,50V (C2297 IS SELECTABLE)	04222	GC105A330J
C3440	281-0816-00	B053267		CAP,FXD,CER DI:82 PF,5%,100V	04222	MA106A820JAA
C4301	283-0177-00			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAA
C4302	283-0177-00			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAA
C4303	283-0177-00			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAA
C4304	283-0177-00			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAA
C4305	290-0755-00			CAP,FXD,ELCTLT:100UF,+50%-20%,10WVDC	54473	ECE-A10V100L
C4314	283-0672-00			CAP,FXD,MICA DI:200PF,1%,500V	00853	D155F2010F0
C4315	281-0603-00			CAP,FXD,CER DI:39PF,5%,500V	52763	2RDPLZ007 39POJC
C4316	283-0177-00			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAA
C4335	281-0603-00			CAP,FXD,CER DI:39PF,5%,500V	52763	2RDPLZ007 39POJC
C4336	281-0549-00			CAP,FXD,CER DI:68PF,10%,500V	52763	2RDPLZ007 68POKU
C4342	283-0032-00			CAP,FXD,CER DI:470PF,5%,500V	59660	831-000-Z5E0471J
C4343	281-0782-00			CAP,FXD,CER DI:33 PF,10%,500V	52763	2RDPLZ007 33POKE
C4345	281-0782-00			CAP,FXD,CER DI:33 PF,10%,500V	52763	2RDPLZ007 33POKE
C4346	283-0032-00			CAP,FXD,CER DI:470PF,5%,500V	59660	831-000-Z5E0471J
C4347	283-0638-00			CAP,FXD,MICA DI:130PF,1%,500V	00853	D155F131F0
C4423	281-0603-00			CAP,FXD,CER DI:39PF,5%,500V	52763	2RDPLZ007 39POJC
C4441	281-0603-00			CAP,FXD,CER DI:39PF,5%,500V	52763	2RDPLZ007 39POJC
C4449	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
C4461	281-0589-00			CAP,FXD,CER DI:170PF,5%,500V	52763	2RDPLZ007170PJK
C4467	281-0589-00			CAP,FXD,CER DI:170PF,5%,500V	52763	2RDPLZ007170PJK
C4470	283-0111-00			CAP,FXD,CER DI:0.1UF,20%,50V	05397	C330C104M5U1CA
C4475	283-0177-00			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAA
C4483	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P

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C4484	283-0177-00			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAA
C4485	283-0060-00			CAP,FXD,CER DI:100PF,5%,200V	59660	855-535U2J101J
CR52	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR71	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR81	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR82	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR83	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR86	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR88	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR342	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR362	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR386	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR552	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR651	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR654	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR711	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR712	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR767	152-0322-00			SEMICOND DVC,DI:SCHOTTKY,SI,15V,1.2PF,DO-35	50434	5082-2672
CR777	152-0322-00			SEMICOND DVC,DI:SCHOTTKY,SI,15V,1.2PF,DO-35	50434	5082-2672
CR862	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR863	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR864	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR875	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR878	152-0066-00			SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
CR883	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR886	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR891	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR893	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR897	152-0066-00			SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
CR1006	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1082	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1112	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35 (CR1112, OPTION 02 ONLY)	03508	DA2527 (1N4152)
CR1215	152-0396-01	B010100	B039999	SEMICOND DVC,DI:RECT,SI,400V,3A	14936	KBPC604-1
CR1215	152-0750-00	B040000		SEMICOND DVC,DI:RECT BRDG,600V,3A,FAST RCVY	05828	RKBPC606-12
CR1232	152-0107-00			SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1	12969	"G727"
CR1233	152-0400-00	B021360		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
CR1234	152-0400-00			SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
CR1236	152-0061-00			SEMICOND DVC,DI:SW,SI,175V,0.1A,DO-35	07263	FDH2161
CR1237	152-0061-00			SEMICOND DVC,DI:SW,SI,175V,0.1A,DO-35	07263	FDH2161
CR1239	152-0400-00	B021360		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
CR1240	152-0107-00			SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1	12969	"G727"
CR1241	152-0400-00			SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
CR1244	152-0107-00			SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1	12969	"G727"
CR1245	152-0061-00			SEMICOND DVC,DI:SW,SI,175V,0.1A,DO-35	07263	FDH2161
CR1246	152-0581-00	B031930		SEMICOND DVC,DI:RECT,SI,20V,1A,A59	04713	1N5817
CR1249	152-0107-00			SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1	12969	"G727"
CR1252	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1259	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1265	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1266	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1273	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1274	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1275	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1276	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1281	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1282	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1283	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
CR1284	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1290	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1320	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1321	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1322	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1323	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1324	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1325	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1327	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1330	152-0586-00			SEMICOND DVC,DI:RECT,SI,600V,0.5A	25403	BYV96D OR BYV95C
CR1331	152-0586-00			SEMICOND DVC,DI:RECT,SI,600V,0.5A	25403	BYV96D OR BYV95C
CR1332	152-0586-00			SEMICOND DVC,DI:RECT,SI,600V,0.5A	25403	BYV96D OR BYV95C
CR1333	152-0586-00			SEMICOND DVC,DI:RECT,SI,600V,0.5A	25403	BYV96D OR BYV95C
CR1340	152-0397-00			SEMICOND DVC,DI:RECT,SI,100V,12A	80009	152-0397-00
CR1341	152-0397-00			SEMICOND DVC,DI:RECT,SI,100V,12A	80009	152-0397-00
CR1342	152-0397-00			SEMICOND DVC,DI:RECT,SI,100V,12A	80009	152-0397-00
CR1343	152-0397-00			SEMICOND DVC,DI:RECT,SI,100V,12A	80009	152-0397-00
CR1350	152-0586-00			SEMICOND DVC,DI:RECT,SI,600V,0.5A	25403	BYV96D OR BYV95C
CR1351	152-0692-00			SEMICOND DVC,DI:SI,20V,30A,TO-3	04713	SD241
CR1353	152-0586-00			SEMICOND DVC,DI:RECT,SI,600V,0.5A	25403	BYV96D OR BYV95C
CR1361	152-0008-00	B010100	B043199	SEMICOND DVC,DI:SIG,GE,60V,60MA,A38A	14433	G1409
CR1361	152-0725-00	B043200		SEMICOND DVC,DI:SI,SCHOTTKY,20V,1.2PF,DO-35	21847	A2X1582
CR1371	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1372	152-0141-02	B010100	B031929	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1374	152-0141-02	B010100	B031929	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1383	152-0141-02	B031930		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1407	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1408	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1410	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1411	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1415	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1419	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1420	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1421	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1422	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1428	152-0066-00	B010100	B031929	SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
CR1428	152-0066-03	B031930		SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	14433	LG4017
CR1445	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1449	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1450	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1451	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1452	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1453	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1458	152-0066-00	B010100	B031929	SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
CR1458	152-0066-03	B031930		SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	14433	LG4017
CR1464	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1476	152-0066-00	B010100	B031929	SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
CR1476	152-0066-03	B031930		SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	14433	LG4017
CR1484	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1496	152-0066-00	B010100	B031929	SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
CR1496	152-0066-03	B031930		SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	14433	LG4017
CR1514	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR1532	152-0066-00	B010100	B031929	SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
CR1532	152-0066-03	B031930		SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	14433	LG4017
CR1542	152-0423-00			SEMICOND DVC,DI:RECT,SI,400V,3A,M176A	04713	1N5000
CR1543	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1544	152-0423-00			SEMICOND DVC,DI:RECT,SI,400V,3A,M176A	04713	1N5000
CR1548	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
CR1600	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1607	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1608	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1609	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1618	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1623	152-0574-00			SEMICOND DVC,DI:SW,SI,120V,0.15A,DO-35	12969	NDP566
CR1624	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1649	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1665	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1666	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1675	152-0574-00			SEMICOND DVC,DI:SW,SI,120V,0.15A,DO-35	12969	NDP566
CR1676	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1677	152-0574-00			SEMICOND DVC,DI:SW,SI,120V,0.15A,DO-35	12969	NDP566
CR1678	152-0574-00			SEMICOND DVC,DI:SW,SI,120V,0.15A,DO-35	12969	NDP566
CR1687	152-0574-00	B010100	B020859	SEMICOND DVC,DI:SW,SI,120V,0.15A,DO-35	12969	NDP566
CR1688	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1690	152-0107-00			SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1	12969	"G727"
CR1691	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1692	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1694	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1696	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1698	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1707	152-0107-00			SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1	12969	"G727"
CR1708	152-0107-00			SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1	12969	"G727"
CR1710	152-0429-00			SEMICOND DVC,DI:RECT,SI,5000V,10MA,A298J	83003	VG5X-1
CR1711	152-0429-00			SEMICOND DVC,DI:RECT,SI,5000V,10MA,A298J	83003	VG5X-1
CR1714	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1715	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1720	152-0141-02	B073914		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1721	152-0141-02	B073914		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1724	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1736	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1747	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1749	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1752	152-0409-00			SEMICOND DVC,DI:RECT,SI,12KV,35MA,2NS	83003	VG12X-1
CR1753	152-0409-00			SEMICOND DVC,DI:RECT,SI,12KV,35MA,2NS	83003	VG12X-1
CR1762	152-0409-00			SEMICOND DVC,DI:RECT,SI,12KV,35MA,2NS	83003	VG12X-1
CR1763	152-0409-00			SEMICOND DVC,DI:RECT,SI,12KV,35MA,2NS	83003	VG12X-1
CR1771	152-0586-00			SEMICOND DVC,DI:RECT,SI,600V,0.5A	25403	BYV96D OR BYV95C
CR1772	152-0586-00			SEMICOND DVC,DI:RECT,SI,600V,0.5A	25403	BYV96D OR BYV95C
CR1774	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1775	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1776	152-0586-00			SEMICOND DVC,DI:RECT,SI,600V,0.5A	25403	BYV96D OR BYV95C
CR1778	152-0586-00			SEMICOND DVC,DI:RECT,SI,600V,0.5A	25403	BYV96D OR BYV95C
CR1785	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1788	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1789	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1792	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1794	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1803	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1804	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1816	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1818	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1819	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1820	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR1835	152-0141-02			SEMICOND DVC,DI:SW,SI;30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1838	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1842	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
CR1900	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1902	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1916	152-0322-00			SEMICOND DVC,DI:SCHOTTKY,SI,15V,1.2PF,DO-35	50434	5082-2672
CR1918	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1922	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1923	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1927	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1928	152-0141-00	B010100	B021249	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-7	80009	152-0141-00
CR1929	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1946	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1947	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1948	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1963	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1971	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1972	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1974	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1982	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1991	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1992	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1993	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1994	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR1998	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2009	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2019	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2124	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2125	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2127	152-0141-02	B010100	B049999	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2137	152-0141-02	B050000		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2139	152-0141-02	B050000		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2140	152-0141-02	B010100	B049999	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2141	152-0141-02	B010100	B049999	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2142	152-0141-02	B010100	B049999	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2145	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2146	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2153	152-0141-02	B050000		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2156	152-0141-02	B010100	B049999	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2157	152-0141-02	B010100	B063938	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2157	152-0322-00	B063939		SEMICOND DVC,DI:SCHOTTKY,SI,15V,1.2PF,DO-35	50434	5082-2672
CR2160	152-0141-02	B050000		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2161	152-0141-02	B050000		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2162	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2163	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2166	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2167	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2170	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2171	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2174	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2175	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2187	152-0141-02	B050000		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2192	152-0141-02	B010100	B049999	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2193	152-0141-02	B010100	B049999	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2196	152-0141-02	B010100	B049999	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2198	152-0141-02	B010100	B049999	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2226	152-0141-02	B010100	B049999	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2229	152-0141-02	B050000		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2235	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR2266	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
CR2267	152-0141-02	B050000		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
CR2270	152-0141-02	B050000		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR2271	152-0141-02	B050000		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4322	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
CR4323	152-0141-02	B010100	B010149	SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4323	152-0322-00	B010150		SEMICOND DVC,DI:SCHOTTKY,SI,15V,1.2PF,DO-35	50434	5082-2672
CR4354	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4355	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4356	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4357	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4368	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4369	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4433	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4434	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4448	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4449	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4461	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4467	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4471	152-0153-00			SEMICOND DVC,DI:SW,SI,10V,50MA,.DO-7	07263	FD7003
CR4472	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4473	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4474	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4487	152-0075-00	B010100	B043199	SEMICOND DVC,DI:SW,GE,22V,80MW,DO-7	80009	152-0075-00
CR4487	152-0664-00	B043200		SEMICOND DVC,DI:SCHOTTKY,SW,SI,70V,DO-35	80009	152-0664-00
CR4491	152-0075-00	B010100	B043199	SEMICOND DVC,DI:SW,GE,22V,80MW,DO-7	80009	152-0075-00
CR4491	152-0664-00	B043200		SEMICOND DVC,DI:SCHOTTKY,SW,SI,70V,DO-35	80009	152-0664-00
CR4492	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4493	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4494	152-0025-00	B010100	B010129	SEMICOND DVC,DI:SIG,GE,125V,100MA,DO-7	15238	G1471
CR4494	152-0581-00	B010130		SEMICOND DVC,DI:RECT,SI,20V,1A,A59	04713	1N5817
CR4495	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4496	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4498	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR4499	152-0025-00	B010100	B010129	SEMICOND DVC,DI:SIG,GE,125V,100MA,DO-7	15238	G1471
CR4499	152-0581-00	B010130		SEMICOND DVC,DI:RECT,SI,20V,1A,A59	04713	1N5817
DL592	119-0933-00			DELAY LINE,ELEC:52NS,50 OHM	80009	119-0933-00
DL1165	119-0932-00			DELAY LINE,ELEC:47NS,100 OHM (DL1165, OPTION 02 ONLY)	80009	119-0932-00
DS304	150-0029-00	B010100	B021449	LAMP,INCAND:6.3V,0.2A,#349,MIDGET FLG	58854	349
DS304	150-0097-00	B021450		LAMP,INCAND:6.3V,0.2A,#7381,WIRE LEADS	92966	7381
DS305	150-0029-00	B010100	021449	LAMP,INCAND:6.3V,0.2A,#349,MIDGET FLG	58854	349
DS305	150-0097-00	B021450		LAMP,INCAND:6.3V,0.2A,#7381,WIRE LEADS	92966	7381
DS306	150-0029-00	B010100	B021449	LAMP,INCAND:6.3V,0.2A,#349,MIDGET FLG	58854	349
DS306	150-0097-00	B021450		LAMP,INCAND:6.3V,0.2A,#7381,WIRE LEADS	92966	7381
DS308	150-0121-02			LAMP,CARTRIDGE:5V,0.06A,GREEN LENS	55292	71320-03
DS342	150-0093-01	B010100	B020839	LAMP,INCAND:5V,0.06A,6833AS15,WIRE LD SEL	58854	6833AS15
DS342	150-0048-01	B020840		LAMP,INCAND:5V,0.06A,#683,AGED & SEL	58854	683AS15
DS345	150-0093-01	B010100	B020839	LAMP,INCAND:5V,0.06A,6833AS15,WIRE LD SEL	58854	6833AS15
DS345	150-0048-01	B020840		LAMP,INCAND:5V,0.06A,#683,AGED & SEL	58854	683AS15
DS346	150-0093-01	B010100	B020839	LAMP,INCAND:5V,0.06A,6833AS15,WIRE LD SEL	58854	6833AS15
DS346	150-0048-01	B020840		LAMP,INCAND:5V,0.06A,#683,AGED & SEL	58854	683AS15
DS362	150-0093-01	B010100	B020839	LAMP,INCAND:5V,0.06A,6833AS15,WIRE LD SEL	58854	6833AS15
DS362	150-0048-01	B020840		LAMP,INCAND:5V,0.06A,#683,AGED & SEL	58854	683AS15
DS365	150-0093-01	B010100	B020839	LAMP,INCAND:5V,0.06A,6833AS15,WIRE LD SEL	58854	6833AS15
DS365	150-0048-01	B020840		LAMP,INCAND:5V,0.06A,#683,AGED & SEL	58854	683AS15
DS366	150-0093-01	B010100	B020839	LAMP,INCAND:5V,0.06A,6833AS15,WIRE LD SEL	58854	6833AS15
DS366	150-0048-01	B020840		LAMP,INCAND:5V,0.06A,#683,AGED & SEL	58854	683AS15
DS1219	150-0035-00			LAMP,GLOW:90V MAX,0.3MA,AID-T,WIRE LD	TK0213	JH005/3011JA
DS1682	150-0030-00			LAMP,GLOW:60-90V MAX,0.6MA,A28-T,WIRE LEADS	58224	A2B-T

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
DS1687	150-1068-00	B020860		LT EMITTING DIO:RED,635NM,10MA MAX	50434	HLMP-6320
DS1792	150-0030-00			LAMP,GLOW:60-90V MAX,0.6MA,A28-T,WIRE LEADS	58224	A2B-T
DS1794	150-0030-00			LAMP,GLOW:60-90V MAX,0.6MA,A28-T,WIRE LEADS	58224	A2B-T
DS1818	150-0030-00			LAMP,GLOW:60-90V MAX,0.6MA,A28-T,WIRE LEADS	58224	A2B-T
DS1819	150-0030-00			LAMP,GLOW:60-90V MAX,0.6MA,A28-T,WIRE LEADS	58224	A2B-T
DS1820	150-0030-00			LAMP,GLOW:60-90V MAX,0.6MA,A28-T,WIRE LEADS	58224	A2B-T
DS1842	150-0030-00			LAMP,GLOW:60-90V MAX,0.6MA,A28-T,WIRE LEADS	58224	A2B-T
DS1844	150-0030-00			LAMP,GLOW:60-90V MAX,0.6MA,A28-T,WIRE LEADS	58224	A2B-T
DS1846	150-0030-00			LAMP,GLOW:60-90V MAX,0.6MA,A28-T,WIRE LEADS	58224	A2B-T
DS1848	150-0030-00			LAMP,GLOW:60-90V MAX,0.6MA,A28-T,WIRE LEADS	58224	A2B-T
DS1970	150-1033-00			LT EMITTING DIO:AMBER,585NM,40MA MAX	50434	HLMP-1401
DS1994	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	50434	HLMP-1002
DS2002	150-0048-01			LAMP,INCAND:5V,0.06A,#683,AGED & SEL	58854	683AS15
DS2003	150-0048-01			LAMP,INCAND:5V,0.06A,#683,AGED & SEL	58854	683AS15
E1208	119-0181-00			ARSR,ELEC SURGE:230,GAS FILLED	25088	B1-A230
E1213	119-0181-00			ARSR,ELEC SURGE:230,GAS FILLED	25088	B1-A230
E2132	276-0532-00	B053267		SHLD BEAD,ELEK:FERRITE	02114	56-590-65/4A6
F1200	159-0017-00			FUSE,CARTRIDGE:3AG,4A,250V,FAST BLOW	71400	MTH-CW-4
FL1200	119-0420-00			FILTER,RFI:6A,250VAC,400HZ	02777	F-11935-6
J1480	131-0608-00	B031930		TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 2)	22526	48283-036
J1785	131-0608-00	B073914		TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (J1785A)	22526	48283-036
J1785	131-0608-00	B073914		TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (J1785B)	22526	48283-036
K1112	148-0071-00	B010100	B010164	RELAY,ARMATURE:PLUG-IN,DPDT (OPTION 02 ONLY)	56623	BR44-S164
K1112	148-0107-00	B010165		RELAY,ARMATURE:2 FORM C,2A,18VDC,COIL 13.5V DC 880 OHM (OPTION 02 ONLY)	02289	MAW-169
K1162	148-0071-00	B010100	B010164	RELAY,ARMATURE:PLUG-IN,DPDT (OPTION 02 ONLY)	56623	BR44-S164
K1162	148-0107-00	B010165		RELAY,ARMATURE:2 FORM C,2A,18VDC,COIL 13.5V DC 880 OHM (OPTION 02 ONLY)	02289	MAW-169
L236	108-0734-00			COIL,RF:FIXED,163NH	TK1345	108-0734-00
L238	108-0734-00			COIL,RF:FIXED,163NH	TK1345	108-0734-00
L246	108-0734-00			COIL,RF:FIXED,163NH	TK1345	108-0734-00
L248	108-0734-00			COIL,RF:FIXED,163NH	TK1345	108-0734-00
L387	108-0440-00	B010100	B021797	COIL,RF:FIXED,8UH	80009	108-0440-00
L436	108-0734-00			COIL,RF:FIXED,163NH	TK1345	108-0734-00
L438	108-0734-00			COIL,RF:FIXED,163NH	TK1345	108-0734-00
L446	108-0734-00			COIL,RF:FIXED,163NH	TK1345	108-0734-00
L448	108-0734-00			COIL,RF:FIXED,163NH	TK1345	108-0734-00
L480	108-0324-00			COIL,RF:FIXED,10MH	76493	70F102A1
L486	108-0733-00	B010100	B010229	COIL,RF:FIXED,117NH	80009	108-0733-00
L486	108-0262-00	B063701		COIL,RF:FIXED,505NH (NOMINAL VALUE,SELECTED)	80009	108-0262-00
L486	108-0170-01	B063701		COIL,RF:FIXED,360NH	TK2042	ORDER BY DESCR
L486	108-0733-00	B063701		COIL,RF:FIXED,117NH (L486 IS SELECTABLE)	80009	108-0733-00
L582	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
L583	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
L584	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
L762	108-0420-00			COIL,RF:FIXED,35NH,15% (NOMINAL VALUE,SELECTED)	TK2042	ORDER BY DESCR
L763	108-0371-00			COIL,RF:FIXED,200NH	TK0852	108-0371-00
L764	108-0057-00			COIL,RF:FIXED,9.4UF	TK1345	108-0057-00
L772	108-0420-00			COIL,RF:FIXED,35NH,15% (NOMINAL VALUE,SELECTED)	TK2042	ORDER BY DESCR

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
L773	108-0371-00			COIL,RF:FIXED,200NH	TK0852	108-0371-00
L774	108-0057-00			COIL,RF:FIXED,9.4UF	TK1345	108-0057-00
L857	108-0170-01			COIL,RF:FIXED,360NH (NOMINAL VALUE,SELECTED)	TK2042	ORDER BY DESCR
L867	108-0735-00			COIL,RF:FIXED,584NH (NOMINAL VALUE,SELECTED)	TK2042	ORDER BY DESCR
L891	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
L893	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
L895	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
L897	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
L1001	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
L1002	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
L1003	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
L1004	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
L1042	108-0733-00			COIL,RF:FIXED,117NH	80009	108-0733-00
L1062	108-0733-00			COIL,RF:FIXED,117NH	80009	108-0733-00
L1156	108-0606-00			COIL,RF:FIXED,31NH (L1156, OPTION 02 ONLY)	80009	108-0606-00
L1229	108-0681-00			COIL,RF:FIXED,140UH	TK1345	108-0681-00
L1237	108-0761-00			COIL,RF:FIXED,1MH	54937	108-0761-00
L1332	108-0473-00			COIL,RF:FIXED,174UH	TK2042	ORDER BY DESCR
L1334	108-0473-00			COIL,RF:FIXED,174UH	TK2042	ORDER BY DESCR
L1342	108-0680-00			COIL,RF:FIXED,27UH	TK1345	108-0680-00
L1344	108-0680-00			COIL,RF:FIXED,27UH	TK1345	108-0680-00
L1352	108-0473-00			COIL,RF:FIXED,174UH	TK2042	ORDER BY DESCR
L1354	108-0556-00			COIL,RF:FIXED,12UH	TK1345	108-0556-00
L1356	108-0337-00			COIL,RF:FIXED,25UH	80009	108-0337-00
L1627	108-0215-00			COIL,RF:FIXED,1.1UH	TK1345	108-0215-00
L1643	108-0543-00			COIL,RF:FIXED,1.1UH	TK1345	108-0543-00
L1645	108-0543-00			COIL,RF:FIXED,1.1UH	TK1345	108-0543-00
L1995	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
L1996	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
L1997	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
L2212	108-0800-00	B050000		COIL,RF:FIXED,820MH	04072	9230-90
L2277	108-0800-00	B050000		COIL,RF:FIXED,820MH	04072	9230-90
L2283	108-0331-00	B010100	B049999	COIL,RF:FIXED,758NH	TK1345	108-0331-00
L4301	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
L4302	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
L4303	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
L4304	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
L4317	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
L4342	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
L4344	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
LR857	108-0683-00			COIL,RF:FIXED,900NH	80009	108-0683-00
LR885	108-0543-00			COIL,RF:FIXED,1.1UH	TK1345	108-0543-00
LR1096	108-0325-00			COIL,RF:FIXED,489NH	TK2042	ORDER BY DESCR
LR1097	108-0685-00			COIL,RF:FIXED,39NH	TK1345	108-0685-00
LR1098	108-0685-00			COIL,RF:FIXED,39NH	TK1345	108-0685-00
LR1142	108-0729-00			COIL,RF:FIXED,204NH,10% (LR1142, OPTION 02 ONLY)	TK1345	108-0729-00
LR1644	108-0537-00			COIL,RF:FIXED,200UH	80009	108-0537-00
LR4338	108-0543-00			COIL,RF:FIXED,1.1UH	TK1345	108-0543-00
LR4359	108-0543-00			COIL,RF:FIXED,1.1UH	TK1345	108-0543-00
LR4368	108-0543-00			COIL,RF:FIXED,1.1UH	TK1345	108-0543-00
LR4412	108-0543-00			COIL,RF:FIXED,1.1UH	TK1345	108-0543-00
P40	131-0589-00			TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ (QUANTITY OF 4)	22526	48283-029
P48	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 5)	22526	48283-036

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
P50	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 7)	22526	48283-036
P52	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 6)	22526	48283-036
P54	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 4)	22526	48283-036
P1454	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 4)	22526	48283-036
P1482	131-0589-00			TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ (QUANTITY OF 10)	22526	48283-029
P1483	131-0589-00			TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ (QUANTITY OF 8)	22526	48283-029
P1490	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 2)	22526	48283-036
P1785	175-9320-00	B073914		CA ASSY,SP,ELEC:9,26 AWG,5.5 L,RIBBON	80009	175-9320-00
Q75	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q254	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q342	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q346	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q362	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q366	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q376	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q382	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q384	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
Q454	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q542	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q548	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q556	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q558	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q642	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q648	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q652	151-0301-00			TRANSISTOR:PNP,SI,TO-18	80009	151-0301-00
Q656	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q658	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q672	151-0301-00			TRANSISTOR:PNP,SI,TO-18	80009	151-0301-00
Q676	151-0235-00	B010100	B020839	TRANSISTOR:PNP,SI,TO-5	04713	SS4353
Q676	151-0134-00	B020840		TRANSISTOR:PNP,SI,TO-39	04713	SM3195
Q682	151-0301-00			TRANSISTOR:PNP,SI,TO-18	80009	151-0301-00
Q712	151-0221-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0221-00
Q718	151-0301-00			TRANSISTOR:PNP,SI,TO-18	80009	151-0301-00
Q722	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q732	151-0333-00	B010100	B032223	TRANSISTOR:SELECTED	04713	SPS1752
Q732	151-0367-00	B032224		TRANSISTOR:NPN,SI,TO-92	04713	SPS 8811
Q742	151-0216-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8803
Q748	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q752	151-0216-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8803
Q758	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q814	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q824	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q862	151-0183-00			TRANSISTOR:NPN,SI,TO-39	04713	ST1512
Q864	151-0301-00			TRANSISTOR:PNP,SI,TO-18	80009	151-0301-00
Q872	151-0301-00			TRANSISTOR:PNP,SI,TO-18	80009	151-0301-00
Q873	151-0529-00			SCR:200V,0.5A	04713	MCR206
Q878	151-0136-00			TRANSISTOR:NPN,SI,TO-39	02735	35495
Q884	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q892	151-0136-00			TRANSISTOR:NPN,SI,TO-39	02735	35495
Q914	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q923	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q924	156-0048-00			MICROCKT,LINEAR:5 XSTR ARRAY	02735	CA3046

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
Q962	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q964	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q992	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q994	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q1022	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q1024	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q1028	151-0424-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8246
Q1034	151-0424-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8246
Q1046	151-0221-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0221-00
Q1049	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q1052	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
Q1058	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q1066	151-0221-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0221-00
Q1072	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
Q1078	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q1084	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q1166	151-0301-00			TRANSISTOR:PNP,SI,TO-18 (Q1166, OPTION 02 ONLY)	80009	151-0301-00
Q1234	151-0632-00	B010100	B020999	TRANSISTOR:NPN,SILICON,TO-220	04713	MJE13007
Q1234	151-0632-03	B021000	B031929	TRANSISTOR:NPN,SI,SCREENED	04713	ORDER BY DESCR
Q1234	151-0632-00	B031930		TRANSISTOR:NPN,SILICON,TO-220	04713	MJE13007
Q1238	151-0508-00			TRANSISTOR:UJT,SI,TO-98	03508	X13T520
Q1240	151-0632-00	B010100	B020999	TRANSISTOR:NPN,SILICON,TO-220	04713	MJE13007
Q1240	151-0632-03	B021000	B031929	TRANSISTOR:NPN,SI,SCREENED	04713	ORDER BY DESCR
Q1240	151-0632-00	B031930		TRANSISTOR:NPN,SILICON,TO-220	04713	MJE13007
Q1243	151-0347-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7951
Q1245	151-0350-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS6700
Q1246	151-0260-00			TRANSISTOR:NPN,SI,TO-39	80009	151-0260-00
Q1252	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q1254	151-0273-00			TRANSISTOR:SELECTED	03508	X16E3616
Q1362	151-0190-00	B010100	B031929	TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q1362	151-0190-05	B031930	B053348	TRANSISTOR:SELECTED 2N3904	80009	151-0190-05
Q1362	151-0190-00	B053349		TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q1371	151-0190-00	B010100	B031929	TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q1371	151-0190-05	B031930	B053348	TRANSISTOR:SELECTED 2N3904	80009	151-0190-05
Q1371	151-0190-00	B053349		TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q1373	151-0188-00	B010100	B031929	TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q1373	151-0188-03	B031930	B053348	TRANSISTOR:SELECTED	80009	151-0188-03
Q1373	151-0188-00	B053349		TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q1377	151-0188-00	B010100	B031929	TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q1377	151-0188-03	B031930	B053348	TRANSISTOR:SELECTED	80009	151-0188-03
Q1377	151-0188-00	B053349		TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q1422	151-0350-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS6700
Q1428	151-0656-00			TRANSISTOR:DARLINGTON,NPN,SI,TO-220	02735	2N6044
Q1434	151-0103-00			TRANSISTOR:NPN,SI,TO-5	80009	151-0103-00
Q1438	151-0134-00			TRANSISTOR:PNP,SI,TO-39	04713	SM3195
Q1452	151-0347-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7951
Q1458	151-0657-00			TRANSISTOR:DARLINGTON,PNP,SI,TO-220	04713	SJE1973
Q1468	151-0347-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7951
Q1474	151-0656-00			TRANSISTOR:DARLINGTON,NPN,SI,TO-220	02735	2N6044
Q1488	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
Q1494	151-0657-00			TRANSISTOR:DARLINGTON,PNP,SI,TO-220	04713	SJE1973
Q1518	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q1522	151-0349-00			TRANSISTOR:NPN,SI,SELECTED,TO-127	04713	SJE924
Q1526	151-0477-00	B010100	B031929	TRANSISTOR:NPN,SI,TO-218	80009	151-0477-00
Q1526	151-0477-01	B031930		TRANSISTOR:SCREENED	80009	151-0477-01
Q1544	151-0224-00	B010100	B031929	TRANSISTOR:NPN,SI,TO-92	04713	SPS6917
Q1544	151-0190-05	B031930		TRANSISTOR:SELECTED 2N3904	80009	151-0190-05

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
Q1548	151-0373-00			TRANSISTOR:PNP,SI,TD-127	04713	SJE925
Q1603	151-0438-00			TRANSISTOR:PNP,SI,AMPLIFIER,625 MA	80009	151-0438-00
Q1607	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q1608	151-0438-00			TRANSISTOR:PNP,SI,AMPLIFIER,625 MA	80009	151-0438-00
Q1617	151-0472-00			TRANSISTOR:NPN,SI,TO-92	51984	NE41632B
Q1618	151-0438-00			TRANSISTOR:PNP,SI,AMPLIFIER,625 MA	80009	151-0438-00
Q1620	151-0472-00			TRANSISTOR:NPN,SI,TO-92	51984	NE41632B
Q1626	151-0427-00			TRANSISTOR:NPN,SI,TO-92	07263	S39287
Q1629	151-0438-00			TRANSISTOR:PNP,SI,AMPLIFIER,625 MA	80009	151-0438-00
Q1632	151-0438-00			TRANSISTOR:PNP,SI,AMPLIFIER,625 MA	80009	151-0438-00
Q1644	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q1648	151-0438-00			TRANSISTOR:PNP,SI,AMPLIFIER,625 MA	80009	151-0438-00
Q1652	151-0472-00	B010100	B020859	TRANSISTOR:NPN,SI,TO-92	51984	NE41632B
Q1652	151-0441-00	B020860		TRANSISTOR:NPN,SI,TO-72	04713	SRF501
Q1658	151-0438-00			TRANSISTOR:PNP,SI,AMPLIFIER,625 MA	80009	151-0438-00
Q1664	151-0438-00			TRANSISTOR:PNP,SI,AMPLIFIER,625 MA	80009	151-0438-00
Q1666	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q1668	151-0659-00			TRANSISTOR:NPN,SI,TO-39,1GHZ	01281	LT 1839
Q1672	151-0103-00			TRANSISTOR:NPN,SI,TO-5	80009	151-0103-00
Q1676	151-0659-00			TRANSISTOR:NPN,SI,TO-39,1GHZ	01281	LT 1839
Q1687	151-0444-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS797
Q1690	156-0281-00			MICROCKT,LINEAR:4-XSTR,HIGH CUR ARRAY	02735	89164
Q1698	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
Q1708	151-0150-00			TRANSISTOR:NPN,SI,TO-39	80009	151-0150-00
Q1724	151-0453-00			TRANSISTOR:PNP,SI,TO-92	27014	ORDER BY DESCR
Q1742	151-0350-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS6700
Q1748	151-0350-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS6700
Q1784	151-0279-00			TRANSISTOR:SELECTED	04713	SS2821
Q1835	151-0126-00			TRANSISTOR:NPN,SI,TO-18	04713	ST1046
Q1838	151-0126-00			TRANSISTOR:NPN,SI,TO-18	04713	ST1046
Q1842	151-0350-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS6700
Q1908	151-0508-00			TRANSISTOR:UJT,SI,TO-98	03508	X13T520
Q1910	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
Q1916	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q1928	151-0271-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8236
Q1934	151-0223-00			TRANSISTOR:NPN,SI,625MW,TO-92	80009	151-0223-00
Q1938	151-0223-00			TRANSISTOR:NPN,SI,625MW,TO-92	80009	151-0223-00
Q1942	151-0301-00			TRANSISTOR:PNP,SI,TO-18	80009	151-0301-00
Q1943	151-0198-00			TRANSISTOR:SELECTED	80009	151-0198-00
Q1946	151-0198-00			TRANSISTOR:SELECTED	80009	151-0198-00
Q1956	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q1970	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q1974	151-1021-00			TRANSISTOR:FET,N-CHAN,SI,TO-18	80009	151-1021-00
Q1978	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q1980	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q1982	151-0301-00			TRANSISTOR:PNP,SI,TO-18	80009	151-0301-00
Q1994	151-0301-00			TRANSISTOR:PNP,SI,TO-18	80009	151-0301-00
Q1995	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q1998	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q1999	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q2108	151-0223-00			TRANSISTOR:NPN,SI,625MW,TO-92	80009	151-0223-00
Q2112	151-0221-00	B010100	B063844	TRANSISTOR:PNP,SI,TO-92	80009	151-0221-00
Q2112	151-0188-00	B063845		TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q2131	151-0190-00	B050000		TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q2132	151-0190-00	B050000	B053266	TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q2132	151-0432-00	B053267		TRANSISTOR:NPN,SI,625MW,TO-92	04713	SPS8512
Q2138	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q2142	151-0190-00	B050000		TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
Q2151	151-0190-00	B050000		TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q2152	151-0190-00	B050000		TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q2153	151-0192-00	B010100	B049999	TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q2153	151-0190-00	B050000		TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q2159	151-0190-00	B010100	B049999	TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q2181	151-0188-00	B050000		TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q2215	151-0232-00	B010100	B049999	TRANSISTOR:NPN,SI,TO-78	07263	SP12141
Q2223	151-0190-00	B010100	B049999	TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q2223	151-0232-00	B050000		TRANSISTOR:NPN,SI,TO-78	07263	SP12141
Q2225	151-0188-00	B010100	B049999	TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q2226	151-0190-00	B050000		TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q2227	151-0190-00	B050000		TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q2229	151-0190-00	B010100	B049999	TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q2229	151-0188-00	B050000		TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q2240	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q2243	151-0190-00	B050000		TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q2250	151-0188-00	B050000		TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q2255	151-1021-00	B050000		TRANSISTOR:FET,N-CHAN,SI,TO-18	80009	151-1021-00
Q2286	151-0188-00	B010100	B049999	TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q2287	151-0188-00	B010100	B049999	TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q2296	151-0188-00	B010100	B049999	TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q2296	151-1021-00	B050000		TRANSISTOR:FET,N-CHAN,SI,TO-18	80009	151-1021-00
Q2299	151-0188-00	B010100	B049999	TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q4336	151-0198-00			TRANSISTOR:SELECTED	80009	151-0198-00
Q4364	151-0198-00			TRANSISTOR:SELECTED	80009	151-0198-00
Q4374	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q4382	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q4392	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q4424	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q4432	151-0223-00			TRANSISTOR:NPN,SI,625MW,TO-92	80009	151-0223-00
Q4438	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q4442	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q4448	151-0216-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8803
Q4456	151-1022-00			TRANSISTOR:FET,N-CHAN,SI,TO-18	80009	151-1022-00
Q4462	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q4468	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q4480	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q4488	151-0192-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8801
Q4492	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
Q4494	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q4498	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q4508	156-0048-00			MICROCKT,LINEAR:5 XSTR ARRAY	02735	CA3046
R20	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
R22	321-0260-00			RES,FXD,FILM:4.99K OHM,1%,0.125W,TC=T0	19701	5033ED4K990F
R23	321-0260-00			RES,FXD,FILM:4.99K OHM,1%,0.125W,TC=T0	19701	5033ED4K990F
R40	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
R42	321-0260-00			RES,FXD,FILM:4.99K OHM,1%,0.125W,TC=T0	19701	5033ED4K990F
R43	321-0260-00			RES,FXD,FILM:4.99K OHM,1%,0.125W,TC=T0	19701	5033ED4K990F
R52	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R60	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
R61	317-0510-00			RES,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R62	317-0510-00			RES,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R66	315-0302-00			RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R67	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R71	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R74	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R75	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R80	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R81	317-0510-00			RES,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R82	317-0510-00			RES,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R83	315-0243-00			RES,FXD,FILM:24K OHM,5%,0.25W	57668	NTR25J-E24K0
R85	315-0105-00			RES,FXD,FILM:1M OHM,5%,0.25W	19701	5043CX1M000J
R86	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R87	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R88	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R90	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R91	315-0132-00			RES,FXD,FILM:1.3K OHM,5%,0.25W	57668	NTR25J-E01K3
R92	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
R93	321-0231-00			RES,FXD,FILM:2.49K OHM,1%,0.125W,TC=T0	19701	5033ED2K49F
R94	323-0160-00			RES,FXD,FILM:453 OHM,1%,0.5W,TC=T0	19701	5053RD453R0F
R95	321-0231-00			RES,FXD,FILM:2.49K OHM,1%,0.125W,TC=T0	19701	5033ED2K49F
R97	315-0132-00			RES,FXD,FILM:1.3K OHM,5%,0.25W	57668	NTR25J-E01K3
R99	315-0132-00			RES,FXD,FILM:1.3K OHM,5%,0.25W	57668	NTR25J-E01K3
R201	321-0164-00			RES,FXD,FILM:499 OHM,1%,0.125W,TC=T0	19701	5033ED499R0F
R202	321-0164-00			RES,FXD,FILM:499 OHM,1%,0.125W,TC=T0	19701	5033ED499R0F
R205	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R208	321-0164-00			RES,FXD,FILM:499 OHM,1%,0.125W,TC=T0	19701	5033ED499R0F
R209	321-0164-00			RES,FXD,FILM:499 OHM,1%,0.125W,TC=T0	19701	5033ED499R0F
R212	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0	91637	CMF50-F50R00F
R213	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0	91637	CMF50-F50R00F
R214	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0	91637	CMF50-F50R00F
R216	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0	91637	CMF50-F50R00F
R217	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0	91637	CMF50-F50R00F
R218	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0	91637	CMF50-F50R00F
R232	321-0202-00			RES,FXD,FILM:1.24K OHM,1%,0.125W,TC=T0	24546	NA55D1241F
R233	322-0111-00			RES,FXD,FILM:140 OHM,1%,0.25W,TC=T0	91637	MFF1421G140R0F
R234	322-0170-00			RES,FXD,FILM:576 OHM,1%,0.25W,TC=T0	75042	CEBT0-5760F
R235	321-0202-00			RES,FXD,FILM:1.24K OHM,1%,0.125W,TC=T0	24546	NA55D1241F
R236	321-0147-00			RES,FXD,FILM:332 OHM,1%,0.125W,TC=T0	07716	CEAD332R0F
R237	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R238	321-0155-00			RES,FXD,FILM:402 OHM,1%,0.125W,TC=T0	07716	CEAD402R0F
R239	321-0085-00			RES,FXD,FILM:75 OHM,1%,0.125W,TC=T0	57668	CRB14FXE 75 OHM
R240	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
R241	322-0114-00			RES,FXD,FILM:150 OHM,1%,0.25W,TC=T0	75042	CEBT0-1500F
R242	321-0202-00			RES,FXD,FILM:1.24K OHM,1%,0.125W,TC=T0	24546	NA55D1241F
R243	322-0111-00			RES,FXD,FILM:140 OHM,1%,0.25W,TC=T0	91637	MFF1421G140R0F
R244	322-0170-00			RES,FXD,FILM:576 OHM,1%,0.25W,TC=T0	75042	CEBT0-5760F
R245	321-0202-00			RES,FXD,FILM:1.24K OHM,1%,0.125W,TC=T0	24546	NA55D1241F
R246	321-0147-00			RES,FXD,FILM:332 OHM,1%,0.125W,TC=T0	07716	CEAD332R0F
R247	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R248	321-0155-00			RES,FXD,FILM:402 OHM,1%,0.125W,TC=T0	07716	CEAD402R0F
R250	317-0200-00			RES,FXD,CMPSN:20 OHM,5%,0.125W	01121	BB2005
R251	321-0218-00			RES,FXD,FILM:1.82K OHM,1%,0.125W,TC=T0	19701	5033ED1K82F
R252	321-0242-00			RES,FXD,FILM:3.24K OHM,1%,0.125W,TC=T0	19701	5043ED3K240F
R254	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R255	311-1236-00			RES,VAR,NONWW:TRMR,250 OHM,0.5W	32997	3386X-T07-251
R256	321-0062-00			RES,FXD,FILM:43.2 OHM,0.5%,0.125W,TC=T0	57668	CRB14 FXE 43.2
R261	321-0178-00			RES,FXD,FILM:698 OHM,1%,0.125W,TC=T0	07716	CEAD698R0F
R262	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R263	322-0151-00			RES,FXD,FILM:365 OHM,1%,0.25W,TC=T0	24546	NA60D3650F
R264	321-0201-00			RES,FXD,FILM:1.21K OHM,1%,0.125W,TC=T0	19701	5043ED1K210F
R265	321-0285-00			RES,FXD,FILM:9.09K OHM,1%,0.125W,TC=T0	07716	CEAD90900F
R270	311-1239-00			RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3386X-T07-252
R271	321-0178-00			RES,FXD,FILM:698 OHM,1%,0.125W,TC=T0	07716	CEAD698R0F
R272	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R273	322-0239-00			RES,FXD,FILM:3.01K OHM,1%,0.25W,TC=T0	75042	CEBT0-3011F

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R274	311-1248-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3386X-T07-501
R277	317-0510-00			RES,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R278	322-0085-00			RES,FXD,FILM:75.0 OHM,1%,0.25W,TC=T0	75042	CEBT0-75R00F
R279	311-1936-00			RES,VAR,NONWW:TRMR,50 OHM,20%,0.5W	32997	3386X-T07-500
R280	317-0510-00			RES,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R301	303-0301-00			RES,FXD,CMPSN:300 OHM,5%,1W	01121	GB3015
R324	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R325	311-1373-00			RES,VAR,NONWW:PNL,5K OHM,1W	32997	81C1D-E20-BA0344
R326	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R341	307-0109-00			RES,FXD,CMPSN:8.2 OHM,5%,0.25W	80009	307-0109-00
R342	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R343	315-0162-00			RES,FXD,FILM:1.6K OHM,5%,0.25W	19701	5043CX1K600J
R345	307-0109-00			RES,FXD,CMPSN:8.2 OHM,5%,0.25W	80009	307-0109-00
R346	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R347	307-0109-00			RES,FXD,CMPSN:8.2 OHM,5%,0.25W	80009	307-0109-00
R361	307-0109-00			RES,FXD,CMPSN:8.2 OHM,5%,0.25W	80009	307-0109-00
R362	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R363	315-0162-00			RES,FXD,FILM:1.6K OHM,5%,0.25W	19701	5043CX1K600J
R365	307-0109-00			RES,FXD,CMPSN:8.2 OHM,5%,0.25W	80009	307-0109-00
R366	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R367	307-0109-00			RES,FXD,CMPSN:8.2 OHM,5%,0.25W	80009	307-0109-00
R368	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R372	315-0823-00			RES,FXD,FILM:82K OHM,5%,0.25W	57668	NTR25J-E82K
R373	321-0258-00			RES,FXD,FILM:4.75K OHM,1%,0.125W,TC=T0	19701	5033ED4K750F
R374	321-0822-06			RES,FXD,FILM:1.76K OHM,0.25%,0.125W,TC=T9	19701	5033RE1K760C
R375	311-1566-00			RES,VAR,NONWW:TRMR,200 OHM,0.5W	32997	3352T-1-201
R376	321-0321-07			RES,FXD,FILM:21.5K OHM,0.1%,0.125W,TC=T9	19701	5033RE21K50B
R380	315-0362-00			RES,FXD,FILM:3.6K OHM,5%,0.25W	19701	5043CX3K600J
R381	321-0321-07			RES,FXD,FILM:21.5K OHM,0.1%,0.125W,TC=T9	19701	5033RE21K50B
R382	315-0223-00	B010100	B021489	RES,FXD,FILM:22K OHM,5%,0.25W	19701	5043CX22K00J92U
R382	315-0123-00	B021490		RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
R383	321-0166-00	B010100	B021489	RES,FXD,FILM:523 OHM,1%,0.125W,TC=T0	07716	CEAD523R0F
R383	321-0164-00	B021490		RES,FXD,FILM:499 OHM,1%,0.125W,TC=T0	19701	5033ED499R0F
R384	308-0307-00			RES,FXD,WW:5K OHM,1%,3W	00213	1240S-5000-1
R385	311-1225-00			RES,VAR,NONWW:TRMR,1K OHM,0.5W	32997	3386F-T04-102
R386	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R387	321-1611-07			RES,FXD,FILM:550 OHM,0.1%,0.125W,TC=T9	19701	5033RE550R0B
R389	321-1008-04	B021798		RES,FXD,FILM:12.0 OHM,0.1%,0.125W,TC=T2	57668	CRB14 BYE 12 OHM
R392	321-1612-07			RES,FXD,FILM:4.455K OHM,0.1%,0.125W,TC=T9	19701	5033RE4K455B
R393	321-1611-07			RES,FXD,FILM:550 OHM,0.1%,0.125W,TC=T9	19701	5033RE550R0B
R394	321-1612-07			RES,FXD,FILM:4.455K OHM,0.1%,0.125W,TC=T9	19701	5033RE4K455B
R395	321-1611-07			RES,FXD,FILM:550 OHM,0.1%,0.125W,TC=T9	19701	5033RE550R0B
R396	321-1612-07			RES,FXD,FILM:4.455K OHM,0.1%,0.125W,TC=T9	19701	5033RE4K455B
R397	321-0813-07			RES,FXD,FILM:495 OHM,0.1%,0.125W,TC=T9	19701	5033RE4950B
R401	321-0164-00			RES,FXD,FILM:499 OHM,1%,0.125W,TC=T0	19701	5033ED499R0F
R402	321-0164-00			RES,FXD,FILM:499 OHM,1%,0.125W,TC=T0	19701	5033ED499R0F
R405	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R408	321-0164-00			RES,FXD,FILM:499 OHM,1%,0.125W,TC=T0	19701	5033ED499R0F
R409	321-0164-00			RES,FXD,FILM:499 OHM,1%,0.125W,TC=T0	19701	5033ED499R0F
R412	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0	91637	CMF50-F50R00F
R413	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0	91637	CMF50-F50R00F
R414	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0	91637	CMF50-F50R00F
R416	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0	91637	CMF50-F50R00F
R417	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0	91637	CMF50-F50R00F
R418	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0	91637	CMF50-F50R00F
R419	321-0143-00			RES,FXD,FILM:301 OHM,1%,0.125W,TC=T0	07716	CEAD301R0F
R420	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0	19701	5033ED200R0F
R425	321-0143-00			RES,FXD,FILM:301 OHM,1%,0.125W,TC=T0	07716	CEAD301R0F

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R426	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0	19701	5033ED200R0F
R432	321-0202-00			RES,FXD,FILM:1.24K OHM,1%,0.125W,TC=T0	24546	NA55D1241F
R433	322-0111-00			RES,FXD,FILM:140 OHM,1%,0.25W,TC=T0	91637	MFF1421G140R0F
R434	322-0170-00			RES,FXD,FILM:576 OHM,1%,0.25W,TC=T0	75042	CEBT0-5760F
R435	321-0202-00			RES,FXD,FILM:1.24K OHM,1%,0.125W,TC=T0	24546	NA55D1241F
R436	321-0147-00			RES,FXD,FILM:332 OHM,1%,0.125W,TC=T0	07716	CEAD332R0F
R437	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R438	321-0155-00			RES,FXD,FILM:402 OHM,1%,0.125W,TC=T0	07716	CEAD402R0F
R439	322-0114-00			RES,FXD,FILM:150 OHM,1%,0.25W,TC=T0	75042	CEBT0-1500F
R440	317-0200-00			RES,FXD,CMPSN:20 OHM,5%,0.125W	01121	BB2005
R441	321-0085-00			RES,FXD,FILM:75 OHM,1%,0.125W,TC=T0	57668	CRB14FXE 75 OHM
R442	321-0202-00			RES,FXD,FILM:1.24K OHM,1%,0.125W,TC=T0	24546	NA55D1241F
R443	322-0111-00			RES,FXD,FILM:140 OHM,1%,0.25W,TC=T0	91637	MFF1421G140R0F
R444	322-0170-00			RES,FXD,FILM:576 OHM,1%,0.25W,TC=T0	75042	CEBT0-5760F
R445	321-0202-00			RES,FXD,FILM:1.24K OHM,1%,0.125W,TC=T0	24546	NA55D1241F
R446	321-0147-00			RES,FXD,FILM:332 OHM,1%,0.125W,TC=T0	07716	CEAD332R0F
R447	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R448	321-0155-00			RES,FXD,FILM:402 OHM,1%,0.125W,TC=T0	07716	CEAD402R0F
R451	321-0218-00			RES,FXD,FILM:1.82K OHM,1%,0.125W,TC=T0	19701	5033ED1K82F
R452	321-0242-00			RES,FXD,FILM:3.24K OHM,1%,0.125W,TC=T0	19701	5043ED3K240F
R454	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R455	311-1236-00			RES,VAR,NONWW:TRMR,250 OHM,0.5W	32997	3386X-T07-251
R456	321-0062-00			RES,FXD,FILM:43.2 OHM,0.5%,0.125W,TC=T0	57668	CRB14 FXE 43.2
R462	322-0151-00			RES,FXD,FILM:365 OHM,1%,0.25W,TC=T0	24546	NA60D3650F
R464	321-0201-00			RES,FXD,FILM:1.21K OHM,1%,0.125W,TC=T0	19701	5043ED1K210F
R465	321-0285-00			RES,FXD,FILM:9.09K OHM,1%,0.125W,TC=T0	07716	CEAD90900F
R473	322-0239-00			RES,FXD,FILM:3.01K OHM,1%,0.25W,TC=T0	75042	CEBT0-3011F
R474	311-1248-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3386X-T07-501
R476	317-0510-00			RES,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R477	317-0510-00			RES,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R478	322-0085-00			RES,FXD,FILM:75.0 OHM,1%,0.25W,TC=T0	75042	CEBT0-75R00F
R479	311-1936-00			RES,VAR,NONWW:TRMR,50 OHM,20%,0.5W	32997	3386X-T07-500
R480	311-1237-00			RES,VAR,NONWW:1K OHM,10%,0.50W	32997	3386X-DY6-102
R481	321-0179-00			RES,FXD,FILM:715 OHM,1%,0.125W,TC=T0	07716	CEAD715R0F
R482	321-0182-00			RES,FXD,FILM:768 OHM,1%,0.125W,TC=T0	07716	CEAD768R0F
R483	317-0100-00	B010100	B010229	RES,FXD,CMPSN:10 OHM,5%,0.125W	01121	BB1005
R483	317-0200-00	B010230	B063700	RES,FXD,CMPSN:20 OHM,5%,0.125W	01121	BB2005
R483	317-0270-00	B063701		RES,FXD,CMPSN:27 OHM,5%,0.125W	01121	BB2705
R484	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R485	311-1936-00			RES,VAR,NONWW:TRMR,50 OHM,20%,0.5W	32997	3386X-T07-500
R486	321-0143-00	B010100	B010229	RES,FXD,FILM:301 OHM,1%,0.125W,TC=T0	07716	CEAD301R0F
R486	325-0026-00	B010230	B063700	RES,FXD,FILM:180 OHM,1%,0.05W,TC=T9,MET	91637	CMF50-C180R0F
R486	321-0111-00	B063701		RES,FXD,FILM:140 OHM,1%,0.125W,TC=T0	07716	CEAD140R0F
R490	311-1237-00			RES,VAR,NONWW:1K OHM,10%,0.50W	32997	3386X-DY6-102
R491	321-0179-00			RES,FXD,FILM:715 OHM,1%,0.125W,TC=T0	07716	CEAD715R0F
R492	321-0182-00			RES,FXD,FILM:768 OHM,1%,0.125W,TC=T0	07716	CEAD768R0F
R493	317-0100-00	B010100	B010229	RES,FXD,CMPSN:10 OHM,5%,0.125W	01121	BB1005
R493	317-0200-00	B010230	B063700	RES,FXD,CMPSN:20 OHM,5%,0.125W	01121	BB2005
R493	317-0270-00	B063701		RES,FXD,CMPSN:27 OHM,5%,0.125W	01121	BB2705
R494	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R495	322-0145-00			RES,FXD,FILM:316 OHM,1%,0.25W,TC=T0	75042	CEBT0-3160F
R496	321-0143-00	B010100	B010229	RES,FXD,FILM:301 OHM,1%,0.125W,TC=T0	07716	CEAD301R0F
R496	325-0026-00	B010230	B063700	RES,FXD,FILM:180 OHM,1%,0.05W,TC=T9,MET	91637	CMF50-C180R0F
R496	321-0111-00	B063701		RES,FXD,FILM:140 OHM,1%,0.125W,TC=T0	07716	CEAD140R0F
R497	322-0175-00			RES,FXD,FILM:649 OHM,1%,0.25W,TC=T0	75042	CEBT0-6490F
R498	321-0143-00			RES,FXD,FILM:301 OHM,1%,0.125W,TC=T0	07716	CEAD301R0F
R499	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R501	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F

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R502	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R504	321-0355-00			RES,FXD,FILM:48.7K OHM,1%,0.125W,TC=T0	07716	CEAD48701F
R505	321-0335-00			RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0	57668	RB14FXE30K1
R511	315-0204-00	B010100	B032400	RES,FXD,FILM:200K OHM,5%,0.25W	19701	5043CX200K0J
R511	321-0414-00	B032401		RES,FXD,FILM:200K OHM,1%,0.125W,TC=T0	07716	CEAD20002F
R512	311-1214-00			RES,VAR,NONWW:TRMR,200K OHM,0.5W	32997	3386F-T04-204
R513	315-0203-00	B010100	B032400	RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R513	321-0318-00	B032401		RES,FXD,FILM:20.0K OHM,1%,0.125W,TC=T0	19701	5033ED20K00F
R514	315-0104-00	B010100	B032400	RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R514	321-0385-00	B032401		RES,FXD,FILM:100K OHM,1%,0.125W,TC=T0	19701	5033ED100K0F
R515	311-1235-00			RES,VAR,NONWW:100K OHM,0.5W	32997	3386F-T04-104
R516	315-0163-00	B010100	B032400	RES,FXD,FILM:16K OHM,5%,0.25W	57668	NTR25J-E 16K
R516	321-0309-00	B032401		RES,FXD,FILM:16.2K OHM,1%,0.125W,TC=T0	19701	5033ED16K20F
R519	315-0104-00	B010100	B032400	RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R519	321-0385-00	B032401		RES,FXD,FILM:100K OHM,1%,0.125W,TC=T0	19701	5033ED100K0F
R520	311-1232-00			RES,VAR,NONWW:TRMR,50K OHM,0.5W	32997	3386F-T04-503
R521	315-0822-00	B010100	B032400	RES,FXD,FILM:8.2K OHM,5%,0.25W	19701	5043CX8K200J
R521	321-0281-00	B032401		RES,FXD,FILM:8.25K OHM,1%,0.125W,TC=T0	19701	5043ED8K250F
R524	315-0513-00	B010100	B032400	RES,FXD,FILM:51K OHM,5%,0.25W	57668	NTR25J-E51K0
R524	321-0357-00	B032401		RES,FXD,FILM:51.1K OHM,1%,0.125W,TC=T0	07716	CEAD51101F
R525	311-1230-00			RES,VAR,NONWW:TRMR,20K OHM,0.5W	32997	3386F-T04-203
R526	315-0183-00	B010100	B032400	RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
R526	321-0314-00	B032401		RES,FXD,FILM:18.2K OHM,1%,0.125W,TC=T0	19701	5043ED18K20F
R529	315-0243-00	B010100	B032400	RES,FXD,FILM:24K OHM,5%,0.25W	57668	NTR25J-E24K0
R529	321-0326-00	B032401		RES,FXD,FILM:24.3K OHM,1%,0.125W,TC=T0	19701	5043ED24K30F
R530	311-1230-00			RES,VAR,NONWW:TRMR,20K OHM,0.5W	32997	3386F-T04-203
R531	315-0474-00	B010100	B032400	RES,FXD,FILM:470K OHM,5%,0.25W	19701	5043CX470K0J92U
R531	321-0450-00	B032401		RES,FXD,FILM:475K OHM,1%,0.125W,TC=T0	19701	5043ED475K0F
R532	315-0474-00	B010100	B032400	RES,FXD,FILM:470K OHM,5%,0.25W	19701	5043CX470K0J92U
R532	321-0450-00	B032401		RES,FXD,FILM:475K OHM,1%,0.125W,TC=T0	19701	5043ED475K0F
R535	311-1235-00			RES,VAR,NONWW:100K OHM,0.5W	32997	3386F-T04-104
R536	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R537	315-0564-00	B010100	B020839	RES,FXD,FILM:560K OHM,5%,0.25W	19701	5043CX560K0J
R537	315-0244-00	B020840		RES,FXD,FILM:240K OHM,5%,0.25W	19701	5043CX240K0J
R538	315-0243-00	B010100	B032400	RES,FXD,FILM:24K OHM,5%,0.25W	57668	NTR25J-E24K0
R538	321-0326-00	B032401		RES,FXD,FILM:24.3K OHM,1%,0.125W,TC=T0	19701	5043ED24K30F
R542	323-0168-00			RES,FXD,FILM:549 OHM,1%,0.5W,TC=T0	19701	5053RD549R0F
R543	321-0065-00			RES,FXD,FILM:46.4 OHM,1%,0.125W,TC=T0	57668	RB14FXE 46E4
R547	321-0084-00			RES,FXD,FILM:73.2 OHM,1%,0.125W,TC=T0	91637	CMF55116G73R20F
R548	323-0168-00			RES,FXD,FILM:549 OHM,1%,0.5W,TC=T0	19701	5053RD549R0F
R549	321-0010-00			RES,FXD,FILM:12.4 OHM,1%,0.125W,TC=T0	57668	RB14FXE 12E4
R550	323-0136-00			RES,FXD,FILM:255 OHM,1%,0.5W,TC=T0	24546	NA65D2550F
R552	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R555	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R556	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0	19701	5033ED200R0F
R557	321-0237-00			RES,FXD,FILM:2.87K OHM,1%,0.125W,TC=T0	07716	CEAD 28700F
R558	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0	19701	5033ED200R0F
R559	317-0103-00			RES,FXD,CMPSN:10K OHM,5%,0125W	01121	BB1035
R601	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R602	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R604	321-0335-00			RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0	57668	RB14FXE30K1
R605	321-0335-00			RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0	57668	RB14FXE30K1
R611	315-0204-00	B010100	B032400	RES,FXD,FILM:200K OHM,5%,0.25W	19701	5043CX200K0J
R611	321-0414-00	B032401		RES,FXD,FILM:200K OHM,1%,0.125W,TC=T0	07716	CEAD20002F
R612	311-1214-00			RES,VAR,NONWW:TRMR,200K OHM,0.5W	32997	3386F-T04-204
R613	315-0203-00	B010100	B032400	RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R613	321-0318-00	B032401		RES,FXD,FILM:20.0K OHM,1%,0.125W,TC=T0	19701	5033ED20K00F
R614	315-0104-00	B010100	B032400	RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K

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R614	321-0385-00	B032401		RES,FXD,FILM:100K OHM,1%,0.125W,TC=T0	19701	5033ED100K0F
R615	311-1235-00			RES,VAR,NONWW:100K OHM,0.5W	32997	3386F-T04-104
R616	315-0163-00	B010100	B032400	RES,FXD,FILM:16K OHM,5%,0.25W	57668	NTR25J-E 16K
R616	321-0309-00	B032401		RES,FXD,FILM:16.2K OHM,1%,0.125W,TC=T0	19701	5033ED16K20F
R619	315-0104-00	B010100	B032400	RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R619	321-0385-00	B032401		RES,FXD,FILM:100K OHM,1%,0.125W,TC=T0	19701	5033ED100K0F
R620	311-1232-00			RES,VAR,NONWW:TRMR,50K OHM,0.5W	32997	3386F-T04-503
R621	315-0822-00	B010100	B032400	RES,FXD,FILM:8.2K OHM,5%,0.25W	19701	5043CX8K200J
R621	321-0281-00	B032401		RES,FXD,FILM:8.25K OHM,1%,0.125W,TC=T0	19701	5043ED8K250F
R624	315-0513-00	B010100	B032400	RES,FXD,FILM:51K OHM,5%,0.25W	57668	NTR25J-E51K0
R624	321-0357-00	B032401		RES,FXD,FILM:51.1K OHM,1%,0.125W,TC=T0	07716	CEAD51101F
R625	311-1230-00			RES,VAR,NONWW:TRMR,20K OHM,0.5W	32997	3386F-T04-203
R626	315-0183-00	B010100	B032400	RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
R626	321-0314-00	B032401		RES,FXD,FILM:18.2K OHM,1%,0.125W,TC=T0	19701	5043ED18K20F
R629	315-0243-00	B010100	B032400	RES,FXD,FILM:24K OHM,5%,0.25W	57668	NTR25J-E24K0
R629	321-0326-00	B032401		RES,FXD,FILM:24.3K OHM,1%,0.125W,TC=T0	19701	5043ED24K30F
R630	311-1230-00			RES,VAR,NONWW:TRMR,20K OHM,0.5W	32997	3386F-T04-203
R631	315-0474-00	B010100	B032400	RES,FXD,FILM:470K OHM,5%,0.25W	19701	5043CX470K0J92U
R631	321-0450-00	B032401		RES,FXD,FILM:475K OHM,1%,0.125W,TC=T0	19701	5043ED475K0F
R632	315-0474-00	B010100	B032400	RES,FXD,FILM:470K OHM,5%,0.25W	19701	5043CX470K0J92U
R632	321-0450-00	B032401		RES,FXD,FILM:475K OHM,1%,0.125W,TC=T0	19701	5043ED475K0F
R638	315-0243-00			RES,FXD,FILM:24K OHM,5%,0.25W	57668	NTR25J-E24K0
R642	323-0168-00			RES,FXD,FILM:549 OHM,1%,0.5W,TC=T0	19701	5053RD549R0F
R643	321-0065-00			RES,FXD,FILM:46.4 OHM,1%,0.125W,TC=T0	57668	RB14FXE 46E4
R646	321-0080-00			RES,FXD,FILM:66.5 OHM,1%,0.125W,TC=T0	91637	CMF55116G66R50F
R647	321-0084-00			RES,FXD,FILM:73.2 OHM,1%,0.125W,TC=T0	91637	CMF55116G73R20F
R648	323-0168-00			RES,FXD,FILM:549 OHM,1%,0.5W,TC=T0	19701	5053RD549R0F
R649	321-0010-00			RES,FXD,FILM:12.4 OHM,1%,0.125W,TC=T0	57668	RB14FXE 12E4
R650	323-0136-00			RES,FXD,FILM:255 OHM,1%,0.5W,TC=T0	24546	NA65D2550F
R651	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R652	315-0153-00			RES,FXD,FILM:15K OHM,5%,0.25W	19701	5043CX15K00J
R653	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R654	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R655	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R656	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0	19701	5033ED200R0F
R657	321-0237-00			RES,FXD,FILM:2.87K OHM,1%,0.125W,TC=T0	07716	CEAD 28700F
R658	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0	19701	5033ED200R0F
R659	321-0080-00			RES,FXD,FILM:66.5 OHM,1%,0.125W,TC=T0	91637	CMF55116G66R50F
R659	317-0103-00			RES,FXD,CMPSN:10K OHM,5%,0125W	01121	BB1035
R671	321-0246-00			RES,FXD,FILM:3.57K OHM,1%,0.125W,TC=T0	19701	5043ED3K570F
R672	321-0295-00	B010100	B020839	RES,FXD,FILM:11.5K OHM,1%,0.125W,TC=T0	07716	CEAD11501F
R672	321-0309-00	B020840		RES,FXD,FILM:16.2K OHM,1%,0.125W,TC=T0	19701	5033ED16K20F
R675	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R680	321-0284-00			RES,FXD,FILM:8.87K OHM,1%,0.125W,TC=T0	19701	5043ED8K870F
R681	321-0296-00			RES,FXD,FILM:11.8K OHM,1%,0.125W,TC=T0	07716	CEAD11801F
R682	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R683	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R684	307-0063-00	B010100	B020839	RES,FXD,CMPSN:9.1 OHM,5%,0.5W	01121	EB91G5
R684	307-0053-00	B020840		RES,FXD,CMPSN:3.3 OHM,5%,0.5W	01121	EB33G5
R690	321-0279-00			RES,FXD,FILM:7.87K OHM,1%,0.125W,TC=T0	07716	CEAD78700F
R691	321-0322-00			RES,FXD,FILM:22.1K OHM,0.1%,0.125W,TC=T0	19701	5033ED22K10F
R694	315-0562-00			RES,FXD,FILM:5.6K OHM,5%,0.25W	57668	NTR25J-E05K6
R700	321-0318-00			RES,FXD,FILM:20.0K OHM,1%,0.125W,TC=T0	19701	5033ED20K00F
R701	311-1232-00			RES,VAR,NONWW:TRMR,50K OHM,0.5W	32997	3386F-T04-503
R702	315-0224-00			RES,FXD,FILM:220K OHM,5%,0.25W	57668	NTR25J-E220K
R703	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R704	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F

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R705	307-0092-00	B010100	B020254	RES,FXD,CMPSN:15 OHM,5%,0.1W,TC=300PPM/DEG C	23223	15-E-5-T
R705	311-0605-00	B020255	B063648	RES,VAR,NONWW:TRMR,200 OHM,0.5W	32997	3329H-G48-201
R705	311-0605-04	B063649		RES,VAR NONWW:TRMR,200 OHM,0.5W	52536	ORDER BY DESCR
R711	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R712	315-0153-00			RES,FXD,FILM:15K OHM,5%,0.25W	19701	5043CX15K00J
R714	315-0623-00			RES,FXD,FILM:62K OHM,5%,0.25W	19701	5043CX62K00J
R718	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R722	315-0432-00			RES,FXD,FILM:4.3K OHM,5%,0.25W	57668	NTR25J-E04K3
R730	315-0302-00			RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R731	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R732	321-0160-00			RES,FXD,FILM:453 OHM,1%,0.125W,MI	19701	5033ED453R0F
R733	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R740	311-1232-00			RES,VAR,NONWW:TRMR,50K OHM,0.5W	32997	3386F-T04-503
R742	321-0094-00	B010100	B021446	RES,FXD,FILM:93.1 OHM,1%,0.125W,TC=T0	91637	CMF55116G93R10F
R742	321-0100-00	B021447		RES,FXD,FILM:107 OHM,1%,0.125W,TC=T0	07716	CEAD107R0F
R743	321-0172-00			RES,FXD,FILM:604 OHM,1%,0.125W,TC=T0	19701	5033ED604R0F
R744	321-0216-00			RES,FXD,FILM:1.74K OHM,1%,0.125W,TC=T0	07716	CEAD17400F
R747	322-0178-00			RES,FXD,FILM:698 OHM,1%,0.25W,TC=T0	75042	CEBT0-6980F
R748	321-0233-00			RES,FXD,FILM:2.61K OHM,1%,0.125W,TC=T0	07716	CEAD26100F
R749	321-0095-00			RES,FXD,FILM:95.3 OHM,1%,0.125W,TC=T0	91637	CMF55116G95R30F
R750	321-0314-00	B010100	B021446	RES,FXD,FILM:18.2K OHM,1%,0.125W,TC=T0	19701	5043ED18K20F
R750	321-0309-00	B021447		RES,FXD,FILM:16.2K OHM,1%,0.125W,TC=T0	19701	5033ED16K20F
R751	321-0161-00			RES,FXD,FILM:464 OHM,1%,0.125W,TC=T0	07716	CEAD464R0F
R752	321-0216-00			RES,FXD,FILM:1.74K OHM,1%,0.125W,TC=T0	07716	CEAD17400F
R753	321-0178-00			RES,FXD,FILM:698 OHM,1%,0.125W,TC=T0	07716	CEAD698R0F
R754	321-0216-00			RES,FXD,FILM:1.74K OHM,1%,0.125W,TC=T0	07716	CEAD17400F
R757	322-0178-00			RES,FXD,FILM:698 OHM,1%,0.25W,TC=T0	75042	CEBT0-6980F
R758	321-0233-00			RES,FXD,FILM:2.61K OHM,1%,0.125W,TC=T0	07716	CEAD26100F
R759	321-0095-00			RES,FXD,FILM:95.3 OHM,1%,0.125W,TC=T0	91637	CMF55116G95R30F
R761	321-0278-00			RES,FXD,FILM:7.68K OHM,1%,0.125W,TC=T0	07716	CEAD76800F
R762	321-0124-00			RES,FXD,FILM:191 OHM,1%,0.125W, TC=T0	07716	CEAD191R0F
R763	321-0109-00			RES,FXD,FILM:133 OHM,1%,0.125W,TC=T0	07716	CEAD133R0F
R764	321-0117-00			RES,FXD,FILM:162 OHM,1%,0.125W,TC=T0	07716	CEAD162R0F
R765	321-0228-00			RES,FXD,FILM:2.32K OHM,1%,0.125W,TC=T0	19701	5043ED2K32F
R767	321-0175-00			RES,FXD,FILM:649 OHM,1%,0.125W,TC=T0	19701	5043ED649R0F
R772	321-0124-00			RES,FXD,FILM:191 OHM,1%,0.125W, TC=T0	07716	CEAD191R0F
R773	321-0109-00			RES,FXD,FILM:133 OHM,1%,0.125W,TC=T0	07716	CEAD133R0F
R774	321-0117-00			RES,FXD,FILM:162 OHM,1%,0.125W,TC=T0	07716	CEAD162R0F
R775	321-0182-00			RES,FXD,FILM:768 OHM,1%,0.125W,TC=T0	07716	CEAD768R0F
R777	321-0127-00			RES,FXD,FILM:205 OHM,1%,0.125W,TC=T0	07716	CEAD205R0F
R780	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R781	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R782	321-0239-00			RES,FXD,FILM:3.01K OHM,1%,0.125W,TC=T0	19701	5043ED3K010F
R785	311-1230-00			RES,VAR,NONWW:TRMR,20K OHM,0.5W	32997	3386F-T04-203
R786	315-0513-00			RES,FXD,FILM:51K OHM,5%,0.25W	57668	NTR25J-E51K0
R787	311-1214-00			RES,VAR,NONWW:TRMR,200K OHM,0.5W	32997	3386F-T04-204
R788	315-0623-00			RES,FXD,FILM:62K OHM,5%,0.25W	19701	5043CX62K00J
R789	315-0334-00			RES,FXD,FILM:330K OHM,5%,0.25W	57668	NTR25J-E 330K
R791	311-1214-00			RES,VAR,NONWW:TRMR,200K OHM,0.5W	32997	3386F-T04-204
R792	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R793	315-0513-00			RES,FXD,FILM:51K OHM,5%,0.25W	57668	NTR25J-E51K0
R795	311-1214-00			RES,VAR,NONWW:TRMR,200K OHM,0.5W	32997	3386F-T04-204
R796	315-0363-00			RES,FXD,FILM:36K OHM,5%,0.25W	57668	NTR25J-E36K0
R797	315-0513-00			RES,FXD,FILM:51K OHM,5%,0.25W	57668	NTR25J-E51K0
R801	311-1214-00			RES,VAR,NONWW:TRMR,200K OHM,0.5W	32997	3386F-T04-204
R802	315-0333-00			RES,FXD,FILM:33K OHM,5%,0.25W	57668	NTR25J-E33K0
R803	315-0513-00			RES,FXD,FILM:51K OHM,5%,0.25W	57668	NTR25J-E51K0

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R804	315-0154-00			RES,FXD,FILM:150K OHM,5%,0.25W	57668	NTR25J-E150K
R805	315-0563-00			RES,FXD,FILM:56K OHM,5%,0.25W	19701	5043CX56K00J
R806	311-1214-00			RES,VAR,NONWW:TRMR,200K OHM,0.5W	32997	3386F-T04-204
R808	315-0433-00			RES,FXD,FILM:43K OHM,5%,0.25W	19701	5043CX43K00J
R814	321-0143-00			RES,FXD,FILM:301 OHM,1%,0.125W,TC=T0	07716	CEAD301R0F
R815	321-0090-00			RES,FXD,FILM:84.5 OHM,1%,0.125W,TC=T0	91637	CMF55116G84R50F
R821	321-0104-00			RES,FXD,FILM:118 OHM,1%,0.125W,TC=T0	24546	NA55D1180F
R823	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R824	321-0143-00			RES,FXD,FILM:301 OHM,1%,0.125W,TC=T0	07716	CEAD301R0F
R825	321-0057-00			RES,FXD,FILM:38.3 OHM,0.5%,0.125W,TC=T0	91637	CMF55116G38R30F
R830	311-1266-00			RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3329P-L58-252
R831	321-0105-00			RES,FXD,FILM:121 OHM 1%,0.125W,TC=T0	07716	CEAD121R0F
R832	321-0105-00			RES,FXD,FILM:121 OHM 1%,0.125W,TC=T0	07716	CEAD121R0F
R835	317-0200-00	B020255		RES,FXD,CMPSN:20 OHM,5%,0.125W	01121	BB2005
R836	311-1260-00	B010100	B020254	RES,VAR,NONWW:TRMR,250 OHM,0.5W	32997	3329P-L58-251
R836	311-1263-00	B020225		RES,VAR,NONWW:1K OHM,10%,0.50W	32997	3329P-L58-102
R837	321-0068-00			RES,FXD,FILM:49.9 OHM,0.5%,0.125W,TC=T0	91637	CMF55116G49R90F
R838	321-0068-00			RES,FXD,FILM:49.9 OHM,0.5%,0.125W,TC=T0	91637	CMF55116G49R90F
R849	322-0104-00			RES,FXD,FILM:118 OHM,1%,0.25W,TC=T0	91637	MFF1421G118R0F
R854	321-0170-00			RES,FXD,FILM:576 OHM,1%,0.125W,TC=T0	07716	CEAD576R0F
R855	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0	19701	5033ED200R0F
R856	321-0238-00			RES,FXD,FILM:2.94K OHM,1%,0.125W,TC=T0	07716	CEAD29400F
R857	317-0122-00			RES,FXD,CMPSN:1.2K OHM,5%,0.125W (NOMINAL VALUE,SELECTED)	01121	BB1225
R860	315-0822-00			RES,FXD,FILM:8.2K OHM,5%,0.25W	19701	5043CX8K200J
R861	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R862	301-0101-00	B010100	B010169	RES,FXD,FILM:100 OHM,5%,0.5W	01121	EB1015
R862	301-0121-00	B010170		RES,FXD,CMPSN:120 OHM,5%,0.5W	19701	5053CX120K0
R863	315-0362-00			RES,FXD,FILM:3.6K OHM,5%,0.25W	19701	5043CX3K600J
R864	315-0133-00			RES,FXD,FILM:13K OHM,5%,0.25W	19701	5043CX13K00J
R865	315-0303-00			RES,FXD,FILM:30K OHM,5%,0.25W	19701	5043CX30K00J
R866	315-0682-00			RES,FXD,FILM:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
R870	315-0431-00			RES,FXD,FILM:430 OHM,5%,0.25W	19701	5043CX430R0J
R871	315-0153-00			RES,FXD,FILM:15K OHM,5%,0.25W	19701	5043CX15K00J
R872	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R873	321-0426-00			RES,FXD,FILM:267K OHM,1%,0.125W,TC=T0	07716	CEAD26702F
R874	321-0377-00			RES,FXD,FILM:82.5K OHM,1%,0.125W,TC=T0	07716	CEAD82501F
R875	315-0623-00			RES,FXD,FILM:62K OHM,5%,0.25W	19701	5043CX62K00J
R876	315-0243-00			RES,FXD,FILM:24K OHM,5%,0.25W	57668	NTR25J-E24K0
R877	301-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.5W	19701	5053CX2K400J
R878	308-0243-00			RES,FXD,WW:240 OHM,5%,3W	14193	SA31-2400J
R881	321-0265-00			RES,FXD,FILM:5.62K OHM,1%,0.125W,TC=T0	19701	5043ED5K620F
R882	321-0201-00			RES,FXD,FILM:1.21K OHM,1%,0.125W,TC=T0	19701	5043ED1K210F
R883	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
R884	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R886	321-0328-00			RES,FXD,FILM:25.5K OHM,1%,0.125W,TC=T0	19701	5043ED25K50F
R887	315-0682-00			RES,FXD,FILM:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
R888	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R891	315-0752-00			RES,FXD,FILM:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
R892	301-0102-00			RES,FXD,CMPSN:1K OHM,5%,0.50W	19701	5053CX1K000J
R893	308-0298-00			RES,FXD,WW:560 OHM,5%,3W	00213	1240S-560-5
R894	321-0001-00			RES,FXD,FILM:10 OHM,1%,0.125W,TC=T0	19701	5033RD10R00FMS
R902	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R903	317-0751-00	B010106		RES,FXD,CMPSN:750 OHM,5%,0.125W (R903, ADDED WHEN NECESSARY)	01121	BB7515
R904	317-0751-00	B010106		RES,FXD,CMPSN:750 OHM,5%,0.125W (R904, ADDED WHEN NECESSARY)	01121	BB7515
R905	321-0186-00			RES,FXD,FILM:845 OHM,1%,0.125W,TC=T0	19701	5043ED845R0F

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R906	321-0252-00			RES,FXD,FILM:4.12K OHM,1%,0.125W,TC=T0	07716	CEAD41200F
R913	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
R921	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R922	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R923	323-0193-00			RES,FXD,FILM:1K OHM,1%,0.5W,TC=T0	75042	CECT0-1001F
R924	321-0069-00			RES,FXD,FILM:51.1 OHM,1%,0.125W,TC=T0	91637	CMF55116G51R10F
R926	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R927	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R928	323-0193-00			RES,FXD,FILM:1K OHM,1%,0.5W,TC=T0	75042	CECT0-1001F
R932	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
R933	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
R934	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
R941	317-0103-00			RES,FXD,CMPSN:10K OHM,5%,0125W	01121	BB1035
R942	317-0303-00			RES,FXD,CMPSN:30K OHM,5%,0.125W	01121	BB3035
R943	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R944	321-0335-00			RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0	57668	RB14FXE30K1
R945	311-1222-00			RES,VAR,NONWW:TRMR,100 OHM,0.5W	32997	3386F-T04-101
R946	315-0680-00			RES,FXD,FILM:68 OHM,5%,0.25W	57668	NTR25J-E68E0
R948	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
R949	321-0251-00			RES,FXD,FILM:4.02K OHM,1%,0.125W,TC=T0	19701	5033ED4K020F
R950	311-1225-00			RES,VAR,NONWW:TRMR,1K OHM,0.5W	32997	3386F-T04-102
R952	311-1227-00			RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3386F-T04-502
R955	311-1230-00			RES,VAR,NONWW:TRMR,20K OHM,0.5W	32997	3386F-T04-203
R958	311-1232-00			RES,VAR,NONWW:TRMR,50K OHM,0.5W	32997	3386F-T04-503
R959	321-0294-00			RES,FXD,FILM:11.3K OHM,1%,0.125W,TC=T0	19701	5043ED11K30F
R962	321-0102-00			RES,FXD,FILM:113 OHM,1%,0.125W,TC=T0	07716	CEAD113R0F
R963	323-0127-00			RES,FXD,FILM:205 OHM,1%,0.5W,TC=T0	24546	NA65D2050F
R964	321-0267-00			RES,FXD,FILM:5.90K OHM,1%,0.125W,TC=T0	19701	5033ED5K900F
R965	311-1224-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3386F-T04-501
R966	321-0252-00			RES,FXD,FILM:4.12K OHM,1%,0.125W,TC=T0	07716	CEAD41200F
R967	321-0102-00			RES,FXD,FILM:113 OHM,1%,0.125W,TC=T0	07716	CEAD113R0F
R968	323-0114-00			RES,FXD,FILM:150 OHM,1%,0.5W,TC=T0	75042	CECT0-1500F
R969	323-0114-00			RES,FXD,FILM:150 OHM,1%,0.5W,TC=T0	75042	CECT0-1500F
R971	317-0103-00			RES,FXD,CMPSN:10K OHM,5%,0125W	01121	BB1035
R972	317-0303-00			RES,FXD,CMPSN:30K OHM,5%,0.125W	01121	BB3035
R973	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R974	321-0335-00			RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0	57668	RB14FXE30K1
R975	311-1222-00			RES,VAR,NONWW:TRMR,100 OHM,0.5W	32997	3386F-T04-101
R976	315-0680-00			RES,FXD,FILM:68 OHM,5%,0.25W	57668	NTR25J-E68E0
R978	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
R979	321-0251-00			RES,FXD,FILM:4.02K OHM,1%,0.125W,TC=T0	19701	5033ED4K020F
R980	311-1225-00			RES,VAR,NONWW:TRMR,1K OHM,0.5W	32997	3386F-T04-102
R982	311-1227-00			RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3386F-T04-502
R985	311-1230-00			RES,VAR,NONWW:TRMR,20K OHM,0.5W	32997	3386F-T04-203
R988	311-1232-00			RES,VAR,NONWW:TRMR,50K OHM,0.5W	32997	3386F-T04-503
R989	321-0294-00			RES,FXD,FILM:11.3K OHM,1%,0.125W,TC=T0	19701	5043ED11K30F
R992	321-0102-00			RES,FXD,FILM:113 OHM,1%,0.125W,TC=T0	07716	CEAD113R0F
R993	323-0127-00			RES,FXD,FILM:205 OHM,1%,0.5W,TC=T0	24546	NA65D2050F
R994	321-0267-00			RES,FXD,FILM:5.90K OHM,1%,0.125W,TC=T0	19701	5033ED5K900F
R995	311-1224-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3386F-T04-501
R996	321-0252-00			RES,FXD,FILM:4.12K OHM,1%,0.125W,TC=T0	07716	CEAD41200F
R997	321-0102-00			RES,FXD,FILM:113 OHM,1%,0.125W,TC=T0	07716	CEAD113R0F
R998	323-0114-00			RES,FXD,FILM:150 OHM,1%,0.5W,TC=T0	75042	CECT0-1500F
R999	323-0114-00			RES,FXD,FILM:150 OHM,1%,0.5W,TC=T0	75042	CECT0-1500F
R1001	315-0563-00			RES,FXD,FILM:56K OHM,5%,0.25W	19701	5043CX56K00J
R1002	321-0262-00			RES,FXD,FILM:5.23K OHM,1,0.125W,TC=T0	19701	5033ED5K230F
R1003	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R1004	321-0231-00			RES,FXD,FILM:2.49K OHM,1%,0.125W,TC=T0	19701	5033ED2K49F

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R1005	311-1224-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3386F-T04-501
R1007	321-0165-00			RES,FXD,FILM:511 OHM,1%,0.125W,TC=T0	07716	CEAD511R0F
R1010	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1011	321-0276-00	B010100	B021049	RES,FXD,FILM:7.32K OHM,1%,0.125W,TC=T0	19701	5043ED7K320F
R1011	321-0271-00	B021050		RES,FXD,FILM:6.49K OHM,1%,0.125W,TC=T0	07716	CEAD64900F
R1012	321-0289-00	B010100	B021049	RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R1012	321-0297-00	B021050		RES,FXD,FILM:12.1K OHM,1%,0.125W,TC=T0	07716	CEAD12101F
R1013	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R1014	315-0752-00			RES,FXD,FILM:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
R1015	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R1016	321-0379-00			RES,FXD,FILM:86.6K OHM,1%,0.125W,TC=T0	07716	CEAD86601F
R1017	321-0396-00			RES,FXD,FILM:130K OHM,1%,0.125W,TC=T0	07716	CEAD13002F
R1018	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R1019	317-0510-00			RES,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R1020	321-0350-00			RES,FXD,FILM:43.2K OHM,1%,0.125W,TC=T0	19701	5043ED43K20F
R1021	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R1022	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R1023	315-0511-00			RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
R1024	315-0123-00			RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
R1025	311-1231-00			RES,VAR,NONWW:TRMR,25K OHM,0.5W	32997	3386F-T04-253
R1026	315-0271-00			RES,FXD,FILM:270 OHM,5%,0.25W	57668	NTR25J-E270E
R1028	321-0291-00			RES,FXD,FILM:10.5K OHM,1%,0.125W,TC=T0	19701	5033ED10K50F
R1029	315-0362-00			RES,FXD,FILM:3.6K OHM,5%,0.25W	19701	5043CX3K600J
R1030	311-1225-00			RES,VAR,NONWW:TRMR,1K OHM,0.5W	32997	3386F-T04-102
R1031	321-0291-00			RES,FXD,FILM:10.5K OHM,1%,0.125W,TC=T0	19701	5033ED10K50F
R1032	315-0221-00			RES,FXD,FILM:220 OHM,5%,0.25W	57668	NTR25J-E220E
R1033	315-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
R1034	321-0192-00			RES,FXD,FILM:976 OHM,1%,0.125W,TC=T0	19701	5043ED976R0F
R1035	311-1222-00			RES,VAR,NONWW:TRMR,100 OHM,0.5W	32997	3386F-T04-101
R1036	321-0235-00			RES,FXD,FILM:2.74K OHM,1%,0.125W,TC=T0	07716	CEAD27400F
R1037	321-0192-00			RES,FXD,FILM:976 OHM,1%,0.125W,TC=T0	19701	5043ED976R0F
R1040	317-0120-00			RES,FXD,CMPSN:12 OHM,5%,0.125W	01121	BB1205
R1041	317-0120-00			RES,FXD,CMPSN:12 OHM,5%,0.125W	01121	BB1205
R1042	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R1043	323-0064-00			RES,FXD,FILM:45.3 OHM,1%,0.5W,TC=T0	07716	CECD45R30F
R1044	315-0911-00			RES,FXD,FILM:910 OHM,5%,0.25W	57668	NTR25J-E910E
R1045	321-0380-00			RES,FXD,FILM:88.7K OHM,1%,0.125W,TC=T0	07716	CEAD88701F
R1046	321-0324-00			RES,FXD,FILM:23.2K OHM,1%,0.125W,TC=T0	07716	CEAD23201F
R1047	323-0606-00			RES,FXD,FILM:60 OHM,1%,0.5W,TC=T0	24546	NA65D60R0F
R1049	321-0160-00			RES,FXD,FILM:453 OHM,1%,0.125W,MI	19701	5033ED453R0F
R1052	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
R1054	317-0100-00			RES,FXD,CMPSN:10 OHM,5%,0.125W	01121	BB1005
R1058	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
R1059	307-0113-00			RES,FXD,CMPSN:5.1 OHM,5%,0.25W	01121	CB51G5
R1060	317-0120-00			RES,FXD,CMPSN:12 OHM,5%,0.125W	01121	BB1205
R1061	317-0120-00			RES,FXD,CMPSN:12 OHM,5%,0.125W	01121	BB1205
R1062	311-1224-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3386F-T04-501
R1063	323-0064-00			RES,FXD,FILM:45.3 OHM,1%,0.5W,TC=T0	07716	CECD45R30F
R1064	315-0911-00			RES,FXD,FILM:910 OHM,5%,0.25W	57668	NTR25J-E910E
R1065	321-0380-00			RES,FXD,FILM:88.7K OHM,1%,0.125W,TC=T0	07716	CEAD88701F
R1066	321-0324-00			RES,FXD,FILM:23.2K OHM,1%,0.125W,TC=T0	07716	CEAD23201F
R1067	323-0606-00			RES,FXD,FILM:60 OHM,1%,0.5W,TC=T0	24546	NA65D60R0F
R1069	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R1071	317-0510-00			RES,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R1072	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
R1073	311-1221-00			RES,VAR,NONWW:TRMR,50 OHM,0.5W	32997	3386F-T04-500
R1074	317-0100-00			RES,FXD,CMPSN:10 OHM,5%,0.125W	01121	BB1005
R1075	317-0820-00			RES,FXD,CMPSN:82 OHM,5%,0.125W	01121	BB8205

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R1076	323-0090-00			RES,FXD,FILM:84.5 OHM,1%,0.5W,TC=T0	91637	CMF65116G84R0F
R1077	317-0510-00			RES,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R1078	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
R1079	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R1080	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R1081	301-0432-00			RES,FXD,FILM:4.3K OHM,5%,0.5W	19701	5053CX4K300J
R1082	311-1225-00			RES,VAR,NONWW:TRMR,1K OHM,0.5W	32997	3386F-T04-102
R1083	315-0162-00			RES,FXD,FILM:1.6K OHM,5%,0.25W	19701	5043CX1K600J
R1084	315-0123-00			RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
R1085	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R1086	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
R1087	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
R1088	321-0261-00			RES,FXD,FILM:5.11K OHM,1%,0.125W,TC=T0	19701	5033ED5K110F
R1089	321-0328-00			RES,FXD,FILM:25.5K OHM,1%,0.125W,TC=T0	19701	5043ED25K50F
R1094	323-0069-00			RES,FXD,FILM:51.1 OHM,1%,0.5W,TC=T0	19701	5053RD51R10F
R1095	323-0069-00			RES,FXD,FILM:51.1 OHM,1%,0.5W,TC=T0	19701	5053RD51R10F
R1096	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
R1099	307-0292-21			RES,FXD,FILM:(2)172 OHM,(2)33.7 OHM (NOM VALUE,SEL)	80009	307-0292-21
R1103	323-0106-00			RES,FXD,FILM:124 OHM,1%,0.5W,TC=T0 (R1103, OPTION 02 ONLY)	24546	NA65D1240G
R1104	323-0106-00			RES,FXD,FILM:124 OHM,1%,0.5W,TC=T0 (R1104, OPTION 02 ONLY)	24546	NA65D1240G
R1105	311-1007-00			RES,VAR,NONWW:TRMR,20 OHM,20%,0.5W (R1105, OPTION 02 ONLY)	32997	3329H-G48-200
R1106	321-0130-00			RES,FXD,FILM:221 OHM,1%,0.125W,TC=T0 (R1106, OPTION 02 ONLY)	19701	5043ED221R0F
R1110	311-1265-00			RES,VAR,NONWW:TRMR,2K OHM,0.5W (R1110, OPTION 02 ONLY)	32997	3329P-L58-202
R1112	311-1265-00			RES,VAR,NONWW:TRMR,2K OHM,0.5W (R1112, OPTION 02 ONLY)	32997	3329P-L58-202
R1113	311-1265-00			RES,VAR,NONWW:TRMR,2K OHM,0.5W (R1113, OPTION 02 ONLY)	32997	3329P-L58-202
R1114	311-1261-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W (R1114, OPTION 02 ONLY)	32997	3329P-L58-501
R1116	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0 (R1116, OPTION 02 ONLY)	91637	CMF50-F50R00F
R1118	321-0381-00			RES,FXD,FILM:90.9K OHM,1%,0.125W,TC=T0 (R1118, OPTION 02 ONLY)	07716	CEAD90901F
R1119	321-0323-00			RES,FXD,FILM:22.6K OHM,1%,0.125W,TC=T0 (R1119, OPTION 02 ONLY)	07716	CEAD22601F
R1120	311-1227-00			RES,VAR,NONWW:TRMR,5K OHM,0.5W (R1120, OPTION 02 ONLY)	32997	3386F-T04-502
R1126	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0 (R1126, OPTION 02 ONLY)	19701	5033ED200R0F
R1127	317-0220-00			RES,FXD,CMPSN:22 OHM,5%,0.125W (R1127, OPTION 02 ONLY)	01121	BB2205
R1136	325-0053-00			RES,FXD,FILM:50 OHM,1%,0.05W,TC=T0 (R1136, OPTION 02 ONLY)	91637	CMF50-F50R00F
R1140	321-0318-00			RES,FXD,FILM:20.0K OHM,1%,0.125W,TC=T0 (R1140, OTPION 2 ONLY)	19701	5033ED20K00F
R1141	321-0335-00			RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0 (R1141, OPTION 02 ONLY)	57668	RB14FXE30K1
R1142	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W (R1142, OPTION 02 ONLY)	57668	NTR25J-E47E0
R1144	321-0265-00			RES,FXD,FILM:5.62K OHM,1%,0.125W,TC=T0 (R1144, OPTION 02 ONLY)	19701	5043ED5K620F
R1145	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W (R1145, OPTION 02 ONLY)	57668	NTR25J-E47E0
R1150	323-0133-00			RES,FXD,FILM:237 OHM,1%,0.5W,TC=T0 (R1150, OPTION 02 ONLY)	75042	CECT0-2370F

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R1152	322-0616-00			RES,FXD,FILM:21.4 OHM,1%,0.25W,TC=T0 (R1152, OPTION 02 ONLY)	57668	CRB60 FXE 21.4
R1153	321-0075-00			RES,FXD,FILM:59.0 OHM,1%,0.125W,TC=T0 (R1153, OPTION 02 ONLY)	91637	CMF55116G59R00F
R1154	321-0010-00			RES,FXD,FILM:12.4 OHM,1%,0.125W,TC=T0 (R1154, OPTION 02 ONLY)	57668	RB14FXE 12E4
R1155	321-0144-00			RES,FXD,FILM:309 OHM,1%,0.125W,TC=T0 (R1155, OPTION 02 ONLY)	07716	CEAD309R0F
R1156	311-1259-00			RES,VAR,NONWW:TRMR,100 OHM,0.5W (R1156, OPTION 02 ONLY)	32997	3329P-L58-101
R1157	317-0620-00			RES,FXD,CMPSN:62 OHM,5%,0.125W (R1157, OPTION 02 ONLY)	01121	BB6205
R1160	323-0133-00			RES,FXD,FILM:237 OHM,1%,0.5W,TC=T0 (R1160, OPTION 02 ONLY)	75042	CECT0-2370F
R1162	301-0681-00			RES,FXD,FILM:680 OHM,5%,0.5W (R1162, OPTION 02 ONLY)	57668	TR50J-E680E
R1163	321-0075-00			RES,FXD,FILM:59.0 OHM,1%,0.125W,TC=T0 (R1163, OPTION 02 ONLY)	91637	CMF55116G59R00F
R1164	321-0010-00			RES,FXD,FILM:12.4 OHM,1%,0.125W,TC=T0 (R1164, OPTION 02 ONLY)	57668	RB14FXE 12E4
R1165	321-0144-00			RES,FXD,FILM:309 OHM,1%,0.125W,TC=T0 (R1165, OPTION 02 ONLY)	07716	CEAD309R0F
R1166	301-0511-00			RES,FXD,FILM:510 OHM,5%,0.5W (R1166, OPTION 02 ONLY)	19701	5053CX510R0J
R1205	304-0270-00	B010100	B039999	RES,FXD,CMPSN:27 OHM,10%,1W	01121	GB2701
R1208	308-0503-00	B031930	B039999	RES,FXD,WW:6.8 OHM,5%,2.5W	14193	SA31-6R80J
R1209	304-0473-00			RES,FXD,CMPSN:47K OHM,10%,1W	01121	GB4731
R1210	303-0304-00	B010100	B031929	RES,FXD,CMPSN:300K OHM,5%,1W	01121	GB3045
R1210	303-0184-00	B031930		RES,FXD,CMPSN:180K OHM,5%,1W	01121	GB1845
R1212	308-0503-00	B031930	B039999	RES,FXD,WW:6.8 OHM,5%,2.5W	14193	SA31-6R80J
R1213	304-0473-00			RES,FXD,CMPSN:47K OHM,10%,1W	01121	GB4731
R1219	302-0565-00			RES,FXD,CMPSN:5.6M OHM,10%,0.5W	01121	EB5651
R1221	304-0154-00			RES,FXD,CMPSN:150K OHM,10%,1W	01121	GB 1541
R1225	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R1231	307-0057-00	B010100	B031929	RES,FXD,CMPSN:5.1 OHM,5%,0.5W	01121	EB51G5
R1231	303-0100-00	B031930		RES,FXD,CMPSN:10 OHM,5%,1W	01121	GB1005
R1232	315-0220-00			RES,FXD,FILM:22 OHM,5%,0.25W	19701	5043CX22R00J
R1236	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1237	301-0200-00	B031930		RES,FXD,FILM:20 OHM,5%,0.5W	19701	5053CX20R00J
R1238	315-0333-00	B010100	B020254	RES,FXD,FILM:33K OHM,5%,0.25W	57668	NTR25J-E33K0
R1238	315-0332-00	B020255		RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R1239	307-0057-00	B010100	B031929	RES,FXD,CMPSN:5.1 OHM,5%,0.5W	01121	EB51G5
R1239	301-0200-00	B031930		RES,FXD,FILM:20 OHM,5%,0.5W	19701	5053CX20R00J
R1240	315-0220-00			RES,FXD,FILM:22 OHM,5%,0.25W	19701	5043CX22R00J
R1241	315-0753-00			RES,FXD,FILM:75K OHM,5%,0.25W	57668	NTR25J-E75K0
R1242	315-0303-00			RES,FXD,FILM:30K OHM,5%,0.25W	19701	5043CX30K00J
R1243	315-0204-00	B010100	B031929	RES,FXD,FILM:200K OHM,5%,0.25W	19701	5043CX200K0J
R1243	315-0274-00	B031930		RES,FXD,FILM:270K OHM,5%,0.25W	57668	NTR25J-E270K
R1244	315-0270-00			RES,FXD,FILM:27 OHM,5%,0.25W	19701	5043CX27R00J
R1245	315-0182-00			RES,FXD,FILM:1.8K OHM,5%,0.25W	57668	NTR25J-E1K8
R1246	315-0123-00	B031930		RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
R1247	301-0184-00			RES,FXD,FILM:180K OHM,5%,0.5W	57668	TR50J-E180K
R1252	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R1254	315-0753-00			RES,FXD,FILM:75K OHM,5%,0.25W	57668	NTR25J-E75K0
R1255	315-0201-00	B031930		RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
R1259	315-0222-00	B010100	B031929	RES,FXD,FILM:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
R1259	315-0562-00	B031930		RES,FXD,FILM:5.6K OHM,5%,0.25W	57668	NTR25J-E05K6
R1260	315-0224-00			RES,FXD,FILM:220K OHM,5%,0.25W	57668	NTR25J-E220K
R1261	315-0123-00			RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
R1262	315-0301-00			RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E

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R1263	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
R1264	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R1266	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R1267	315-0154-00			RES,FXD,FILM:150K OHM,5%,0.25W	57668	NTR25J-E150K
R1270	315-0560-00			RES,FXD,FILM:56 OHM,5%,0.25W	57668	NTR25J-E56E0
R1271	315-0560-00			RES,FXD,FILM:56 OHM,5%,0.25W	57668	NTR25J-E56E0
R1274	321-0346-00			RES,FXD,FILM:39.2K OHM,1%,0.125W,TC=T0	19701	5043ED39K20F
R1280	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R1281	321-0334-00			RES,FXD,FILM:29.4K OHM,1%,0.125W,TC=T0	07716	CEAD29401F
R1282	321-0340-00			RES,FXD,FILM:34.0K OHM,1%,0.125W,TC=T0	19701	5043ED34K00F
R1283	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R1284	321-0008-00	B010100	B031929	RES,FXD,FILM:11.8 OHM,1%,0.125W,TC=T0	57668	RB14FXE 11E8
R1284	321-0005-00	B031930		RES,FXD,FILM:11.0 OHM,1%,0.125W,TC=T0	91637	CMF55116G11R00F
R1286	321-0283-00	B010100	B031929	RES,FXD,FILM:8.66K OHM,1%,0.125W,TC=T0	19701	5043ED8K660F
R1286	321-0284-00	B031930		RES,FXD,FILM:8.87K OHM,1%,0.125W,TC=T0	19701	5043ED8K870F
R1287	321-0282-00	B010100	B031929	RES,FXD,FILM:8.45K OHM,1%,0.125W,TC=T0	07716	CFAD84500F
R1287	321-0283-00	B031930		RES,FXD,FILM:8.66K OHM,1%,0.125W,TC=T0	19701	5043ED8K660F
R1288	315-0102-00	B010100	B031929	RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R1288	315-0122-00	B031930		RES,FXD,FILM:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
R1290	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R1292	315-0105-00			RES,FXD,FILM:1M OHM,5%,0.25W	19701	5043CX1M000J
R1293	311-1239-00	B010100	B053348	RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3386X-T07-252
R1293	311-2273-00	B053349		RES,VAR,NONWW:TRMR,2K OHM,20%,0.5W	TK1450	GF06VT 2 K OHM
R1294	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R1295	321-0419-00	B010100	B063973	RES,FXD,FILM:226K OHM,1%,0.125W,TC=T0	07716	CEAD22602F
R1295	321-0418-00	B063974		RES,FXD,FILM:221K OHM,1%,0.125W,TC=T0	07716	CEAD22102F
R1320	315-0150-00			RES,FXD,FILM:15 OHM,5%,0.25W	19701	5043CX15R00J
R1321	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1327	301-0391-00			RES,FXD,FILM:390 OHM,5%,0.5W	01121	EB3915
R1361	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R1362	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R1370	315-0100-00	B031930		RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
R1371	315-0472-00	B010100	B031929	RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R1371	315-0274-00	B031930		RES,FXD,FILM:270K OHM,5%,0.25W	57668	NTR25J-E270K
R1372	315-0474-00	B031930		RES,FXD,FILM:470K OHM,5%,0.25W	19701	5043CX470K0J92U
R1373	315-0753-00	B010100	B031929	RES,FXD,FILM:75K OHM,5%,0.25W	57668	NTR25J-E75K0
R1373	315-0272-00	B031930		RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R1374	315-0273-00	B010100	B031929	RES,FXD,FILM:27K OHM,5%,0.25W	57668	NTR25J-E27K0
R1374	315-0182-00	B031930		RES,FXD,FILM:1.8K OHM,5%,0.25W	57668	NTR25J-E1K8
R1375	315-0472-00	B010100	B031929	RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R1375	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R1376	315-0203-00	B031930		RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R1377	315-0203-00	B031930		RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R1379	315-0472-00	B031930		RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R1381	315-0334-00	B031930		RES,FXD,FILM:330K OHM,5%,0.25W	57668	NTR25J-E 330K
R1382	315-0754-00	B031930		RES,FXD,FILM:750K OHM,5%,0.25W,MI	19701	5043CX750K0J
R1401	321-0385-00	B010100	B031929	RES,FXD,FILM:100K OHM,1%,0.125W,TC=T0	19701	5033ED100K0F
R1401	321-0369-00	B031930		RES,FXD,FILM:68.1K OHM,1%,0.125W,TC=T0	19701	5043ED68K10F
R1402	321-0407-00	B010100	B031929	RES,FXD,FILM:169K OHM,1%,0.125W,TC=T0	07716	CEAD16902F
R1402	321-0386-00	B031930		RES,FXD,FILM:102K OHM,1%,0.125W,TC=T0	07716	CEAD10202F
R1403	321-0357-00	B010100	B031929	RES,FXD,FILM:51.1K OHM,1%,0.125W,TC=T0	07716	CEAD51101F
R1403	321-0336-00	B031930		RES,FXD,FILM:30.9K OHM,1%,0.125W,TC=T0	19701	5043ED30K90F
R1404	321-0311-00	B010100	B031929	RES,FXD,FILM:16.9K OHM,1%,0.125W,TC=T0	07716	CEAC16901F
R1404	321-0290-00	B031930		RES,FXD,FILM:10.2K OHM,1%,0.125W,TC=T0	19701	5043ED10K20F
R1405	321-0345-00	B010100	B031929	RES,FXD,FILM:38.3K OHM,1%,0.125W,TC=T0	19701	5043ED38K30F
R1405	321-0319-00	B031930		RES,FXD,FILM:20.5K OHM,1%,0.125W,TC=T0	19701	5033ED20K50F
R1408	315-0562-00	B010100	B031929	RES,FXD,FILM:5.6K OHM,5%,0.25W	57668	NTR25J-E05K6
R1408	315-0332-00	B031930		RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3

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R1410	323-0265-00			RES,FXD,FILM:5.62K OHM,1%,0.5W,TC=T0	75042	CECT0-5621F
R1412	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R1413	315-0103-00	B031930		RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1414	321-0730-06			RES,FXD,FILM:5.703K OHM,0.2%,0.125W,TC=T9	19701	5033RE5K703C
R1415	311-1225-00			RES,VAR,NONWW:TRMR,1K OHM,0.5W	32997	3386F-T04-102
R1416	321-0331-09			RES,FXD,FILM:27.4K OHM,1%,0.125W,TC=T9	19701	5033RE27K4F
R1417	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R1421	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R1422	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
R1424	315-0331-00			RES,FXD,FILM:330 OHM,5%,0.25W	57668	NTR25J-E330E
R1425	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R1426	315-0181-00			RES,FXD,FILM:180 OHM,5%,0.25W	57668	NTR25J-E180E
R1427	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R1428	308-0365-00			RES,FXD,WW:1.5 OHM,5%,3W	00213	1240S-1.5-5
R1432	315-0432-00			RES,FXD,FILM:4.3K OHM,5%,0.25W	57668	NTR25J-E04K3
R1434	304-0102-00			RES,FXD,CMPSN:1K OHM,10%,1W	01121	GB1021
R1436	315-0121-00			RES,FXD,FILM:120 OHM,5%,0.25W	19701	5043CX120R0J
R1437	315-0123-00			RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
R1438	301-0182-00			RES,FXD,FILM:1.8K OHM,5%,0.5W	19701	5053CX1K800J
R1442	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R1444	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1445	321-0924-07			RES,FXD,FILM:40K OHM,0.1%,0.125W,TC=T9	19701	5033RE40K00B
R1446	321-0924-07			RES,FXD,FILM:40K OHM,0.1%,0.125W,TC=T9	19701	5033RE40K00B
R1447	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R1451	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R1452	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
R1454	315-0511-00			RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
R1455	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R1456	315-0181-00			RES,FXD,FILM:180 OHM,5%,0.25W	57668	NTR25J-E180E
R1457	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R1458	308-0686-00			RES,FXD,WW:2.2 OHM,5%,2W	18235	C-2D 2.2 OHM 5%
R1461	321-0332-07			RES,FXD,FILM:28.0K OHM,0.1%,0.125W,TC=T9	19701	5033RE28K00B
R1462	321-1296-07			RES,FXD,FILM:12.0K OHM,0.1%,0.125W,TC=T9	19701	5033RE12K00B
R1463	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R1467	315-0123-00			RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
R1468	315-0362-00	B010100	B031929	RES,FXD,FILM:3.6K OHM,5%,0.25W	19701	5043CX3K600J
R1468	315-0302-00	B031930		RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R1469	315-0822-00			RES,FXD,FILM:8.2K OHM,5%,0.25W	19701	5043CX8K200J
R1473	315-0221-00	B010100	B031929	RES,FXD,FILM:220 OHM,5%,0.25W	57668	NTR25J-E220E
R1473	315-0201-00	B031930		RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
R1474	315-0433-00	B010100	B031929	RES,FXD,FILM:43K OHM,5%,0.25W	19701	5043CX43K00J
R1474	315-0393-00	B031930		RES,FXD,FILM:39K OHM,5%,0.25W	57668	NTR25J-E39K0
R1475	308-0804-00			RES,FXD,WW:0.025 OHM,5%,0.5W	80009	308-0804-00
R1476	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R1477	315-0432-00			RES,FXD,FILM:4.3K OHM,5%,0.25W	57668	NTR25J-E04K3
R1480	321-0924-07			RES,FXD,FILM:40K OHM,0.1%,0.125W,TC=T9	19701	5033RE40K00B
R1481	321-1296-07			RES,FXD,FILM:12.0K OHM,0.1%,0.125W,TC=T9	19701	5033RE12K00B
R1482	315-0912-00			RES,FXD,FILM:9.1K OHM,5%,0.25W	57668	NTR25J-E09K1
R1483	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R1487	315-0123-00			RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
R1488	315-0302-00			RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R1493	315-0221-00	B010100	B031929	RES,FXD,FILM:220 OHM,5%,0.25W	57668	NTR25J-E220E
R1493	315-0201-00	B031930		RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
R1494	315-0433-00			RES,FXD,FILM:43K OHM,5%,0.25W	19701	5043CX43K00J
R1495	308-0804-00			RES,FXD,WW:0.025 OHM,5%,0.5W	80009	308-0804-00
R1496	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R1497	315-0432-00			RES,FXD,FILM:4.3K OHM,5%,0.25W	57668	NTR25J-E04K3
R1513	321-1713-07			RES,FXD,FILM:36K OHM 0.1%,0.125W,TC=T9	19701	5033RE36K00B

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R1514	321-0926-07			RES,FXD,FILM:4K OHM,0.1%,0.125W,TC=T9	19701	5033RE4K00B
R1521	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R1526	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
R1527	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R1528	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R1529	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1531	315-0362-00			RES,FXD,FILM:3.6K OHM,5%,0.25W	19701	5043CX3K600J
R1532	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R1533	308-0804-00			RES,FXD,WW:0.025 OHM,5%,0.5W	80009	308-0804-00
R1534	308-0804-00			RES,FXD,WW:0.025 OHM,5%,0.5W	80009	308-0804-00
R1535	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
R1536	315-0432-00			RES,FXD,FILM:4.3K OHM,5%,0.25W	57668	NTR25J-E04K3
R1541	315-0822-00			RES,FXD,FILM:8.2K OHM,5%,0.25W	19701	5043CX8K200J
R1542	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1543	315-0243-00			RES,FXD,FILM:24K OHM,5%,0.25W	57668	NTR25J-E24K0
R1544	315-0562-00			RES,FXD,FILM:5.6K OHM,5%,0.25W	57668	NTR25J-E05K6
R1545	315-0221-00			RES,FXD,FILM:220 OHM,5%,0.25W	57668	NTR25J-E220E
R1548	308-0702-00			RES,FXD,WW:0.33 OHM,5%,2W	75042	SPH-R3300J
R1552	301-0561-00			RES,FXD,FILM:560 OHM,5%,0.5W	01121	EB5615
R1556	301-0431-00			RES,FXD,FILM:430 OHM,5%,0.5W	19701	5053CX430R0J
R1600	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R1601	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1602	321-0064-00			RES,FXD,FILM:45.3 OHM,0.5%,0.125W,TC=T0	91637	CMF55116G45R30F
R1603	315-0510-04			RES,FXD,CMPSN:51 OHM,5%,0.25 W	01121	CB5105
R1604	315-0330-00			RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
R1605	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1606	321-0125-00			RES,FXD,FILM:196 OHM,1%,0.125W, TC=T0	07716	CEAD196R0F
R1607	321-0234-00			RES,FXD,FILM:2.67K OHM,1%,0.125W,TC=T0	19701	5033ED2K67F
R1608	321-0225-00			RES,FXD,FILM:2.15K OHM,1%,0.125W,TC=T0	19701	5033ED2K15F
R1610	321-0223-00			RES,FXD,FILM:2.05K OHM,1%,0.125W,TC=T0	19701	5033ED2K05F
R1611	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R1612	321-0064-00			RES,FXD,FILM:45.3 OHM,0.5%,0.125W,TC=T0	91637	CMF55116G45R30F
R1613	321-0196-00			RES,FXD,FILM:1.07K OHM,1%,0.125W,TC=T0	07716	CEAD10700F
R1614	315-0330-00			RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
R1615	321-0270-00			RES,FXD,FILM:6.34K OHM,1%,0.125W,TC=T0	19701	5043ED6K340F
R1616	321-0158-00			RES,FXD,FILM:432 OHM,1%,0.125W,TC=T0	07716	CEAD432R0F
R1617	321-0177-00			RES,FXD,FILM:681 OHM,1%,0.125W,TC=T0	07716	CEAD681R0F
R1618	315-0510-04			RES,FXD,CMPSN:51 OHM,5%,0.25 W	01121	CB5105
R1619	321-0074-00			RES,FXD,FILM:57.6 OHM,1%,0.125W,TC=T0	91637	CMF55116G57R60F
R1620	322-0126-00			RES,FXD,FILM:200 OHM,1%,0.25W,TC=T0	19701	5043RD200R0F
R1621	321-0143-00			RES,FXD,FILM:301 OHM,1%,0.125W,TC=T0	07716	CEAD301R0F
R1622	311-1223-00			RES,VAR,NONWW:TRMR,250 OHM,0.5W	32997	3386F-T04-251
R1623	315-0681-03			RES,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R1624	315-0181-00			RES,FXD,FILM:180 OHM,5%,0.25W	57668	NTR25J-E180E
R1625	321-0242-00			RES,FXD,FILM:3.24K OHM,1%,0.125W,TC=T0	19701	5043ED3K240F
R1626	311-1222-00			RES,VAR,NONWW:TRMR,100 OHM,0.5W	32997	3386F-T04-101
R1627	315-0271-00			RES,FXD,FILM:270 OHM,5%,0.25W	57668	NTR25J-E270E
R1628	315-0430-02			RES,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
R1629	315-0103-03			RES,FXD,CMPSN:10K OHM,5%,0.25W	80009	315-0103-03
R1630	315-0510-04			RES,FXD,CMPSN:51 OHM,5%,0.25 W	01121	CB5105
R1632	321-0217-00			RES,FXD,FILM:1.78K OHM,1%,0.125W,TC=T0	19701	5043D1K780F
R1633	315-0470-00	B010100	B020859	RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
R1633	315-0270-00	B020860		RES,FXD,FILM:27 OHM,5%,0.25W	19701	5043CX27R00J
R1634	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
R1635	311-1259-00			RES,VAR,NONWW:TRMR,100 OHM,0.5W	32997	3329P-L58-101
R1636	321-0151-00			RES,FXD,FILM:365 OHM,1%,0.125W,TC=T0	07716	CEAD365R0F
R1637	311-1221-00			RES,VAR,NONWW:TRMR,50 OHM,0.5W	32997	3386F-T04-500
R1638	322-0202-00			RES,FXD,FILM:1.24K OHM,1%,0.25W,TC=T0	75042	CEBT0-1241F

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R1639	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R1641	315-0103-03			RES,FXD,CMPSN:10K OHM,5%,0.25W	80009	315-0103-03
R1642	315-0132-00			RES,FXD,FILM:1.3K OHM,5%,0.25W	57668	NTR25J-E01K3
R1643	315-0333-00			RES,FXD,FILM:33K OHM,5%,0.25W	57668	NTR25J-E33K0
R1644	322-0202-00			RES,FXD,FILM:1.24K OHM,1%,0.25W,TC=T0	75042	CEBT0-1241F
R1645	311-1258-00			RES,VAR,NONWW:TRMR,50 OHM,0.5W	32997	3329P-L58-500
R1646	321-0112-00			RES,FXD,FILM:143 OHM,1%,0.125W,TC=T0	07716	CEAD143R0F
R1647	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1649	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0	19701	5033ED200R0F
R1651	315-0150-00			RES,FXD,FILM:15 OHM,5%,0.25W	19701	5043CX15R00J
R1652	321-0108-00			RES,FXD,FILM:130 OHM 1%,0.125W,TC=T0	07716	CEAD13000F
R1653	301-0391-00	B010100	B020859	RES,FXD,FILM:390 OHM,5%,0.5W	01121	EB3915
R1656	301-0271-00			RES,FXD,FILM:270 OHM,5%,0.5W	19701	5053CX270R0J
R1657	315-0220-00			RES,FXD,FILM:22 OHM,5%,0.25W	19701	5043CX22R00J
R1658	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R1659	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1660	323-0293-00			RES,FXD,FILM:11.0K OHM,1%,0.5W,TC=T0	19701	5053RD11K00F
R1662	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
R1663	315-0390-00			RES,FXD,FILM:39 OHM,5%,0.25W	57668	NTR25J-E39E0
R1664	315-0301-00			RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E
R1665	315-0680-00			RES,FXD,FILM:68 OHM,5%,0.25W	57668	NTR25J-E68E0
R1668	315-0510-04	B010100	B020859	RES,FXD,CMPSN:51 OHM,5%,0.25 W	01121	CB5105
R1668	315-0510-00	B020860		RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R1670	321-0312-00			RES,FXD,FILM:17.4K OHM,1%,0.125W,TC=T0	19701	5033ED17K40F
R1671	315-0823-00			RES,FXD,FILM:82K OHM,5%,0.25W	57668	NTR25J-E82K
R1672	315-0272-00	B010100	B020859	RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R1672	301-0202-00	B020860		RES,FXD,FILM:2K OHM,5%,0.5W	19701	5053CX2K000J
R1673	315-0101-00	B010100	B020859	RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1673	315-0201-00	B020860		RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
R1674	315-0223-00			RES,FXD,FILM:22K OHM,5%,0.25W	19701	5043CX22K00J92U
R1675	315-0273-00			RES,FXD,FILM:27K OHM,5%,0.25W	57668	NTR25J-E27K0
R1676	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
R1679	315-0430-02			RES,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
R1680	315-0203-02			RES,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R1682	315-0105-03			RES,FXD,CMPSN:1M OHM,5%,0.25W	80009	315-0105-03
R1685	315-0105-03			RES,FXD,CMPSN:1M OHM,5%,0.25W	80009	315-0105-03
R1687	315-0104-03			RES,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1688	315-0103-03			RES,FXD,CMPSN:10K OHM,5%,0.25W	80009	315-0103-03
R1691	303-0150-00			RES,FXD,CMPSN:15 OHM,5%,1W	01121	GB1505
R1692	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1693	323-0140-00			RES,FXD,FILM:280 OHM,1%,0.5W,TC=T0	75042	CECT0-2800F
R1694	315-0161-02			RES,FXD,CMPSN:160 OHM,5%,0.25	01121	CB1615(CD PACK)
R1695	321-0228-00			RES,FXD,FILM:2.32K OHM,1%,0.125W,TC=T0	19701	5043ED2K32F
R1696	321-0062-00			RES,FXD,FILM:43.2 OHM,0.5%,0.125W,TC=T0	57668	CRB14 FXE 43.2
R1697	321-0204-00			RES,FXD,FILM:1.30K OHM,1%,0.125W,TC=T0	19701	5033ED1K300F
R1698	315-0363-00			RES,FXD,FILM:36K OHM,5%,0.25W	57668	NTR25J-E36K0
R1699	323-0140-00			RES,FXD,FILM:280 OHM,1%,0.5W,TC=T0	75042	CECT0-2800F
R1701	315-0105-00	B073914		RES,FXD,FILM:1M OHM,5%,0.25W	19701	5043CX1M000J
R1702	321-0347-00	B073914		RES,FXD,FILM:40.2K OHM,1%,0.125W,TC=T0	91637	CMF55116G40201F
R1704	315-0105-00	B073914		RES,FXD,FILM:1M OHM,5%,0.25W	19701	5043CX1M000J
R1706	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R1708	315-0102-03			RES,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1709	315-0123-00			RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
R1712	301-0164-00	B010100	B021479	RES,FXD,FILM:160K OHM,5%,0.5W	19701	5053CX160K0J
R1712	301-0164-01	B021480		RES,FXD,CMPSN:160K OHM,5%,0.5W	01121	EB1645
R1713	321-0422-00	B010100	B010164	RES,FXD,FILM:243K OHM,1%,0.125W,TC=T0	07716	CEAD24302F
R1713	321-0414-00	B010165		RES,FXD,FILM:200K OHM,1%,0.125W,TC=T0	07716	CEAD20002F
R1714	321-0138-00			RES,FXD,FILM:267 OHM,1%,0.125W,TC=T0	80009	321-0138-00

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R1715	323-0347-00	B073914		RES,FXD,FILM:40.2K OHM,1%,0.5W,TC=T0	75042	CECT0-4022F
R1716	323-0793-07			RES,FXD,FILM:2.5 MEG OHM,0.1%,0.5W,TC=T9	07716	CECE25003B
R1717	323-0793-07			RES,FXD,FILM:2.5 MEG OHM,0.1%,0.5W,TC=T9	07716	CECE25003B
R1718	323-0793-07			RES,FXD,FILM:2.5 MEG OHM,0.1%,0.5W,TC=T9	07716	CECE25003B
R1719	321-0428-00			RES,FXD,FILM:280K OHM,1%,0.125W,TC=T0	24546	NA55D2803F
R1720	311-1232-00			RES,VAR,NONWW:TRMR,50K OHM,0.5W	32997	3386F-T04-503
R1722	321-0318-00			RES,FXD,FILM:20.0K OHM,1%,0.125W,TC=T0	19701	5033ED20K00F
R1724	321-0254-00			RES,FXD,FILM:4.32K OHM,1%,0.125W,TC=T0	07716	CEAD43200F
R1725	301-0104-00	B010100	B021479	RES,FXD,FILM:100K OHM,5%,0.5W	19701	5053CX100K0J
R1725	301-0104-02	B021480		RES,FXD,CMPSN:100K OHM,5%,0.5W	01121	EB1045
R1726	301-0104-00	B010100	B021479	RES,FXD,FILM:100K OHM,5%,0.5W	19701	5053CX100K0J
R1726	301-0104-02	B021480		RES,FXD,CMPSN:100K OHM,5%,0.5W	01121	EB1045
R1732	321-0280-00			RES,FXD,FILM:8.06K OHM,1%,0.125W,TC=T0	19701	5033ED8K060F
R1733	315-0755-00			RES,FXD,FILM:7.5M OHM,5%,0.25W	19701	5043CX7M500J
R1734	321-0184-00			RES,FXD,FILM:806 OHM,1%,0.125W,TC=T0	19701	5033ED806R0F
R1735	321-0269-00			RES,FXD,FILM:6.19K OHM,1%,0.125W,TC=T0	07716	CEAD61900F
R1736	315-0566-00			RES,FXD,FILM:56M OHM,5%,0.25W	01121	CB5665
R1738	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R1741	321-0275-00			RES,FXD,FILM:7.15K OHM,1%,0.125W,TC=T0	07716	CEAD71500F
R1742	321-0353-00			RES,FXD,FILM:46.4K OHM,1%,0.125W,TC=T0	07716	CEAD46401F
R1743	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R1746	311-1232-00			RES,VAR,NONWW:TRMR,50K OHM,0.5W	32997	3386F-T04-503
R1747	315-0103-03			RES,FXD,CMPSN:10K OHM,5%,0.25W	80009	315-0103-03
R1748	315-0103-03			RES,FXD,CMPSN:10K OHM,5%,0.25W	80009	315-0103-03
R1750	301-0152-00	B010100	B021479	RES,FXD,FILM:1.5K OHM,5%,0.5W	19701	5053CX1K500J
R1750	301-0152-03	B021480		RES,FXD,CMPSN:1.5K OHM,5%,0.5W	01121	EB1525
R1754	323-0540-00			RES,FXD,FILM:4.12 MEG OHM,1%,0.5W,TC=T0	19701	5053RD4M120F
R1755	301-0106-00	B010100	B021479	RES,FXD,FILM:10M OHM,5%,0.50W	01121	EB1065
R1755	301-0106-03	B021480		RES,FXD,CMPSN:10M OHM,5%,0.5W	01121	EB1065
R1756	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1757	321-0044-00			RES,FXD,FILM:28.0 OHM,1%,0.125W,TC=T0	91637	CMF55116G28R00F
R1758	321-0033-00			RES,FXD,FILM:21.5 OHM,1%,0.125W,TC=T0	91637	CMF55116G21R50F
R1764	301-0103-00	B010100	B021479	RES,FXD,FILM:10K OHM,5%,0.50W	19701	5053CX10K00J
R1764	301-0103-02	B021480		RES,FXD,CMPSN:10K OHM,5%,0.5W	01121	EB1035
R1770	315-0470-03			RES,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1771	315-0391-00			RES,FXD,FILM:390 OHM,5%,0.25W	57668	NTR25J-E390E
R1772	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R1774	307-0104-00			RES,FXD,CMPSN:3.3 OHM,5%,0.25W	01121	CB33G5
R1776	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1778	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R1783	315-0331-00			RES,FXD,FILM:330 OHM,5%,0.25W	57668	NTR25J-E330E
R1784	315-0102-03			RES,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1785	315-0102-03			RES,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1788	301-0105-00	B010100	B021479	RES,FXD,FILM:1M OHM,5%,0.50W	19701	5053CX1M000J
R1788	301-0105-01	B021480		RES,FXD,CMPSN:1M OHM,5%,0.5W	01121	EB1055
R1789	301-0105-00	B010100	B021479	RES,FXD,FILM:1M OHM,5%,0.50W	19701	5053CX1M000J
R1789	301-0105-01	B021480		RES,FXD,CMPSN:1M OHM,5%,0.5W	01121	EB1055
R1790	315-0104-03			RES,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1791	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R1792	315-0103-03			RES,FXD,CMPSN:10K OHM,5%,0.25W	80009	315-0103-03
R1793	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R1794	315-0183-03			RES,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R1795	315-0226-01			RES,FXD,CMPSN:22 M OHM,5%,0.25W	01121	CB2265
R1796	321-0193-00	B010100	B073913	RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R1796	321-0347-00	B073914		RES,FXD,FILM:40.2K OHM,1%,0.125W,TC=T0	91637	CMF55116G40201F
R1797	321-0319-00			RES,FXD,FILM:20.5K OHM,1%,0.125W,TC=T0	19701	5033ED20K50F
R1800	315-0683-03			RES,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835 (AB ONLY)
R1802	307-0556-00			RES NTWK,FXD,FI:HIGH VOLTAGE DIVIDER	80009	307-0556-00

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R1803	315-0204-00			RES,FXD,FILM:200K OHM,5%,0.25W	19701	5043CX200K0J
R1804	315-0755-00			RES,FXD,FILM:7.5M OHM,5%,0.25W	19701	5043CX7M500J
R1805	311-1235-00			RES,VAR,NONWW:100K OHM,0.5W	32997	3386F-T04-104
R1806	321-0983-00			RES,FXD,FILM:4.5 MEG OHM,1%,0.125W,TC=T0	91637	CMF55116-G45003F
R1807	315-0302-00			RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R1811	301-0155-00	B010100	B021479	RES,FXD,FILM:1.5M OHM,5%,0.5W	01121	EB1555
R1811	301-0155-01	B021480		RES,FXD,CMPSN:1.5M OHM,5%,0.5W	01121	EB1555
R1812	301-0155-00	B010100	B021479	RES,FXD,FILM:1.5M OHM,5%,0.5W	01121	EB1555
R1812	301-0155-01	B021480		RES,FXD,CMPSN:1.5M OHM,5%,0.5W	01121	EB1555
R1813	301-0205-00	B010100	B021479	RES,FXD,FILM:2M OHM,5%,0.5W	19701	5053CX2M000J
R1813	301-0205-01	B021480		RES,FXD,CMPSN:2M OHM,5%,0.5W	01121	EB2055
R1814	301-0205-00	B010100	B021479	RES,FXD,FILM:2M OHM,5%,0.5W	19701	5053CX2M000J
R1814	301-0205-01	B021480		RES,FXD,CMPSN:2M OHM,5%,0.5W	01121	EB2055
R1815	315-0226-01			RES,FXD,CMPSN:22 M OHM,5%,0.25W	01121	CB2265
R1816	315-0103-03			RES,FXD,CMPSN:10K OHM,5%,0.25W	80009	315-0103-03
R1817	315-0104-03			RES,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1818	315-0183-03			RES,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R1819	315-0183-03			RES,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R1820	315-0103-03			RES,FXD,CMPSN:10K OHM,5%,0.25W	80009	315-0103-03
R1821	315-0105-03			RES,FXD,CMPSN:1M OHM,5%,0.25W	80009	315-0105-03
R1822	323-0540-00			RES,FXD,FILM:4.12 MEG OHM,1%,0.5W,TC=T0	19701	5053RD4M120F
R1823	323-0540-00			RES,FXD,FILM:4.12 MEG OHM,1%,0.5W,TC=T0	19701	5053RD4M120F
R1824	323-0540-00			RES,FXD,FILM:4.12 MEG OHM,1%,0.5W,TC=T0	19701	5053RD4M120F
R1825	311-1967-00			RES,VAR,NONWW:PNL,2M OHM,10%,0.5W	12697	CM41731
R1827	323-0540-00			RES,FXD,FILM:4.12 MEG OHM,1%,0.5W,TC=T0	19701	5053RD4M120F
R1828	323-0525-00			RES,FXD,FILM:2.87 MEG OHM,1%,0.5W,TC=T0	19701	5053RD2M870F
R1829	323-0540-00			RES,FXD,FILM:4.12 MEG OHM,1%,0.5W,TC=T0	19701	5053RD4M120F
R1831	315-0102-03			RES,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1834	315-0103-03			RES,FXD,CMPSN:10K OHM,5%,0.25W	80009	315-0103-03
R1835	315-0153-03			RES,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R1837	315-0105-03			RES,FXD,CMPSN:1M OHM,5%,0.25W	80009	315-0105-03
R1838	315-0153-03			RES,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R1839	321-0444-00			RES,FXD,FILM:412K OHM,1%,0.125W,TC=T0	07716	CEAD41202F
R1840	321-0486-00			RES,FXD,FILM:1.13 MEG OHM,1%,0.125W,T=T0	19701	5033RD1M130F
R1841	315-0184-01			RES,FXD,CMPSN:180K OHM,5%,0.25W	01121	CB1845
R1842	315-0103-03			RES,FXD,CMPSN:10K OHM,5%,0.25W	80009	315-0103-03
R1848	315-0683-03			RES,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835 (AB ONLY)
R1849	315-0161-02			RES,FXD,CMPSN:160 OHM,5%,0.25	01121	CB1615(CD PACK)
R1850	315-0161-02			RES,FXD,CMPSN:160 OHM,5%,0.25	01121	CB1615(CD PACK)
R1852	315-0161-02			RES,FXD,CMPSN:160 OHM,5%,0.25	01121	CB1615(CD PACK)
R1853	311-1969-00			RES,VAR,NONWW:PNL,DUAL,5M OHM,20%,0.5W	01121	72P4N048S505M
R1854	311-1969-00			RES,VAR,NONWW:PNL,DUAL,5M OHM,20%,0.5W	01121	72P4N048S505M
R1855	311-1969-00			RES,VAR,NONWW:PNL,DUAL,5M OHM,20%,0.5W	01121	72P4N048S505M
R1856	311-1969-00			RES,VAR,NONWW:PNL,DUAL,5M OHM,20%,0.5W	01121	72P4N048S505M
R1857	323-0505-00			RES,FXD,FILM:1.78 MEG OHM,1%,0.5W,TC=T0	91637	CMF65116G17803F
R1858	323-0505-00			RES,FXD,FILM:1.78 MEG OHM,1%,0.5W,TC=T0	91637	CMF65116G17803F
R1859	323-0505-00			RES,FXD,FILM:1.78 MEG OHM,1%,0.5W,TC=T0	91637	CMF65116G17803F
R1860	315-0161-02			RES,FXD,CMPSN:160 OHM,5%,0.25	01121	CB1615(CD PACK)
R1862	315-0161-02			RES,FXD,CMPSN:160 OHM,5%,0.25	01121	CB1615(CD PACK)
R1863	311-1969-00			RES,VAR,NONWW:PNL,DUAL,5M OHM,20%,0.5W	01121	72P4N048S505M
R1864	311-1969-00			RES,VAR,NONWW:PNL,DUAL,5M OHM,20%,0.5W	01121	72P4N048S505M
R1865	311-1969-00			RES,VAR,NONWW:PNL,DUAL,5M OHM,20%,0.5W	01121	72P4N048S505M
R1866	311-1969-00			RES,VAR,NONWW:PNL,DUAL,5M OHM,20%,0.5W	01121	72P4N048S505M
R1867	323-0505-00			RES,FXD,FILM:1.78 MEG OHM,1%,0.5W,TC=T0	91637	CMF65116G17803F
R1870	315-0161-02			RES,FXD,CMPSN:160 OHM,5%,0.25	01121	CB1615(CD PACK)
R1872	315-0161-02			RES,FXD,CMPSN:160 OHM,5%,0.25	01121	CB1615(CD PACK)
R1873	311-1969-00			RES,VAR,NONWW:PNL,DUAL,5M OHM,20%,0.5W	01121	72P4N048S505M
R1874	311-1969-00			RES,VAR,NONWW:PNL,DUAL,5M OHM,20%,0.5W	01121	72P4N048S505M

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R1875	311-1969-00			RES,VAR,NONWW:PNL,DUAL,5M OHM,20%,0.5W	01121	72P4N048S505M
R1876	311-1969-00			RES,VAR,NONWW:PNL,DUAL,5M OHM,20%,0.5W	01121	72P4N048S505M
R1877	315-0103-03			RES,FXD,CMPSN:10K OHM,5%,0.25W	80009	315-0103-03
R1880	315-0161-02			RES,FXD,CMPSN:160 OHM,5%,0.25	01121	CB1615(CD PACK)
R1881	315-0361-00			RES,FXD,FILM:360 OHM,5%,0.25W	19701	5043CX360R0J
R1882	323-0540-00			RES,FXD,FILM:4.12 MEG OHM,1%,0.5W,TC=T0	19701	5053RD4M120F
R1883	311-1968-00			RES,VAR,NONWW:PNL,5M OHM,20%,0.5W	01121	72M4N048S505M
R1884	323-0745-00			RES,FXD,FILM:5 MEG OHM,1%,0.5W,TC=T0	03888	PME65 5MOHM T0
R1885	323-0745-00			RES,FXD,FILM:5 MEG OHM,1%,0.5W,TC=T0	03888	PME65 5MOHM T0
R1886	323-0745-00			RES,FXD,FILM:5 MEG OHM,1%,0.5W,TC=T0	03888	PME65 5MOHM T0
R1887	323-0496-00			RES,FXD,FILM:1.43M OHM,1%,0.5W,TC=T0	19701	5053RD1M430F
R1888	311-1227-00			RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3386F-T04-502
R1890	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R1891	311-1232-00	B010100	B010139	RES,VAR,NONWW:TRMR,50K OHM,0.5W	32997	3386F-T04-503
R1891	311-1252-00	B010140		RES,VAR,NONWW:TRMR,500K OHM,0.5W	32997	3386F-T04-504
R1893	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R1894	311-1235-00			RES,VAR,NONWW:100K OHM,0.5W	32997	3386F-T04-104
R1895	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R1896	321-0277-00			RES,FXD,FILM:7.50K OHM,1%,0.125W,TC=T0	24546	NA55D7501F
R1897	321-0314-00			RES,FXD,FILM:18.2K OHM,1%,0.125W,TC=T0	19701	5043ED18K20F
R1900	311-1587-00			RES,VAR,NONWW:PNL,10K OHM,1W,W/SW (FURNISHED AS A UNIT WITH S1900)	01121	12M435
R1901	315-0106-00			RES,FXD,FILM:10M OHM,5%,0.25W	01121	CB1065
R1902	311-1319-00			RES,VAR,NONWW:TRMR,10K OHM,0.5W	32997	3006P-W84-103
R1903	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1905	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1906	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1908	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R1909	315-0244-00			RES,FXD,FILM:240K OHM,5%,0.25W	19701	5043CX240K0J
R1910	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R1911	321-0143-00	B010100	B021249	RES,FXD,FILM:301 OHM,1%,0.125W,TC=T0	07716	CEAD301R0F
R1914	315-0471-00	B010100	B063670	RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R1914	315-0201-00	B063671		RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
R1915	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R1916	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R1917	315-0153-00			RES,FXD,FILM:15K OHM,5%,0.25W	19701	5043CX15K00J
R1918	315-0106-00			RES,FXD,FILM:10M OHM,5%,0.25W	01121	CB1065
R1919	315-0105-00			RES,FXD,FILM:1M OHM,5%,0.25W	19701	5043CX1M000J
R1920	315-0101-00	B010100	B021249	RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1921	315-0105-00	B010100	B021249	RES,FXD,FILM:1M OHM,5%,0.25W	19701	5043CX1M000J
R1922	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R1923	311-1339-00			RES,VAR,NONWW:TRMR,5K OHM,0.75W	02111	43P502T672
R1924	311-1588-00			RES,VAR,NONWW:PNL,5K OHM,1W,W/SW (FURNISHED AS A UNIT WITH S1924)	01121	20M718
R1925	315-0202-00	B010100	B020870	RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R1925	315-0622-00	B020871		RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
R1926	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1927	321-0226-00			RES,FXD,FILM:2.21K OHM,1%,0.125W,TC=T0	01121	RNK2211F
R1928	321-0180-00			RES,FXD,FILM:732 OHM,1%,0.125W,TC=T0	07716	CEAD732R0F
R1929	321-0190-00			RES,FXD,FILM:931 OHM,1%,0.125W,TC=T0	19701	5043ED931R0F
R1930	315-0431-00			RES,FXD,FILM:430 OHM,5%,0.25W	19701	5043CX430R0J
R1931	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R1932	323-0189-00			RES,FXD,FILM:909 OHM,1%,0.5W,TC=T0	19701	5053RD909R0F
R1933	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1934	315-0301-00			RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E
R1935	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R1936	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1936	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R1937	315-0123-00			RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
R1938	315-0331-00			RES,FXD,FILM:330 OHM,5%,0.25W	57668	NTR25J-E330E
R1940	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R1941	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R1942	315-0204-00			RES,FXD,FILM:200K OHM,5%,0.25W	19701	5043CX200K0J
R1943	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
R1944	321-0262-00			RES,FXD,FILM:5.23K OHM,1,0.125W,TC=T0	19701	5033ED5K230F
R1945	301-0102-00			RES,FXD,CMPSN:1K OHM,5%,0.50W	19701	5053CX1K000J
R1946	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
R1948	321-0190-00			RES,FXD,FILM:931 OHM,1%,0.125W,TC=T0	19701	5043ED931R0F
R1950	315-0393-00			RES,FXD,FILM:39K OHM,5%,0.25W	57668	NTR25J-E39K0
R1951	321-0481-00			RES,FXD,FILM:1M OHM,1%,0.125W,TC=T0	19701	5043ED1M000F
R1952	321-0300-00			RES,FXD,FILM:13.0K OHM,1%,0.125W,TC=T0	07716	CEAD13001F
R1953	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R1954	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R1955	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1957	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
R1958	315-0625-00	B010100	B020870	RES,FXD,FILM:6.2M OHM,5%,0.25W	01121	CB6255
R1958	315-0335-00	B020871		RES,FXD,FILM:3.3M OHM,5%,0.25W	01121	CB3355
R1959	321-0217-00			RES,FXD,FILM:1.78K OHM,1%,0.125W,TC=T0	19701	5043D1K780F
R1960	321-0126-00	B010100	B020870	RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0	19701	5033ED200R0F
R1960	321-0039-00	B020871		RES,FXD,FILM:24.9 OHM,1%,0.125W,TC=T0	91637	CMF55116G24R90F
R1961	315-0102-00	B010100	B020870	RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R1961	315-0101-00	B020871		RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1962	315-0514-00			RES,FXD,FILM:510K OHM,5%,0.25W	19701	5043CX510K0J
R1963	321-0283-00			RES,FXD,FILM:8.66K OHM,1%,0.125W,TC=T0	19701	5043ED8K660F
R1964	321-0205-00			RES,FXD,FILM:1.33K OHM,1%,0.125W,TC=T0	19701	5033ED1K330F
R1965	321-0260-00			RES,FXD,FILM:4.99K OHM,1%,0.125W,TC=T0	19701	5033ED4K990F
R1966	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1967	315-0473-00			RES,FXD,FILM:47K OHM,5%,0.25W	57668	NTR25J-E47K0
R1968	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R1969	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R1970	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R1971	315-0625-00			RES,FXD,FILM:6.2M OHM,5%,0.25W	01121	CB6255
R1972	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1973	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1974	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R1975	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R1976	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R1977	315-0433-00			RES,FXD,FILM:43K OHM,5%,0.25W	19701	5043CX43K00J
R1979	321-0296-00			RES,FXD,FILM:11.8K OHM,1%,0.125W,TC=T0	07716	CEAD11801F
R1980	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1981	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R1982	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R1983	321-0243-00	B010100	B021249	RES,FXD,FILM:3.32K OHM,1%,0.125W,TC=T0	19701	5033ED3K32F
R1985	315-0154-00			RES,FXD,FILM:150K OHM,5%,0.25W	57668	NTR25J-E150K
R1986	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1987	315-0471-00			RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R1988	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R1989	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1990	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R1991	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1992	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R1993	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R1994	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R1995	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R1996	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R1997	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R1998	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R1999	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R2005	311-1372-00			RES,VAR,NONWW:PNL,100K OHM,0.5W	01121	73U1G040L104M
R2007	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
R2008	315-0303-00			RES,FXD,FILM:30K OHM,5%,0.25W	19701	5043CX30K00J
R2009	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R2010	311-1375-00			RES,VAR,NONWW:PNL,10K OHM,1W	01121	73M1G040L103M
R2015	311-1372-00			RES,VAR,NONWW:PNL,100K OHM,0.5W	01121	73U1G040L104M
R2016	315-0154-00			RES,FXD,FILM:150K OHM,5%,0.25W	57668	NTR25J-E150K
R2017	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
R2018	315-0303-00			RES,FXD,FILM:30K OHM,5%,0.25W	19701	5043CX30K00J
R2019	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R2020	311-1375-00			RES,VAR,NONWW:PNL,10K OHM,1W	01121	73M1G040L103M
R2025	311-1973-00			RES,VAR,NONWW:PNL,2.5M OHM,20%,0.75 W	01121	73M1G040L255M
R2035	311-1972-00			RES,VAR,NONWW:PNL,2K OHM,10%,2.0 W	01121	70N1G100L202W
R2101	315-0682-00			RES,FXD,FILM:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
R2102	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R2104	315-0333-00			RES,FXD,FILM:33K OHM,5%,0.25W	57668	NTR25J-E33K0
R2105	315-0153-00			RES,FXD,FILM:15K OHM,5%,0.25W	19701	5043CX15K00J
R2107	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
R2108	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R2109	315-0221-00			RES,FXD,FILM:220 OHM,5%,0.25W	57668	NTR25J-E220E
R2112	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R2113	315-0301-00			RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E
R2122	315-0432-00			RES,FXD,FILM:4.3K OHM,5%,0.25W	57668	NTR25J-E04K3
R2123	315-0683-00			RES,FXD,FILM:68K OHM,5%,0.25W	57668	NTR25J-E68K0
R2127	315-0302-00	B010100	B049999	RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R2127	315-0102-00	B050000		RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R2128	311-1263-00	B010100	B049999	RES,VAR,NONWW:1K OHM,10%,0.50W	32997	3329P-L58-102
R2129	315-0183-00	B010100	B049999	RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
R2131	315-0472-00	B050000		RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R2132	315-0222-00	B050000		RES,FXD,FILM:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
R2134	315-0302-00	B050000		RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R2135	315-0393-00			RES,FXD,FILM:39K OHM,5%,0.25W	57668	NTR25J-E39K0
R2137	315-0752-00			RES,FXD,FILM:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
R2139	315-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
R2140	315-0103-00	B050000		RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R2141	315-0102-00	B050000		RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R2144	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R2146	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R2148	315-0103-00	B010100	B049999	RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R2150	321-0403-00	B010100	B049999	RES,FXD,FILM:154K OHM,1%,0.125W,TC=T0	07716	CEAD15402F
R2150	315-0183-00	B050000		RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
R2151	321-0372-00	B010100	B049999	RES,FXD,FILM:73.2K OHM,1%,0.125W,TC=T0	07716	CEAD73201F
R2151	315-0362-00	B050000		RES,FXD,FILM:3.6K OHM,5%,0.25W	19701	5043CX3K600J
R2152	315-0622-00	B050000		RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
R2153	315-0103-00	B010100	B049999	RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R2153	315-0301-00	B050000		RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E
R2154	321-0350-00	B050000		RES,FXD,FILM:43.2K OHM,1%,0.125W,TC=T0	19701	5043ED43K20F
R2155	315-0512-00	B010100	B049999	RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R2155	321-0350-00	B050000		RES,FXD,FILM:43.2K OHM,1%,0.125W,TC=T0	19701	5043ED43K20F
R2157	315-0222-00	B050000	B063540	RES,FXD,FILM:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
R2157	315-0621-00	B063541		RES,FXD,FILM:620 OHM,5%,0.25W	57668	NTR25J-E620E
R2158	315-0152-00	B010100	B049999	RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R2161	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R2162	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R2163	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R2165	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R2166	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R2167	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R2169	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R2170	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R2171	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R2173	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R2174	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R2175	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R2177	315-0511-00	B010100	B049999	RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
R2178	315-0511-00	B010100	B049999	RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
R2179	315-0511-00	B010100	B049999	RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
R2180	313-1103-00	B063845		RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
R2181	321-0386-00	B050000		RES,FXD,FILM:102K OHM,1%,0.125W,TC=T0	07716	CEAD10202F
R2182	321-0262-00	B010100	B049999	RES,FXD,FILM:5.23K OHM,1,0.125W,TC=T0	19701	5033ED5K230F
R2182	321-0361-00	B050000	B063844	RES,FXD,FILM:56.2K OHM,1%,0.125W,TC=T0	07716	CEAD56201F
R2182	321-0756-00	B063845		RES,FXD,FILM:50K OHM,1%,0.125W,TC=T0	24546	NA55D5002F
R2183	311-1224-00	B010100	B049999	RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3386F-T04-501
R2183	311-2230-00	B050000		RES,VAR,NONWW:TRMR,500 OHM,20%,0.50 LINEAR	TK1450	GF06UT 500
R2184	321-0262-00	B050000		RES,FXD,FILM:5.23K OHM,1,0.125W,TC=T0	19701	5033ED5K230F
R2185	307-0445-00	B050000		RES NTWK,FXD,FI:4.7K OHM,20%,(9)RES	32997	4310R-101-472
R2187	315-0102-00	B050000		RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R2191	315-0513-00	B010100	B049999	RES,FXD,FILM:51K OHM,5%,0.25W	57668	NTR25J-E51K0
R2191	321-0356-00	B050000		RES,FXD,FILM:49.9K OHM,1%,0.125W,TC=T0	19701	5033ED49K90F
R2192	315-0133-00	B010100	B049999	RES,FXD,FILM:13K OHM,5%,0.25W	19701	5043CX13K00J
R2192	321-0334-00	B050000		RES,FXD,FILM:29.4K OHM,1%,0.125W,TC=T0	07716	CEAD29401F
R2193	315-0133-00	B010100	B049999	RES,FXD,FILM:13K OHM,5%,0.25W	19701	5043CX13K00J
R2193	321-0306-00	B050000		RES,FXD,FILM:15.0K OHM,1%,0.125W,TC=T0	19701	5033ED15J00F
R2194	315-0753-00	B010100	B049999	RES,FXD,FILM:75K OHM,5%,0.25W	57668	NTR25J-E75K0
R2194	321-0373-00	B050000		RES,FXD,FILM:75.0K OHM,1%,0.125W,TC=T0	19701	5033ED75K00F
R2196	321-0308-00	B010100	B049999	RES,FXD,FILM:15.8K OHM,1%,0.125W,TC=T0	07716	CEAD 15801F
R2196	321-0311-00	B050000		RES,FXD,FILM:16.9K OHM,1%,0.125W,TC=T0	07716	CEAC16901F
R2197	315-0513-00	B010100	B049999	RES,FXD,FILM:51K OHM,5%,0.25W	57668	NTR25J-E51K0
R2197	321-0356-00	B050000		RES,FXD,FILM:49.9K OHM,1%,0.125W,TC=T0	19701	5033ED49K90F
R2198	321-0319-00	B010100	B049999	RES,FXD,FILM:20.5K OHM,1%,0.125W,TC=T0	19701	5033ED20K50F
R2198	321-0321-00	B050000		RES,FXD,FILM:21.5K OHM,1%,0.125W,TC=T0	07716	CEAD21501F
R2199	321-0335-00			RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0	57668	RB14FXE30K1
R2201	315-0154-00	B010100	B049999	RES,FXD,FILM:150K OHM,5%,0.25W	57668	NTR25J-E150K
R2201	315-0471-00	B050000		RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
R2202	321-0335-00	B010100	B049999	RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0	57668	RB14FXE30K1
R2202	315-0182-00	B050000		RES,FXD,FILM:1.8K OHM,5%,0.25W	57668	NTR25J-E1K8
R2203	321-0344-00	B010100	B049999	RES,FXD,FILM:37.4K OHM,1%,0.125W,TC=T0	19701	5033ED 37K40F
R2203	315-0511-00	B050000		RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
R2204	321-0335-00	B010100	B049999	RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0	57668	RB14FXE30K1
R2204	307-0446-00	B050000		RES NTWK,FXD,FI:10K OHM,20%,(9)RES	11236	750-101-R10K
R2206	315-0513-00	B010100	B049999	RES,FXD,FILM:51K OHM,5%,0.25W	57668	NTR25J-E51K0
R2206	321-0376-00	B050000		RES,FXD,FILM:80.6K OHM,1%,0.125W,TC=T0	19701	5043ED80K60F
R2207	315-0154-00	B010100	B049999	RES,FXD,FILM:150K OHM,5%,0.25W	57668	NTR25J-E150K
R2207	321-0405-00	B050000		RES,FXD,FILM:162K OHM,1%,0.125W,TC=T0	07716	CEAD16202F
R2208	321-0335-00	B010100	B049999	RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0	57668	RB14FXE30K1
R2208	321-0434-00	B050000		RES,FXD,FILM:324K OHM,1%,0.125W,TC=T0	07716	CEAD32402F
R2209	321-0335-00	B010100	B049999	RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0	57668	RB14FXE30K1
R2210	311-2232-00	B050000		RES,VAR,NONWW:TRMR,2K OHM,20%,0.5W LINEAR	TK1450	GF06UT 2K
R2211	315-0752-00	B010100	B049999	RES,FXD,FILM:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
R2211	315-0332-00	B050000		RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R2212	321-0218-00	B050000		RES,FXD,FILM:1.82K OHM,1%,0.125W,TC=T0	19701	5033ED1K82F
R2213	321-0259-00	B010100	B049999	RES,FXD,FILM:4.87K OHM,1%,0.125W,TC=T0	07716	CEAD48700F
R2213	321-0221-00	B050000		RES,FXD,FILM:1.96K OHM,1%,0.125W,TC=T0	19701	5043ED1K960F
R2214	311-1224-00	B010100	B049999	RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3386F-T04-501

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R2215	315-0133-00	B010100	B049999	RES,FXD,FILM:13K OHM,5%,0.25W	19701	5043CX13K00J
R2216	321-0452-00	B050000		RES,FXD,FILM:499K OHM,1%,0.125W,TC=T0	19701	5043ED499K0F
R2217	315-0124-00	B010100	B049999	RES,FXD,FILM:120K OHM,5%,0.25W	19701	5043CX120K0J
R2217	321-0425-00	B050000		RES,FXD,FILM:261K OHM,1%,0.125W,TC=T0	07716	CEAD26102F
R2218	321-0396-00	B050000		RES,FXD,FILM:130K OHM,1%,0.125W,TC=T0	07716	CEAD13002F
R2219	315-0751-00	B010100	B049999	RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R2220	321-0299-00	B010100	B049999	RES,FXD,FILM:12.7K OHM,1%,0.125W,TC=T0	19701	5033ED12K70F
R2221	321-0212-00	B010100	B049999	RES,FXD,FILM:1.58K OHM,1%,0.125W,TC=T0	19701	5033ED1K58F
R2221	315-0752-00	B050000		RES,FXD,FILM:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
R2222	315-0133-00	B050000		RES,FXD,FILM:13K OHM,5%,0.25W	19701	5043CX13K00J
R2223	315-0124-00	B050000		RES,FXD,FILM:120K OHM,5%,0.25W	19701	5043CX120K0J
R2224	315-0751-00	B050000		RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R2225	321-0299-00	B050000		RES,FXD,FILM:12.7K OHM,1%,0.125W,TC=T0	19701	5033ED12K70F
R2226	315-0222-00	B010100	B049999	RES,FXD,FILM:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
R2226	321-0212-00	B050000		RES,FXD,FILM:1.58K OHM,1%,0.125W,TC=T0	19701	5033ED1K58F
R2227	321-0268-00	B010100	B049999	RES,FXD,FILM:6.04K OHM,1%,0.125W,TC=T0	19701	5043ED6K040F
R2227	315-0152-00	B050000		RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R2229	321-0210-00	B010100	B049999	RES,FXD,FILM:1.50K OHM,1%,0.125W,TC=T0	19701	5033ED1K50F
R2229	315-0512-00	B050000		RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R2230	315-0103-00	B050000		RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R2231	315-0303-00	B010100	B049999	RES,FXD,FILM:30K OHM,5%,0.25W	19701	5043CX30K00J
R2235	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R2236	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R2237	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R2238	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R2239	315-0303-00	B050000	B063533	RES,FXD,FILM:30K OHM,5%,0.25W	19701	5043CX30K00J
R2239	315-0104-00	B063534		RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
R2241	321-0326-00	B010100	B049999	RES,FXD,FILM:24.3K OHM,1%,0.125W,TC=T0	19701	5043ED24K30F
R2242	321-0259-00	B050000		RES,FXD,FILM:4.87K OHM,1%,0.125W,TC=T0	07716	CEAD48700F
R2243	311-2230-00	B050000		RES,VAR,NONWW:TRMR,500 OHM,20%,0.50 LINEAR	TK1450	GF06UT 500
R2244	321-0326-00	B050000		RES,FXD,FILM:24.3K OHM,1%,0.125W,TC=T0	19701	5043ED24K30F
R2245	315-0472-00	B050000		RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R2246	307-0445-00	B050000		RES NTWK,FXD,FI:4.7K OHM,20%,(9)RES	32997	4310R-101-472
R2247	315-0472-00	B050000		RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R2250	315-0222-00	B050000	B063540	RES,FXD,FILM:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
R2250	315-0621-00	B063541		RES,FXD,FILM:620 OHM,5%,0.25W	57668	NTR25J-E620E
R2251	315-0102-00	B010100	B049999	RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R2251	315-0203-00	B050000	B063540	RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R2251	315-0472-00	B063541		RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
R2252	315-0102-00	B010100	B049999	RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R2252	321-0202-00	B050000		RES,FXD,FILM:1.24K OHM,1%,0.125W,TC=T0	24546	NA55D1241F
R2253	315-0102-00	B010100	B049999	RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R2253	321-0202-00	B050000		RES,FXD,FILM:1.24K OHM,1%,0.125W,TC=T0	24546	NA55D1241F
R2254	315-0303-00	B010100	B049999	RES,FXD,FILM:30K OHM,5%,0.25W	19701	5043CX30K00J
R2254	321-0254-00	B050000		RES,FXD,FILM:4.32K OHM,1%,0.125W,TC=T0	07716	CEAD43200F
R2255	321-0302-00	B050000		RES,FXD,FILM:13.7K OHM,1%,0.125W,TC=T0	07716	CEAD 13701F
R2257	321-0251-00	B050000		RES,FXD,FILM:4.02K OHM,1%,0.125W,TC=T0	19701	5033ED4K020F
R2258	315-0203-00	B050000		RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R2259	315-0303-00	B050000		RES,FXD,FILM:30K OHM,5%,0.25W	19701	5043CX30K00J
R2260	311-2232-00	B050000		RES,VAR,NONWW:TRMR,2K OHM,20%,0.5W LINEAR	TK1450	GF06UT 2K
R2261	315-0272-00	B010100	B049999	RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
R2262	315-0102-00	B010100	B049999	RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R2263	307-0696-00	B050000		RES NTWK,FXD,FI:7,10K OHM,2%,0.15W EACH	01121	108A103
R2264	321-0318-00	B050000		RES,FXD,FILM:20.0K OHM,1%,0.125W,TC=T0	19701	5033ED20K00F
R2265	315-0512-00	B010100	B049999	RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R2265	321-0259-00	B050000		RES,FXD,FILM:4.87K OHM,1%,0.125W,TC=T0	07716	CEAD48700F
R2266	315-0912-00	B010100	B049999	RES,FXD,FILM:9.1K OHM,5%,0.25W	57668	NTR25J-E09K1
R2266	321-0430-00	B050000		RES,FXD,FILM:294K OHM,1%,0.125W,TC=T0	07716	CEAD29402F

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R2267	321-0399-00	B050000		RES,FXD,FILM:140K OHM,1%,0.125W,TC=T0	07716	CEAD14002F
R2268	321-0296-00	B010100	B020359	RES,FXD,FILM:11.8K OHM,1%,0.125W,TC=T0	07716	CEAD11801F
R2268	321-0297-00	B020360	B049999	RES,FXD,FILM:12.1K OHM,1%,0.125W,TC=T0	07716	CEAD12101F
R2268	321-0294-00	B042880	B049999	RES,FXD,FILM:11.3K OHM,1%,0.125W,TC=T0 (SELECTED)	19701	5043ED11K30F
R2268	321-0295-00	B042880	B049999	RES,FXD,FILM:11.5K OHM,1%,0.125W,TC=T0 (SELECTED)	07716	CEAD11501F
R2268	321-0296-00	B042880	B049999	RES,FXD,FILM:11.8K OHM,1%,0.125W,TC=T0 (SELECTED)	07716	CEAD11801F
R2268	321-0298-00	B042880	B049999	RES,FXD,FILM:12.4K OHM,1%,0.125W,TC=T0 (SELECTED)	07716	CEAD12401F
R2268	321-0299-00	B042880	B049999	RES,FXD,FILM:12.7K OHM,1%,0.125W,TC=T0 (SELECTED)	19701	5033ED12K70F
R2268	321-0631-00	B042880	B049999	RES,FXD,FILM:12.5K OHM,1%,0.125W,TC=T0 (SELECTED)	91637	MFF1816G12501F
R2268	321-0367-00	B050000		RES,FXD,FILM:64.9K OHM,1%,0.125W,TC=T0	07716	CEAD64901F
R2269	321-0331-00	B050000		RES,FXD,FILM:27.4K OHM,1%,0.125W,TC=T0	19701	5043ED27K40F
R2271	315-0183-00	B050000		RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
R2273	311-1226-00	B010100	B049999	RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3386F-T04-252
R2274	321-0153-00	B010100	B049999	RES,FXD,FILM:383 OHM,1%,0.125W,TC=T0	07716	CEAD383R0F
R2275	321-0170-00	B010100	B049999	RES,FXD,FILM:576 OHM,1%,0.125W,TC=T0	07716	CEAD576R0F
R2276	315-0223-00	B010100	B049999	RES,FXD,FILM:22K OHM,5%,0.25W	19701	5043CX22K00J92U
R2276	321-0251-00	B050000		RES,FXD,FILM:4.02K OHM,1%,0.125W,TC=T0	19701	5033ED4K020F
R2277	321-0250-00	B010100	B049999	RES,FXD,FILM:3.92K OHM,1%,0.125W,TC=T0	07716	CEAD39200F
R2277	321-0218-00	B050000		RES,FXD,FILM:1.82K OHM,1%,0.125W,TC=T0	19701	5033ED1K82F
R2278	315-0823-00	B010100	B049999	RES,FXD,FILM:82K OHM,5%,0.25W	57668	NTR25J-E82K
R2279	321-0222-00	B010100	B049999	RES,FXD,FILM:2.00K OHM,1%,0.125W,TC=T0	19701	5033ED2K00F
R2279	321-0221-00	B050000		RES,FXD,FILM:1.96K OHM,1%,0.125W,TC=T0	19701	5043ED1K960F
R2280	315-0823-00	B010100	B049999	RES,FXD,FILM:82K OHM,5%,0.25W	57668	NTR25J-E82K
R2280	321-0254-00	B050000		RES,FXD,FILM:4.32K OHM,1%,0.125W,TC=T0	07716	CEAD43200F
R2281	315-0101-00	B010100	B049999	RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R2282	315-0332-00	B010100	B049999	RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R2283	315-0753-00	B010100	B049999	RES,FXD,FILM:75K OHM,5%,0.25W	57668	NTR25J-E75K0
R2284	321-0216-00	B010100	B049999	RES,FXD,FILM:1.74K OHM,1%,0.125W,TC=T0	07716	CEAD17400F
R2285	321-0245-00	B010100	B049999	RES,FXD,FILM:3.48K OHM,1%,0.125W,TC=T0	19701	5033ED3K48F
R2285	321-0242-00	B042880	B049999	RES,FXD,FILM:3.24K OHM,1%,0.125W,TC=T0 (SELECTED)	19701	5043ED3K240F
R2285	321-0243-00	B042880	B049999	RES,FXD,FILM:3.32K OHM,1%,0.125W,TC=T0 (SELECTED)	19701	5033ED3K32F
R2285	321-0244-00	B042880	B049999	RES,FXD,FILM:3.40K OHM,1%,0.125W,TC=T0 (SELECTED)	19701	5043ED3K400F
R2285	321-0246-00	B042880	B049999	RES,FXD,FILM:3.57K OHM,1%,0.125W,TC=T0 (SELECTED)	19701	5043ED3K570F
R2285	321-0247-00	B042880	B049999	RES,FXD,FILM:3.65K OHM,1%,0.125W,TC=T0 (SELECTED)	19701	5043ED3K650F
R2285	321-0248-00	B042880	B049999	RES,FXD,FILM:3.74K OHM,1%,0.125W,TC=T0 (SELECTED)	19701	5043ED3K740F
R2286	321-0210-00	B010100	B049999	RES,FXD,FILM:1.50K OHM,1%,0.125W,TC=T0	19701	5033ED1K50F
R2286	307-0651-00	B050000		RES NTWK,FXD,FI:5,3.3K OHM,5%,0.150W	11236	750-61-R3.3K OHM
R2287	321-0199-00	B010100	B049999	RES,FXD,FILM:1.15K OHM,1%,0.125W,TC=T0	07716	CEAD11500F
R2288	321-0273-00	B010100	B049999	RES,FXD,FILM:6.81K OHM,1%,0.125W,TC=T0	07716	CEAD68100F
R2288	321-0353-00	B050000		RES,FXD,FILM:46.4K OHM,1%,0.125W,TC=T0	07716	CEAD46401F
R2289	321-0193-00	B010100	B049999	RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R2289	321-0335-00	B050000		RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0	57668	RB14FXE30K1
R2290	321-0321-00	B050000		RES,FXD,FILM:21.5K OHM,1%,0.125W,TC=T0	07716	CEAD21501F
R2291	311-1225-00	B010100	B049999	RES,VAR,NONWW:TRMR,1K OHM,0.5W	32997	3386F-T04-102
R2291	321-0310-00	B050000		RES,FXD,FILM:16.5K OHM,1%,0.125W,TC=T0	19701	5033ED16K50F
R2292	315-0132-00	B010100	B049999	RES,FXD,FILM:1.3K OHM,5%,0.25W	57668	NTR25J-E01K3
R2292	321-0301-00	B050000		RES,FXD,FILM:13.3K OHM,1%,0.125W,TC=T0	07716	CEAD13301F
R2293	321-0245-00	B010100	B049999	RES,FXD,FILM:3.48K OHM,1%,0.125W,TC=T0	19701	5033ED3K48F
R2293	321-0302-00	B050000		RES,FXD,FILM:13.7K OHM,1%,0.125W,TC=T0	07716	CEAD 13701F

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R2294	321-0255-00	B010100	B049999	RES,FXD,FILM:4.42K OHM,1%,0.125W,TC=T0	19701	5033ED4K420F
R2295	321-0241-00	B010100	B049999	RES,FXD,FILM:3.16K OHM,1%,0.125W,TC=T0	07716	CEAD31600F
R2296	321-0251-00	B050000		RES,FXD,FILM:4.02K OHM,1%,0.125W,TC=T0	19701	5033ED4K020F
R2297	315-0152-00	B010100	B049999	RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R2297	321-0254-00	B050000		RES,FXD,FILM:4.32K OHM,1%,0.125W,TC=T0	07716	CEAD43200F
R2298	315-0102-00	B010100	B049999	RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R2298	315-0203-00	B050000		RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R2299	315-0431-00	B010100	B049999	RES,FXD,FILM:430 OHM,5%,0.25W	19701	5043CX430R0J
R3486	315-0241-00	B053267		RES,FXD,FILM:240 OHM,5%,0.25W	19701	5043CX240R0J
R4302	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
R4304	315-0223-00			RES,FXD,FILM:22K OHM,5%,0.25W	19701	5043CX22K00J92U
R4305	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R4306	315-0223-00			RES,FXD,FILM:22K OHM,5%,0.25W	19701	5043CX22K00J92U
R4307	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R4312	321-0147-00			RES,FXD,FILM:332 OHM,1%,0.125W,TC=T0	07716	CEAD332R0F
R4313	321-0239-00			RES,FXD,FILM:3.01K OHM,1%,0.125W,TC=T0	19701	5043ED3K010F
R4314	315-0912-00			RES,FXD,FILM:9.1K OHM,5%,0.25W	57668	NTR25J-E09K1
R4315	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R4316	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
R4318	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R4319	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R4321	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R4322	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R4333	315-0682-00			RES,FXD,FILM:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
R4334	315-0303-00			RES,FXD,FILM:30K OHM,5%,0.25W	19701	5043CX30K00J
R4335	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R4336	315-0752-00			RES,FXD,FILM:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
R4342	315-0271-00			RES,FXD,FILM:270 OHM,5%,0.25W	57668	NTR25J-E270E
R4343	315-0222-00			RES,FXD,FILM:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
R4344	315-0271-00			RES,FXD,FILM:270 OHM,5%,0.25W	57668	NTR25J-E270E
R4345	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R4354	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R4356	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R4357	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R4358	315-0152-00	B010100	B020599	RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R4358	315-0101-00	B020600		RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R4363	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R4366	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R4367	315-0152-00	B010100	B020459	RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R4367	315-0751-00	B020460	B020599	RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R4367	315-0101-00	B020600		RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R4369	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R4374	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R4380	315-0302-00			RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R4381	315-0303-00			RES,FXD,FILM:30K OHM,5%,0.25W	19701	5043CX30K00J
R4382	315-0182-00	B010100	B010149	RES,FXD,FILM:1.8K OHM,5%,0.25W	57668	NTR25J-E1K8
R4382	315-0122-00	B010150		RES,FXD,FILM:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
R4390	315-0301-00			RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E
R4391	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R4392	315-0332-00	B010100	B010149	RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R4392	315-0202-00	B010150		RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R4394	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
R4413	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R4422	315-0153-00			RES,FXD,FILM:15K OHM,5%,0.25W	19701	5043CX15K00J
R4423	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
R4424	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R4425	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
R4431	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R4432	315-0222-00			RES,FXD,FILM:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
R4437	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R4438	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
R4441	315-0822-00			RES,FXD,FILM:8.2K OHM,5%,0.25W	19701	5043CX8K200J
R4442	315-0132-00			RES,FXD,FILM:1.3K OHM,5%,0.25W	57668	NTR25J-E01K3
R4448	315-0271-00			RES,FXD,FILM:270 OHM,5%,0.25W	57668	NTR25J-E270E
R4449	315-0302-00			RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R4456	315-0102-00	B010100	B021446	RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R4456	315-0821-00	B021447		RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
R4461	321-0290-00			RES,FXD,FILM:10.2K OHM,1%,0.125W,TC=T0	19701	5043ED10K20F
R4462	321-0246-00			RES,FXD,FILM:3.57K OHM,1%,0.125W,TC=T0	19701	5043ED3K570F
R4467	321-0290-00			RES,FXD,FILM:10.2K OHM,1%,0.125W,TC=T0	19701	5043ED10K20F
R4468	321-0246-00			RES,FXD,FILM:3.57K OHM,1%,0.125W,TC=T0	19701	5043ED3K570F
R4470	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
R4471	321-0243-00			RES,FXD,FILM:3.32K OHM,1%,0.125W,TC=T0	19701	5033ED3K32F
R4472	315-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
R4473	315-0622-00	B010100	B020954	RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
R4473	315-0512-00	B020955		RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R4474	315-0622-00	B010100	B020954	RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
R4474	315-0512-00	B020955		RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R4475	315-0151-00			RES,FXD,FILM:150 OHM,5%,0.25W	57668	NTR25J-E150E
R4476	321-0243-00			RES,FXD,FILM:3.32K OHM,1%,0.125W,TC=T0	19701	5033ED3K32F
R4477	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R4478	321-0205-00			RES,FXD,FILM:1.33K OHM,1%,0.125W,TC=T0	19701	5033ED1K330F
R4480	315-0511-00			RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
R4481	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
R4482	321-0222-00			RES,FXD,FILM:2.00K OHM,1%,0.125W,TC=T0	19701	5033ED2K00F
R4483	321-0222-00			RES,FXD,FILM:2.00K OHM,1%,0.125W,TC=T0	19701	5033ED2K00F
R4484	315-0913-00			RES,FXD,FILM:91K OHM,5%,0.25W	19701	5043CX91K00J
R4485	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
R4486	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
R4487	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R4488	315-0752-00			RES,FXD,FILM:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
R4489	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R4490	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R4491	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
R4492	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R4493	315-0431-00			RES,FXD,FILM:430 OHM,5%,0.25W	19701	5043CX430R0J
R4494	315-0911-00			RES,FXD,FILM:910 OHM,5%,0.25W	57668	NTR25J-E910E
R4496	315-0431-00			RES,FXD,FILM:430 OHM,5%,0.25W	19701	5043CX430R0J
R4498	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R4501	321-0385-00	B010100	B010164	RES,FXD,FILM:100K OHM,1%,0.125W,TC=T0	19701	5033ED100K0F
R4501	321-0398-00	B010165		RES,FXD,FILM:137K OHM,1%,0.125W,TC=T0	07716	CEAD13702F
R4502	321-0357-00			RES,FXD,FILM:51.1K OHM,1%,0.125W,TC=T0	07716	CEAD51101F
R4503	321-0385-00	B010100	B010164	RES,FXD,FILM:100K OHM,1%,0.125W,TC=T0	19701	5033ED100K0F
R4503	321-0398-00	B010165		RES,FXD,FILM:137K OHM,1%,0.125W,TC=T0	07716	CEAD13702F
R4504	321-0238-00			RES,FXD,FILM:2.94K OHM,1%,0.125W,TC=T0	07716	CEAD29400F
R4505	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R4506	321-0281-00			RES,FXD,FILM:8.25K OHM,1%,0.125W,TC=T0	19701	5043ED8K250F
R4507	321-0254-00			RES,FXD,FILM:4.32K OHM,1%,0.125W,TC=T0	07716	CEAD43200F
R4508	321-0363-00			RES,FXD,FILM:59.0K OHM,1%,0.125W,TC=T0	07716	CEAD59001F
R4509	321-0387-00			RES,FXD,FILM:105K OHM,1%,0.125W,TC=T0	07716	CEAD10502F
RT813	307-0127-00			RES,THERMAL:1K OHM,10%	15801	JB-31J42
RT1080	307-0181-00			RES,THERMAL:100K OHM,10%,NTC	14193	K10-10002K
RT1209	307-0353-00			RES,THERMAL:5 OHM,10%	15454	5DA5R0K270SS-SIL
RT1213	307-0353-00			RES,THERMAL:5 OHM,10%	15454	5DA5R0K270SS-SIL
RT1696	307-0124-00			RES,THERMAL:5K OHM,10%,NTC	15454	1DC502K-220-EC
RT1804	307-0181-00			RES,THERMAL:100K OHM,10%,NTC	14193	K10-10002K

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
S70	260-0638-00			SWITCH,THRMSTC:NC,OPEN 75,CL 55,10A,240V	14859	20700 LA506-2042
S315	263-0021-02			SWITCH PB ASSY:4 LATCH,7.5 MM,8 CONTACTS	80009	263-0021-02
S325	263-0022-02			SWITCH PB ASSY:5 LATCH,7.5 MM,10 CONTACTS	80009	263-0022-02
S345	263-0013-10			SWITCH PB ASSY:3 LATCH,10 MM,W/3 CONTACTS	80009	263-0013-10
S365	263-0013-10			SWITCH PB ASSY:3 LATCH,10 MM,W/3 CONTACTS	80009	263-0013-10
S395	263-0013-11			SWITCH PB ASSY:3 LATCH,10 MM,5 CONTACTS	80009	263-0013-11
S1200	260-1709-00			SWITCH,PUSH:DPST,15A,250VAC,PUSH-PUSH	77342	A9M1-762-6-3
S1212	260-0450-00			SWITCH,SLIDE:DPTT,0.5A,125VAC	82389	11D-1007
S1540	260-1300-00			SWITCH,SLIDE:DPDT,3A,125VAC	82389	46206LFE
S1900	311-1587-00			RES,VAR,NONWW:PNL,10K OHM,1W,W/SW (FURNISHED AS A UNIT WITH R1900)	01121	12M435
S1905	260-1380-00			SWITCH,PUSH:2 BUTTON,2 POLE,STORAGE LOGIC	59821	2KBM020000619
S1910	260-1380-00			SWITCH,PUSH:2 BUTTON,2 POLE,STORAGE LOGIC	59821	2KBM020000619
S1915	260-1380-00			SWITCH,PUSH:2 BUTTON,2 POLE,STORAGE LOGIC	59821	2KBM020000619
S1920	260-1380-00			SWITCH,PUSH:2 BUTTON,2 POLE,STORAGE LOGIC	59821	2KBM020000619
S1924	311-1588-00			RES,VAR,NONWW:PNL,5K OHM,1W,W/SW (FURNISHED AS A UNIT WITH R1924)	01121	20M718
S1930	260-1208-00			SWITCH,PUSH:DPDT,28VDC,PUSH-PUSH	31918	ORDER BY DESCR
S1940	260-1208-00			SWITCH,PUSH:DPDT,28VDC,PUSH-PUSH	31918	ORDER BY DESCR
S1988	260-0247-00			SWITCH,PUSH:SPST,1A,115VAC	81073	30YY1009
S2005	260-1208-00			SWITCH,PUSH:DPDT,28VDC,PUSH-PUSH	31918	ORDER BY DESCR
S2110	260-0723-00	B010100	B049999	SWITCH,SLIDE:DPDT,0.5A,125VAC	79727	GF126-0028
S4488	260-1811-00			SWITCH,SLIDE:DPDT,0.5A,125VAC-DC	82389	11P-1137
S4488	260-1811-00			SWITCH,SLIDE:DPDT,0.5A,125VAC-DC	82389	11P-1137
T1209	120-0636-00			XFMR,PWR,STPDN:LINE TRIGGER	75498	120-0636-00
T1225	120-0743-00			XFMR,TOROID:	80009	120-0743-00
T1230	120-0744-00			XFMR,TOROID:5 WINDINGS	TK1345	120-0744-00
T1235	120-0747-00			XFMR,TOROID:	TK1345	120-0747-00
T1310	120-1183-00			XFMR,PWR,STPDN:HIGH FREQUENCY	75498	120-1183-00
T1664	120-0487-00			XFMR,TOROID:	80009	120-0487-00
T1708	120-1174-00	B010100	B063909	XFMR,PWR,STU:HIGH VOLTAGE POT CORE	80009	120-1174-00
T1708	120-1174-01	B063910		XFMR,PWR,STU:HIGH VOLTAGE POT CORE	54937	120-1174-01
T1770	120-1173-00			XFMR,PWR,SDN&SU:HIGH VOLTAGE	80009	120-1173-00
TP1231	214-0579-00	B010100	B063761	TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP1234	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP1238	214-0579-00	B031930	B063761	TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP1246	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP1720	131-0608-00	B073914		TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
TP1721	131-0608-00	B073914		TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
TP1956	214-0579-00	B021250	B042929	TERM,TEST POINT:BRS CD PL	80009	214-0579-00
U15	156-0067-01	B010100	B063629	MICROCKT,LINEAR:OPNL AMPL,CHECKED	04713	MC1741CP1DS
U15	156-0067-00	B063630		MICROCKT,LINEAR:BIPOLAR,OPNL AMPL	04713	MC1741CP1
U45	156-0067-01	B010100	B063629	MICROCKT,LINEAR:OPNL AMPL,CHECKED	04713	MC1741CP1DS
U45	156-0067-00	B063630		MICROCKT,LINEAR:BIPOLAR,OPNL AMPL	04713	MC1741CP1
U64	156-0158-04	B031930		MICROCKT,LINEAR:DUAL OPNL AMPL	01295	MC1458JG
U232	155-0173-00			MICROCKT,LINEAR:VERTICAL CHANNEL SWITCH	80009	155-0173-00
U252	156-0158-00			MICROCKT,LINEAR:BIPOLAR,DUAL OPNL AMPL	04713	MC1458P1/MC1458U
U274	155-0175-00			MICROCKT,LINEAR:TRIGGER AMPLIFIER	80009	155-0175-00
U352	156-0384-02			MICROCKT,DGTL:QUAD 2-INP NAND GATE,SCRN	07263	74LS03PCQR
U362	156-0386-02			MICROCKT,DGTL:TRIPLE 3-INP NAND GATE,SCRN	07263	74LS10PCQR
U364	156-0382-02			MICROCKT,DGTL:QUAD 2 INP NAND GATE BURN	18324	N74LS00NB
U366	156-0382-02			MICROCKT,DGTL:QUAD 2 INP NAND GATE BURN	18324	N74LS00NB
U368	156-0722-02			MICROCKT,DGTL:TRIPLE 3-INP NAND W/OC OUT	01295	SN74LS12NP3
U402	156-0730-02			MICROCKT,DGTL:QUAD 2-INP NOR BFR,SCRN	01295	SN74LS33NP3
U432	155-0173-00			MICROCKT,LINEAR:VERTICAL CHANNEL SWITCH	80009	155-0173-00
U452	156-0158-00			MICROCKT,LINEAR:BIPOLAR,DUAL OPNL AMPL	04713	MC1458P1/MC1458U
U474	155-0175-00			MICROCKT,LINEAR:TRIGGER AMPLIFIER	80009	155-0175-00
U492	155-0175-00	B010100	B031999	MICROCKT,LINEAR:TRIGGER AMPLIFIER	80009	155-0175-00

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U492	155-0175-05	B032000		MICROCKT,LINEAR:AMPLIFIER,M178	80009	155-0175-05
U508	156-1149-00			MICROCKT,LINEAR:OPERATIONAL AMP,JFET INPUT	27014	LF351N/GLEA134
U538	156-1149-00			MICROCKT,LINEAR:OPERATIONAL AMP,JFET INPUT	27014	LF351N/GLEA134
U608	156-1149-00			MICROCKT,LINEAR:OPERATIONAL AMP,JFET INPUT	27014	LF351N/GLEA134
U638	156-1149-00			MICROCKT,LINEAR:OPERATIONAL AMP,JFET INPUT	27014	LF351N/GLEA134
U668	155-0173-00			MICROCKT,LINEAR:VERTICAL CHANNEL SWITCH	80009	155-0173-00
U682	156-0067-00			MICROCKT,LINEAR:BIPOLAR,OPNL AMPL	04713	MC1741CP1
U694	156-0067-00			MICROCKT,LINEAR:BIPOLAR,OPNL AMPL	04713	MC1741CP1
U705	156-1149-00			MICROCKT,LINEAR:OPERATIONAL AMP,JFET INPUT	27014	LF351N/GLEA134
U762	155-0174-00			MICROCKT,LINEAR:DELAY LINE COMPENSATOR	80009	155-0174-00
U782	156-1149-00			MICROCKT,LINEAR:OPERATIONAL AMP,JFET INPUT	27014	LF351N/GLEA134
U808	156-1149-00			MICROCKT,LINEAR:OPERATIONAL AMP,JFET INPUT	27014	LF351N/GLEA134
U842	155-0175-00			MICROCKT,LINEAR:TRIGGER AMPLIFIER	80009	155-0175-00
U862	155-0176-00			MICROCKT,LINEAR:MAIN VERTICAL OUTPUT	80009	155-0176-00
U876	156-0158-00			MICROCKT,LINEAR:BIPOLAR,DUAL OPNL AMPL	04713	MC1458P1/MC1458U
U883	155-0194-00			MICROCKT,LINEAR:CRT TERMINATION 200 OHM (NOMINAL VALUE)	80009	155-0194-00
U883	155-0194-01			MICROCKT,LINEAR:CRT TERMINATION,194 OHM	80009	155-0194-01
U883	155-0194-02			MICROCKT,LINEAR:CRT TERMINATION,206 OHM (U883 IS SELECTABLE)	80009	155-0194-02
U944	156-1149-00			MICROCKT,LINEAR:OPERATIONAL AMP,JFET INPUT	27014	LF351N/GLEA134
U962	155-0173-00	B010100	B031999	MICROCKT,LINEAR:VERTICAL CHANNEL SWITCH	80009	155-0173-00
U962	155-0173-05	B032000		MICROCKT,DGTL:CHANNEL SWITCH	80009	155-0173-05
U974	156-1149-00			MICROCKT,LINEAR:OPERATIONAL AMP,JFET INPUT	27014	LF351N/GLEA134
U1006	156-0067-00			MICROCKT,LINEAR:BIPOLAR,OPNL AMPL	04713	MC1741CP1
U1014	156-0158-00			MICROCKT,LINEAR:BIPOLAR,DUAL OPNL AMPL	04713	MC1458P1/MC1458U
U1018	155-0179-00			MICROCKT,LINEAR:CLAMP	80009	155-0179-00
U1082	155-0175-00	B010100	B031999	MICROCKT,LINEAR:TRIGGER AMPLIFIER	80009	155-0175-00
U1082	155-0175-05	B032000		MICROCKT,LINEAR:AMPLIFIER,M178	80009	155-0175-05
U1094	155-0178-00			MICROCKT,LINEAR:HORIZONTAL OUTPUT	80009	155-0178-00
U1140	155-0078-10			MICROCKT,LINEAR:VERTICAL AMPLIFIER ML (U1140, OPTION 02 ONLY)	80009	155-0078-10
U1166	156-0158-00			MICROCKT,LINEAR:BIPOLAR,DUAL OPNL AMPL (U1166, OPTION 02 ONLY)	04713	MC1458P1/MC1458U
U1275	155-0067-02			MICROCKT,DGTL:POWER SPLY RGLTR	80009	155-0067-02
U1374	156-0113-03	B010100	B031929	MICROCKT,DGTL:QUAD 2 INP NAND GATE,SCRN,	01295	SN74L00NP3
U1379	156-0481-02	B031930		MICROCKT,DGTL:TRIPLE 3-INP & GATE,SCRN	01295	SN74LS11NP3
U1415	156-0067-12	B010100	B032499	MICROCKT,LINEAR:OPERATIONAL AMPLIFIER	01295	UA741CJG
U1415	156-0067-01	B032500	B063629	MICROCKT,LINEAR:OPNL AMPL,CHECKED	04713	MC1741CP1DS
U1415	156-0067-00	B063630		MICROCKT,LINEAR:BIPOLAR,OPNL AMPL	04713	MC1741CP1
U1445	156-0067-12	B010100	B032499	MICROCKT,LINEAR:OPERATIONAL AMPLIFIER	01295	UA741CJG
U1445	156-0067-01	B032500	B063629	MICROCKT,LINEAR:OPNL AMPL,CHECKED	04713	MC1741CP1DS
U1445	156-0067-00	B063630		MICROCKT,LINEAR:BIPOLAR,OPNL AMPL	04713	MC1741CP1
U1458	156-0158-00			MICROCKT,LINEAR:BIPOLAR,DUAL OPNL AMPL	04713	MC1458P1/MC1458U
U1464	156-0158-04	B010100	B031929	MICROCKT,LINEAR:DUAL OPNL AMPL	01295	MC1458JG
U1464	156-0158-03	B031930		MICROCKT,LINEAR:DUAL OPNL AMPL,CHK	80009	156-0158-03
U1484	156-0158-04	B010100	B031929	MICROCKT,LINEAR:DUAL OPNL AMPL	01295	MC1458JG
U1484	156-0158-03	B031930		MICROCKT,LINEAR:DUAL OPNL AMPL,CHK	80009	156-0158-03
U1514	156-0158-04	B010100	B031929	MICROCKT,LINEAR:DUAL OPNL AMPL	01295	MC1458JG
U1514	156-0158-03	B031930		MICROCKT,LINEAR:DUAL OPNL AMPL,CHK	80009	156-0158-03
U1700	152-0687-00			SEMICOND DVC,DI:HV MULTR,SI,3.0KV PP INPUT	80009	152-0687-00
U1714	156-0158-00			MICROCKT,LINEAR:BIPOLAR,DUAL OPNL AMPL	04713	MC1458P1/MC1458U
U1720	156-1191-00	B073914		MICROCKT,LINEAR:BIFET,DUAL OPNL AMPL	01295	TL072CP
U1736	156-0512-00			MICROCKT,LINEAR:OPNL AMPL	04713	LM308N
U1802	156-0067-00			MICROCKT,LINEAR:BIPOLAR,OPNL AMPL	04713	MC1741CP1
U1952	156-0686-00			MICROCKT,LINEAR:MOS,OPNL AMPL	02735	CA3130S
U1958	156-0158-00			MICROCKT,LINEAR:BIPOLAR,DUAL OPNL AMPL	04713	MC1458P1/MC1458U
U1968	156-0402-00			MICROCKT,LINEAR:TIMER	27014	LM555CN

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
U1970	156-1149-00			MICROCKT,LINEAR:OPERATIONAL AMP,JFET INPUT	27014	LF351N/GLEA134
U1986	156-0402-00			MICROCKT,LINEAR:TIMER	27014	LM555CN
U1992	156-0038-02			MICROCKT,DGTL:J-K MASTER SLAVE FF,SCRN	01295	SN7472NP3
U2120	156-0043-03			MICROCKT,DGTL:TTL,QUAD 2 INP NOR GATE,SCRN	18324	N7402(NB OR FB)
U2126	155-0021-01			MICROCKT,DGTL:SCAN OSCILLATOR & LOGIC	80009	155-0021-01
U2127	156-1172-01	B050000	B063746	MICROCKT,DGTL:DUAL 4 BIT BIN CNTR,SCRN	01295	SN74LS393NP3
U2127	156-1172-02	B063747		MICROCKT,DGTL:DUAL 4-STAGE BIN CNTR,SCRN	80009	156-1172-02
U2155	156-0043-03			MICROCKT,DGTL:TTL,QUAD 2 INP NOR GATE,SCRN	18324	N7402(NB OR FB)
U2157	156-0730-02	B050000		MICROCKT,DGTL:QUAD 2-INP NOR BFR,SCRN	01295	SN74LS33NP3
U2159	155-0017-00			MICROCKT,DGTL:BCD DECIMAL	80009	155-0017-00
U2162	156-0388-03	B050000		MICROCKT,DGTL:DUAL D FLIP-FLOP,SCRN	01295	SN74LS74ANP3
U2180	155-0015-01			MICROCKT,DGTL:ANALOG DATA SWITCH	80009	155-0015-01
U2185	155-0014-01			MICROCKT,DGTL:A-D CONVERTER	80009	155-0014-01
U2186	156-1177-01	B050000		MICROCKT,DGTL:STET LINE PRIORITY ENCODER	01295	SN74LS147NP3
U2190	155-0015-01			MICROCKT,DGTL:ANALOG DATA SWITCH	80009	155-0015-01
U2202	156-1172-01	B050000	B063746	MICROCKT,DGTL:DUAL 4 BIT BIN CNTR,SCRN	01295	SN74LS393NP3
U2202	156-1172-02	B063747		MICROCKT,DGTL:DUAL 4-STAGE BIN CNTR,SCRN	80009	156-1172-02
U2203	160-2997-00	B050000	B063844	MICROCKT,DGTL:4096 X 8 EPROM,PRGM	80009	160-2997-00
U2203	160-2997-01	B063845		MICROCKT,DGTL:4096 X 8 PROM,PRGM	80009	160-2997-01
U2204	156-0865-02	B050000		MICROCKT,DGTL:OCTAL D FF W/CLEAR,SCRN	01295	SN74LS273NP3
U2210	156-1191-00	B050000		MICROCKT,LINEAR:BIFET,DUAL OPNL AMPL	01295	TL072CP
U2232	155-0018-00			MICROCKT,DGTL:ZERO LOGIC	80009	155-0018-00
U2244	155-0014-01			MICROCKT,DGTL:A-D CONVERTER	80009	155-0014-01
U2246	156-1177-01	B050000		MICROCKT,DGTL:STET LINE PRIORITY ENCODER	01295	SN74LS147NP3
U2250	156-0032-03	B010100	B049999	MICROCKT,DGTL:4 BIT BINARY COUNTER	01295	SN7493NP3
U2251	156-0730-02	B050000		MICROCKT,DGTL:QUAD 2-INP NOR BFR,SCRN	01295	SN74LS33NP3
U2257	156-1191-00	B050000		MICROCKT,LINEAR:BIFET,DUAL OPNL AMPL	01295	TL072CP
U2260	155-0019-00	B010100	B049999	MICROCKT,DGTL:DECIMAL POINT & SPACE	80009	155-0019-00
U2263	156-0140-02	B050000		MICROCKT,DGTL:HEX BUFFERS W/OC HV OUT,	18324	N7417(NB OR FB)
U2264	156-0480-02	B050000		MICROCKT,DGTL:QUAD 2-INP & GATE,SCRN,	01295	SN74LS08NP3
U2270	155-0023-00	B010100	B049999	MICROCKT,DGTL:CHARACTER GENERATOR,NUM	80009	155-0023-00
U2272	155-0024-00	B010100	B049999	MICROCKT,DGTL:CHAR GEN SPCL SYMBOLS	80009	155-0024-00
U2274	155-0025-00	B010100	B049999	MICROCKT,DGTL:CHAR GEN PREFIXES	80009	155-0025-00
U2276	155-0026-00	B010100	B049999	MICROCKT,DGTL:CHARACTER GENERATOR LETTERS	80009	155-0026-00
U2276	156-1191-00	B050000		MICROCKT,LINEAR:BIFET,DUAL OPNL AMPL	01295	TL072CP
U2278	155-0027-00	B010100	B049999	MICROCKT,DGTL:CHAR GEN SPECIAL ALPHA	80009	155-0027-00
U2284	155-0020-00	B010100	B049999	MICROCKT,DGTL:CHANNEL SW OUTPUT ASSY	80009	155-0020-00
U4320	155-0011-00			MICROCKT,DGTL:CLOCK & CHOP BLANKING	80009	155-0011-00
U4340	155-0010-00			MICROCKT,DGTL:CHOP COUNTER	80009	155-0010-00
U4358	155-0013-00			MICROCKT,DGTL:DC BINARY	80009	155-0013-00
U4368	155-0013-00			MICROCKT,DGTL:DC BINARY	80009	155-0013-00
U4412	155-0013-00			MICROCKT,DGTL:DC BINARY	80009	155-0013-00
U4428	155-0009-00			MICROCKT,DGTL:HORIZ LOCKOUT LGC	80009	155-0009-00
U4485	155-0012-00			MICROCKT,DGTL:Z-AXIS AMPLIFIER	80009	155-0012-00
V1850	154-0783-00			ELECTRON TUBE:CRT,P31,T7100-31-2	80009	154-0783-00
VR237	153-0067-00			SEMICOND DVC SE:ZENER,PAIR	80009	153-0067-00
VR247	153-0067-00			SEMICOND DVC SE:ZENER,PAIR	80009	153-0067-00
VR437	153-0067-00			SEMICOND DVC SE:ZENER,PAIR	80009	153-0067-00
VR447	153-0067-00			SEMICOND DVC SE:ZENER,PAIR	80009	153-0067-00
VR852	152-0683-00	B010100	B063749	SEMICOND DVC,DI:ZEN,SI,7.5V 5%,1.0W	12954	DZ850321D
VR852	152-0683-01	B063750		SEMCOND DVC,DI:ZEN,SI,7.5V,5%,1.0W	80009	152-0683-01
VR862	152-0683-00	B010100	B063749	SEMICOND DVC,DI:ZEN,SI,7.5V 5%,1.0W	12954	DZ850321D
VR862	152-0683-01	B063750		SEMCOND DVC,DI:ZEN,SI,7.5V,5%,1.0W	80009	152-0683-01
VR878	152-0281-00			SEMICOND DVC,DI:ZEN,SI,22V,5%,0.4W,DO-7	12954	1N969B/DO-35
VR1005	152-0278-00			SEMICOND DVC,DI:ZEN,SI,3V,5%,0.4W,DO-7	80009	152-0278-00
VR1082	152-0395-00			SEMICOND DVC,DI:ZEN,SI,4.3V,5%,0.4W	04713	SZG35009K18
VR1151	152-0279-00			SEMICOND DVC,DI:ZEN,SI,5.1V,5%,0.4W,DO-7 (VR1151, OPTION 02 ONLY)	14552	TD3810989

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
VR1161	152-0279-00			SEMICOND DVC,DI:ZEN,SI,5.1V,5%,0.4W,DO-7 (VR1161, OPTION 02 ONLY)	14552	TD3810989
VR1238	152-0241-00			SEMICOND DVC,DI:ZEN,SI,33V,5%,0.4W,DO-7	14552	1N973B
VR1245	152-0428-00			SEMICOND DVC,DI:ZEN,SI,120V,5%,0.4W,DO-7	04713	SZ13202 (1N987B)
VR1252	152-0284-00	B010100	B020829	SEMICOND DVC,DI:ZEN,SI,47V,5%,0.4W,DO-7	80009	152-0284-00
VR1252	152-0590-00	B020830		SEMICOND DVC,DI:ZEN,SI,18V,5%,400MW	80009	152-0590-00
VR1272	152-0243-00			SEMICOND DVC,DI:ZEN,SI,15V,5%,0.4W,DO-7	04713	SZ13203 (1N965B)
VR1288	152-0212-00	B010100	B063973	SEMICOND DVC,DI:ZEN,SI,9V,5%,0.5W,DO-7	04713	SZ50646RL
VR1288	152-1006-00	B063974		SEMICOND DVC,DI:ZENER,SI,9V,2%,500MV,DO-7	80009	152-1006-00
VR1410	152-0217-00			SEMICOND DVC,DI:ZEN,SI,8.2V,5%,0.4W,DO-7	04713	SZG20
VR1412	152-0212-00			SEMICOND DVC,DI:ZEN,SI,9V,5%,0.5W,DO-7	04713	SZ50646RL
VR1417	152-0283-00			SEMICOND DVC,DI:ZEN,SI,43V,5%,0.4W,D-07	04713	1N976B
VR1432	152-0281-00			SEMICOND DVC,DI:ZEN,SI,22V,5%,0.4W,DO-7	12954	1N969B/DO-35
VR1436	152-0281-00			SEMICOND DVC,DI:ZEN,SI,22V,5%,0.4W,DO-7	12954	1N969B/DO-35
VR1447	152-0283-00			SEMICOND DVC,DI:ZEN,SI,43V,5%,0.4W,D-07	04713	1N976B
VR1552	152-0175-01			SEMICOND DVC,DI:ZEN,SI,5.6V,5%,0.4W,DO-7	04713	SZG5021RL
VR1556	152-0175-01			SEMICOND DVC,DI:ZEN,SI,5.6V,5%,0.4W,DO-7	04713	SZG5021RL
VR1653	152-0212-00	B020860		SEMICOND DVC,DI:ZEN,SI,9V,5%,0.5W,DO-7	04713	SZ50646RL
VR1671	152-0580-00			SEMICOND DVC,DI:ZEN,SI,75V,2%,0.4W,DO-7	04713	SZ14358RL
VR1688	152-0149-00			SEMICOND DVC,DI:ZEN,SI,10V,5%,0.4W,DO-7	04713	1N961B
VR1784	152-0470-00			SEMICOND DVC,DI:ZEN,SI,200V,5%,0.4W,DO-7	80009	152-0470-00
VR1910	152-0280-00			SEMICOND DVC,DI:ZEN,S1,6.2V,5%,0.4W,DO-7	04713	1N753A
VR2185	152-0405-00	B050000		SEMICOND DVC,DI:ZEN,SI,15V,5%,1W,TO-41	12954	DZ841205A
VR2186	152-0405-00	B050000		SEMICOND DVC,DI:ZEN,SI,15V,5%,1W,TO-41	12954	DZ841205A
VR2187	152-0405-00	B050000		SEMICOND DVC,DI:ZEN,SI,15V,5%,1W,TO-41	12954	DZ841205A
VR2262	152-0405-00	B010100	B049999	SEMICOND DVC,DI:ZEN,SI,15V,5%,1W,TO-41	12954	DZ841205A
VR2263	152-0405-00	B010100	B049999	SEMICOND DVC,DI:ZEN,SI,15V,5%,1W,TO-41	12954	DZ841205A
VR2264	152-0405-00	B010100	B049999	SEMICOND DVC,DI:ZEN,SI,15V,5%,1W,TO-41	12954	DZ841205A
VR4334	152-0166-00			SEMICOND DVC,DI:ZEN,SI,6.2V,5%,400MW,DO-7	04713	SZ11738RL
W5	131-0566-00	B040000		BUS,CONDUCTOR:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
W2005	131-0566-00	B063483		BUS,CONDUCTOR:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it is in the low state.

Abbreviations are based on ANSI Y1.1-1972.

Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966	Drafting Practices.
Y14.2, 1973	Line Conventions and Lettering.
Y10.5, 1968	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

American National Standard Institute
1430 Broadway
New York, New York 10018

Component Values

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

Capacitors = Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).

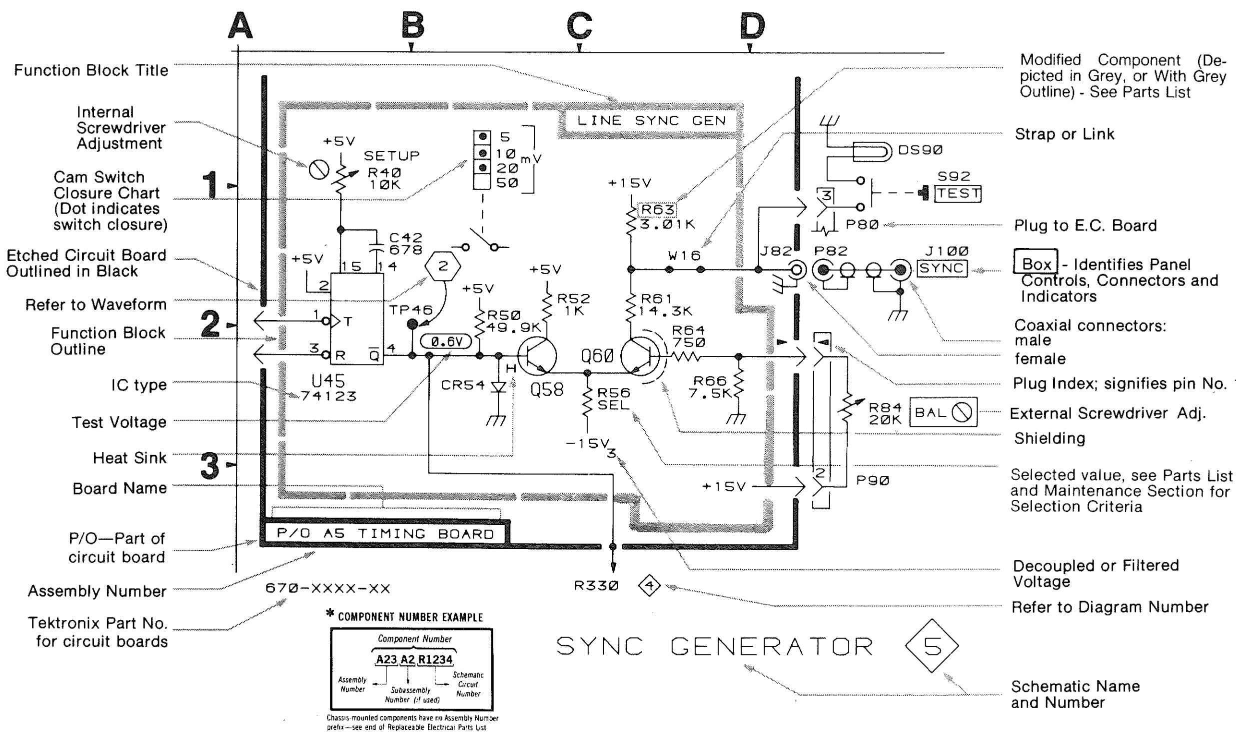
Resistors = Ohms (Ω).

The information and special symbols below may appear in this manual.

Assembly Numbers and Grid Coordinates

Each assembly in the instrument is assigned an assembly number (e.g., A20). The assembly number appears on the circuit board outline on the diagram, in the title for the circuit board component location illustration, and in the lookup table for the schematic diagram and corresponding component locator illustration. The Replaceable Electrical Parts list is arranged by assemblies in numerical sequence; the components are listed by component number *(see following illustration for constructing a component number).

The schematic diagram and circuit board component location illustration have grids. A lookup table with the grid coordinates is provided for ease of locating the component. Only the components illustrated on the facing diagram are listed in the lookup table. When more than one schematic diagram is used to illustrate the circuitry on a circuit board, the circuit board illustration may only appear opposite the first diagram on which it was illustrated; the lookup table will list the diagram number of other diagrams that the circuitry of the circuit board appears on.



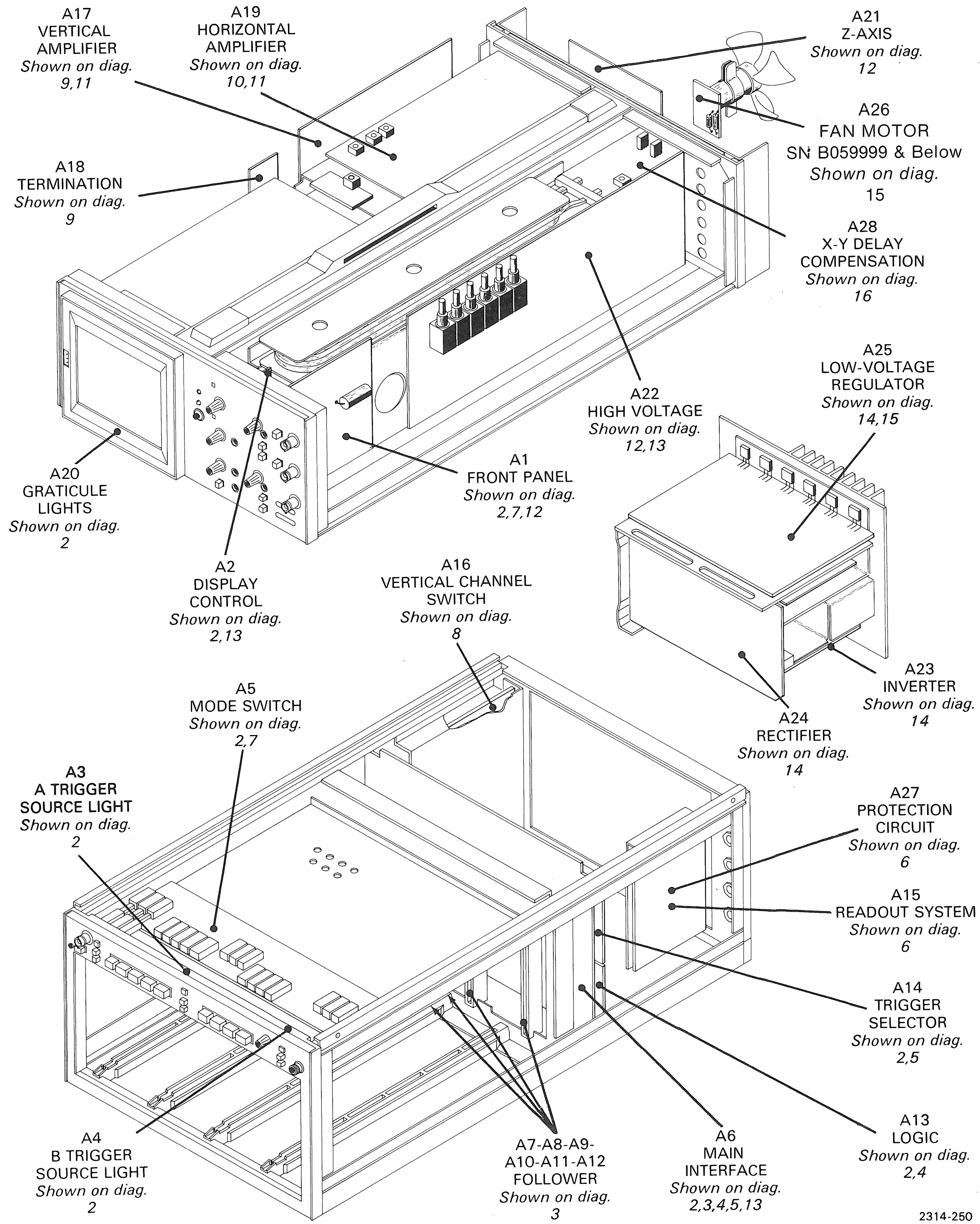


Figure 8-1. Location of circuit boards in the 7104.

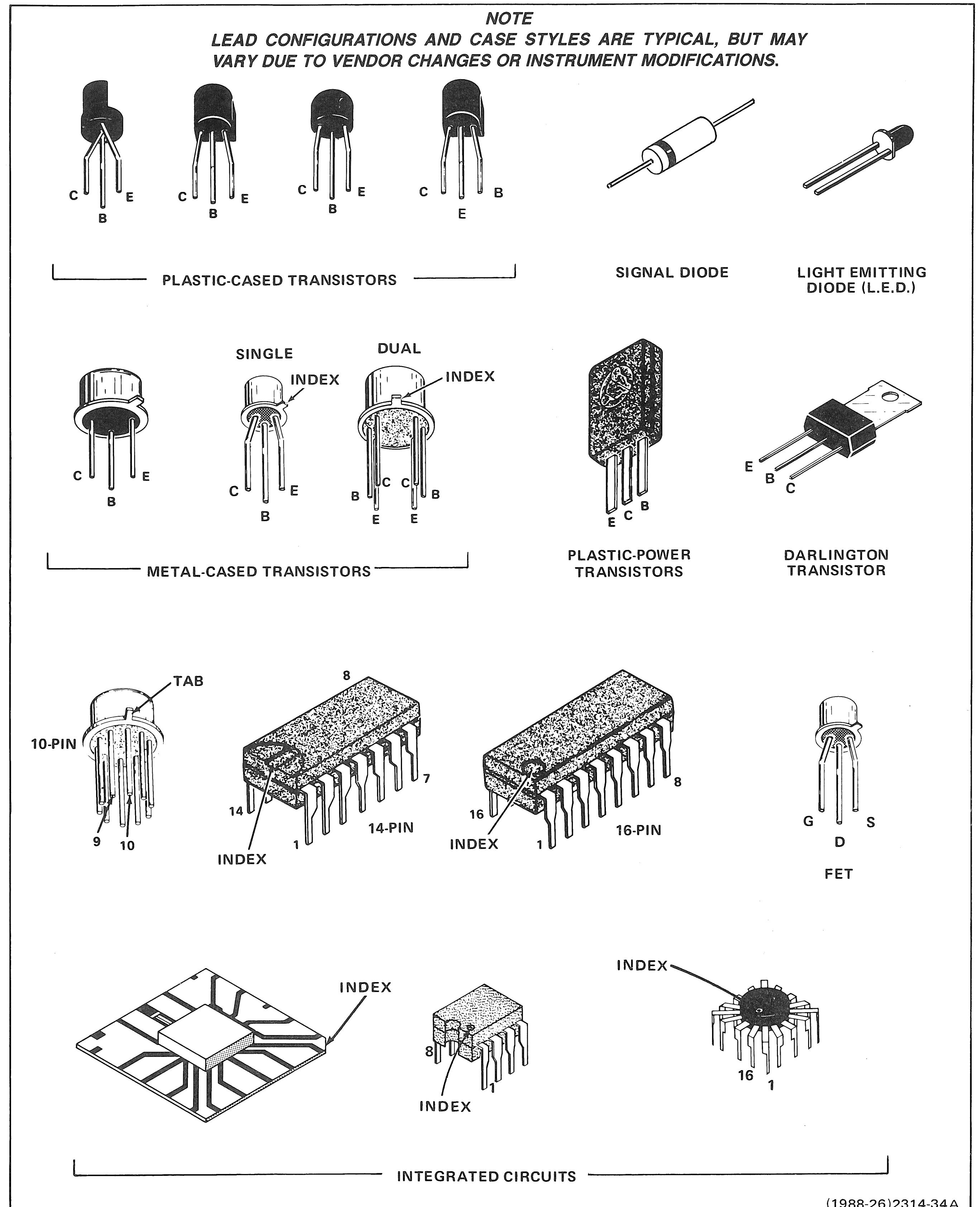


Figure 8-2. Semiconductor lead configurations.

251A

Locator for Figure 8-3.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1901	5B	Q1910	5C	R1957	4E
C1904	5B	Q1916	4C	R1958	2E
C1906	5B	Q1928	3C	R1959	4E
C1908	5C	Q1934	3D	R1960	3E
C1914	4C	Q1938	3C	R1961	3E
C1915	4C	Q1942	1D	R1962	3E
C1918	4C	Q1943	1C	R1963	4E
C1919	4C	Q1946	1C	R1964	4E
C1920	3B	Q1956	4D	R1965	4E
C1921	3B	Q1970	4E	R1966	4E
C1935	2D	Q1974	2E	R1967	5E
C1938	3D	Q1978	2F	R1968	5E
C1950	1E	Q1980	2E	R1969	5E
C1952	2D	Q1982	2E	R1970	5E
C1953	1E	Q1994	5G	R1971	3E
C1955	2E	Q1995	5F	R1972	5E
C1956	2E	Q1998	2F	R1973	4E
C1968	5E	Q1999	1F	R1974	3E
C1969	5D			R1975	3E
C1971	3F	R301	4D	R1976	5E
C1982	2G	R1900	4B	R1977	4E
C1984	3F	R1901	5B	R1979	4F
C1985	4F	R1902	4B	R1980	1E
C1990	1E	R1903	5B	R1981	2E
C1993	5F	R1905	5B	R1982	2F
C1994	5E	R1906	4B	R1983	3F
C1995	2F	R1908	4C	R1985	4F
C1996	2F	R1909	5D	R1986	4F
C1997	2F	R1910	5D	R1987	5F
		R1911	3B	R1988	1E
CR1900	3B	R1914	4C	R1989	1E
CR1902	3B	R1915	4C	R1990	1F
CR1916	4C	R1916	4C	R1991	5F
CR1918	4D	R1917	4D	R1992	5E
CR1922	2B	R1918	4D	R1993	4F
CR1923	2C	R1919	4B	R1994	4F
CR1927	3C	R1920	3B	R1995	4F
CR1928	3C	R1921	3B	R1996	2F
CR1929	3C	R1922	1B	R1997	2F
CR1946	1D	R1923	2B	R1998	1F
CR1947	1D	R1924	2B	R1999	1F
CR1948	1D	R1925	1B		
CR1963	4E	R1926	3C	S1900	4B
CR1971	3F	R1927	3C	S1905	5C
CR1972	4E	R1928	2D	S1910	5C
CR1974	3E	R1929	3C	S1915	3C
CR1991	4F	R1930	3C	S1920	3C
CR1992	3F	R1931	3D	S1924	2C
CR1993	4F	R1932	4D	S1930	3D
CR1994	4F	R1933	3D	S1940	2D
CR1998	2F	R1934	3D		
		R1935	3D	TP1911	4F
J1917	4D	R1936	2D	TP1925	2C
J1924	3C	R1937	2D	TP1952	2D
J1943	1D	R1938	2C	TP1958	4D
J1992	2C	R1940	2D	TP1962	2E
		R1941	2D	TP1968	5E
L1995	2F	R1942	1D	TP1970	4E
L1996	1F	R1943	1D	TP1986	4F
L1997	2F	R1944	1C	TP1992	4F
		R1945	1C		
P1900	2D	R1946	1C	U1952	2E
P1904	1F	R1948	1D	U1958	3E
P1909	1G	R1950	1E	U1968	5E
P1910	5D	R1951	1E	U1970	3E
P1917	5D	R1952	4E	U1986	3F
		R1953	1E	U1992	5F
PT1991	4F	R1954	3E		
		R1955	2E	VR1910	5C
Q1908	5C	R1956	3D		

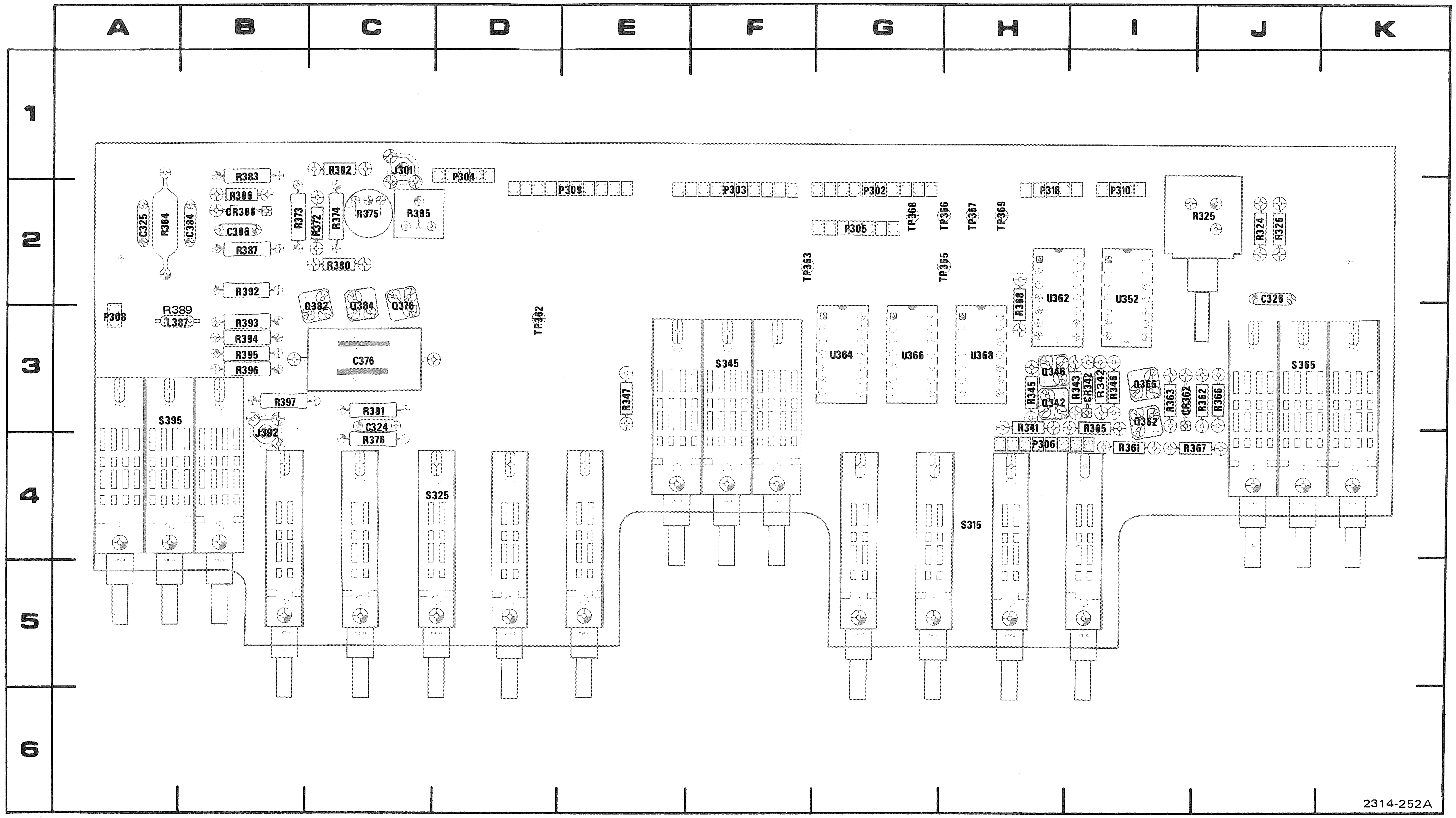


Figure 8-4. A5—Mode Switch circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
						R376	4C		
C324	3C	P304	1D	R326	2J	R380	2C	S345	3F
C325	2A	P305	2G	R341	3H	R381	3C	S365	3J
C326	2J	P306	4H	R342	3I	R382	1C	S395	3A
C376	3C	P308	3A	R343	3I	R383	1B		
C384	2B	P309	2E	R345	3H	R384	2A	TP362	3D
C386	2B	P310	2I	R346	3I	R385	2C	TP363	2F
		P318	2H	R347	3E	R386	2B	TP365	2H
CR342	3I			R361	4I	R387	2B	TP366	2H
CR362	3I	Q342	3H	R362	3J	R389*	3A	TP367	2H
CR386	2B	Q346	3H	R363	3I	R392	2B	TP368	2G
		Q362	3I	R365	3I	R393	3B	TP369	2H
J301	1C	Q366	3I	R366	3J	R394	3B		
J392	3B	Q376	3C	R367	4J	R395	3B	U352	2I
		Q382	3C	R368	3H	R396	3B	U362	2H
L387*	3A	Q384	3C	R372	2C	R397	3B	U364	3G
				R373	2B			U366	3G
P302	2G	R324	2J	R374	2C	S315	4H	U368	3H
P303	2F	R325	2J	R375	2C	S325	4D		

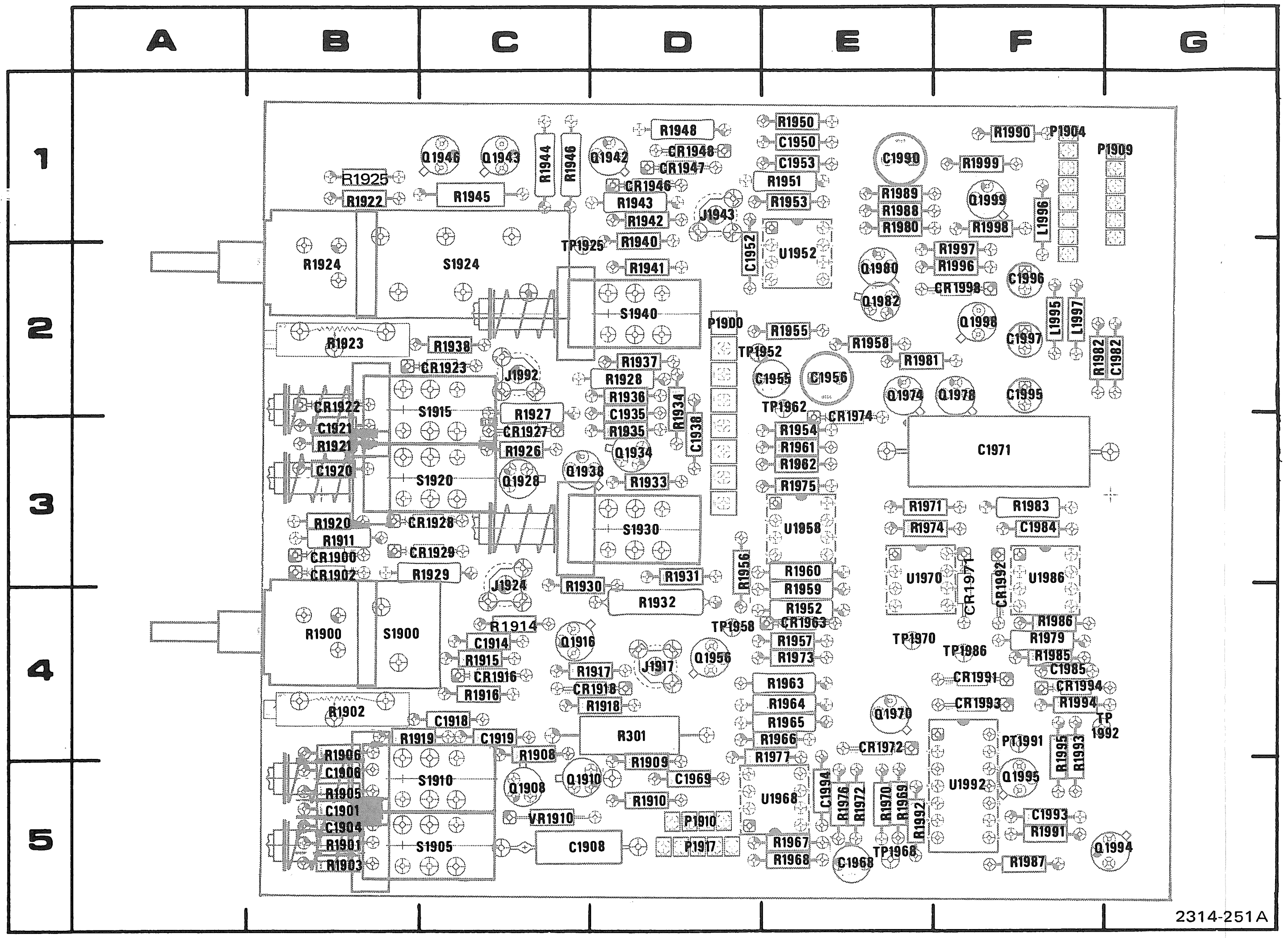
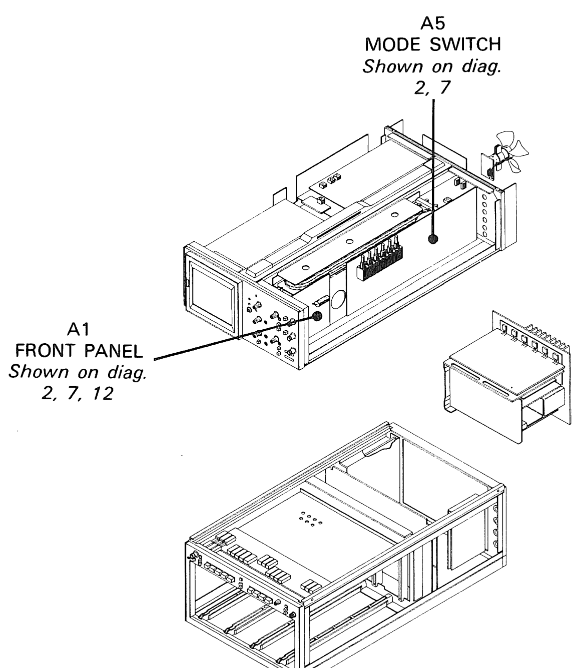


Figure 8-3. A1—Front Panel ciruit board assembly.



Locator for Figure 8-3.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1901	5B	Q1910	5C	R1957	4E
C1904	5B	Q1916	4C	R1958	2E
C1906	5B	Q1928	3C	R1959	4E
C1908	5C	Q1934	3D	R1960	3E
C1914	4C	Q1938	3C	R1961	3E
C1915	4C	Q1942	1D	R1962	3E
C1918	4C	Q1943	1C	R1963	4E
C1919	4C	Q1946	1C	R1964	4E
C1920	3B	Q1956	4D	R1965	4E
C1921	3B	Q1970	4E	R1966	4E
C1935	2D	Q1974	2E	R1967	5E
C1938	3D	Q1978	2F	R1968	5E
C1950	1E	Q1980	2E	R1969	5E
C1952	2D	Q1982	2E	R1970	5E
C1953	1E	Q1994	5G	R1971	3E
C1955	2E	Q1995	5F	R1972	5E
C1956	2E	Q1998	2F	R1973	4E
C1968	5E	Q1999	1F	R1974	3E
C1969	5D			R1975	3E
C1971	3F	R301	4D	R1976	5E
C1982	2G	R1900	4B	R1977	4E
C1984	3F	R1901	5B	R1979	4F
C1985	4F	R1902	4B	R1980	1E
C1990	1E	R1903	5B	R1981	2E
C1993	5F	R1905	5B	R1982	2F
C1994	5E	R1906	4B	R1983	3F
C1995	2F	R1908	4C	R1985	4F
C1996	2F	R1909	5D	R1986	4F
C1997	2F	R1910	5D	R1987	5F
		R1911	3B	R1988	1E
CR1900	3B	R1914	4C	R1989	1E
CR1902	3B	R1915	4C	R1990	1F
CR1916	4C	R1916	4C	R1991	5F
CR1918	4D	R1917	4D	R1992	5E
CR1922	2B	R1918	4D	R1993	4F
CR1923	2C	R1919	4B	R1994	4F
CR1927	3C	R1920	3B	R1995	4F
CR1928	3C	R1921	3B	R1996	2F
CR1929	3C	R1922	1B	R1997	2F
CR1946	1D	R1923	2B	R1998	1F
CR1947	1D	R1924	2B	R1999	1F
CR1948	1D	R1925	1B		
CR1963	4E	R1926	3C	S1900	4B
CR1971	3F	R1927	3C	S1905	5C
CR1972	4E	R1928	2D	S1910	5C
CR1974	3E	R1929	3C	S1915	3C
CR1991	4F	R1930	3C	S1920	3C
CR1992	3F	R1931	3D	S1924	2C
CR1993	4F	R1932	4D	S1930	3D
CR1994	4F	R1933	3D	S1940	2D
CR1998	2F	R1934	3D		
		R1935	3D	TP1911	4F
J1917	4D	R1936	2D	TP1925	2C
J1924	3C	R1937	2D	TP1952	2D
J1943	1D	R1938	2C	TP1958	4D
J1992	2C	R1940	2D	TP1962	2E
		R1941	2D	TP1968	5E
L1995	2F	R1942	1D	TP1970	4E
L1996	1F	R1943	1D	TP1986	4F
L1997	2F	R1944	1C	TP1992	4F
		R1945	1C		
P1900	2D	R1946	1C	U1952	2E
P1904	1F	R1948	1D	U1958	3E
P1909	1G	R1950	1E	U1968	5E
P1910	5D	R1951	1E	U1970	3E
P1917	5D	R1952	4E	U1986	3F
		R1953	1E	U1992	5F
PT1991	4F	R1954	3E		
		R1955	2E	VR1910	5C
Q1908	5C	R1956	3D		

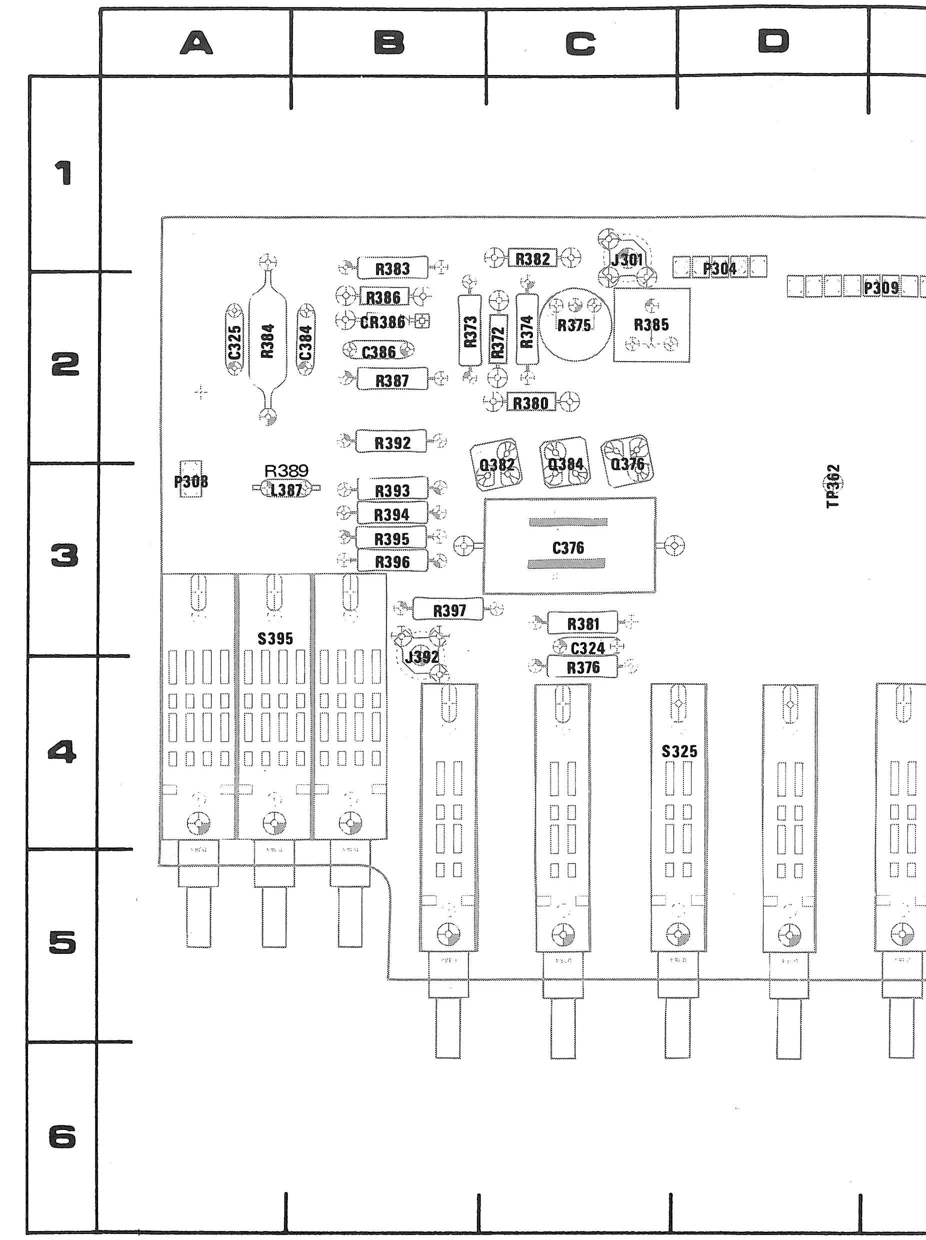
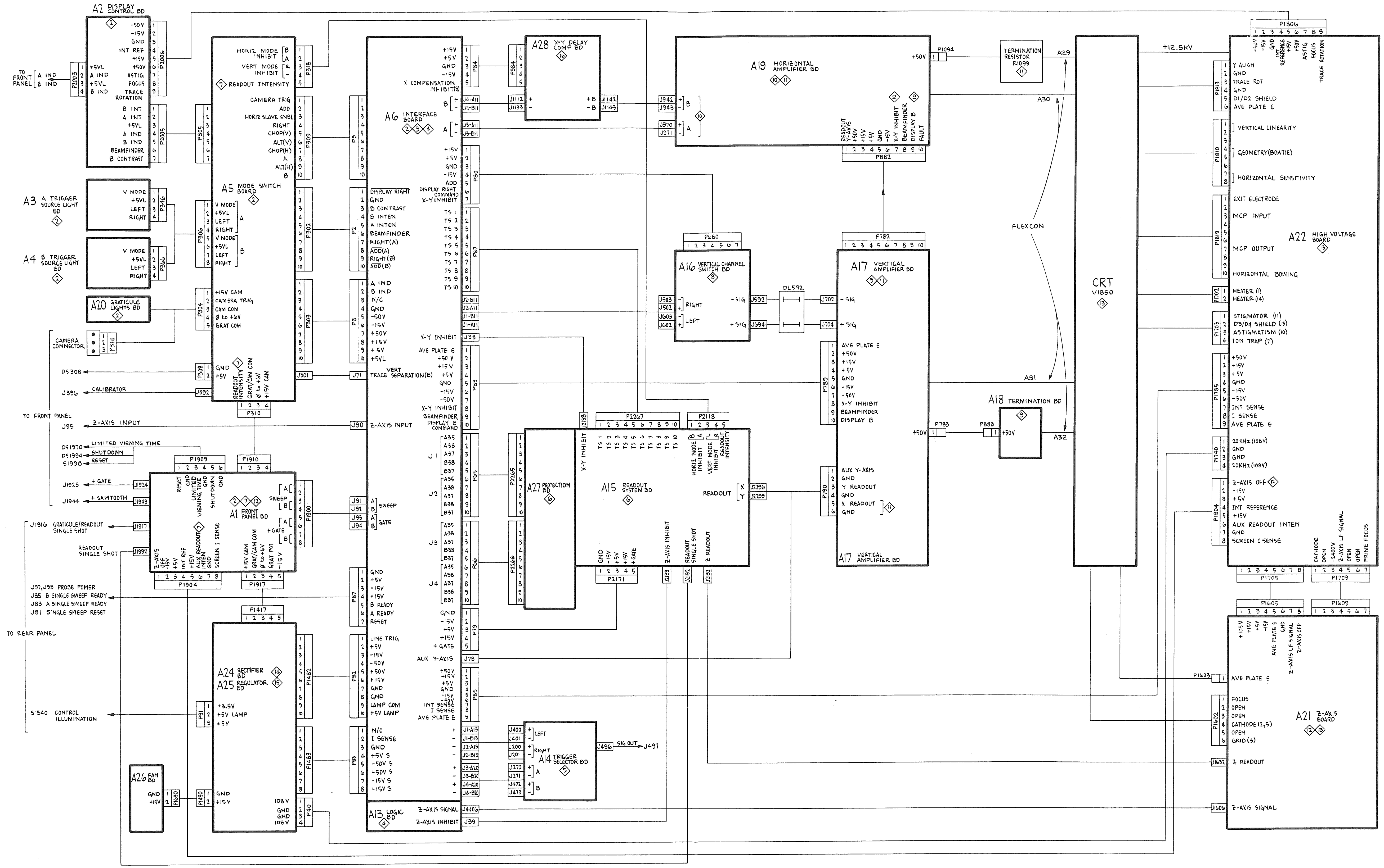


Figure 8-

CKT NO	GRID COORD	CKT NO
C324	3C	P304
C325	2A	P305
C326	2J	P306
C376	3C	P308
C384	2B	P309
C386	2B	P310
		P318
CR342	3I	
CR362	3I	Q342
CR386	2B	Q346
		Q362
J301	1C	Q366
J392	3B	Q376
		Q382
L387*	3A	Q384
P302	2G	R324
P303	2F	R325

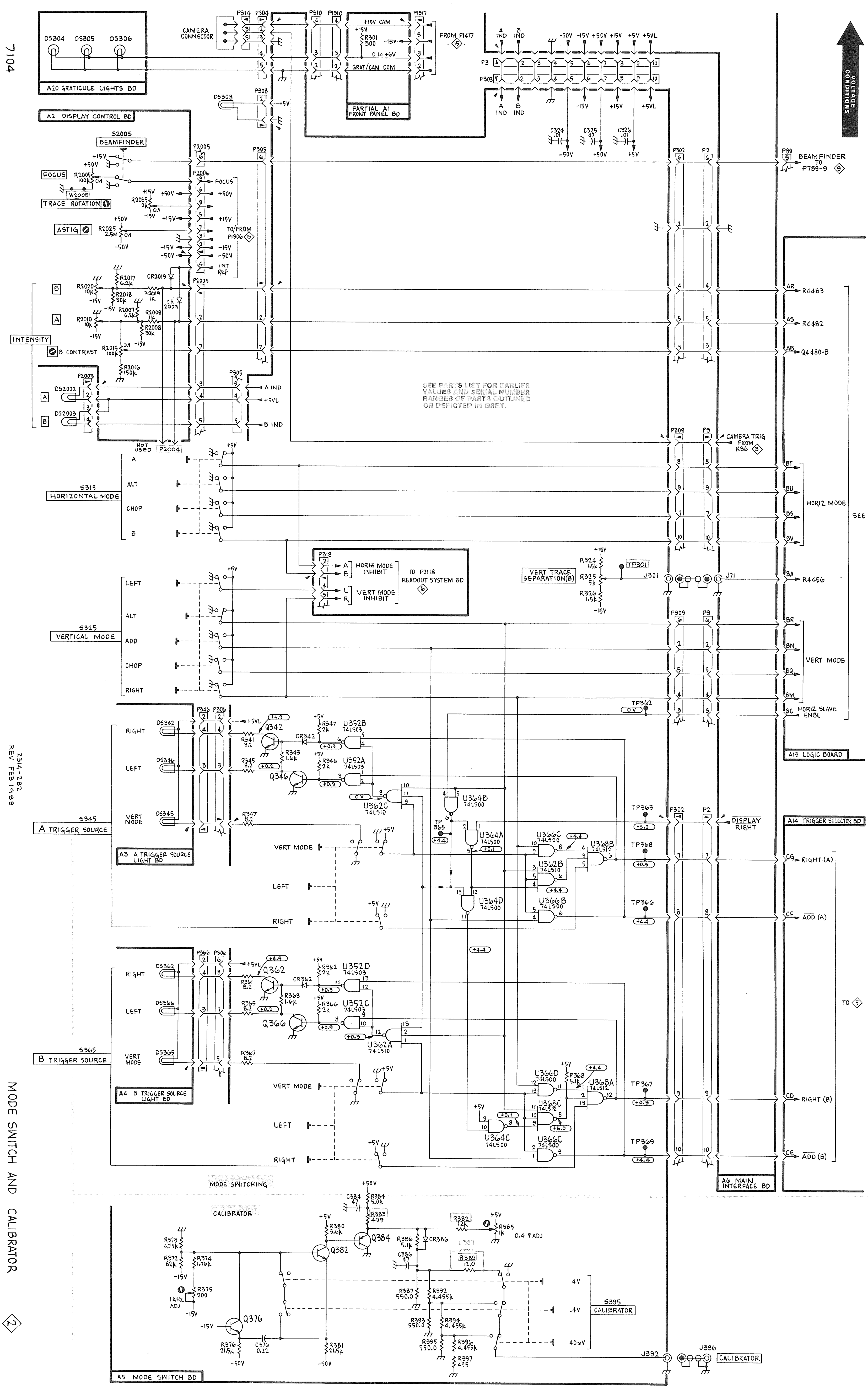

A2 DISPLAY CONTROL BD
A3 A TRIGGER SOURCE LIGHT BD
A4 B TRIGGER SOURCE LIGHT BD
A20 GRATICULE LIGHTS BD
CAMERA CONNECTOR
A5 MODE SWITCH BOARD
A6 INTERFACE BOARD
A28 X-Y DELAY COMP BD
A19 HORIZONTAL AMPLIFIER BD
TERMINATION RESISTOR R1099
CRT V1850
A22 HIGH VOLTAGE BOARD
A16 VERTICAL CHANNEL SWITCH BD
DL592
A17 VERTICAL AMPLIFIER BD
FLEXCON
A18 TERMINATION BD
A1 FRONT PANEL BD
A15 READOUT SYSTEM BD
A27 PROTECTION BD
A24 RECTIFIER BD
A25 REGULATOR BD
A26 FAN BD
A13 LOGIC BD
A14 TRIGGER SELECTOR BD
A21 Z-AXIS BOARD
TO FRONT PANEL
TO REAR PANEL
+12.5KV

VOLTAGE CONDITIONS

The voltages shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY controls fully counterclockwise (READOUT INTENSITY at OFF); VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B. No plug-in units were installed.

The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with a readout-equipped 7000-series Oscilloscope).

7104



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REV FEB 1988

MODE SWITCH AND CALIBRATOR 2

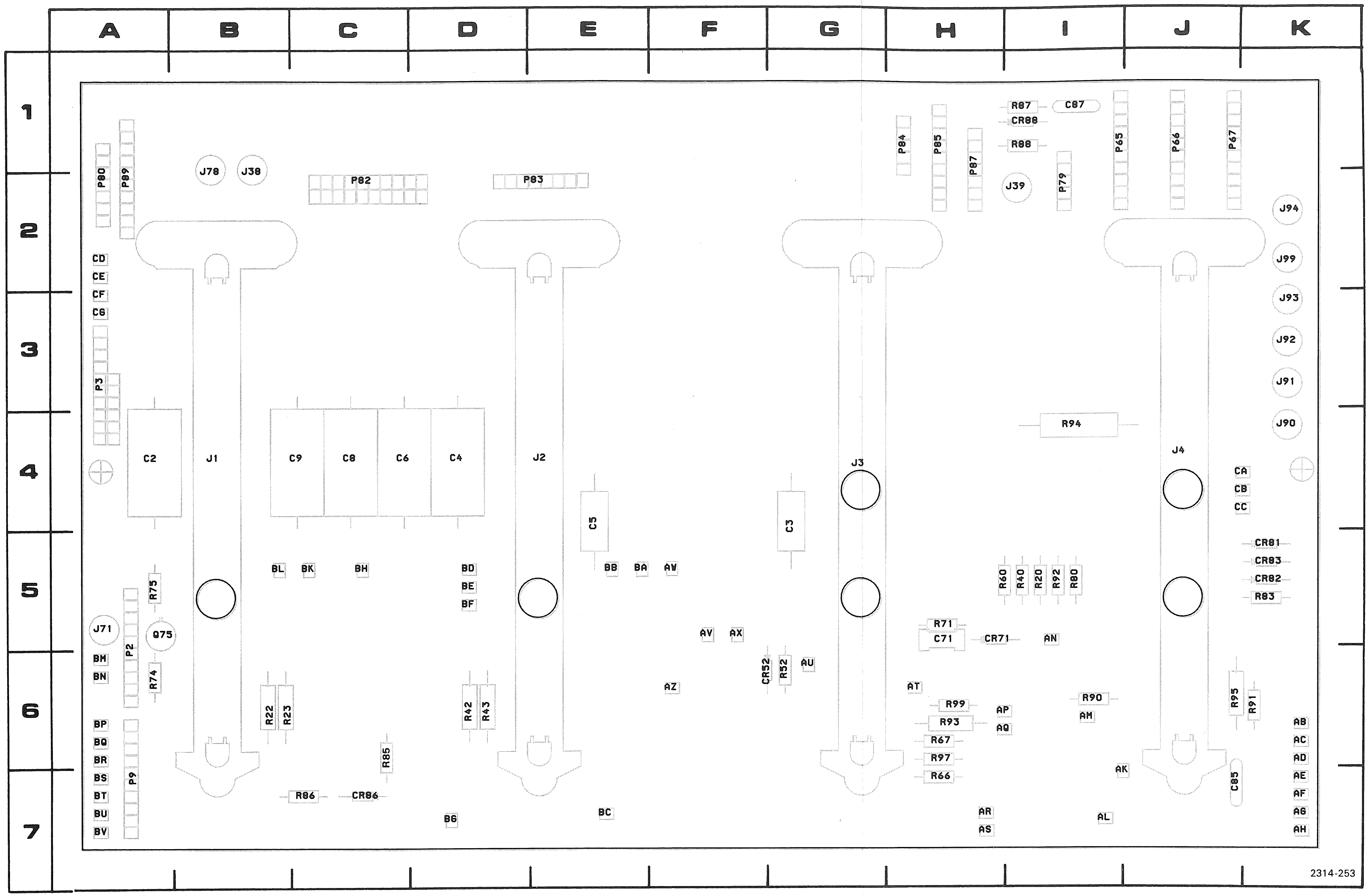
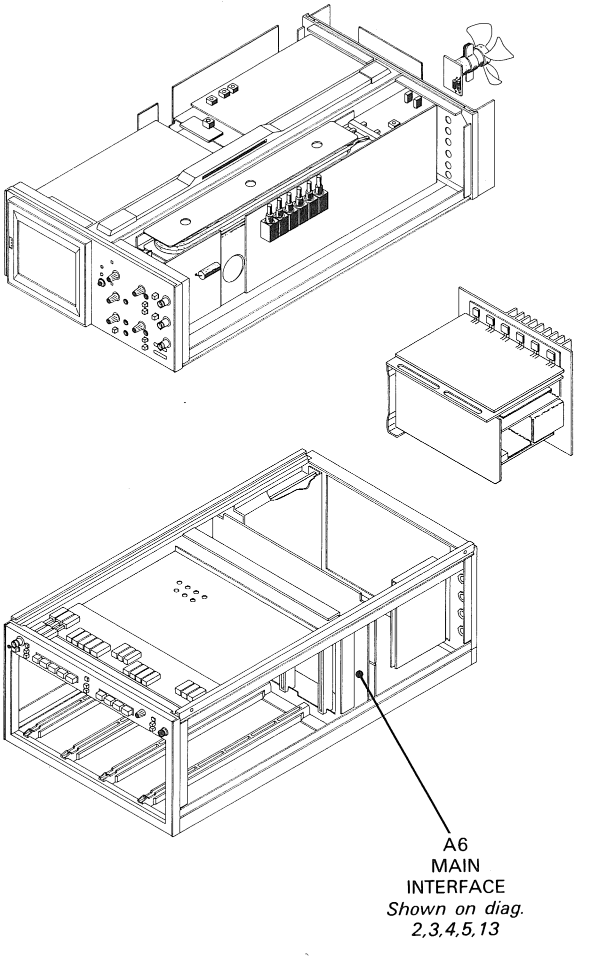


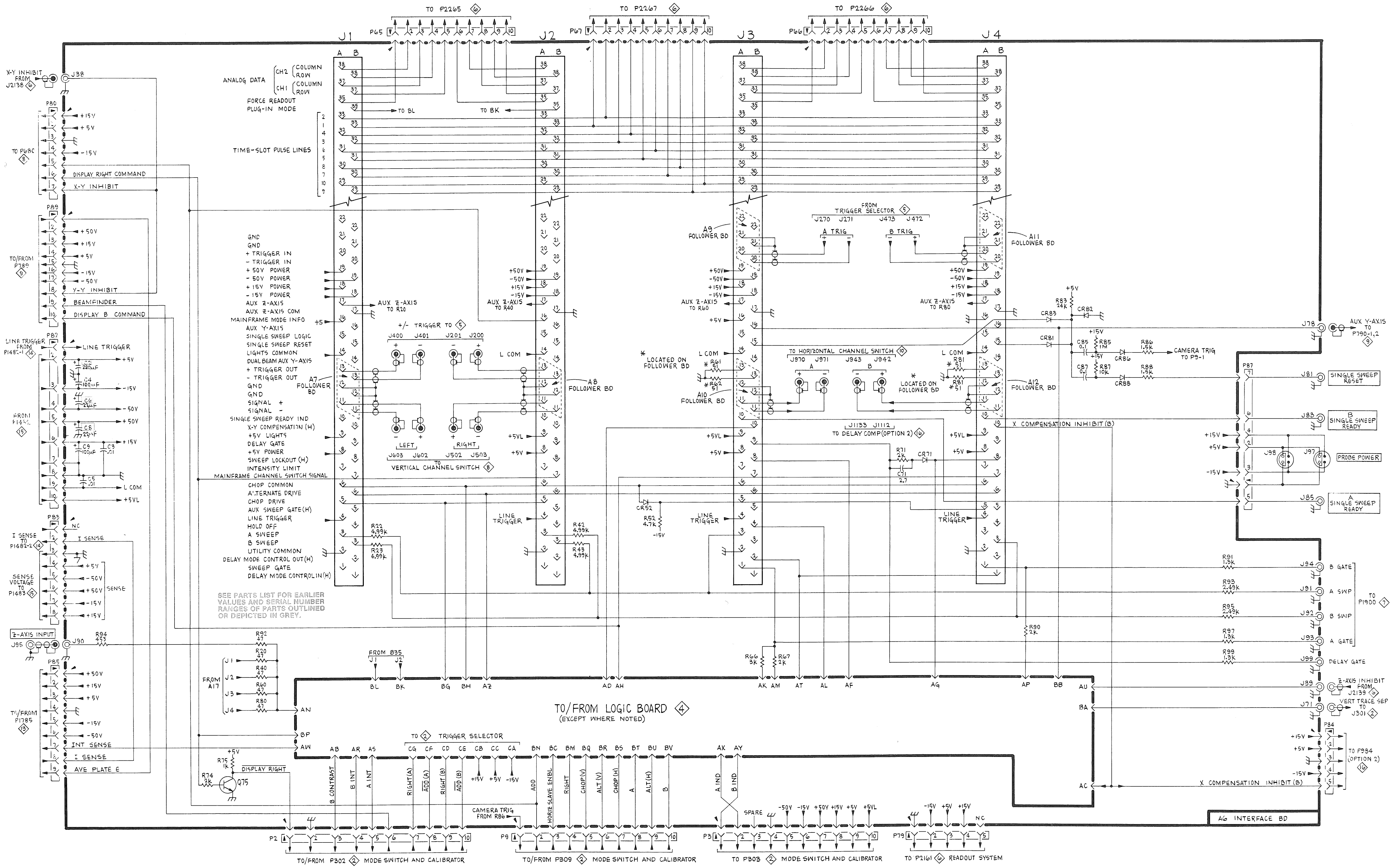
Figure 8-5. A6—Main Interface circuit board assembly.

Locator for Figure 8-5.

CKT NO	GRID COORD	CKT NO	GRID COORD
C2	4A	P79	2I
C3	4G	P80	1A
C4	4D	P82	2C
C5	4E	P83	2E
C6	4C	P84	1H
C8	4C	P85	1H
C9	4C	P87	1H
C71	5H	P89	1A
C85	7J	P9	7A
C87	1I	Q75	5A
CR52	6F	R20	5I
CR71	5H	R22	6B
CR81	5K	R23	6B
CR82	5K	R40	5I
CR83	5K	R42	6D
CR86	7C	R43	6D
CR88	1I	R52	6G
J1	4B	R60	5H
J2	4E	R66	7H
J3	4G	R67	6H
J4	4J	R71	5H
J4	4J	R74	6A
J38	1B	R75	5A
J39	2I	R80	5I
J71	5A	R83	5K
J78	1B	R85	6C
J90	4K	R86	7C
J91	3K	R87	1I
J92	3K	R88	1I
J93	3K	R90	6I
J94	2K	R91	6K
J99	2K	R92	5I
P2	5A	R93	6H
P3	3A	R94	4I
P9	7A	R95	6J
P65	1I	R97	6H
P66	1J	R99	6H
P67	1J		

ASSEMBLY A6


A6
MAIN
INTERFACE
Shown on diag.
2,3,4,5,13



7104

2314-283
REV MAY 1986

MAIN INTERFACE ③

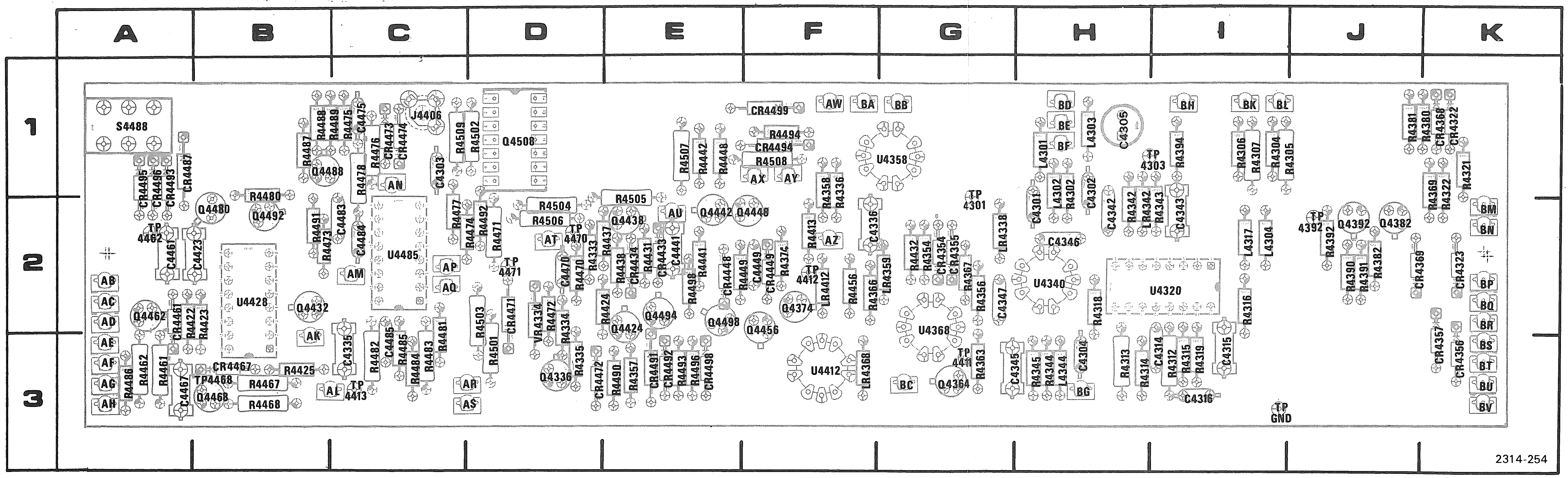
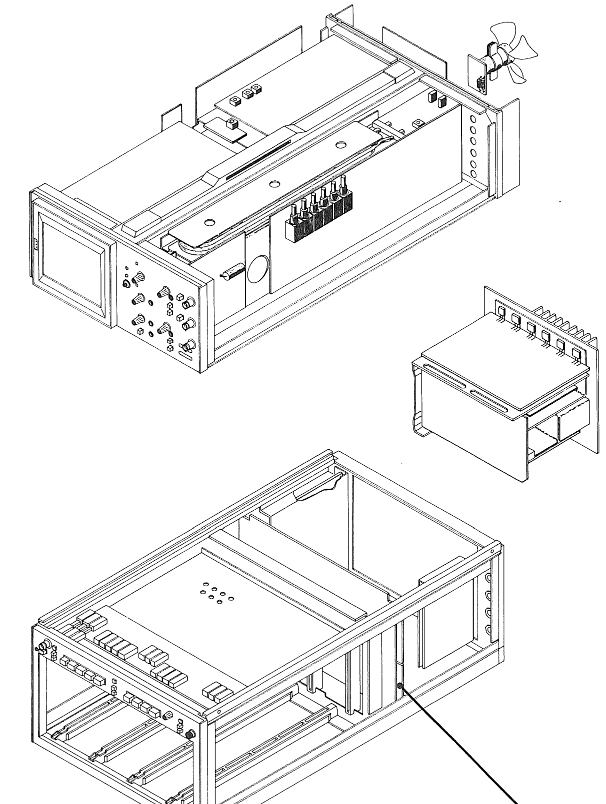


Figure 8-6. A13—Logic circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C4301	2H	CR4473	1C	Q4480	2B	R4391	2J	R4492	2D
C4302	1H	CR4474	1C	Q4488	1B	R4392	2J	R4493	3E
C4303	1C	CR4487	1A	Q4492	2B	R4394	1I	R4494	1F
C4304	3H	CR4491	3E	Q4494	2E	R4413	2F	R4496	3E
C4305	1H	CR4492	3E	Q4498	2E	R4422	2A	R4498	2E
C4314	3I	CR4493	1A	Q4508	1D	R4423	2B	R4501	3D
C4315	3I	CR4494	1F			R4424	2E	R4502	1D
C4316	3I	CR4495	1A	R4302	1H	R4425	3B	R4503	2D
C4335	3C	CR4496	1A	R4304	1I	R4431	2E	R4504	2D
C4336	2F	CR4498	3E	R4305	1I	R4432	2G	R4505	2E
C4342	2H	CR4499	1F	R4306	1I	R4437	2E	R4506	2D
C4343	2I			R4307	1I	R4438	2E	R4507	1E
C4345	3G	GND	3I	R4312	3I	R4441	2E	R4508	1F
C4346	2H			R4313	3H	R4442	1E	R4509	1C
C4347	2G	J4406	1C	R4314	3H	R4448	1E		
C4423	2B			R4315	3I	R4449	2E	S4488	1A
C4441	2E	L4301	1H	R4316	2I	R4456	2F		
C4449	2F	L4302	1H	R4318	2H	R4461	3A	TP4301	2G
C4461	2A	L4303	1H	R4319	3I	R4462	3A	TP4303	1H
C4467	3A	L4304	2I	R4321	1K	R4467	3B	TP4392	2J
C4470	2D	L4317	2I	R4322	1K	R4468	3B	TP4411	3G
C4475	1C	L4344	3H	R4333	2D	R4470	2D	TP4412	2F
C4483	2C			R4334	2D	R4471	2D	TP4413	3C
C4484	2C	LR4338	2G	R4335	3D	R4472	2D	TP4462	2A
C4485	3C	LR4342	2H	R4336	1F	R4473	1C	TP4468	3B
		LR4359	2G	R4342	2H	R4474	1C	TP4470	2D
CR4322	1K	LR4368	3F	R4343	2I	R4475	1C	TP4471	2D
CR4323	2K	LR4412	2F	R4344	3H	R4476	1C	TP	3I
CR4354	2G			R4345	3H	R4477	2C		
CR4355	2G	Q4336	3D	R4354	2G	R4478	1C	U4320	2I
CR4356	3K	Q4364	3G	R4356	2G	R4480	1B	U4340	2H
CR4357	3K	Q4374	2F	R4357	3E	R4481	3C	U4358	1G
CR4368	1K	Q4382	2J	R4358	1F	R4482	3C	U4368	2G
CR4369	2J	Q4392	2J	R4363	3G	R4483	3C	U4412	3F
CR4433	2E	Q4424	2E	R4366	2F	R4484	3C	U4428	2B
CR4434	2E	Q4432	2B	R4367	2G	R4485	3C	U4485	2C
CR4448	2E	Q4438	2E	R4369	1K	R4486	3A		
CR4449	2F	Q4442	2E	R4374	2F	R4487	1B	VR4334	2D
CR4461	2A	Q4448	2F	R4380	1K	R4488	1B		
CR4467	3B	Q4456	2F	R4381	1J	R4489	1C		
CR4471	2D	Q4462	2A	R4382	2J	R4490	3E		
CR4472	3D	Q4468	3B	R4390	2J	R4491	2B		

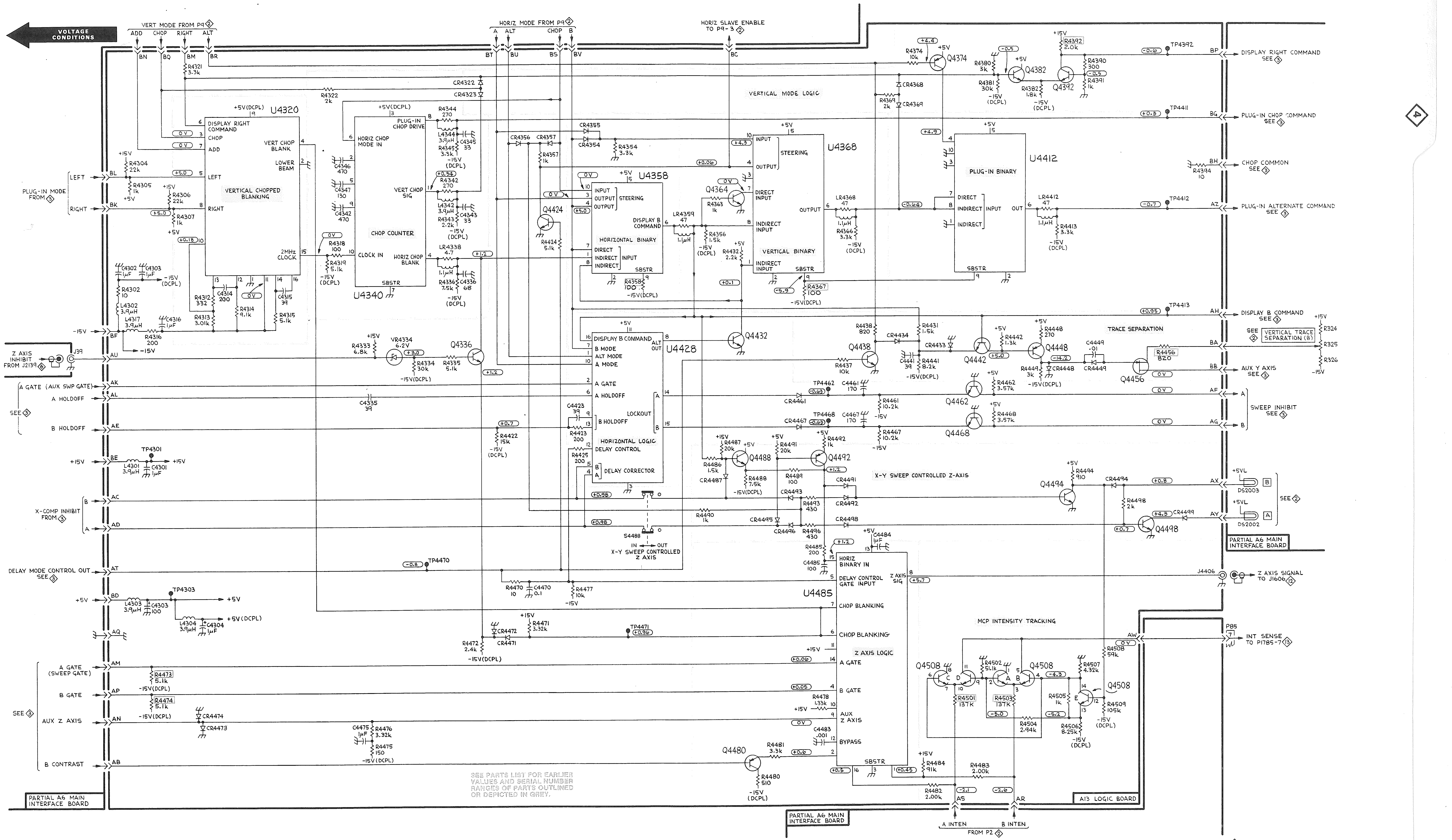


A13
LOGIC
Shown on diag. 2, 4

VOLTAGE CONDITIONS

The voltages shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY controls fully counterclockwise (READOUT INTENSITY at OFF); VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B. No plug-in units were installed.

The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with a readout-equipped 7000-series Oscilloscope).


VOLTAGE CONDITIONS
VERT MODE FROM P9 ②
ADD CHOP RIGHT ALT
HORIZ MODE FROM P9 ②
A ALT CHOP B
HORIZ SLAVE ENABLE TO P9-3 ②
VERTICAL MODE LOGIC
U4320
DISPLAY RIGHT COMMAND
VERTICAL CHOPPED BLANKING
VERT CHOP BLANK
LOWER BEAM
2MHz CLOCK
U4340
HORIZ CHOP MODE IN
PLUG-IN CHOP DRIVE
VERT CHOP SIG
CHOP COUNTER
CLOCK IN
HORIZ CHOP BLANK
U4358
HORIZONTAL BINARY
DISPLAY B COMMAND
STEERING
U4368
VERTICAL BINARY
U4412
PLUG-IN BINARY
U4428
HORIZONTAL LOGIC DELAY CONTROL
LOCKOUT
DELAY CORRECTOR
U4485
HORIZ BINARY IN
DELAY CONTROL GATE INPUT
Z AXIS SIG
CHOP BLANKING
Z AXIS LOGIC
A GATE
B GATE
AUX Z AXIS
BYPASS
PLUG-IN MODE FROM ⑤
LEFT
RIGHT
Z AXIS INHIBIT FROM J2139 ⑥
A GATE (AUX SWP GATE)
A HOLDOFF
B HOLDOFF
SEE ③
X-COMP INHIBIT FROM ③
DELAY MODE CONTROL OUT SEE ③
A GATE (SWEEP GATE)
B GATE
AUX Z AXIS
B CONTRAST
TRACE SEPARATION
X-Y SWEEP CONTROLLED Z-AXIS
S4488
IN OUT X-Y SWEEP CONTROLLED Z AXIS
MCP INTENSITY TRACKING
DISPLAY RIGHT COMMAND SEE ③
PLUG-IN CHOP COMMAND SEE ③
CHOP COMMON SEE ③
PLUG-IN ALTERNATE COMMAND SEE ③
DISPLAY B COMMAND SEE ③
SEE VERTICAL TRACE SEPARATION (B)
AUX Y AXIS SEE ③
SWEEP INHIBIT SEE ③
SEE ②
Z AXIS SIGNAL TO J1606 ⑫
INT SENSE TO P1785-7 ⑬
PARTIAL A6 MAIN INTERFACE BOARD
A13 LOGIC BOARD
A INTEN B INTEN FROM P2 ②
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

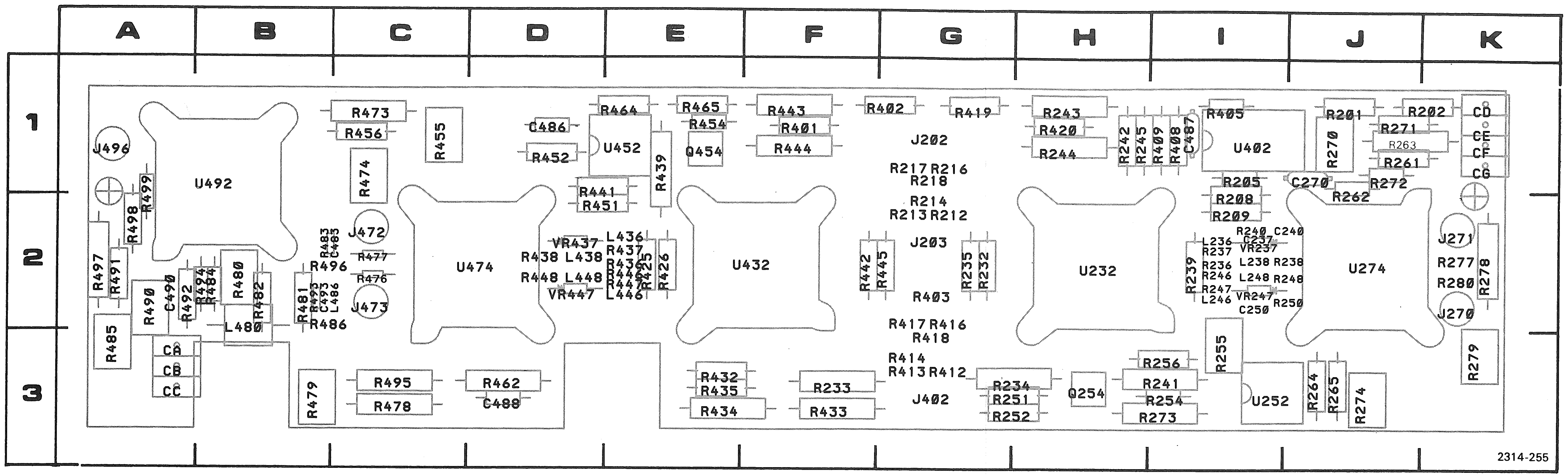
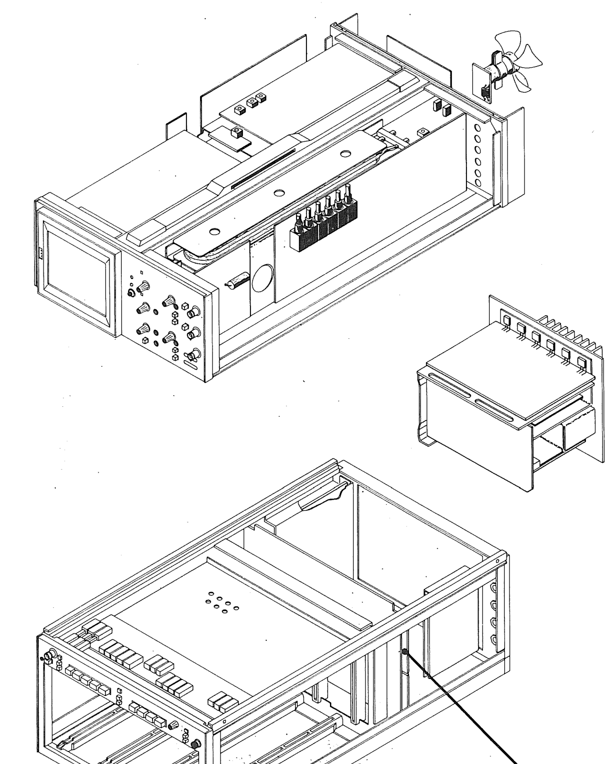


Figure 8-7. A14—Trigger Selector circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C237	2I	Q454	1E	R254	3I	R432	3E	R482	2B
C240	2I			R255	3I	R433	3F	R483	2B
C250	2I	R201	1J	R256	3I	R434	3E	R484	2B
C270	1J	R202	1J	R261	1J	R435	3E	R485	3A
C483	2C	R205	1I	R262	1J	R436	2E	R486	2B
C486	1D	R208	2I	R263	2J	R437	2E	R490	2A
C487	1I	R209	2I	R264	3J	R438	1D	R491	2A
C488	3D	R212	2G	R265	3J	R439	1E	R492	2A
C490	2A	R213	2G	R270	1J	R441	1D	R493	2B
C493	2B	R214	2G	R271	1J	R442	2F	R494	2B
		R216	1G	R272	1J	R443	1F	R495	3C
J202	1G	R217	1G	R273	3I	R444	1F	R496	2B
J203	2G	R218	1G	R274	3J	R445	2G	R497	2A
J270	2K	R232	2G	R277	2K	R446	2E	R498	2A
J271	2K	R233	3F	R278	2K	R447	2E	R499	1A
J402	3G	R234	3G	R279	3K	R448	1D		
J472	2C	R235	2G	R280	2K	R451	1D	U232	1H
J473	2C	R236	2I	R401	1F	R452	1D	U252	3I
J496	1A	R237	2I	R402	1G	R454	1E	U274	2J
		R238	2I	R403	2G	R455	1C	U402	1I
L236	2I	R239	2I	R405	1I	R456	1C	U432	2F
L238	2I	R240	2I	R408	1I	R462	3D	U452	1E
L246	2I	R241	3I	R409	1I	R464	1E	U474	1D
L248	2I	R242	1H	R412	3G	R465	1E	U492	1B
L436	2E	R243	1H	R413	3G	R473	1C		
L438	2D	R244	1H	R414	3G	R474	1C	VR237	2I
L446	2E	R245	1H	R416	2G	R476	2C	VR247	2I
L448	2D	R246	2I	R417	2G	R477	2C	VR437	1D
L480	2B	R247	2I	R418	3G	R478	3C	VR447	1D
L486	2C	R248	2I	R419	1G	R479	3B		
		R250	2I	R420	1H	R480	2B		
Q254	3H	R251	3G	R426	2E	R481	2B		



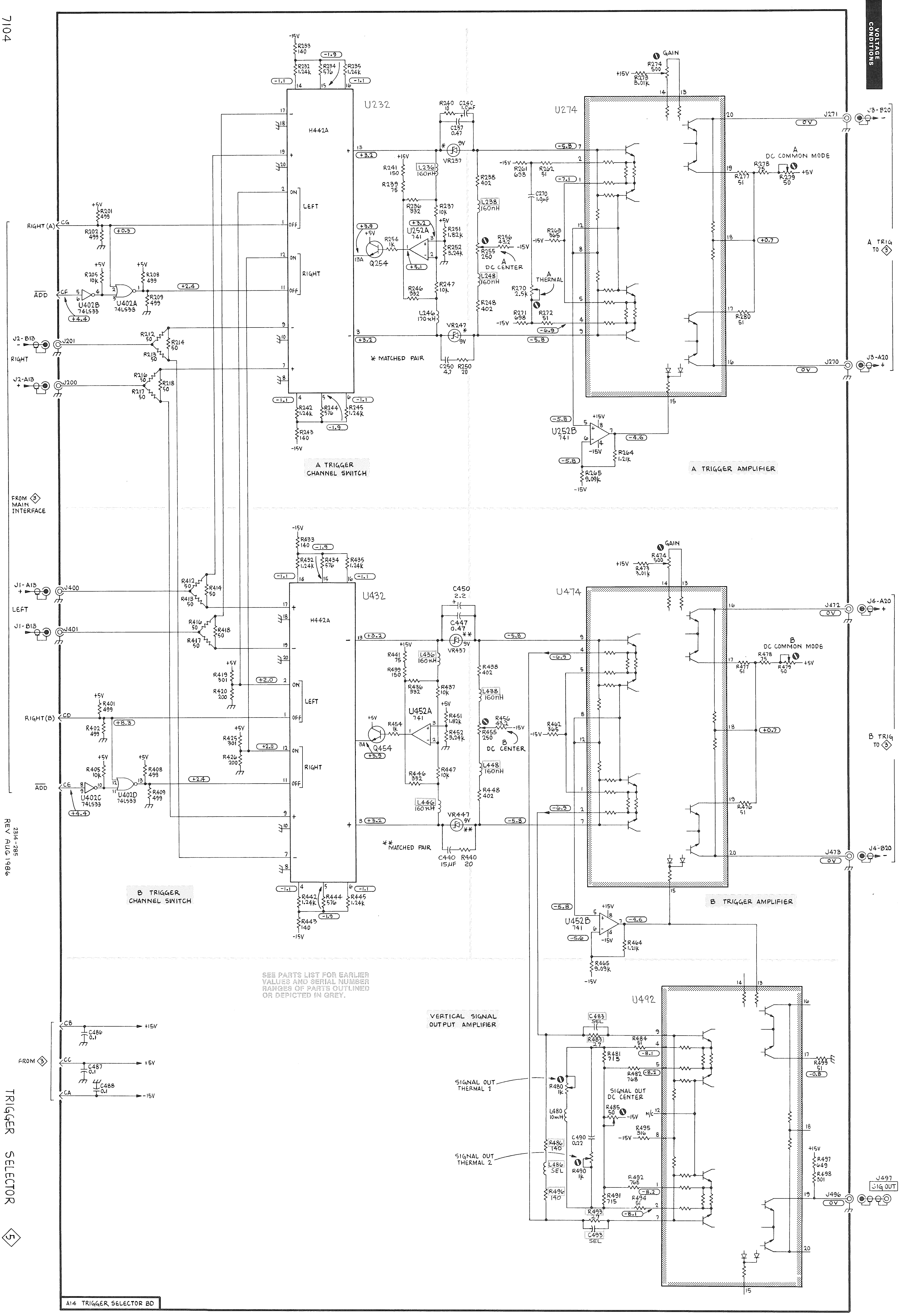
VOLTAGE CONDITIONS

The voltages shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY controls fully counterclockwise (READOUT INTENSITY at OFF); VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B. No plug-in units were installed.

The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with a readout-equipped 7000-series Oscilloscope).

7104

VOLTAGE CONDITIONS



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TRIGGER SELECTOR 5

TRIGGER SELECTOR 5

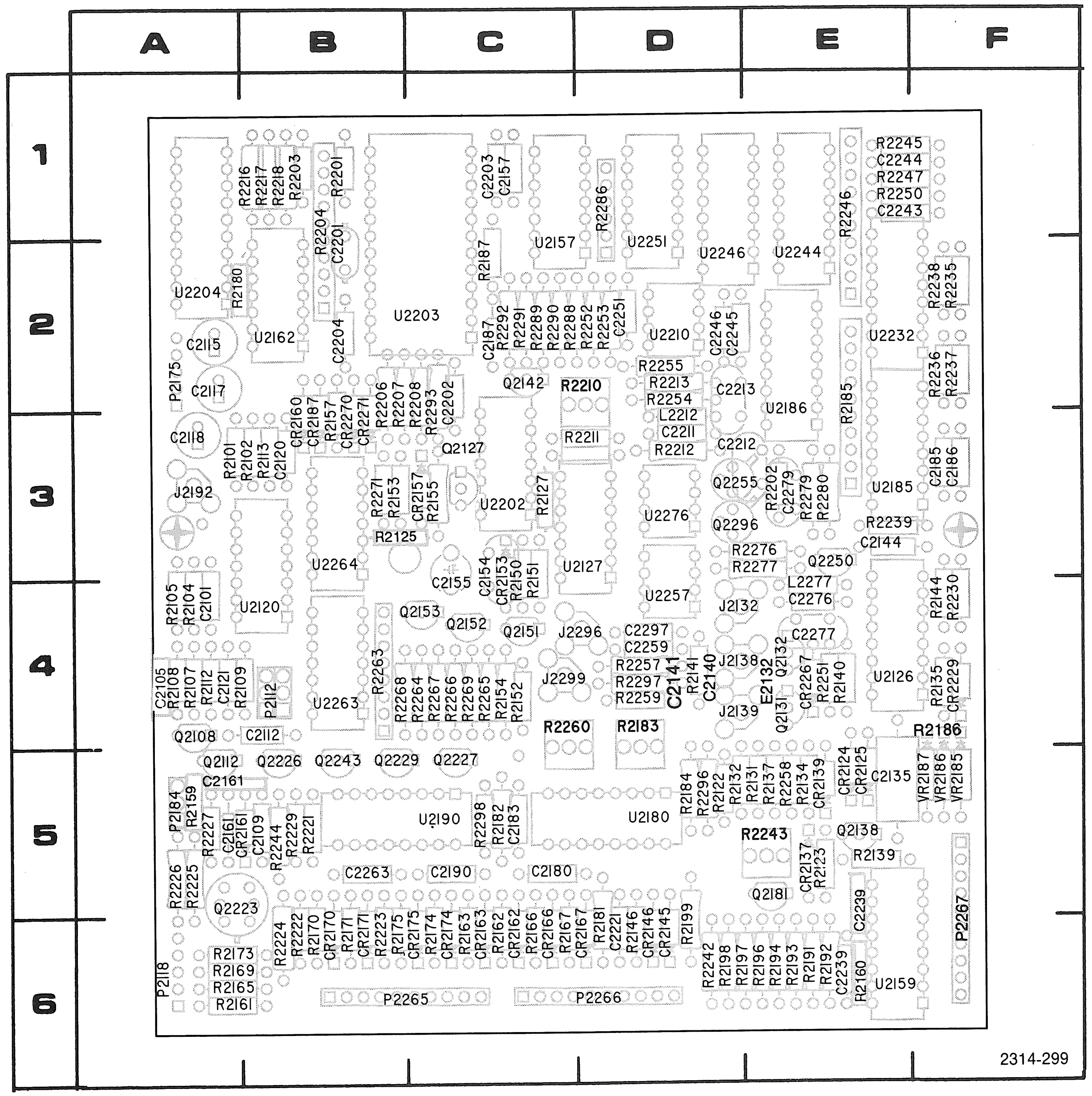


Figure 8-8A. A15—Readout System circuit board assembly (SN B053267-Up).

* COMPONENTS TEPEED

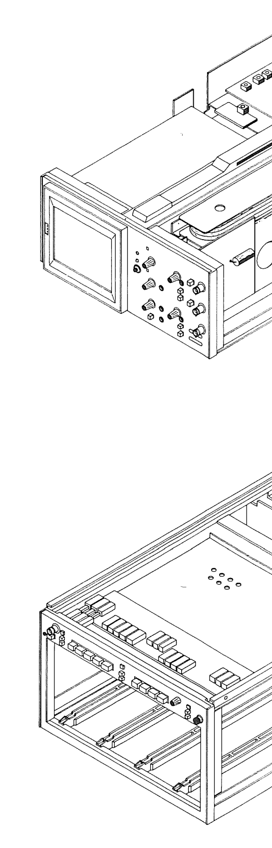
CKT NO	GRID COORD
C2101	A4
C2105	A4
C2109	B5
C2112	B4
C2115	5A
C2117	A2
C2118	A3
C2120	B3
C2121	A4
C2135	E5
C2140	D4
C2141	D4
C2144	E4
C2154	C4
C2155	C4
C2157	C1
C2161	A5
C2180	C5
C2183	C5
C2185	F3
C2186	F3
C2187	C2
C2190	C5
C2201	B1
C2202	C2
C2203	C1
C2204	B2
C2211	D3
C2212	D3
C2213	D2
C2221	D6
C2239	E6
C2243	E1
C2244	E1
C2245	D2
C2246	D2
C2251	D2
C2259	D4
C2263	B5
C2276	E4
C2277	E4
C2279	E3
C2297	D4
CR2124	E5
CR2125	E5
CR2137	E5
CR2139	E5
CR2145	D6
CR2146	D6
CR2153	C4
CR2157	C3
CR2160	B3
CR2161	B5
CR2162	C6
CR2163	C6
CR2166	C6

CKT NO	GRID COORD
CR2167	D7
CR2170	B6
CR2171	B6
CR2174	C6
CR2175	C6
CR2187	B3
CR2229	F4
CR2267	E4
CR2270	B3
CR2271	B3
E2132	E4
J2132	E4
J2138	E4
J2139	E4
J2192	A3
J2296	D4
J2299	C4
L2212	D3
L2277	E4
P2112	B4
P2118	A6
P2118	A6
P2175	A2
P2184	A5
P2265	B6
P2266	D6
P2267	F6
Q2108	A4
Q2112	A5
Q2127	C3
Q2131	E4
Q2132	E4
Q2138	E5
Q2142	C2
Q2151	C4
Q2152	C4
Q2153	C4
Q2181	E5
Q2223	B5
Q2226	B5
Q2227	C5
Q2229	B5
Q2243	B5
Q2250	E3
Q2255	D3
Q2296	D3
R2101	A3
R2102	B3
R2104	A4
R2105	A4
R2107	A4

CKT NO	GRID COORD
R2108	A4
R2109	B4
R2112	A4
R2113	B3
R2122	D5
R2123	D5
R2125	B3
R2127	D3
R2131	E5
R2132	D5
R2134	E5
R2135	F4
R2137	E5
R2139	E5
R2140	E4
R2141	D4
R2144	F4
R2146	D6
R2150	C4
R2151	C4
R2152	C4
R2153	B3
R2154	C4
R2155	C3
R2157	B3
R2159	A5
R2160	E6
R2161	A6
R2162	C6
R2163	C6
R2165	A6
R2166	C6
R2167	C6
R2169	A6
R2170	B6
R2171	B6
R2173	A6
R2174	C6
R2175	B6
R2180	A2
R2181	D6
R2182	C5
R2183	D4
R2184	D5
R2185	E2
R2186	F4
R2187	C2
R2191	E6
R2192	E6
R2193	E6
R2194	E6
R2196	E6
R2197	D6
R2198	D6
R2199	D6
R2201	B1
R2202	E3
R2203	B1
R2204	B1
R2206	B2

CKT NO	GRID COORD
R2207	B2
R2208	C2
R2210	D2
R2211	D3
R2212	D3
R2213	D2
R2216	B1
R2217	B1
R2218	B1
R2221	B5
R2222	B6
R2223	B6
R2224	B6
R2225	A5
R2226	A5
R2227	A5
R2229	B5
R2230	F4
R2235	F2
R2236	F2
R2237	F2
R2238	F2
R2239	E2
R2242	D6
R2243	E5
R2244	B5
R2245	E1
R2246	E1
R2247	E1
R2250	E1
R2251	E4
R2252	D2
R2253	D2
R2254	D2
R2255	D2
R2257	D4
R2258	E5
R2259	D4
R2260	C4
R2263	B4
R2264	C4
R2265	C4
R2266	C4
R2267	C4
R2268	B4
R2269	C4
R2271	B3
R2276	E3
R2277	E3
R2279	E3
R2280	E3
R2286	D1
R2288	D2
R2289	C2
R2290	C2
R2291	C2

CKT NO	GRID COORD
R2292	C2
R2293	C2
R2296	D5
R2297	D4
R2298	C5
U2120A	B4
U2120B	B4
U2120C	B4
U2120D	B4
U2126	B4
U2127A	D3
U2127B	D3
U2157A	C2
U2157B	C2
U2157C	C2
U2157D	C2
U2159	E6
U2162	B2
U2180	D5
U2185	E3
U2186	E3
U2190	C5
U2202A	C3
U2202B	C3
U2203	C2
U2204	A2
U2210A	D2
U2210B	D2
U2232	E2
U2244	E2
U2246	D2
U2251A	D1
U2251B	D1
U2251C	D1
U2251D	D1
U2257A	D4
U2257B	D4
U2263A	B4
U2264	B3
U2276A	D3
VR2185	F5
VR2186	F5
VR2187	F5
W2127	C3



CKT NO	GRID COORD
C2101	A4
C2105	A4
C2109	B5
C2112	B4
C2115	5A
C2117	A2
C2118	A3
C2120	B3
C2121	A4
C2135	E5
C2140	D4
C2141	D4
C2144	E4
C2154	C4
C2155	C4
C2157	C1
C2161	A5
C2180	C5
C2183	C5
C2185	F3
C2186	F3
C2187	C2
C2190	C5
C2201	B1
C2202	C2
C2203	C1
C2204	B2
C2211	D3
C2212	D3
C2213	D2
C2221	D6
C2239	E6
C2243	E1
C2244	E1
C2245	D2
C2246	D2
C2251	D2
C2259	D4
C2263	B5
C2276	E4
C2277	E4
C2279	E3
C2297	D4
CR2124	E5
CR2125	E5
CR2137	E5
CR2139	E5
CR2145	D6
CR2146	D6
CR2153	C4
CR2157	C3
CR2160	B3
CR2161	B5
CR2162	C6
CR2163	C6
CR2166	C6

CKT NO	GRID COORD
CR2167	D7
CR2170	B6
CR2171	B6
CR2174	C6
CR2175	C6
CR2187	B3
CR2229	F4
CR2267	E4
CR2270	B3
CR2271	B3
E2132	E4
J2132	E4
J2138	E4
J2139	E4
J2192	A3
J2296	D4
J2299	C4
L2212	D3
L2277	E4
P2112	B4
P2118	A6
P2118	A6
P2175	A2
P2184	A5
P2265	B6
P2266	D6
P2267	F6
Q2108	A4
Q2112	A5
Q2127	C3
Q2131	E4
Q2132	E4
Q2138	E5
Q2142	C2
Q2151	C4
Q2152	C4
Q2153	C4
Q2181	E5
Q2223	B5
Q2226	B5
Q2227	C5
Q2229	B5
Q2243	B5
Q2250	E3
Q2255	D3
Q2296	D3
R2101	A3
R2102	B3
R2104	A4
R2105	A4
R2107	A4

CKT NO	GRID COORD
R2108	A4
R2109	B4
R2112	A4
R2113	B3
R2122	D5
R2123	D5
R2125	B3
R2127	D3
R2131	E5
R2132	D5
R2134	E5
R2135	F4
R2137	E5
R2139	E5
R2140	E4
R2141	D4
R2144	F4
R2146	D6
R2150	C4
R2151	C4
R2152	C4
R2153	B3
R2154	C4
R2155	C3
R2157	B3
R2159	A5
R2160	E6
R2161	A6
R2162	C6
R2163	C6
R2165	A6
R2166	C6
R2167	C6
R2169	A6
R2170	B6
R2171	B6
R2173	A6
R2174	C6
R2175	B6
R2180	A2
R2181	D6
R2182	C5
R2183	D4
R2184	D5
R2185	E2
R2186	F4
R2187	C2
R2191	E6
R2192	E6
R2193	E6
R2194	E6
R2196	E6
R2197	D6
R2198	D6
R2199	D6
R2201	B1
R2202	E3
R2203	B1
R2204	B1
R2206	B2

CKT NO	GRID COORD
R2207	B2
R2208	C2
R2210	D2
R2211	D3
R2212	D3
R2213	D2
R2216	B1
R2217	B1
R2218	B1
R2221	B5
R2222	B6
R2223	B6
R2224	B6
R2225	A5
R2226	A5
R2227	A5
R2229	B5
R2230	F4
R2235	F2
R2236	F2
R2237	F2
R2238	F2
R2239	E2
R2242	D6
R2243	E5
R2244	B5
R2245	E1
R2246	E1
R2247	E1
R2250	E1
R2251	E4
R2252	D2
R2253	D2
R2254	D2
R2255	D2
R2257	D4
R2258	E5
R2259	D4
R2260	C4
R2263	B4
R2264	C4
R2265	C4
R2266	C4
R2267	C4
R2268	B4
R2269	C4
R2271	B3
R2276	E3
R2277	E3
R2279	E3
R2280	E3
R2286	D1
R2288	D2
R2289	C2
R2290	C2
R2291	C2

CKT NO	GRID COORD
R2292	C2
R2293	C2
R2296	D5
R2297	D4
R2298	C5
U2120A	B4
U2120B	B4
U2120C	B4
U2120D	B4
U2126	B4
U2127A	D3
U2127B	D3
U2157A	C2
U2157B	C2
U2157C	C2
U2157D	C2
U2159	E6
U2162	B2
U2180	D5
U2185	E3
U2186	E3
U2190	C5
U2202A	C3
U2202B	C3
U2203	C2
U2204	A2
U2210A	D2
U2210B	D2
U2232	E2
U2244	E2
U2246	D2
U2251A	D1
U2251B	D1
U2251C	D1
U2251D	D1
U2257A	D4
U2257B	D4
U2263A	B4
U2264	B3
U2276A	D3
VR2185	F5
VR2186	F5
VR2187	F5
W2127	C3

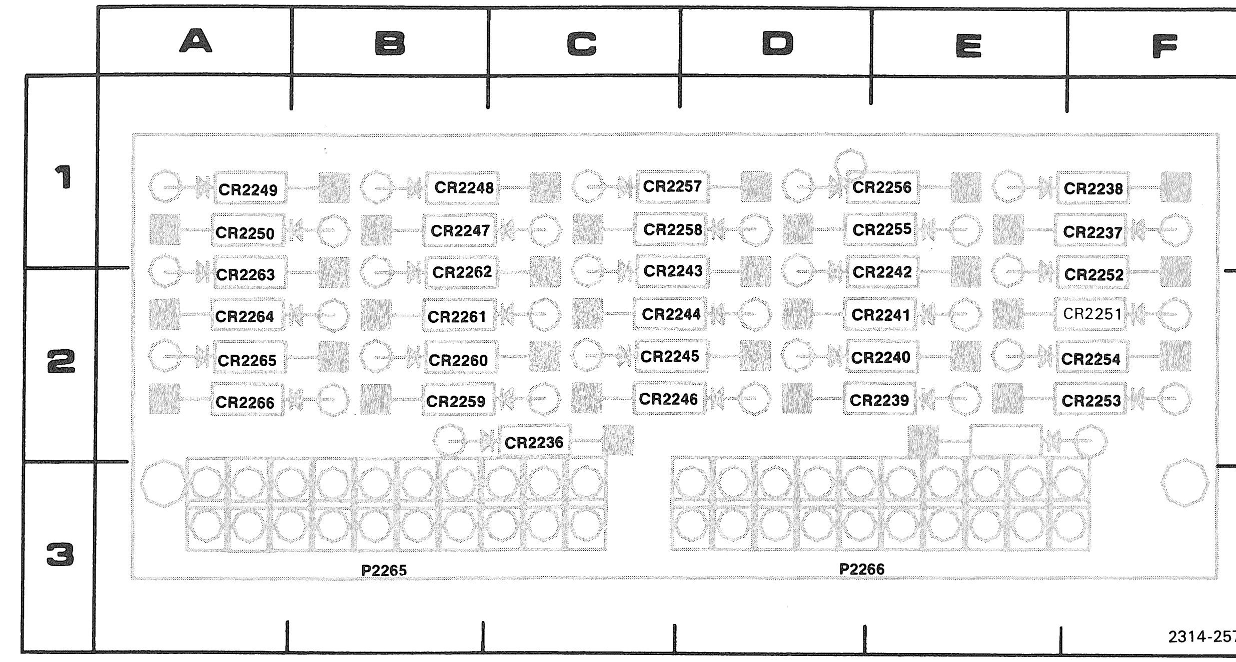
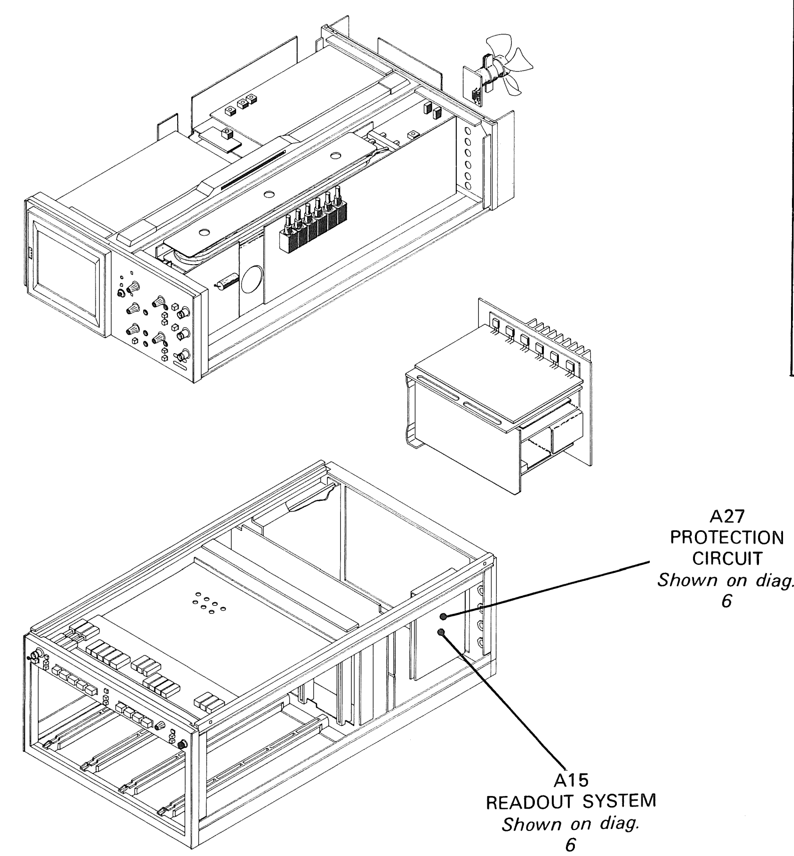
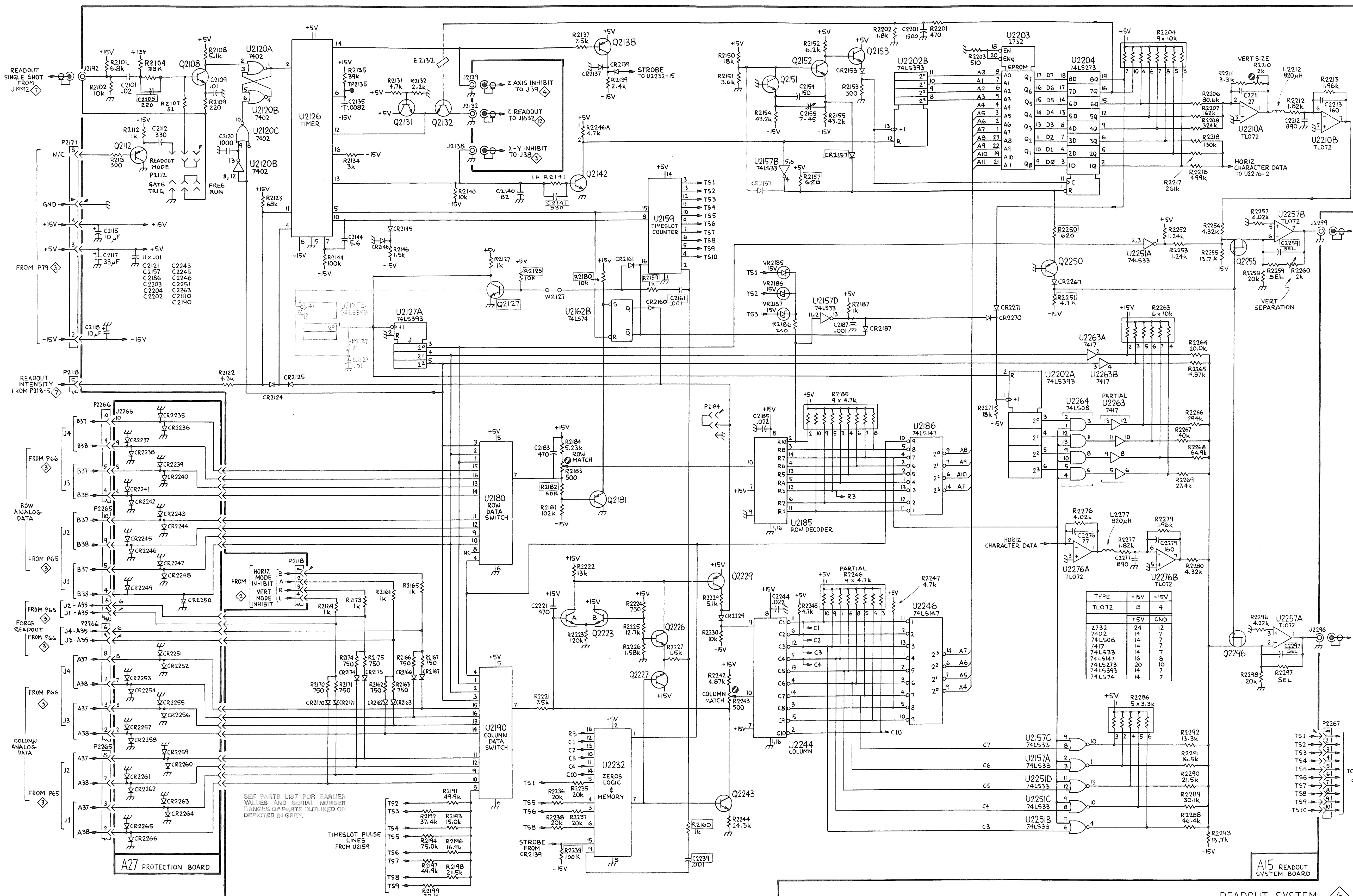


Figure 8-8B. A27—Readout Protection circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD
CR2236	2C	CR2253	2F
CR2237	1F	CR2254	2F
CR2238	1F	CR2255	1D
CR2239	2D	CR2256	1D
CR2240	2D	CR2257	1C
CR2241	2D	CR2258	1C
CR2242	2D	CR2259	2B
CR2243	2C	CR2260	2B
CR2244	2C	CR2261	2B
CR2245	2C	CR2262	2B
CR2246	2C	CR2263	2A
CR2247	1B	CR2264	2A
CR2248	1B	CR2265	2A
CR2249	1A	CR2266	2A
CR2250	1A		
CR2251	2F	P2265	3B
CR2252	2F	P2266	3D





TYPE	+15V	-15V
TL072	8	4
	+5V	GND
2732	24	12
7402	14	7
74LS08	14	7
7417	14	7
74LS33	14	7
74LS147	16	8
74LS273	20	10
74LS393	14	7
74LS74	14	7

READOUT SYSTEM SN B053267-UP

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(SN B053267-UP) READOUT SYSTEM 6

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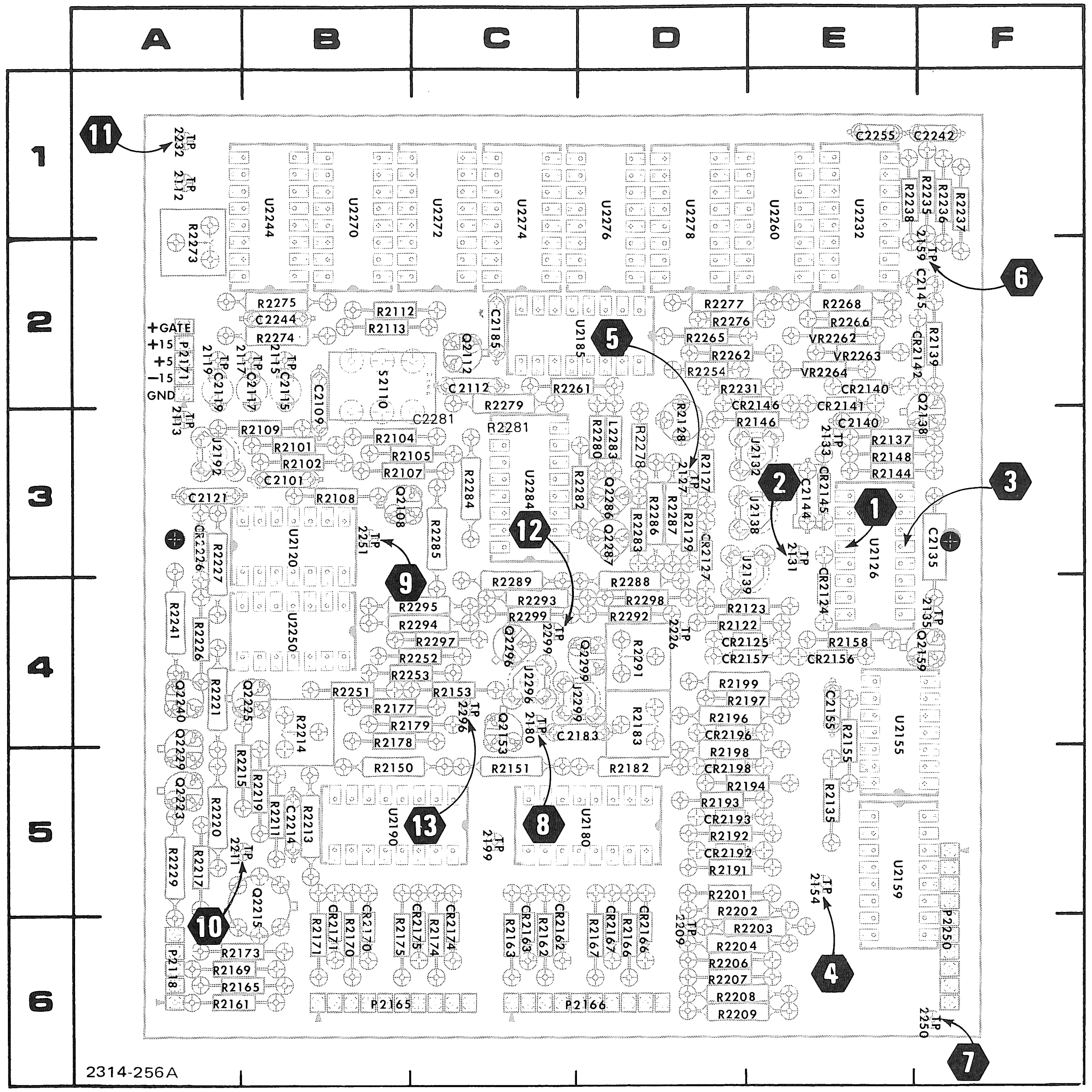


Located on back of board

C2284

Figure 8-9. A15—Readout System circuit board assembly (SN B053266-Below).

ASSEMBLY A15
(SN B053266-Below)

Locator for Figure 8-8.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C2101	3B	R2104	3B	R2254	2D
C2109	2B	R2105	3B	R2261	2C
C2112	2C	R2107	3B	R2262	2D
C2115	2B	R2108	3B	R2265	2D
C2117	2B	R2109	3B	R2266	2E
C2119	2A	R2112	2B	R2268	2E
C2121	3A	R2113	2B	R2274	2B
C2135	3F	R2122	4D	R2275	2B
C2140	3E	R2123	4D	R2276	2D
C2144	3E	R2127	3D	R2277	2D
C2145	2F	R2128	3D	R2278	3D
C2155	4E	R2129	3D	R2279	2C
C2183	4D	R2135	5E	R2280	3D
C2185	2C	R2137	3E	R2281	3C
C2214	5B	R2139	2F	R2282	3C
C2242	1F	R2144	3E	R2283	3D
C2244	2B	R2146	3E	R2284	3C
C2255	1E	R2148	3E	R2285	3C
C2281	3C	R2150	5B	R2286	3D
		R2151	5C	R2287	3D
CR2124	4E	R2153	4C	R2288	4D
CR2125	4D	R2155	4E	R2289	4C
CR2127	3D	R2158	4E	R2291	4D
CR2140	2E	R2161	6A	R2292	4D
CR2141	2E	R2162	6C	R2293	4C
CR2142	2F	R2163	6C	R2294	4B
CR2145	3E	R2165	6A	R2295	4B
CR2146	2D	R2166	6D	R2297	4C
CR2156	4E	R2167	6D	R2298	4D
CR2157	4D	R2169	6A	R2299	4C
CR2162	6C	R2170	6B		
CR2163	6C	R2171	6B	S2110	2B
CR2166	6D	R2173	6A		
CR2167	6D	R2174	6C	TP2112	1A
CR2170	6B	R2175	6B	TP2113	3A
CR2171	6B	R2177	4B	TP2115	2B
CR2174	6C	R2178	4B	TP2117	2A
CR2175	6C	R2179	4B	TP2119	2A
CR2192	5D	R2182	5D	TP2127	3D
CR2193	5D	R2183	4D	TP2131	3E
CR2196	4D	R2191	5D	TP2133	3E
CR2198	5D	R2192	5D	TP2135	4F
CR2226	3A	R2193	5D	TP2154	5E
		R2194	5D	TP2159	2F
J2132	3E	R2196	4D	TP2180	4C
J2138	3E	R2197	4D	TP2199	5C
J2139	4D	R2198	5D	TP2209	6D
J2192	3A	R2199	4D	TP2211	5A
J2296	4C	R2201	5D	TP2226	4D
J2299	4D	R2202	5D	TP2232	1A
		R2203	6D	TP2250	6F
L2283	3D	R2204	6D	TP2251	3B
		R2206	6D	TP2296	4C
P2118	6A	R2207	6D	TP2299	4C
P2165	6B	R2208	6D		
P2166	6D	R2209	6D	U2120	3B
P2171	2A	R2211	5B	U2126	3E
P2250	6F	R2213	5B	U2155	4E
		R2214	4B	U2159	5E
Q2108	3B	R2215	5A	U2180	5D
Q2112	2C	R2217	5A	U2185	2C
Q2138	3F	R2219	5B	U2190	5B
Q2153	4C	R2220	5A	U2232	1E
Q2159	4F	R2221	4A	U2244	1B
Q2215	5B	R2226	4A	U2250	4B
Q2223	5A	R2227	3A	U2260	1E
Q2225	4B	R2229	5A	U2270	1B
Q2229	5A	R2231	2D	U2272	1C
Q2240	4A	R2235	1F	U2274	1C
Q2286	3D	R2236	1F	U2276	1D
Q2287	3D	R2237	1F	U2278	1D
Q2296	4C	R2238	1E	U2284	3C
Q2299	4D	R2241	4A		
		R2251	4B	VR2262	2E
R2101	3B	R2252	4B	VR2263	2E
R2102	3B	R2253	4B	VR2264	2E

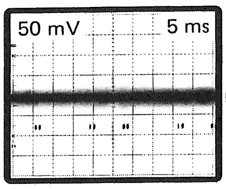
VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the 7104 front panel variable controls at midrange except A and B INTENSITY fully counterclockwise; VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B; RO Pulsed SOURCE B + GATE.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM501A Digital Multimeter or Tektronix 7D13A Digital Multimeter used with a readout-equipped 7000-series Oscilloscope).

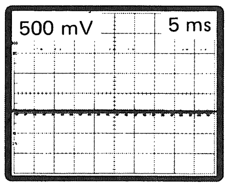
Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with a 1 MΩ input impedance and at least 60 MHz bandwidth. The test oscilloscope (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with a 10X probe) was externally triggered through a 1X probe connected to TP2251 on the 7104 A15 Readout System circuit board. A 7B-series time base was installed in the mainframe B HORIZ compartment and set for internal auto-trigger and 2 millisecond/division sweep rate, holdoff minimum. A 7A-series plug-in was installed in the mainframe left vertical compartment. The readout preset intensity was adjusted for a readout display.

1



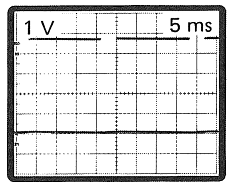
4.3 V

2



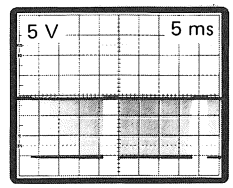
0 V

3



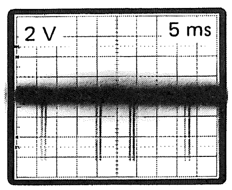
2 V

4



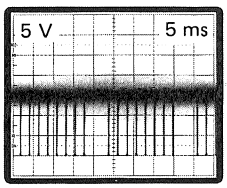
0 V

5



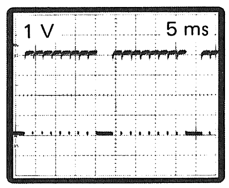
−4 V

6



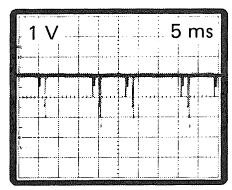
0 V

7



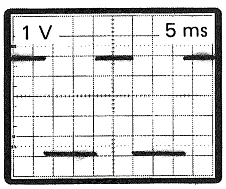
2 V

8



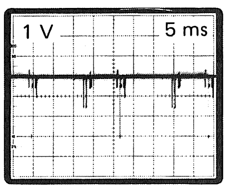
14 V

9



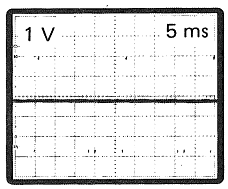
3 V

10



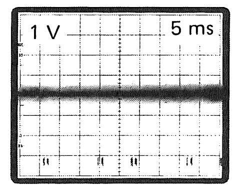
14 V

11



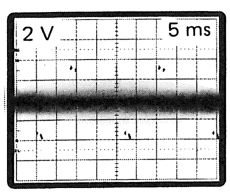
3 V

12

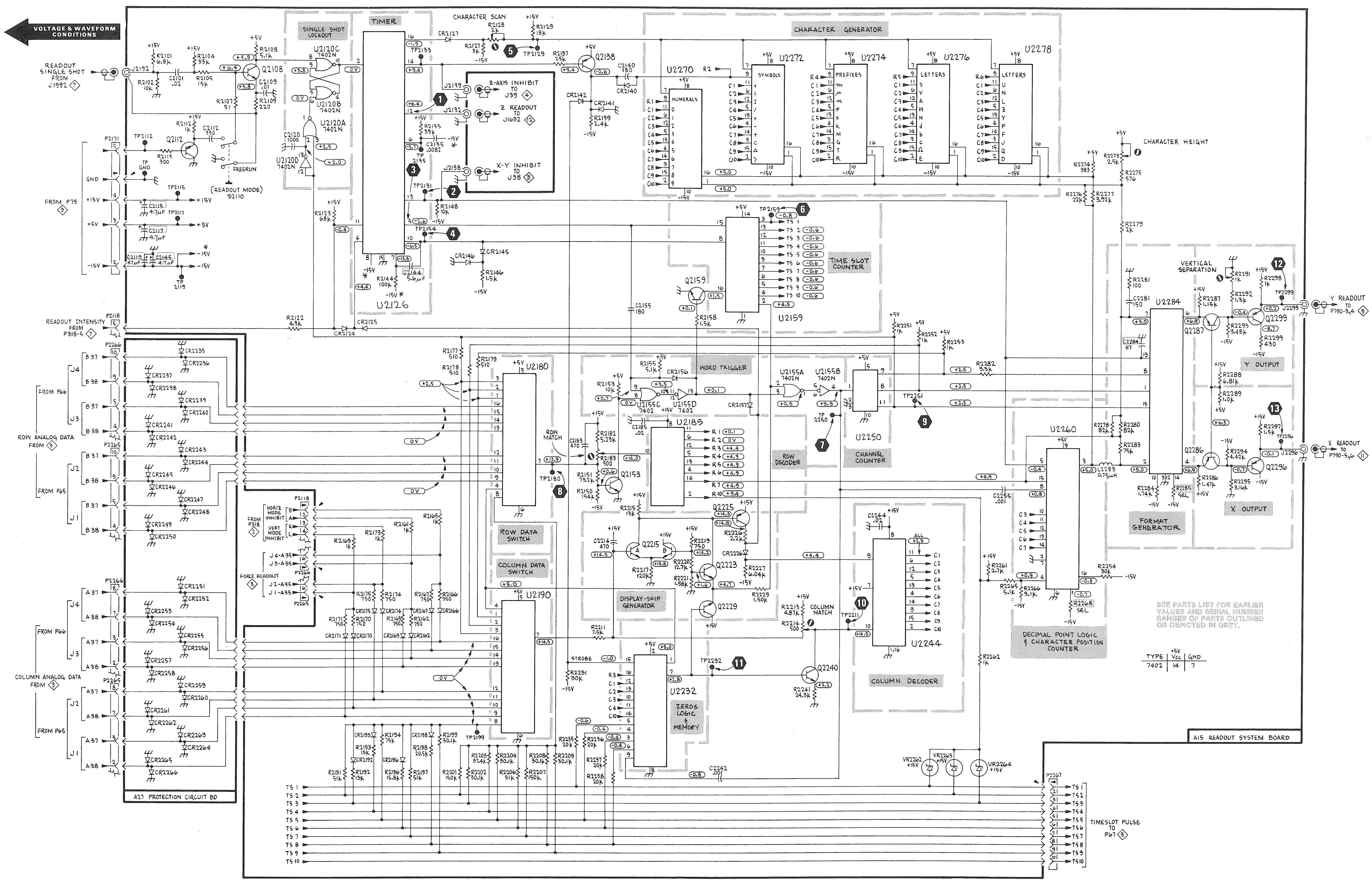


0 V

13



0 V



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(SN B053266 & BELOW) READOUT SYSTEM 6

READOUT SYSTEM
SN B053266-Below

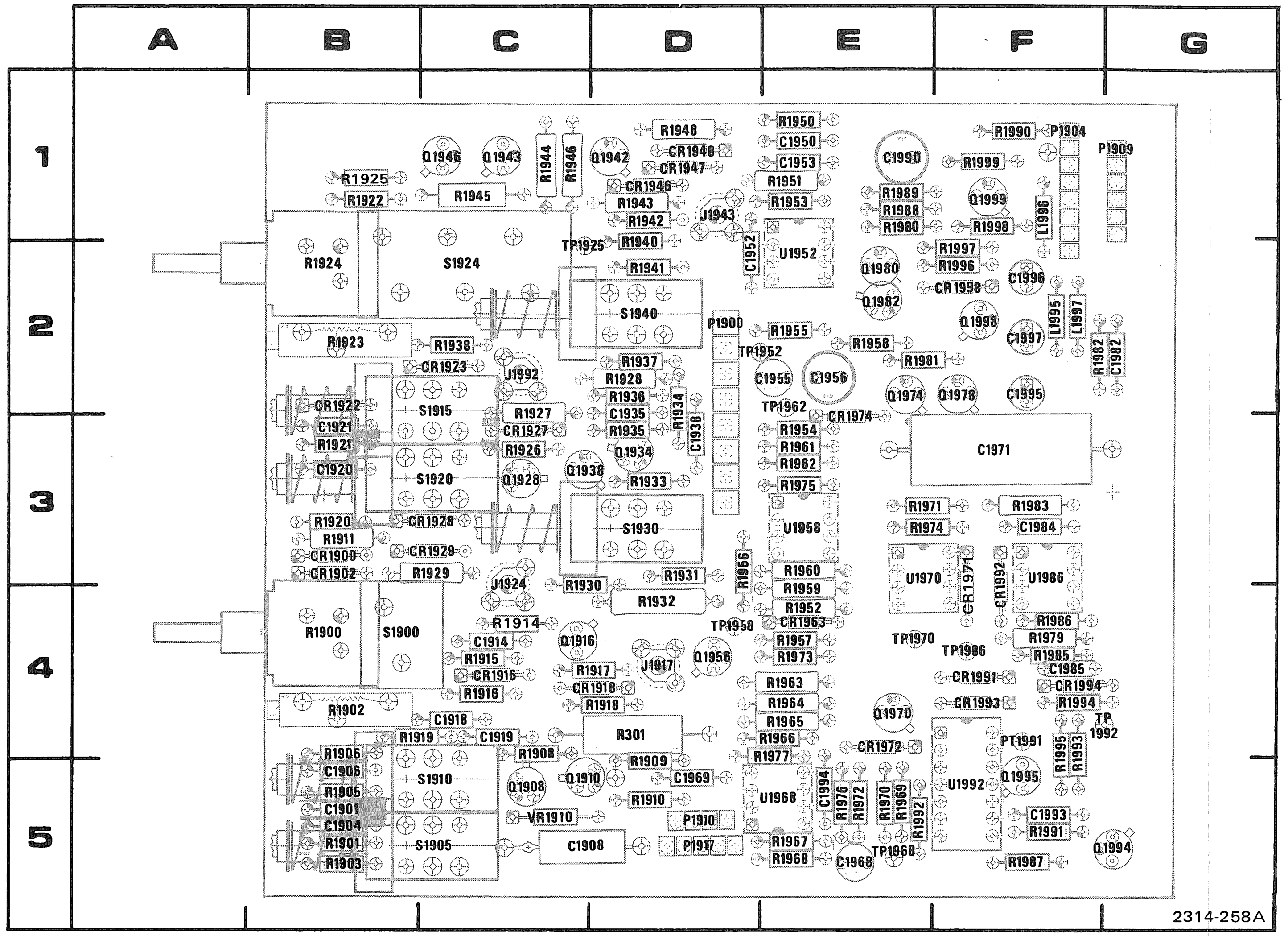
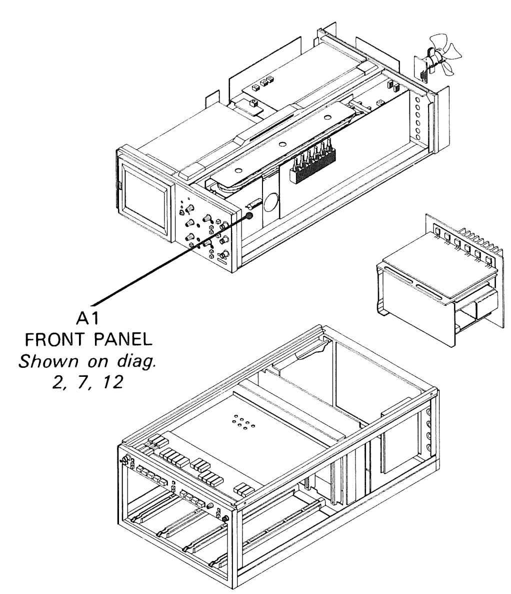


Figure 8-10. A1—Front Panel circuit board assembly.



ASSEMBLY A1

Locator for Figure 8-10

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1901	5B	Q1910	5C	R1957	4E
C1904	5B	Q1916	4C	R1958	2E
C1906	5B	Q1928	3C	R1959	4E
C1908	5C	Q1934	3D	R1960	3E
C1914	4C	Q1938	3C	R1961	3E
C1915	4C	Q1942	1D	R1962	3E
C1918	4C	Q1943	1C	R1963	4E
C1919	4C	Q1946	1C	R1964	4E
C1920	3B	Q1956	4D	R1965	4E
C1921	3B	Q1970	4E	R1966	4E
C1935	2D	Q1974	2E	R1967	5E
C1938	3D	Q1978	2F	R1968	5E
C1950	1E	Q1980	2E	R1969	5E
C1952	2D	Q1982	2E	R1970	5E
C1953	1E	Q1994	5G	R1971	3E
C1955	2E	Q1995	5F	R1972	5E
C1956	2E	Q1998	2F	R1973	4E
C1968	5E	Q1999	1F	R1974	3E
C1969	5D			R1975	3E
C1971	3F	R301	4D	R1976	5E
C1982	2G	R1900	4B	R1977	4E
C1984	3F	R1901	5B	R1979	4F
C1985	4F	R1902	4B	R1980	1E
C1990	1E	R1903	5B	R1981	2E
C1993	5F	R1905	5B	R1982	2F
C1994	5E	R1906	4B	R1983	3F
C1995	2F	R1908	4C	R1985	4F
C1996	2F	R1909	5D	R1986	4F
C1997	2F	R1910	5D	R1987	5F
		R1911	3B	R1988	1E
CR1900	3B	R1914	4C	R1989	1E
CR1902	3B	R1915	4C	R1990	1F
CR1916	4C	R1916	4C	R1991	5F
CR1918	4D	R1917	4D	R1992	5E
CR1922	2B	R1918	4D	R1993	4F
CR1923	2C	R1919	4B	R1994	4F
CR1927	3C	R1920	3B	R1995	4F
CR1928	3C	R1921	3B	R1996	2F
CR1929	3C	R1922	1B	R1997	2F
CR1946	1D	R1923	2B	R1998	1F
CR1947	1D	R1924	2B	R1999	1F
CR1948	1D	R1925	1B		
CR1963	4E	R1926	3C	S1900	4B
CR1971	3F	R1927	3C	S1905	5C
CR1972	4E	R1928	2D	S1910	5C
CR1974	3E	R1929	3C	S1915	3C
CR1991	4F	R1930	3C	S1920	3C
CR1992	3F	R1931	3D	S1924	2C
CR1993	4F	R1932	4D	S1930	3D
CR1994	4F	R1933	3D	S1940	2D
CR1998	2F	R1934	3D		
		R1935	3D	TP1911	4F
J1917	4D	R1936	2D	TP1925	2C
J1924	3C	R1937	2D	TP1952	2D
J1943	1D	R1938	2C	TP1958	4D
J1992	2C	R1940	2D	TP1962	2E
		R1941	2D	TP1968	5E
L1995	2F	R1942	1D	TP1970	4E
L1996	1F	R1943	1D	TP1986	4F
L1997	2F	R1944	1C	TP1992	4F
		R1945	1C		
P1900	2D	R194	1C	U1952	2E
P1904	1F	R1948	1D	U1958	3E
P1909	1G	R1950	1E	U1968	5E
P1910	5D	R1951	1E	U1970	3E
P1917	5D	R1952	4E	U1986	3F
		R1953	1E	U1992	5F
PT1991	4F	R1954	3E		
		R1955	2E	VR1910	5C
Q1908	5C	R1956	3D		

VOLTAGE CONDITIONS

The voltages shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY controls fully counterclockwise; VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B. No plug-in units were installed.

The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with a readout-equipped 7000-series Oscilloscope).

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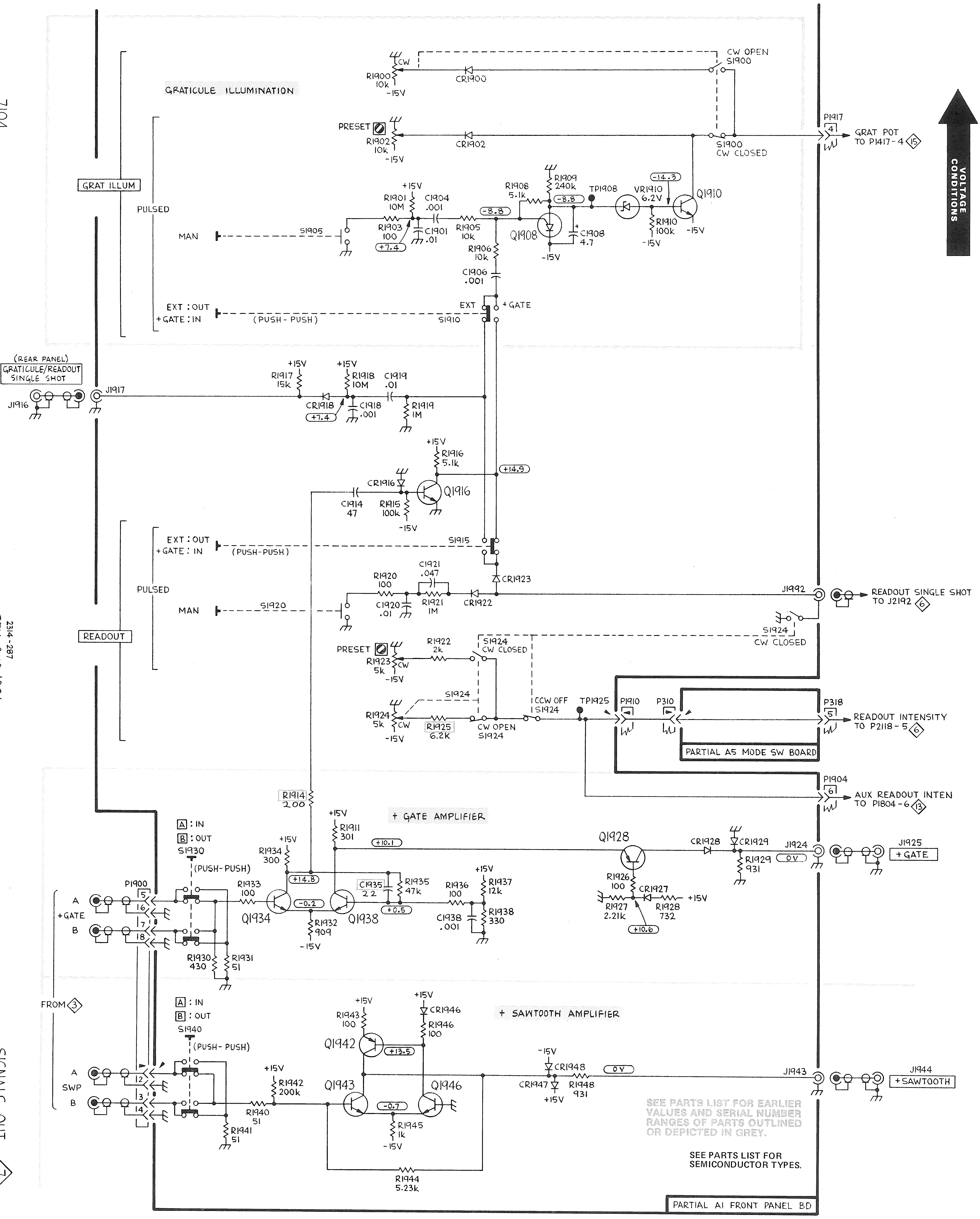


SIGNALS OUT ⟨7⟩

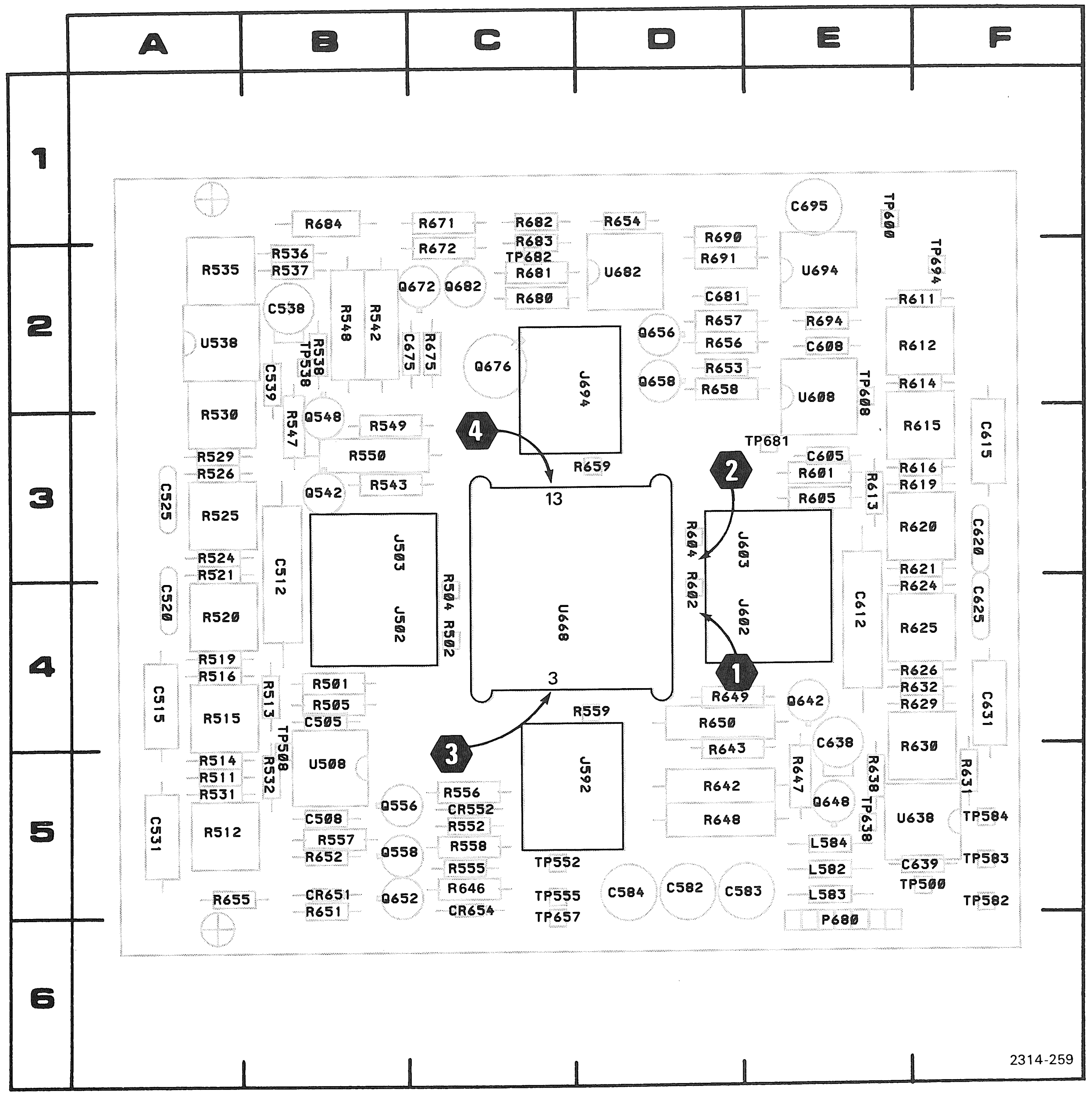
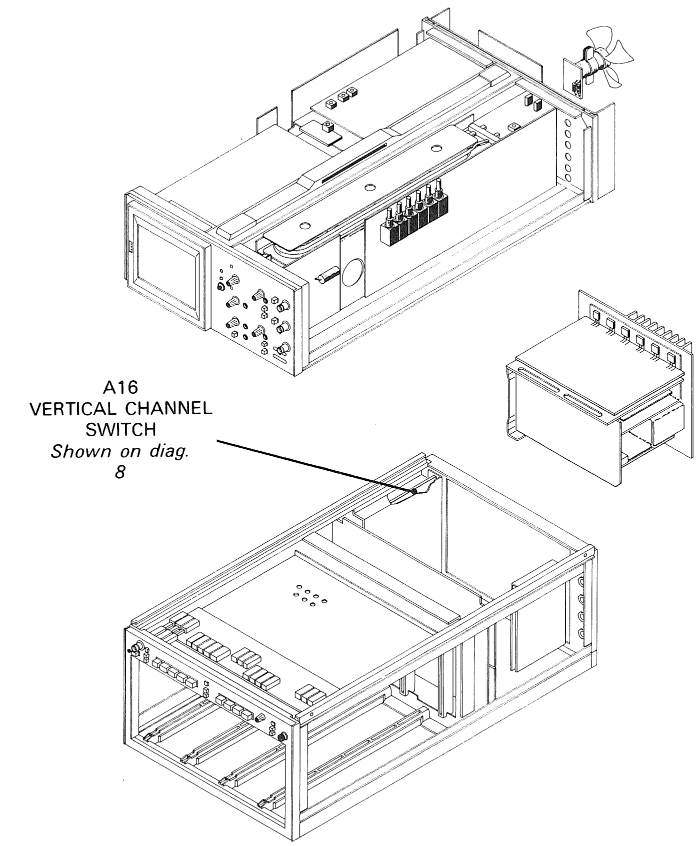


Figure 8-11. A16—Vertical Channel Switch circuit board assembly.

Locator for Figure 8-11.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C505	4B	R501	4B	R632	4E
C508	5B	R502	4C	R638	5E
C512	3B	R504	4C	R642	5D
C515	4A	R505	4B	R643	5D
C520	4A	R511	5A	R646	5C
C525	3A	R512	5A	R647	5E
C531	5A	R513	4B	R648	5D
C538	2B	R514	5A	R649	5D
C539	2B	R515	4A	R650	4D
C582	5D	R516	4A	R651	5B
C583	5D	R519	4A	R652	5B
C584	5D	R520	4A	R653	2D
C605	3E	R521	3A	R654	1D
C608	2E	R524	3A	R655	5A
C612	4E	R525	3A	R656	2D
C615	3F	R526	3A	R657	2D
C620	3F	R529	3A	R658	2D
C625	4F	R530	2A	R659	3D
C631	4F	R531	5A	R671	1C
C638	4E	R532	5B	R672	1C
C639	5E	R535	2A	R675	2C
C675	2B	R536	2B	R680	2C
C681	2D	R537	2B	R681	2C
C695	1E	R538	2B	R682	1C
		R542	2B	R683	1C
CR552	5C	R543	3B	R684	1B
CR651	5B	R547	3B	R690	1D
CR654	5C	R548	2B	R691	2D
		R549	3B	R694	2E
J502	4B	R550	3B		
J503	3B	R552	5C	TP500	5E
J592	5D	R555	5C	TP508	4B
J602	4D	R556	5C	TP538	2B
J603	3E	R557	5B	TP552	5C
J694	2D	R558	5C	TP555	5C
		R559	4D	TP582	5E
L582	5E	R601	3E	TP583	5E
L583	5E	R602	4D	TP584	5E
L584	5E	R604	3D	TP600	1E
		R605	3E	TP608	2E
P680	6E	R611	2F	TP638	5E
		R612	2F	TP657	6C
Q542	3B	R613	3E	TP681	3E
Q548	3B	R614	2F	TP682	2C
Q556	5B	R615	3F	TP694	2F
Q558	5B	R616	3F		
Q642	4E	R619	3F	U508	5B
Q648	5E	R620	3F	U538	2A
Q652	5B	R621	4E	U608	2E
Q656	2D	R624	4E	U638	5E
Q658	2D	R625	4E	U668	4C
Q672	2C	R626	4E	U682	2D
Q676	2C	R629	4E	U694	2E
Q682	2C	R630	5E		
		R631	5E		



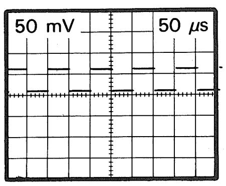
VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY controls counterclockwise; VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with a readout-equipped 7000-series Oscilloscope).

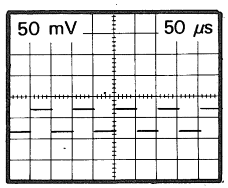
Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 10 MΩ input impedance and at least 60 MHz bandwidth. The test oscilloscope was externally triggered from the Pretrig out connector of a 067-0587-02 Calibration Fixture installed in the 7104 LEFT VERT compartment. (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with a 10X probe.) Calibration Fixture: +Step Response, 10 kHz Rep Rate, 6 divisions of vertical display centered at 0 volts. Test oscilloscope time base: 50 ns/div, +Slope, Auto, AC, Ext. A 7B-series time base was installed in the 7104 B HORIZ compartment and set for a free running sweep.

1



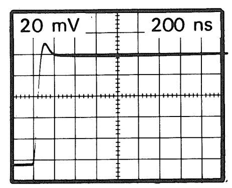
0 V

2



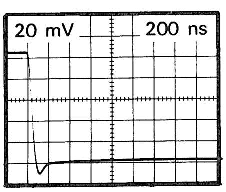
0 V

3

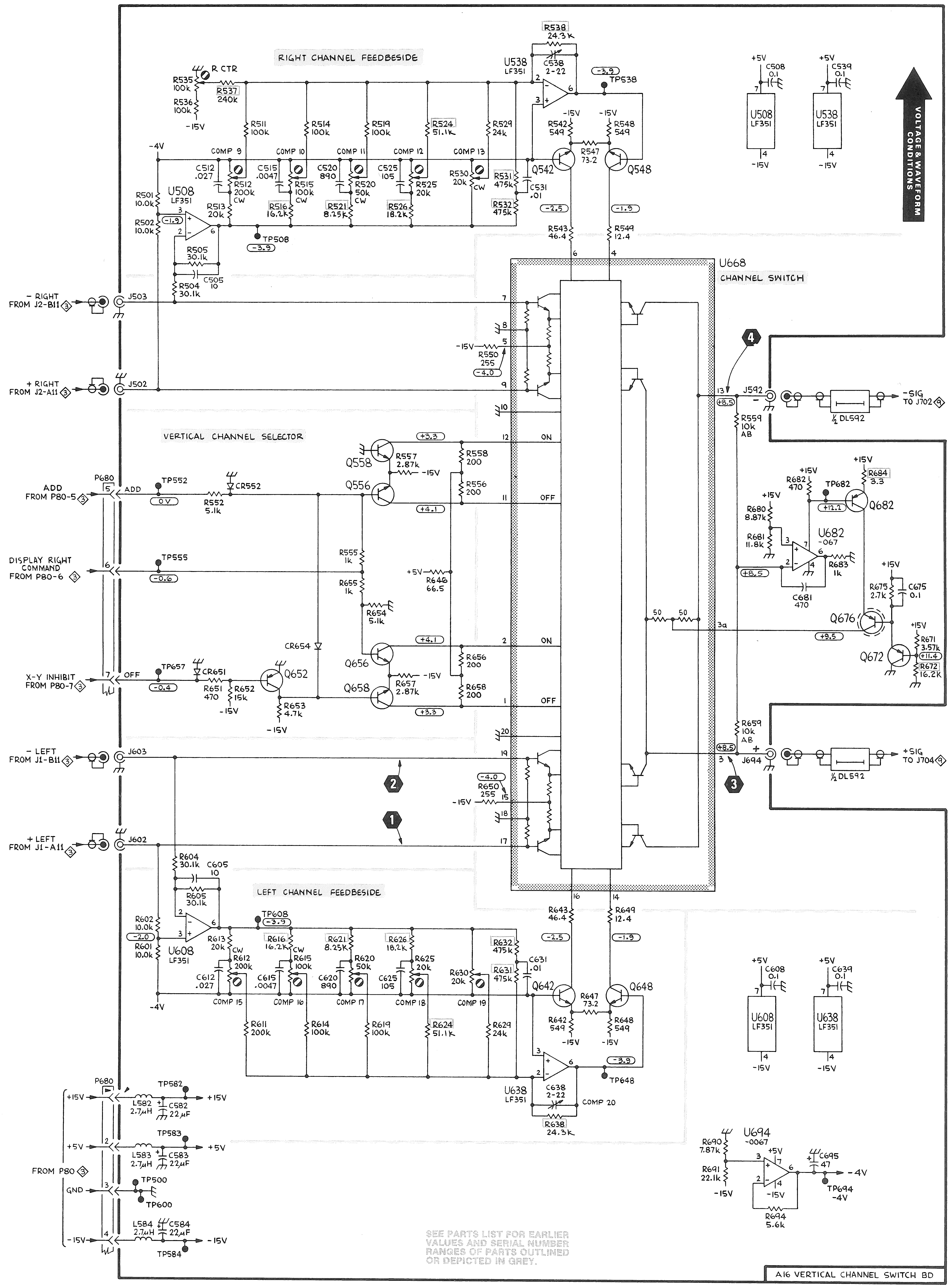


7.7 V

4



7.6 V



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VERTICAL CHANNEL SWITCH ⑧

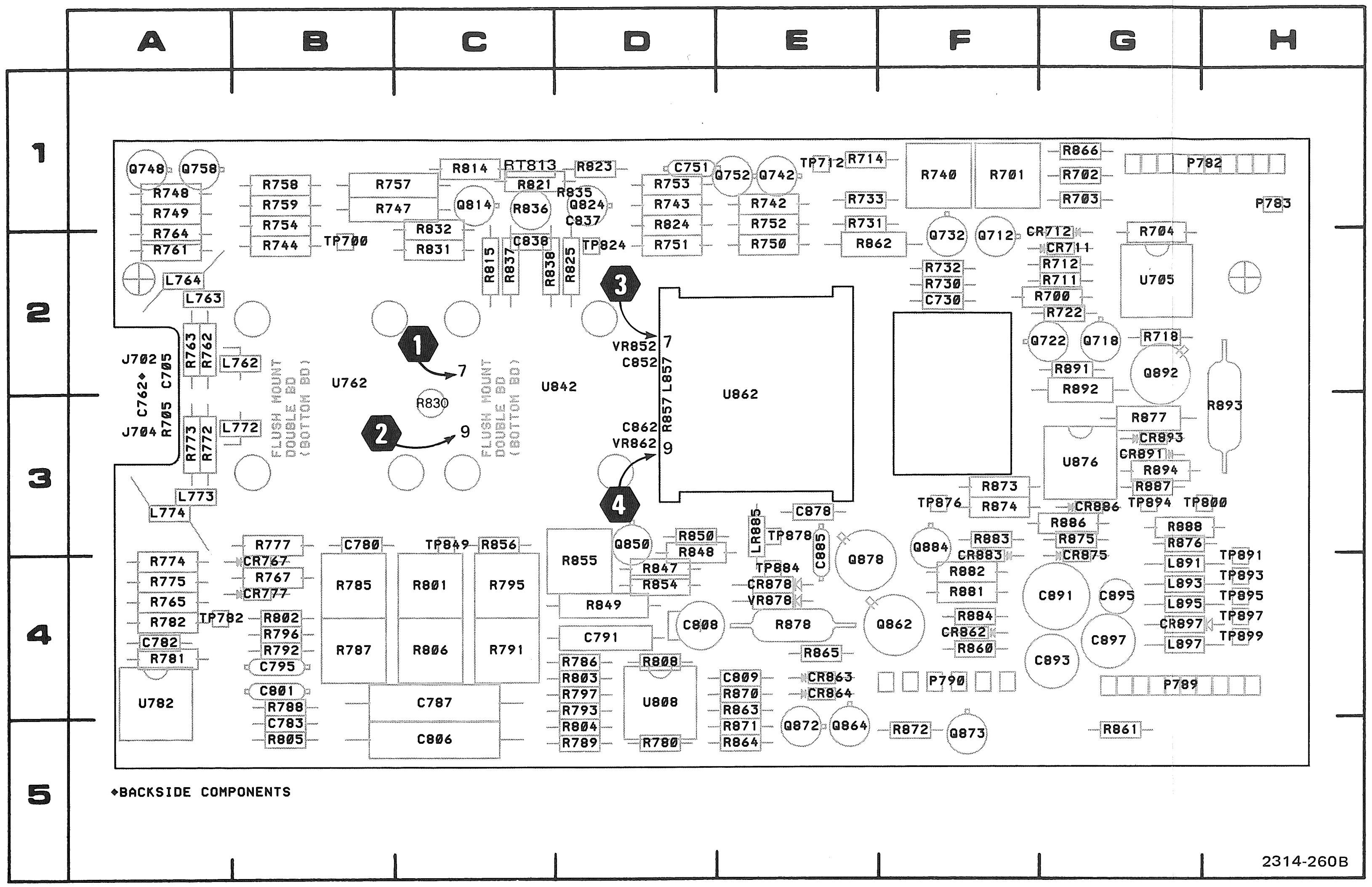
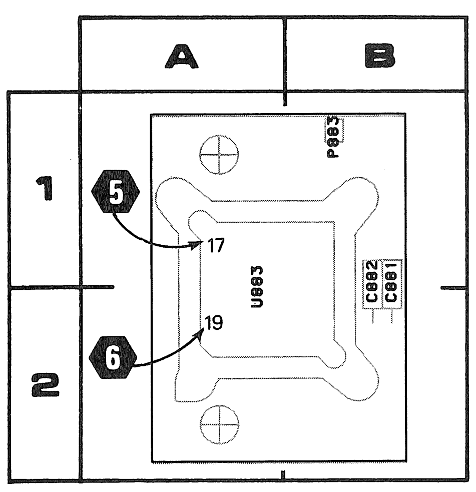


Figure 8-12A. A17-Vertical Amplifier circuit board assembly (SN B020954 & below).

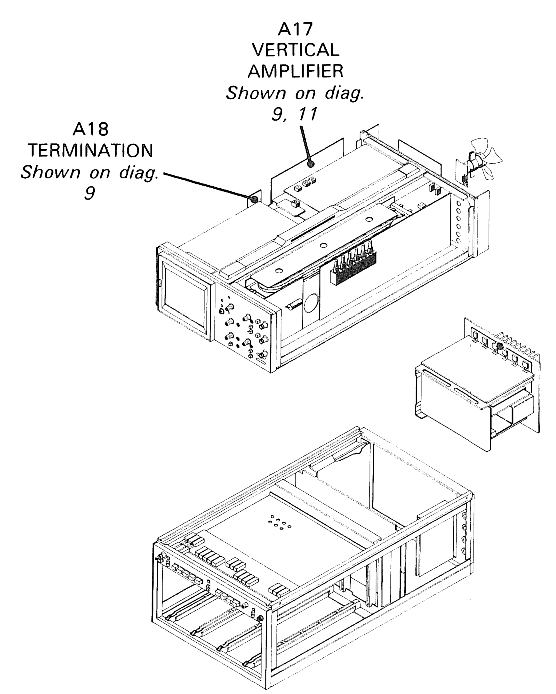
Locator for Figure 8-12A.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C705	2A	Q864	5E	R824	1D
C730	2F	Q872	5E	R825	2D
C751	1D	Q873	5F	R830	3C
C762	3A	Q878	4E	R831	2C
C780	3B	Q884	3F	R832	1C
C782	4A	Q892	2G	R835*	1D
C783	5B	R700	2G	R836	1C
C787	4C	R701	1F	R837	2C
C791	4D	R702	1G	R838	2C
C795	4B	R703	1G	R847	4D
C801	4B	R704	2G	R848	3D
C806	5C	R705	3A	R849	4D
C808	4D	R711	2G	R850	3D
C809	4E	R712	2G	R854	4D
C837*	1D	R714	1E	R855	4D
C838	2C	R718	2G	R856	3C
C852	2D	R722	2G	R857	3D
C862	3D	R730	2F	R860	4F
C878	3E	R731	1E	R861	5G
C885	4E	R732	2F	R862	2E
C891	4G	R733	1E	R863	4E
C893	4G	R740	1F	R864	5E
C895	4G	R742	1E	R865	4E
C897	4G	R743	1D	R866	1G
CR711	2G	R744	2B	R870	4E
CR712	2G	R747	1B	R871	5E
CR767	4B	R748	1A	R872	5F
CR777	4B	R749	1A	R873	3F
CR862	4F	R750	2E	R874	3F
CR863	4E	R751	2D	R875	3G
CR864	4E	R752	1E	R876	3G
CR875	4G	R753	1D	R877	3G
CR878	4E	R754	1B	R878	4E
CR883	4F	R757	1B	R881	4F
CR886	3G	R758	1B	R882	4F
CR891	3G	R759	1B	R883	3F
CR893	3G	R761	2A	R884	4F
CR897	4G	R762	2A	R886	3G
J702	2A	R763	2A	R887	3G
J704	3A	R764	1A	R888	3G
L762	2B	R765	4A	R891	2G
L763	2A	R767	4B	R892	3G
L764	2A	R772	3A	R893	3H
L772	3B	R773	3A	R894	3G
L773	3A	R774	4A	RT813	1C
L774	3A	R775	4A	TP700	2B
L857	2D	R777	3B	TP712	1E
L891	4G	R780	5D	TP782	4A
L893	4G	R781	4A	TP800	3G
L895	4G	R782	4A	TP824	2D
L897	4G	R785	4B	TP849	3C
LR885	3E	R786	4D	TP876	3F
P782	1G	R787	4B	TP878	3E
P783	1H	R788	4B	TP884	4E
P789	4G	R789	5D	TP891	4H
P790	4F	R791	4C	TP893	4H
Q712	2F	R792	4B	TP894	3G
Q718	2G	R793	4D	TP895	4H
Q722	2G	R795	4C	TP897	4H
Q732	2F	R796	4B	TP899	4H
Q742	1E	R797	4D	U705	2G
Q748	1A	R801	4D	U762	2B
Q752	1E	R802	4B	U782	4A
Q758	1A	R803	4D	U808	4D
Q814	1C	R804	5D	U842	2C
Q824	1D	R805	5B	U862	3E
Q850	3D	R806	4C	U876	3G
Q862	4F	R808	4D	VR852	2D
		R814	1C	VR862	3D
		R815	2C	VR878	4E
		R821	1C		
		R823	1D		



CKT NO	GRID COORD
C881	2B
C882	2B
P883	1B
U883	1A

Figure 8-12B. A18-Termination circuit board assembly.



*See Parts List for serial number ranges.

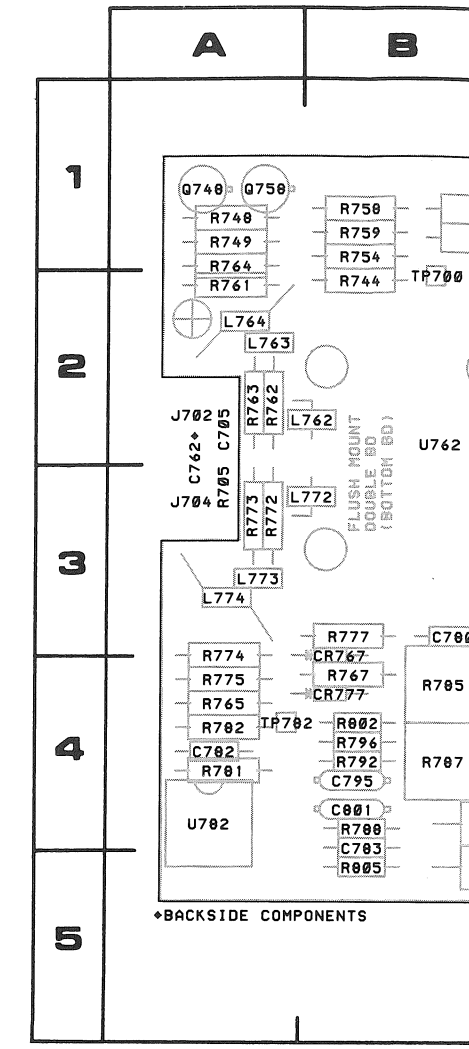
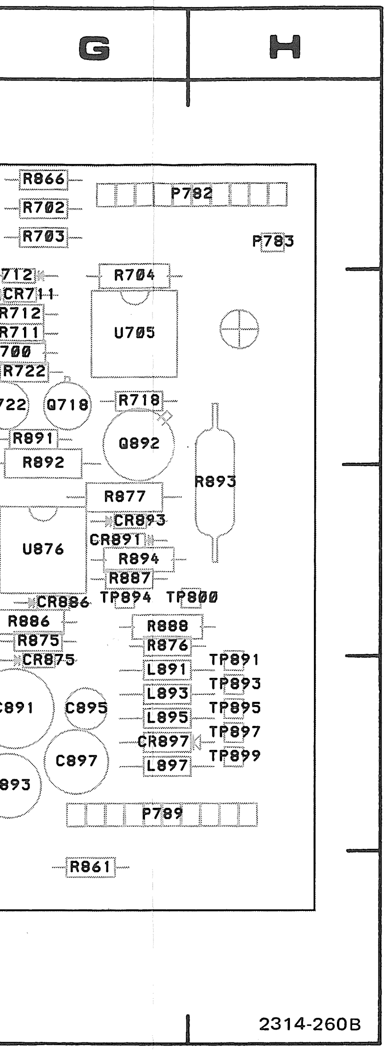


Figure 8-12(

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C705	2A	C895	4G	L772	3B
C730	2F	C897	4G	L773	3A
C751	1D			L774	3A
C762	3A	CR711	2G	L857	2D
C780	3B	CR712	2G	L867	3D
C782	4A	CR767	4B	L891	4G
C783	5B	CR777	4B	L893	4G
C787	4C	CR862	4F	L895	4G
C791	4D	CR863	4E	L897	4G
C795	4B	CR864	4E		
C795	4B	CR875	4G	LR885	3E
C801	4B	CR878	4E		
C806	5C	CR883	4F	P782	1G
C808	4D	CR886	3G	P783	1H
C809	4E	CR891	3G	P789	4G
C837	1D	CR893	3G	P790	4F
C838	2C	CR897	4G		
C842	2C			Q712	2F
C852	2D	J702	2A	Q718	2G
C862	3D	J704	3A	Q722	2G
C878	3E			Q732	2F
C885	4E	L762	2B	Q742	1E
C891	4G	L763	2A	Q748	1A
C893	4G	L764	2A	Q752	1E

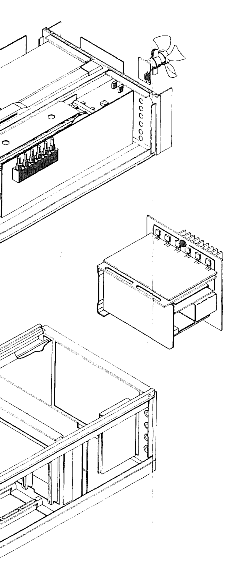


Locator for Figure 8-12A.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C705	2A	Q864	5E	R824	1D
C730	2F	Q872	5E	R825	2D
C751	1D	Q873	5F	R830	3C
C762	3A	Q878	4E	R831	2C
C780	3B	Q884	3F	R832	1C
C782	4A	Q892	2G	R835*	1D
C783	5B			R836	1C
C787	4C	R700	2G	R837	2C
C791	4D	R701	1F	R838	2C
C795	4B	R702	1G	R847	4D
C801	4B	R703	1G	R848	3D
C806	5C	R704	2G	R849	4D
C808	4D	R705	3A	R850	3D
C809	4E	R711	2G	R854	4D
C837*	1D	R712	2G	R855	4D
C838	2C	R714	1E	R856	3C
C852	2D	R718	2G	R857	3D
C862	3D	R722	2G	R860	4F
C878	3E	R730	2F	R861	5G
C885	4E	R731	1E	R862	2E
C891	4G	R732	2F	R863	4E
C893	4G	R733	1E	R864	5E
C895	4G	R740	1F	R865	4E
C897	4G	R742	1E	R866	1G
CR711	2G	R743	1D	R870	4E
CR712	2G	R744	2B	R871	5E
CR767	4B	R747	1B	R872	5F
CR777	4B	R748	1A	R873	3F
CR862	4F	R749	1A	R874	3F
CR863	4E	R750	2E	R875	3G
CR864	4E	R751	2D	R876	3G
CR875	4G	R752	1E	R877	3G
CR878	4E	R753	1D	R878	4E
CR883	4F	R754	1B	R881	4F
CR886	3G	R757	1B	R882	4F
CR891	3G	R758	1B	R883	3F
CR893	3G	R759	1B	R884	4F
CR897	4G	R761	2A	R886	3G
		R762	2A	R887	3G
J702	2A	R763	2A	R888	3G
J704	3A	R764	1A	R891	2G
		R765	4A	R892	3G
L762	2B	R767	4B	R893	3H
L763	2A	R772	3A	R894	3G
L764	2A	R773	3A	RT813	1C
L772	3B	R774	4A	TP700	2B
L773	3A	R775	4A	TP712	1E
L774	3A	R777	3B	TP782	4A
L857	2D	R780	5D	TP800	3G
L891	4G	R781	4A	TP824	2D
L893	4G	R782	4A	TP849	3C
L895	4G	R785	4B	TP876	3F
L897	4G	R786	4D	TP878	3E
		R787	4B	TP884	4E
LR885	3E	R788	4B	TP891	4H
		R789	5D	TP893	4H
P782	1G	R791	4C	TP894	3G
P783	1H	R792	4B	TP895	4H
P789	4G	R793	4D	TP897	4H
P790	4F	R795	4C	TP899	4H
		R796	4B		
Q712	2F	R797	4D	U705	2G
Q718	2G	R801	4D	U762	2B
Q722	2G	R802	4B	U782	4A
Q732	2F	R803	4D	U808	4D
Q742	1E	R804	5D	U842	2C
Q748	1A	R805	5B	U862	3E
Q752	1E	R806	4C	U876	3G
Q758	1A	R808	4D		
Q814	1C	R814	1C	VR852	2D
Q824	1D	R815	2C	VR862	3D
Q850	3D	R821	1C	VR878	4E
Q862	4F	R823	1D		

below).

AL
ER
diag.



*See Parts List for serial number ranges.

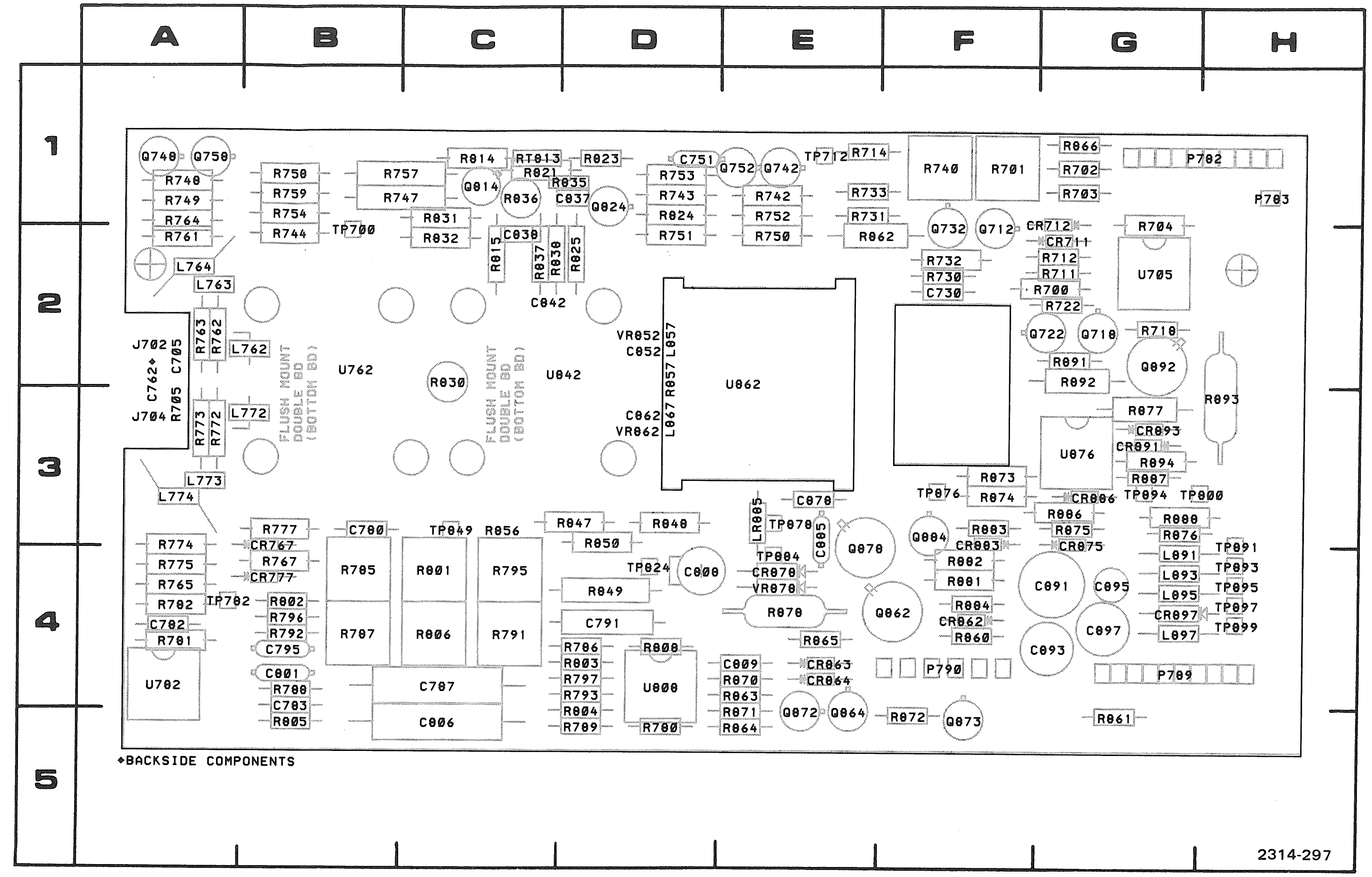


Figure 8-12C. A17—Vertical Amplifier circuit board assembly (SN B020955 & up).

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C705	2A	C895	4G	L772	3B	Q758	1A	R732	2F	R773	3A	R808	4D	R863	4E			U808	4D
C730	2F	C897	4G	L773	3A	Q814	1C	R733	1E	R774	4A	R813	1D	R864	5E			U842	2C
C751	1D			L774	3A	Q824	1D	R740	1F	R775	4A	R814	1C	R865	4E	RT813	1C	U862	3E
C762	3A	CR711	2G	L857	2D	Q862	4F	R742	1E	R777	3B	R815	2C	R866	1G			U876	3G
C780	3B	CR712	2G	L867	3D	Q864	5E	R743	1D	R780	5D	R821	1C	R870	4E	TP700	2B		
C782	4A	CR767	4B	L891	4G	Q872	5E	R744	2B	R781	4A	R823	1D	R871	5E	TP712	1E	VR852	2D
C783	5B	CR777	4B	L893	4G	Q873	5F	R747	1B	R782	4A	R824	1D	R872	5F	TP782	4A	VR862	3D
C787	4C	CR862	4F	L895	4G	Q878	4E	R748	1A	R785	4B	R825	2D	R873	3F	TP800	3G	VR878	4E
C791	4D	CR863	4E	L897	4G	Q884	3F	R749	1A	R786	4D	R830	3C	R874	3F	TP824	4D		
C795	4B	CR864	4E			Q892	2G	R750	2E	R787	4B	R831	1C	R875	3G	TP849	3C		
C795	4B	CR875	4G	LR885	3E			R751	2D	R788	4B	R832	2C	R876	3G	TP876	3F		
C801	4B	CR878	4E			R700	2G	R752	1E	R789	5D	R835	1D	R877	3G	TP878	3E		
C806	5C	CR883	4F	P782	1G	R701	1F	R753	1D	R791	4C	R836	1C	R878	4E	TP884	4E		
C808	4D	CR886	3G	P783	1H	R702	1G	R754	1B	R792	4B	R837	2C	R881	4F	TP891	4H		
C809	4E	CR891	3G	P789	4G	R703	1G	R757	1B	R793	4D	R838	2C	R882	4F	TP893	4H		
C837	1D	CR893	3G	P790	4F	R704	2G	R758	1B	R795	4C	R847	3D	R883	3F	TP894	3G		
C838	2C	CR897	4G			R705	3A	R759	1B	R796	4B	R848	3D	R884	4F	TP895	4H		
C842	2C			Q712	2F	R711	2G	R761	2A	R797	4D	R849	4D	R886	3G	TP897	4H		
C852	2D	J702	2A	Q718	2G	R712	2G	R762	2A	R801	4D	R850	3D	R887	3G	TP899	4H		
C862	3D	J704	3A	Q722	2G	R714	1E	R763	2A	R802	4B	R856	3C	R888	3G				
C878	3E			Q732	2F	R718	2G	R764	1A	R803	4D	R857	3D	R891	2G	U705	2G		
C885	4E	L762	2B	Q742	1E	R722	2G	R765	4A	R804	5D	R860	4F	R892	3G	U762	2B		
C891	4G	L763	2A	Q748	1A	R730	2F	R767	4B	R805	5B	R861	5G	R893	3H	U782	4A		
C893	4G	L764	2A	Q752	1E	R731	1E	R772	3A	R806	4C	R862	2E	R894	3G				

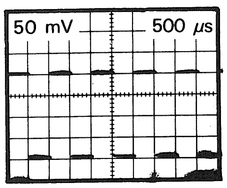
VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY controls fully counterclockwise; VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B; CALIBRATOR, 4V.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with a readout-equipped 7000-series Oscilloscope).

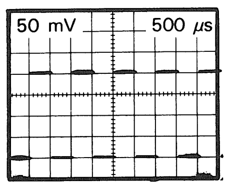
Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 1 MΩ input impedance and at least 60 MHz bandwidth. (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with a 10X probe.) A 7B-series vertical amplifier plug-in was installed in the 7104 LEFT VERT compartment and a 7B-series time base plug-in in the 7104 B HORIZ compartment. The vertical amplifier was set for a 6 to 8 division 7104 display with the CALIBRATOR output fed to the vertical amplifier input. The oscilloscope time base was externally triggered with the CALIBRATOR signal.

1



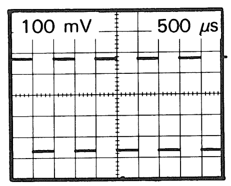
8.2 V

2



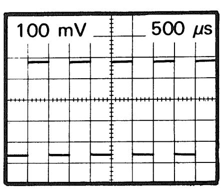
8.2 V

3



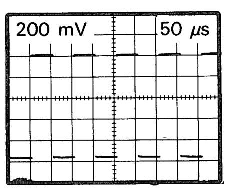
23.8 V

4



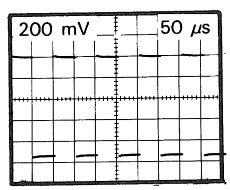
23.6 V

5

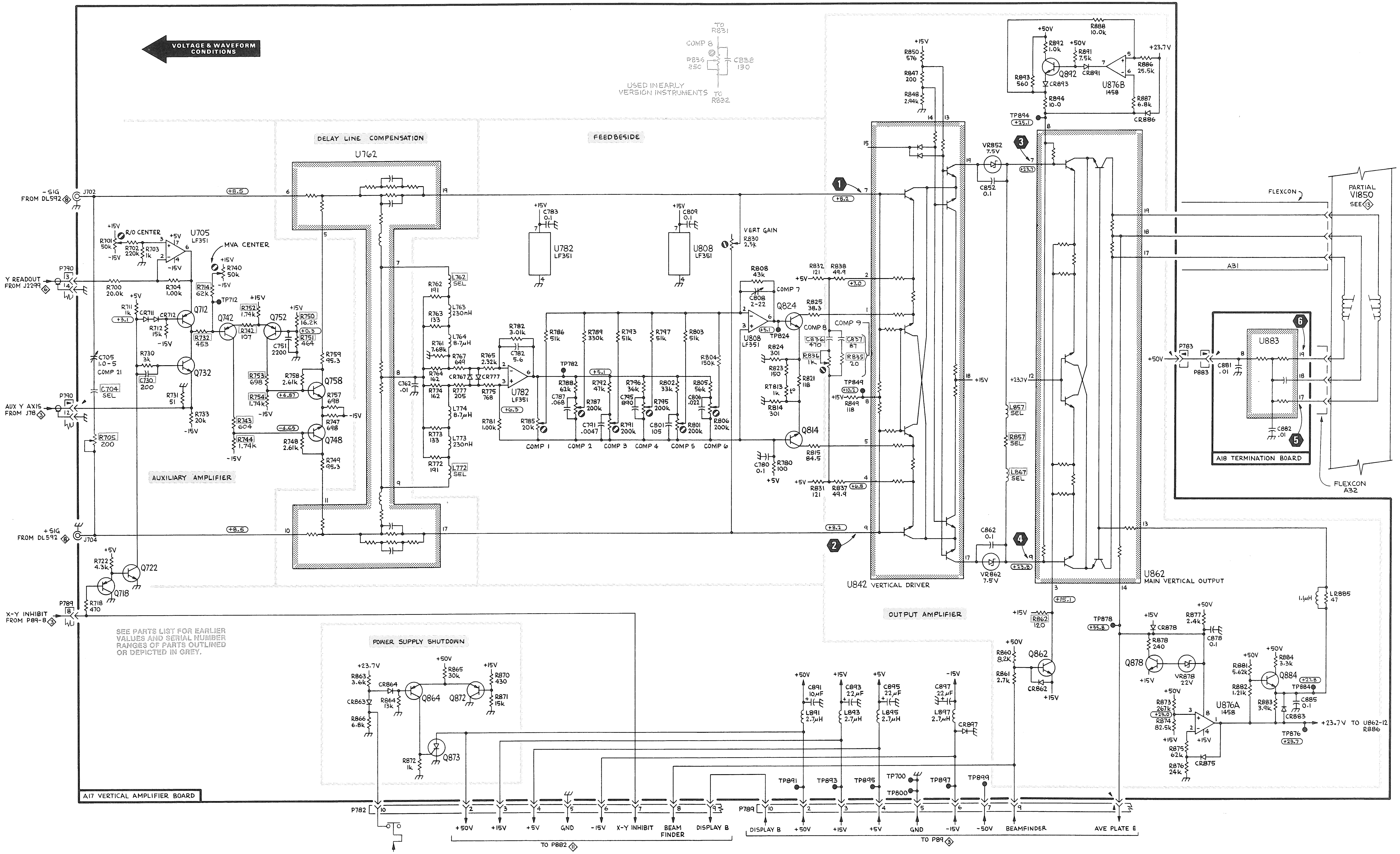


35.9 V

6



36.3 V


VOLTAGE & WAVEFORM CONDITIONS
USED IN EARLY VERSION INSTRUMENTS
DELAY LINE COMPENSATION
U762
FEEDBESIDE
-SIG FROM DL592
+SIG FROM DL592
Y READOUT FROM J2299
AUX Y AXIS FROM J78
X-Y INHIBIT FROM P89-8
R/O CENTER
MVA CENTER
U705 LF351
U782 LF351
U808 LF351
VERT GAIN
AUXILIARY AMPLIFIER
COMP 1
COMP 2
COMP 3
COMP 4
COMP 5
COMP 6
COMP 7
COMP 8
COMP 9
U842 VERTICAL DRIVER
U862 MAIN VERTICAL OUTPUT
OUTPUT AMPLIFIER
U876B 1458
U876A 1458
FLEXCON
PARTIAL V1850
A31
U883
A18 TERMINATION BOARD
FLEXCON A32
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.
POWER SUPPLY SHUTDOWN
A17 VERTICAL AMPLIFIER BOARD
+23.7V TO U862-12 R886
P782
P789
+50V
+15V
+5V
GND
-15V
X-Y INHIBIT
BEAM FINDER
DISPLAY B
-50V
BEAMFINDER
AVE PLATE E
TO P882
TO P89
FAULT FROM P882-10

ASSEMBLY A19

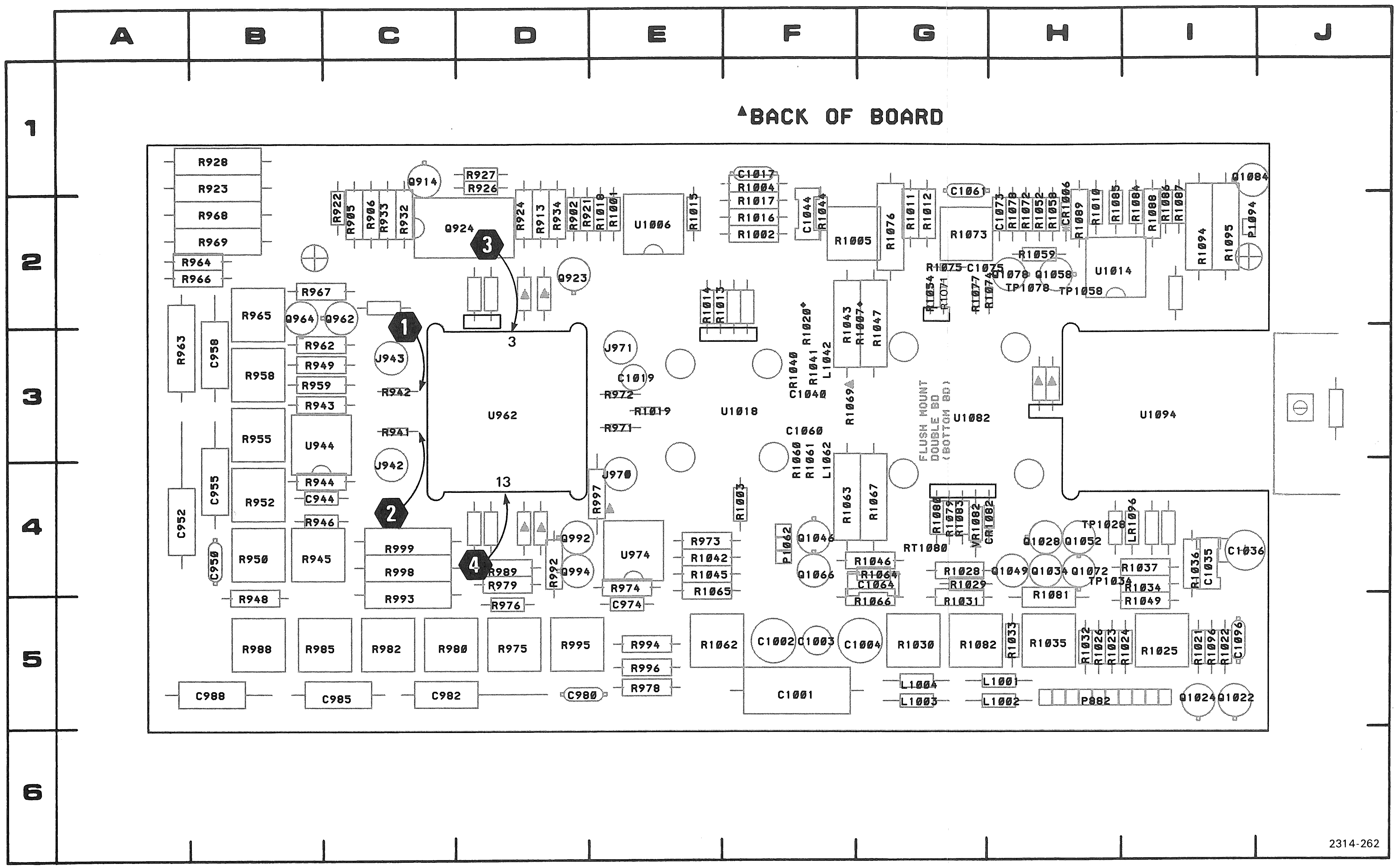


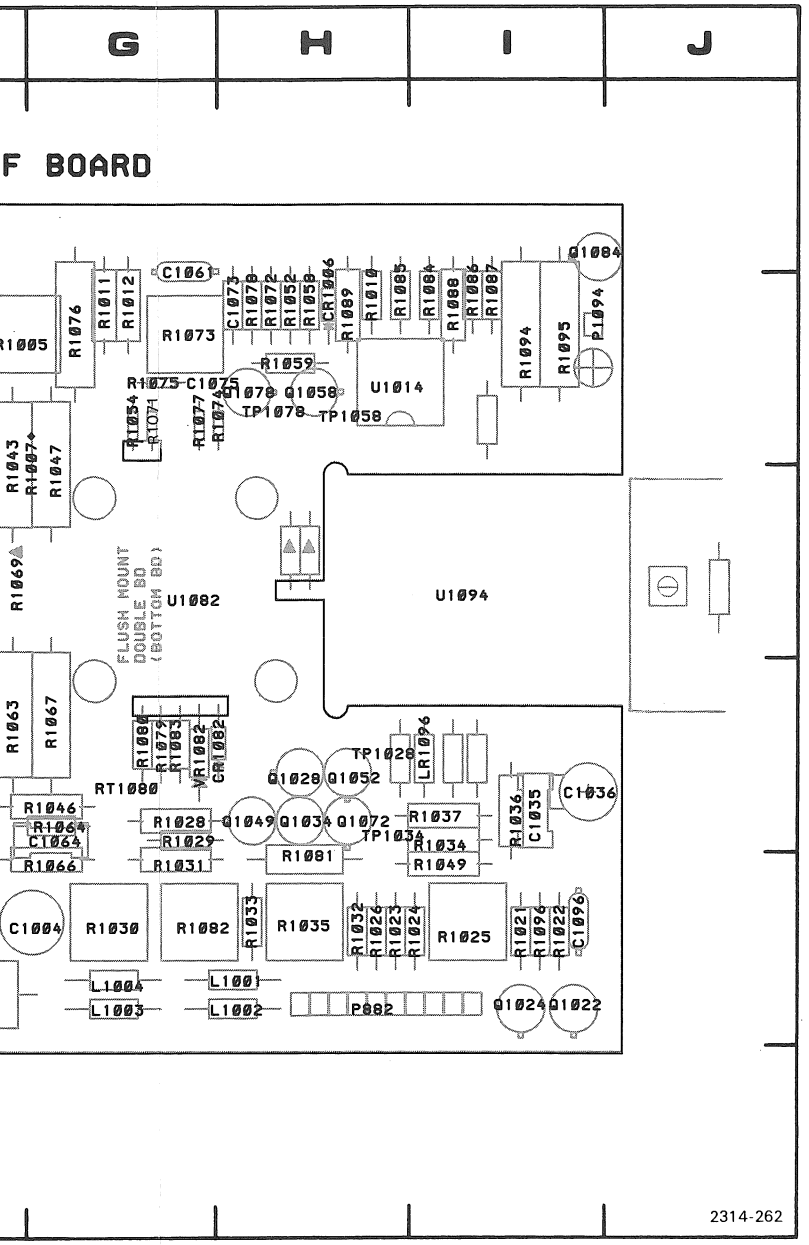
Figure 8-13. A19 Horizontal Amplifier circuit board assembly.

Locator for Figure 8-13.

CKT NO	GRID COORD
C944	4B
C950	4B
C952	4A
C955	4B
C958	3B
C974	5E
C980	5D
C982	5C
C985	5C
C988	5B
C1001	5F
C1002	5F
C1003	5F
C1004	5G
C1017	1F
C1019	3E
C1035	4I
C1036	4I
C1044	2F
C1060	3F
C1061	2G
C1064	4G
C1073	2H
C1075	2G
C1096	5I
CR1006	2H
CR1082	4G
J942	4C
J943	3C
J970	4E
J971	3E
L1001	5H
L1002	5H
L1003	5G
L1004	5G
L1042	3F
L1062	4F
LR1096	4I
P882	5H
P1062	4F
P1094	1I
Q914	1C
Q923	2D
Q924	2D
Q964	2B
Q992	4D
Q994	4D
Q1022	5I
Q1024	5I
Q1028	4H
Q1034	4H
Q1046	4F
Q1049	4H
Q1052	4H
Q1058	2H
Q1066	4F
Q1072	4H
Q1078	2H
Q1084	1I
R902	2D
R905	2C
R906	2C
R913	2D
R921	2D
R922	2C

CKT NO	GRID COORD
R923	1B
R924	2D
R926	1D
R927	1D
R928	1B
R932	2C
R933	2C
R934	2D
R941	3C
R942	3C
R944	4B
R945	4B
R946	4B
R948	5B
R949	3B
R950	4B
R952	4B
R955	3B
R958	3B
R959	3B
R962	3B
R963	3A
R964	2B
R965	2B
R966	2B
R967	2B
R968	2B
R969	2B
R971	3E
R972	3E
R973	4E
R974	4E
R975	5D
R976	5D
R978	5E
R979	4D
R980	5C
R982	5C
R985	5B
R988	5B
R989	4D
R992	4D
R993	5C
R994	5E
R995	5D
R996	5E
R997	4E
R998	4C
R999	4C
R1001	2E
R1002	2F
R1003	4F
R1004	1F
R1005	2F
R1007	2G
R1010	2H
R1011	2G
R1013	2E
R1014	2E
R1015	2E
R1016	2F
R1017	2F
R1018	2E
R1019	3E
R1020	3F
R1021	5I
R1022	5I
R1023	5H
R1024	5I
R1025	5I
R1026	5H
R1028	4G

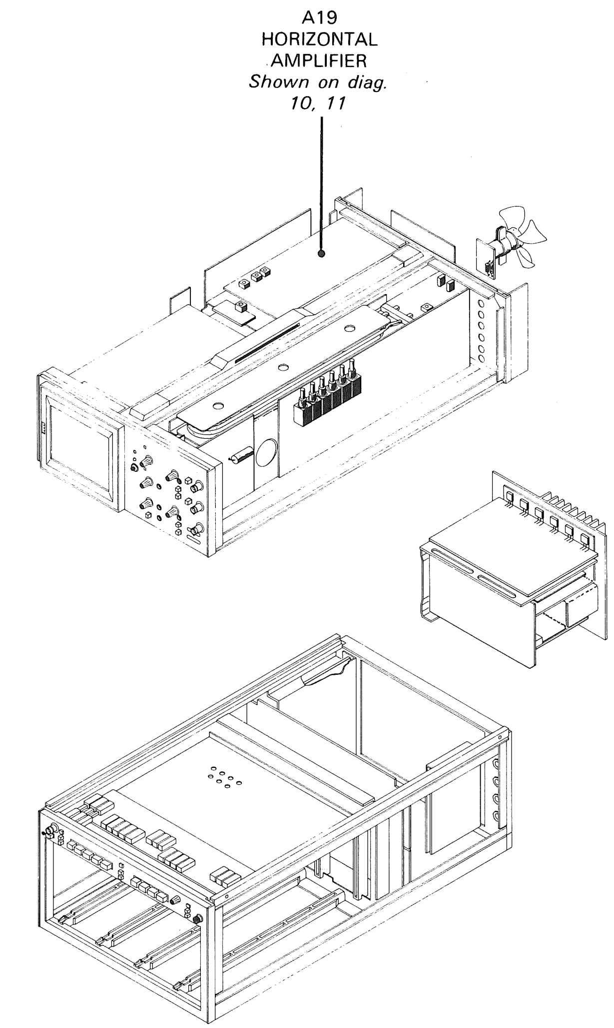
CKT NO	GRID COORD
R1029	4G
R1030	5G
R1031	5G
R1032	5H
R1033	5H
R1034	4I
R1035	5H
R1036	4I
R1037	4I
R1040	3F
R1041	3F
R1042	4E
R1043	3F
R1044	2F
R1045	4E
R1046	4G
R1047	2G
R1049	5I
R1052	2H
R1054	2G
R1058	2H
R1059	2H
R1060	4F
R1061	4F
R1062	5E
R1063	4F
R1064	4G
R1065	4E
R1066	5G
R1067	4G
R1069	3F
R1071	2G
R1072	2H
R1073	2G
R1074	2G
R1075	2G
R1076	2G
R1077	2G
R1078	2H
R1079	4G
R1080	4G
R1081	5H
R1082	5G
R1083	4G
R1084	1I
R1085	2H
R1086	1I
R1087	1I
R1088	1I
R1089	2H
R1094	1I
R1095	1I
R1096	5I
RT1080	4G
TP1028	4H
TP1034	4H
TP1058	2H
TP1078	2H
U944	3B
U962	3D
U974	4E
U1006	2E
U1014	2H
U1018	3F
U1082	3G
U1094	3I
VR1082	4G



l assembly.

Locator for Figure 8-13.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C944	4B	R923	1B	R1029	4G
C950	4B	R924	2D	R1030	5G
C952	4A	R926	1D	R1031	5G
C955	4B	R927	1D	R1032	5H
C958	3B	R928	1B	R1033	5H
C974	5E	R932	2C	R1034	4I
C980	5D	R933	2C	R1035	5H
C982	5C	R934	2D	R1036	4I
C985	5C	R941	3C	R1037	4I
C988	5B	R942	3C	R1040	3F
C1001	5F	R944	4B	R1041	3F
C1002	5F	R945	4B	R1042	4E
C1003	5F	R946	4B	R1043	3F
C1004	5G	R948	5B	R1044	2F
C1017	1F	R949	3B	R1045	4E
C1019	3E	R950	4B	R1046	4G
C1035	4I	R952	4B	R1047	2G
C1036	4I	R955	3B	R1049	5I
C1044	2F	R958	3B	R1052	2H
C1060	3F	R959	3B	R1054	2G
C1061	2G	R962	3B	R1058	2H
C1064	4G	R963	3A	R1059	2H
C1073	2H	R964	2B	R1060	4F
C1075	2G	R965	2B	R1061	4F
C1096	5I	R966	2B	R1062	5E
		R967	2B	R1063	4F
CR1006	2H	R968	2B	R1064	4G
CR1082	4G	R969	2B	R1065	4E
		R971	3E	R1066	5G
J942	4C	R972	3E	R1067	4G
J943	3C	R973	4E	R1069	3F
J970	4E	R974	4E	R1071	2G
J971	3E	R975	5D	R1072	2H
		R976	5D	R1073	2G
L1001	5H	R978	5E	R1074	2G
L1002	5H	R979	4D	R1075	2G
L1003	5G	R980	5C	R1076	2G
L1004	5G	R982	5C	R1077	2G
L1042	3F	R985	5B	R1078	2H
L1062	4F	R988	5B	R1079	4G
		R989	4D	R1080	4G
LR1096	4I	R992	4D	R1081	5H
		R993	5C	R1082	5G
P882	5H	R994	5E	R1083	4G
P1062	4F	R995	5D	R1084	1I
P1094	1I	R996	5E	R1085	2H
		R997	4E	R1086	1I
Q914	1C	R998	4C	R1087	1I
Q923	2D	R999	4C	R1088	1I
Q924	2D	R1001	2E	R1089	2H
Q964	2B	R1002	2F	R1094	1I
Q992	4D	R1003	4F	R1095	1I
Q994	4D	R1004	1F	R1096	5I
Q1022	5I	R1005	2F		
Q1024	5I	R1007	2G	RT1080	4G
Q1028	4H	R1010	2H		
Q1034	4H	R1011	2G	TP1028	4H
Q1046	4F	R1013	2E	TP1034	4H
Q1049	4H	R1014	2E	TP1058	2H
Q1052	4H	R1015	2E	TP1078	2H
Q1058	2H	R1016	2F		
Q1066	4F	R1017	2F	U944	3B
Q1072	4H	R1018	2E	U962	3D
Q1078	2H	R1019	3E	U974	4E
Q1084	1I	R1020	3F	U1006	2E
		R1021	5I	U1014	2H
R902	2D	R1022	5I	U1018	3F
R905	2C	R1023	5H	U1082	3G
R906	2C	R1024	5I	U1094	3I
R913	2D	R1025	5I		
R921	2D	R1026	5H	VR1082	4G
R922	2C	R1028	4G		



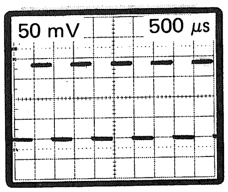
VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY controls fully counterclockwise; VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B; Vertical plug-in installed in B compartment at 1 V/Div, position control at midrange; CALIBRATOR 4 V to input.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with a readout-equipped 7000-series Oscilloscope).

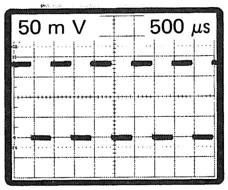
Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 1 MΩ input impedance and at least 60 MHz bandwidth. (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with a 10X probe.) A 7A-series vertical amplifier plug-in was installed in the 7104 B HORIZ compartment and the CALIBRATOR output was connected to the vertical amplifier input. The B INTENSITY control and vertical amplifier was set to display 6 to 8 horizontal divisions on the 7104. The test oscilloscope was externally triggered on the +Slope of the CALIBRATOR signal.

1



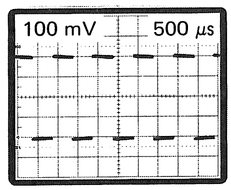
0 V

2



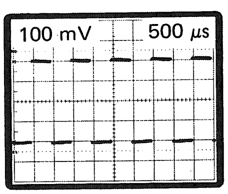
0 V

3

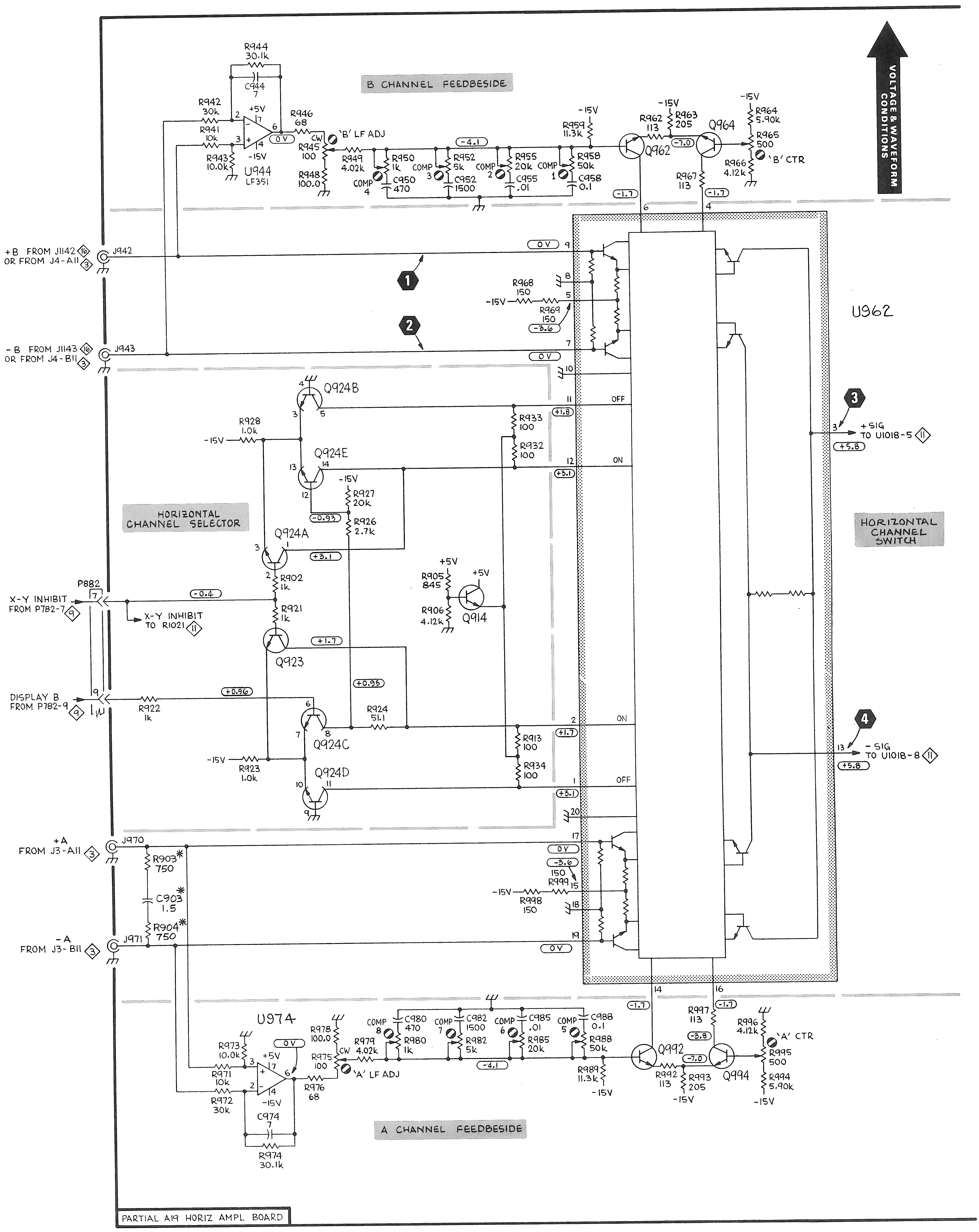


5.8 V

4



5.8 V



✱ SELECTABLE, FOR OPTION 2 ONLY
NOMINALLY THESE PARTS ARE NOT USED.

2314-290
REV NOV 1981

HORIZONTAL CHANNEL SWITCH ⟨10⟩

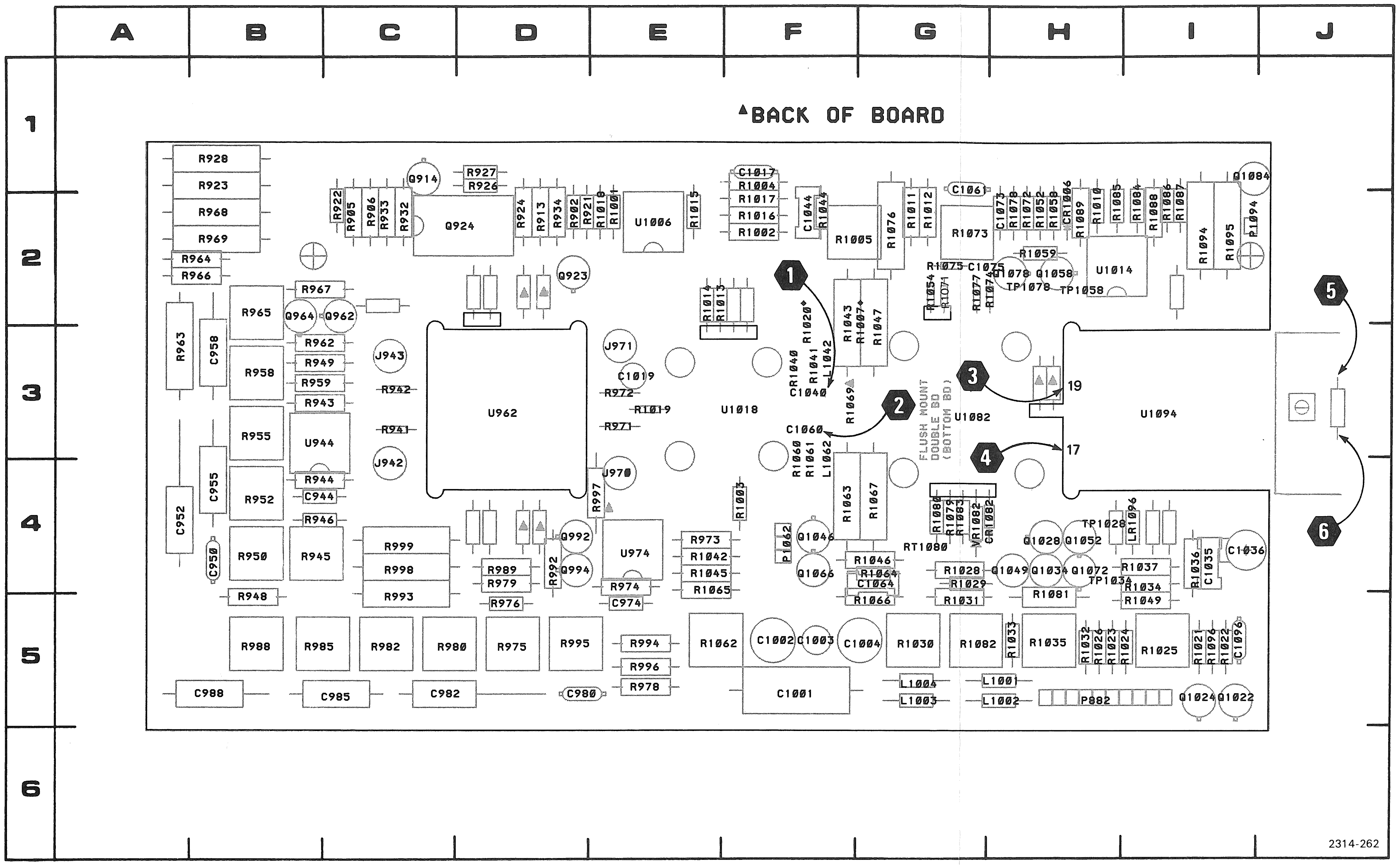


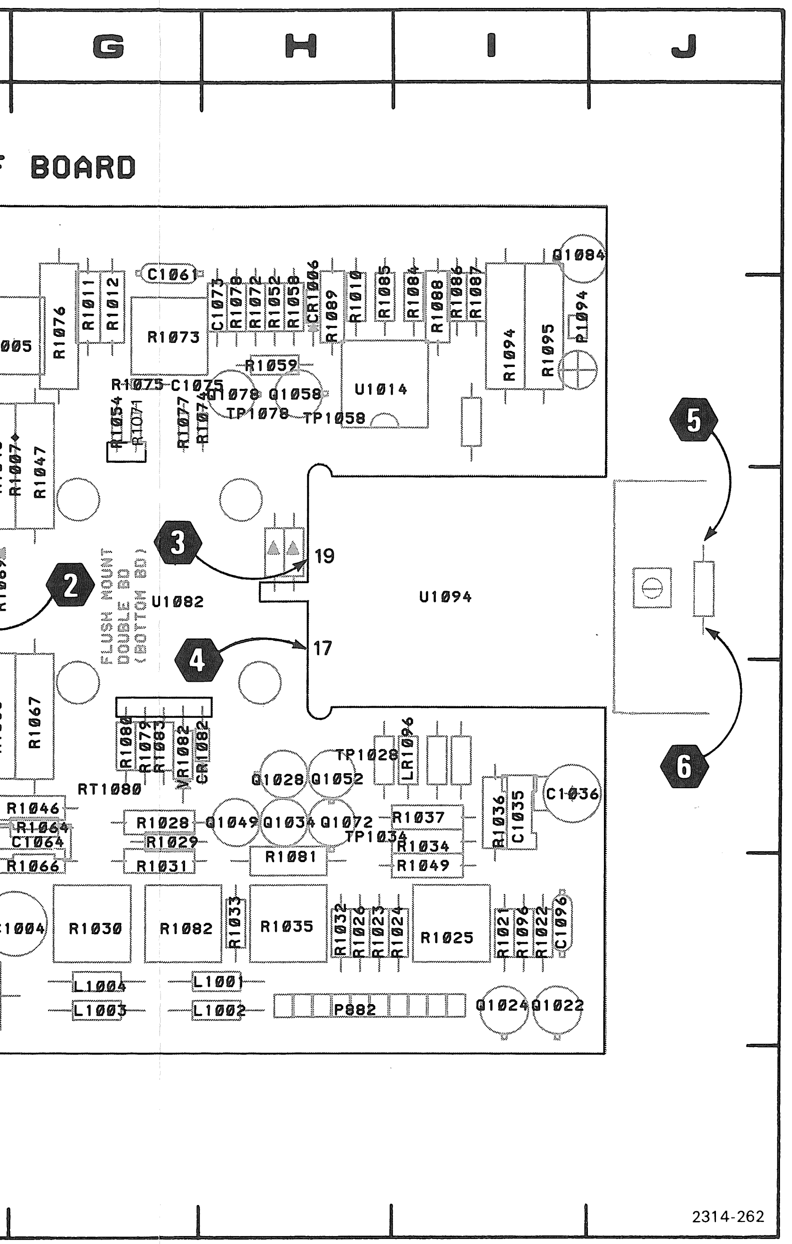
Figure 8-14. A19—Horizontal Amplifier circuit board assembly.

Locator for Figure 8-14.

CKT NO	GRID COORD
C944	4B
C950	4B
C952	4A
C955	4B
C958	3B
C974	5E
C980	5D
C982	5C
C985	5C
C988	5B
C1001	5F
C1002	5F
C1003	5F
C1004	5G
C1017	1F
C1019	3E
C1035	4I
C1036	4I
C1044	2F
C1060	3F
C1061	2G
C1064	4G
C1073	2H
C1075	2G
C1096	5I
CR1006	2H
CR1082	4G
J942	4C
J943	3C
J970	4E
J971	3E
L1001	5H
L1002	5H
L1003	5G
L1004	5G
L1042	3F
L1062	4F
LR1096	4I
P882	5H
P1062	4F
P1094	1I
Q914	1C
Q923	2D
Q924	2D
Q964	2B
Q992	4D
Q994	4D
Q1022	5I
Q1024	5I
Q1028	4H
Q1034	4H
Q1046	4F
Q1049	4H
Q1052	4H
Q1058	2H
Q1066	4F
Q1072	4H
Q1078	2H
Q1084	1I
R902	2D
R905	2C
R906	2C
R913	2D
R921	2D
R922	2C

CKT NO	GRID COORD
R923	1B
R924	2D
R926	1D
R927	1D
R928	1B
R932	2C
R933	2C
R934	2D
R941	3C
R942	3C
R944	4B
R945	4B
R946	4B
R948	5B
R949	3B
R950	4B
R952	4B
R955	3B
R958	3B
R959	3B
R962	3B
R963	3A
R964	2B
R965	2B
R966	2B
R967	2B
R968	2B
R969	2B
R971	3E
R972	3E
R973	4E
R974	4E
R975	5D
R976	5D
R978	5E
R979	4D
R980	5C
R982	5C
R985	5B
R988	5B
R989	4D
R992	4D
R993	5C
R994	5E
R995	5D
R996	5E
R997	4E
R998	4C
R999	4C
R1001	2E
R1002	2F
R1003	4F
R1004	1F
R1005	2F
R1007	2G
R1010	2H
R1011	2G
R1013	2E
R1014	2E
R1015	2E
R1016	2F
R1017	2F
R1018	2E
R1019	3E
R1020	3F
R1021	5I
R1022	5I
R1023	5H
R1024	5I
R1025	5I
R1026	5H
R1028	4G

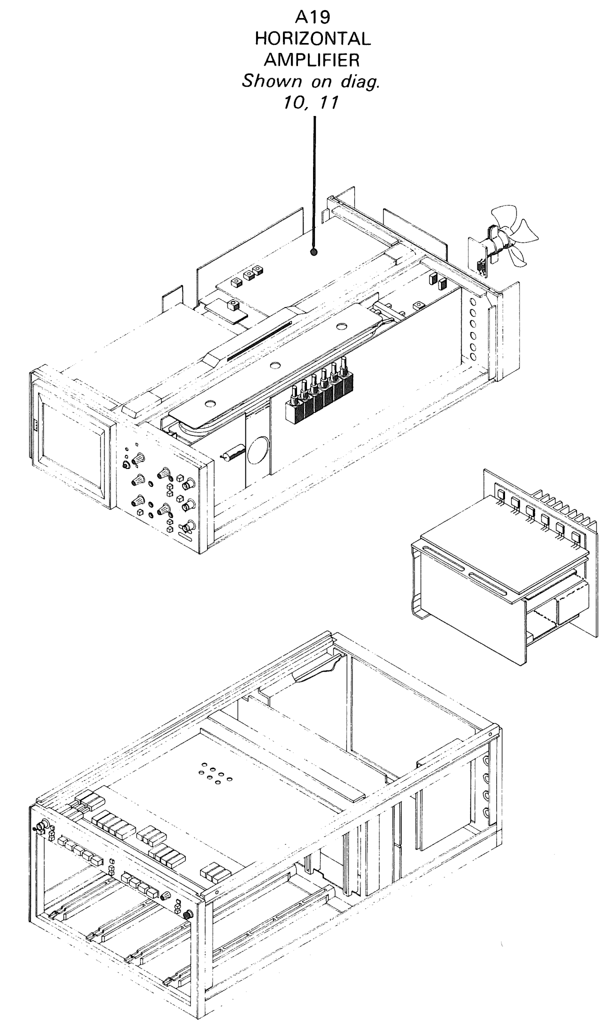
CKT NO	GRID COORD
R1029	4G
R1030	5G
R1031	5G
R1032	5H
R1033	5H
R1034	4I
R1035	5H
R1036	4I
R1037	4I
R1040	3F
R1041	3F
R1042	4E
R1043	3F
R1044	2F
R1045	4E
R1046	4G
R1047	2G
R1049	5I
R1052	2H
R1054	2G
R1058	2H
R1059	2H
R1060	4F
R1061	4F
R1062	5E
R1063	4F
R1064	4G
R1065	4E
R1066	5G
R1067	4G
R1069	3F
R1071	2G
R1072	2H
R1073	2G
R1074	2G
R1075	2G
R1076	2G
R1077	2G
R1078	2H
R1079	4G
R1080	4G
R1081	5H
R1082	5G
R1083	4G
R1084	1I
R1085	2H
R1086	1I
R1087	1I
R1088	1I
R1089	2H
R1094	1I
R1095	1I
R1096	5I
RT1080	4G
TP1028	4H
TP1034	4H
TP1058	2H
TP1078	2H
U944	3B
U962	3D
U974	4E
U1006	2E
U1014	2H
U1018	3F
U1082	3G
U1094	3I
VR1082	4G



rd assembly.

Locator for Figure 8-14.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C944	4B	R923	1B	R1029	4G
C950	4B	R924	2D	R1030	5G
C952	4A	R926	1D	R1031	5G
C955	4B	R927	1D	R1032	5H
C958	3B	R928	1B	R1033	5H
C974	5E	R932	2C	R1034	4I
C980	5D	R933	2C	R1035	5H
C982	5C	R934	2D	R1036	4I
C985	5C	R941	3C	R1037	4I
C988	5B	R942	3C	R1040	3F
C1001	5F	R944	4B	R1041	3F
C1002	5F	R945	4B	R1042	4E
C1003	5F	R946	4B	R1043	3F
C1004	5G	R948	5B	R1044	2F
C1017	1F	R949	3B	R1045	4E
C1019	3E	R950	4B	R1046	4G
C1035	4I	R952	4B	R1047	2G
C1036	4I	R955	3B	R1049	5I
C1044	2F	R958	3B	R1052	2H
C1060	3F	R959	3B	R1054	2G
C1061	2G	R962	3B	R1058	2H
C1064	4G	R963	3A	R1059	2H
C1073	2H	R964	2B	R1060	4F
C1075	2G	R965	2B	R1061	4F
C1096	5I	R966	2B	R1062	5E
		R967	2B	R1063	4F
CR1006	2H	R968	2B	R1064	4G
CR1082	4G	R969	2B	R1065	4E
		R971	3E	R1066	5G
J942	4C	R972	3E	R1067	4G
J943	3C	R973	4E	R1069	3F
J970	4E	R974	4E	R1071	2G
J971	3E	R975	5D	R1072	2H
		R976	5D	R1073	2G
L1001	5H	R978	5E	R1074	2G
L1002	5H	R979	4D	R1075	2G
L1003	5G	R980	5C	R1076	2G
L1004	5G	R982	5C	R1077	2G
L1042	3F	R985	5B	R1078	2H
L1062	4F	R988	5B	R1079	4G
		R989	4D	R1080	4G
LR1096	4I	R992	4D	R1081	5H
		R993	5C	R1082	5G
P882	5H	R994	5E	R1083	4G
P1062	4F	R995	5D	R1084	1I
P1094	1I	R996	5E	R1085	2H
		R997	4E	R1086	1I
Q914	1C	R998	4C	R1087	1I
Q923	2D	R999	4C	R1088	1I
Q924	2D	R1001	2E	R1089	2H
Q964	2B	R1002	2F	R1094	1I
Q992	4D	R1003	4F	R1095	1I
Q994	4D	R1004	1F	R1096	5I
Q1022	5I	R1005	2F		
Q1024	5I	R1007	2G	RT1080	4G
Q1028	4H	R1010	2H		
Q1034	4H	R1011	2G	TP1028	4H
Q1046	4F	R1013	2E	TP1034	4H
Q1049	4H	R1014	2E	TP1058	2H
Q1052	4H	R1015	2E	TP1078	2H
Q1058	2H	R1016	2F		
Q1066	4F	R1017	2F	U944	3B
Q1072	4H	R1018	2E	U962	3D
Q1078	2H	R1019	3E	U974	4E
Q1084	1I	R1020	3F	U1006	2E
		R1021	5I	U1014	2H
R902	2D	R1022	5I	U1018	3F
R905	2C	R1023	5H	U1082	3G
R906	2C	R1024	5I	U1094	3I
R913	2D	R1025	5I		
R921	2D	R1026	5H	VR1082	4G
R922	2C	R1028	4G		



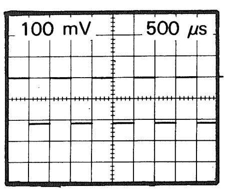
VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY controls fully counterclockwise; VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B; CALIBRATOR, 4V. Vertical plug-in in B compartment at 1 V/Div, position control at midrange; CALIBRATOR 4 V to input.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with a readout-equipped 7000-series Oscilloscope).

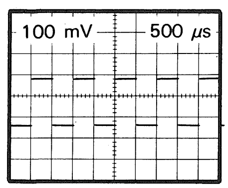
Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 1 MΩ input impedance and at least 60 MHz bandwidth (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with a 10X probe). A 7A-series vertical amplifier plug-in was installed in the 7104 B HORIZ compartment and the CALIBRATOR output was connected to the vertical amplifier input. The B INTENSITY control and vertical amplifier was set to display 6 to 8 horizontal divisions on the 7104. The test oscilloscope was externally triggered on the +Slope of the CALIBRATOR signal.

1



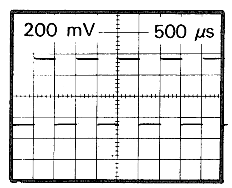
7.6 V

2



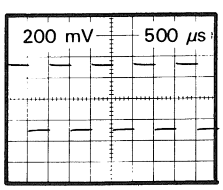
7.6 V

3



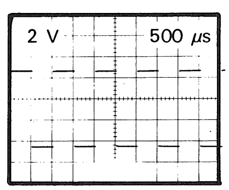
11 V

4



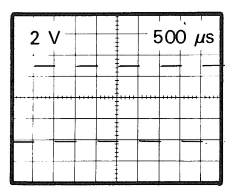
11 V

5

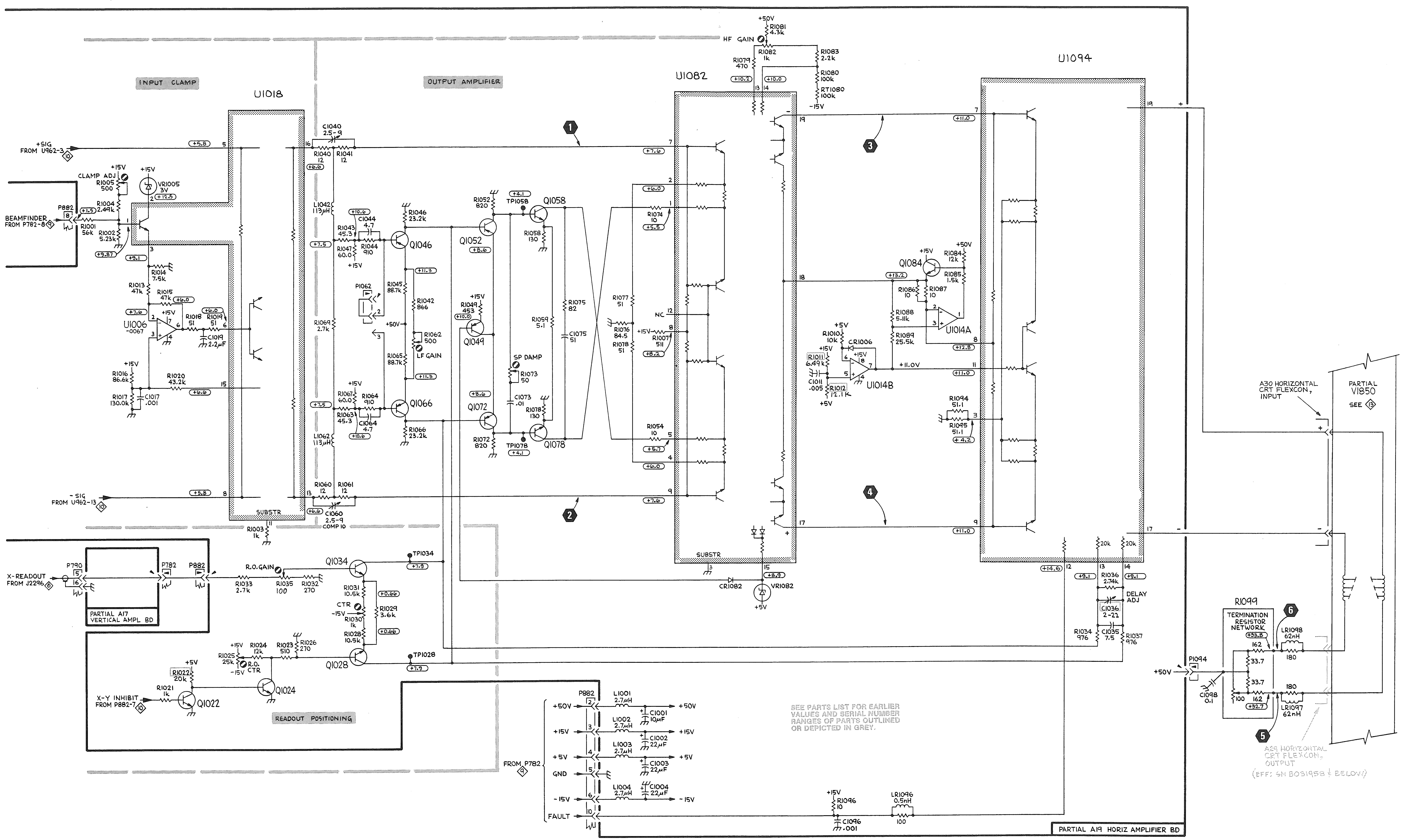


33.8 V

6



33.8 V



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HORIZONTAL AMPLIFIER 11

HORIZONTAL AMPLIFIER 11

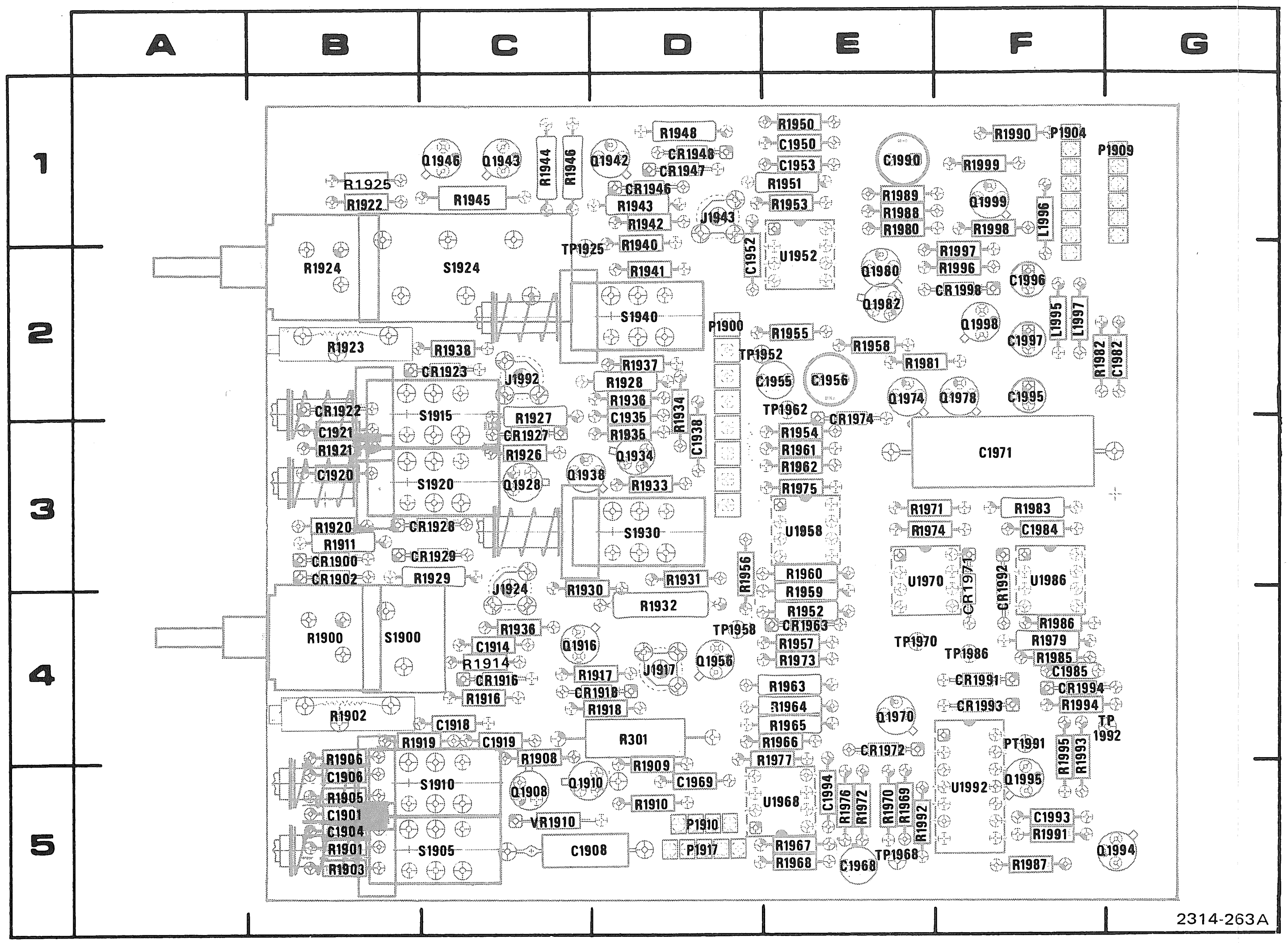


Figure 8-15. A1—Front Panel circuit board assembly.

Locator for Figure 8-15.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1901	5B	Q1910	5C	R1957	4E
C1904	5B	Q1916	4C	R1958	2E
C1906	5B	Q1928	3C	R1959	4E
C1908	5C	Q1934	3D	R1960	3E
C1914	4C	Q1938	3C	R1961	3E
C1915	4C	Q1942	1D	R1962	3E
C1918	4C	Q1943	1C	R1963	4E
C1919	4C	Q1946	1C	R1964	4E
C1920	3B	Q1956	4D	R1965	4E
C1921	3B	Q1970	4E	R1966	4E
C1935	2D	Q1974	2E	R1967	5E
C1938	3D	Q1978	2F	R1968	5E
C1950	1E	Q1980	2E	R1969	5E
C1952	2D	Q1982	2E	R1970	5E
C1953	1E	Q1994	5G	R1971	3E
C1955	2E	Q1995	5F	R1972	5E
C1956	2E	Q1998	2F	R1973	4E
C1968	5E	Q1999	1F	R1974	3E
C1969	5D			R1975	3E
C1971	3F	R301	4D	R1976	5E
C1982	2G	R1900	4B	R1977	4E
C1984	3F	R1901	5B	R1979	4F
C1985	4F	R1902	4B	R1980	1E
C1990	1E	R1903	5B	R1981	2E
C1993	5F	R1905	5B	R1982	2F
C1994	5E	R1906	4B	R1983	3F
C1995	2F	R1908	4C	R1985	4F
C1996	2F	R1909	5D	R1986	4F
C1997	2F	R1910	5D	R1987	5F
		R1911	3B	R1988	1E
CR1900	3B	R1914	4C	R1989	1E
CR1902	3B	R1915	4C	R1990	1F
CR1916	4C	R1916	4C	R1991	5F
CR1918	4D	R1917	4D	R1992	5E
CR1922	2B	R1918	4D	R1993	4F
CR1923	2C	R1919	4B	R1994	4F
CR1927	3C	R1920	3B	R1995	4F
CR1928	3C	R1921	3B	R1996	2F
CR1929	3C	R1922	1B	R1997	2F
CR1946	1D	R1923	2B	R1998	1F
CR1947	1D	R1924	2B	R1999	1F
CR1948	1D	R1925	1B		
CR1963	4E	R1926	3C	S1900	4B
CR1971	3F	R1927	3C	S1905	5C
CR1972	4E	R1928	2D	S1910	5C
CR1974	3E	R1929	3C	S1915	3C
CR1991	4F	R1930	3C	S1920	3C
CR1992	3F	R1931	3D	S1924	2C
CR1993	4F	R1932	4D	S1930	3D
CR1994	4F	R1933	3D	S1940	2D
CR1998	2F	R1934	3D		
		R1935	3D	TP1911	4F
J1917	4D	R1936	2D	TP1925	2C
J1924	3C	R1937	2D	TP1952	2D
J1943	1D	R1938	2C	TP1958	4D
J1992	2C	R1940	2D	TP1962	2E
		R1941	2D	TP1968	5E
L1995	2F	R1942	1D	TP1970	4E
L1996	1F	R1943	1D	TP1986	4F
L1997	2F	R1944	1C	TP1992	4F
		R1945	1C		
P1900	2D	R1946	1C	U1952	2E
P1904	1F	R1948	1D	U1958	3E
P1909	1G	R1950	1E	U1968	5E
P1910	5D	R1951	1E	U1970	3E
P1917	5D	R1952	4E	U1986	3F
		R1953	1E	U1992	5F
PT1991	4F	R1954	3E		
		R1955	2E	VR1910	5C
Q1908	5C	R1956	3D		

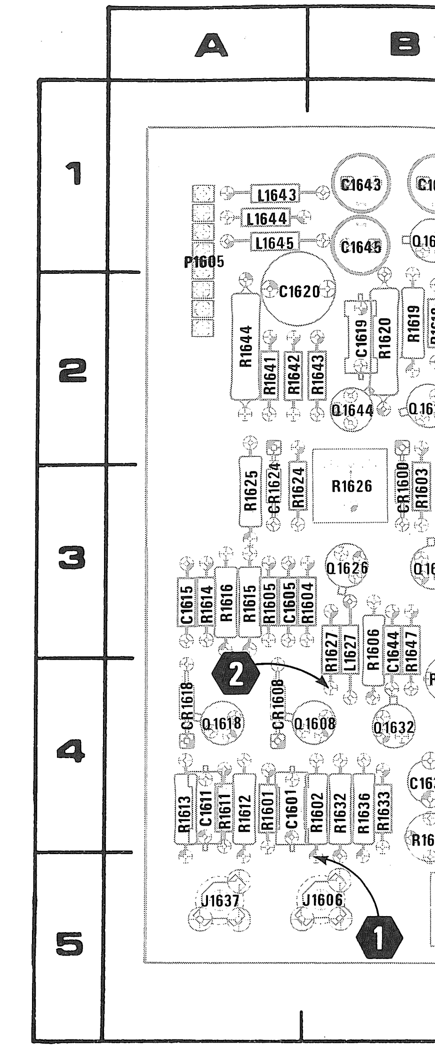
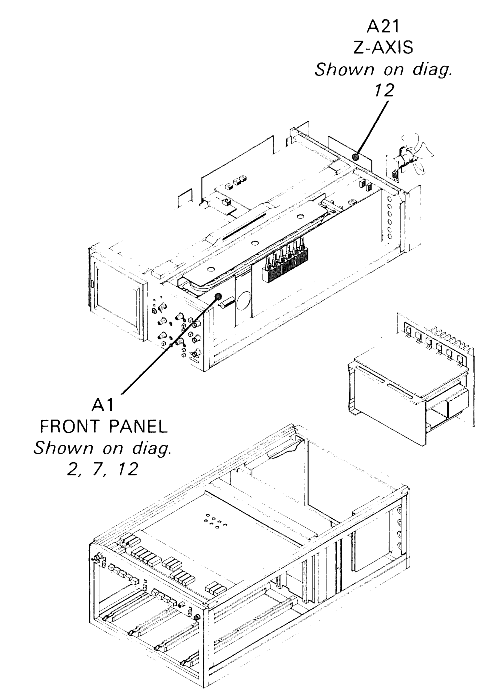
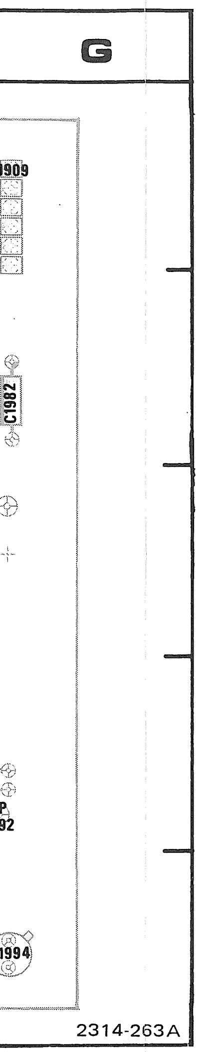


Figure 8-16. A





Locator for Figure 8-15.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1901	5B	Q1910	5C	R1957	4E
C1904	5B	Q1916	4C	R1958	2E
C1906	5B	Q1928	3C	R1959	4E
C1908	5C	Q1934	3D	R1960	3E
C1914	4C	Q1938	3C	R1961	3E
C1915	4C	Q1942	1D	R1962	3E
C1918	4C	Q1943	1C	R1963	4E
C1919	4C	Q1946	1C	R1964	4E
C1920	3B	Q1956	4D	R1965	4E
C1921	3B	Q1970	4E	R1966	4E
C1935	2D	Q1974	2E	R1967	5E
C1938	3D	Q1978	2F	R1968	5E
C1950	1E	Q1980	2E	R1969	5E
C1952	2D	Q1982	2E	R1970	5E
C1953	1E	Q1994	5G	R1971	3E
C1955	2E	Q1995	5F	R1972	5E
C1956	2E	Q1998	2F	R1973	4E
C1968	5E	Q1999	1F	R1974	3E
C1969	5D			R1975	3E
C1971	3F	R301	4D	R1976	5E
C1982	2G	R1900	4B	R1977	4E
C1984	3F	R1901	5B	R1979	4F
C1985	4F	R1902	4B	R1980	1E
C1990	1E	R1903	5B	R1981	2E
C1993	5F	R1905	5B	R1982	2F
C1994	5E	R1906	4B	R1983	3F
C1995	2F	R1908	4C	R1985	4F
C1996	2F	R1909	5D	R1986	4F
C1997	2F	R1910	5D	R1987	5F
		R1911	3B	R1988	1E
CR1900	3B	R1914	4C	R1989	1E
CR1902	3B	R1915	4C	R1990	1F
CR1916	4C	R1916	4C	R1991	5F
CR1918	4D	R1917	4D	R1992	5E
CR1922	2B	R1918	4D	R1993	4F
CR1923	2C	R1919	4B	R1994	4F
CR1927	3C	R1920	3B	R1995	4F
CR1928	3C	R1921	3B	R1996	2F
CR1929	3C	R1922	1B	R1997	2F
CR1946	1D	R1923	2B	R1998	1F
CR1947	1D	R1924	2B	R1999	1F
CR1948	1D	R1925	1B		
CR1963	4E	R1926	3C	S1900	4B
CR1971	3F	R1927	3C	S1905	5C
CR1972	4E	R1928	2D	S1910	5C
CR1974	3E	R1929	3C	S1915	3C
CR1991	4F	R1930	3C	S1920	3C
CR1992	3F	R1931	3D	S1924	2C
CR1993	4F	R1932	4D	S1930	3D
CR1994	4F	R1933	3D	S1940	2D
CR1998	2F	R1934	3D		
		R1935	3D	TP1911	4F
J1917	4D	R1936	2D	TP1925	2C
J1924	3C	R1937	2D	TP1952	2D
J1943	1D	R1938	2C	TP1958	4D
J1992	2C	R1940	2D	TP1962	2E
		R1941	2D	TP1968	5E
L1995	2F	R1942	1D	TP1970	4E
L1996	1F	R1943	1D	TP1986	4F
L1997	2F	R1944	1C	TP1992	4F
		R1945	1C		
P1900	2D	R1946	1C	U1952	2E
P1904	1F	R1948	1D	U1958	3E
P1909	1G	R1950	1E	U1968	5E
P1910	5D	R1951	1E	U1970	3E
P1917	5D	R1952	4E	U1986	3F
		R1953	1E	U1992	5F
PT1991	4F	R1954	3E		
		R1955	2E	VR1910	5C
Q1908	5C	R1956	3D		

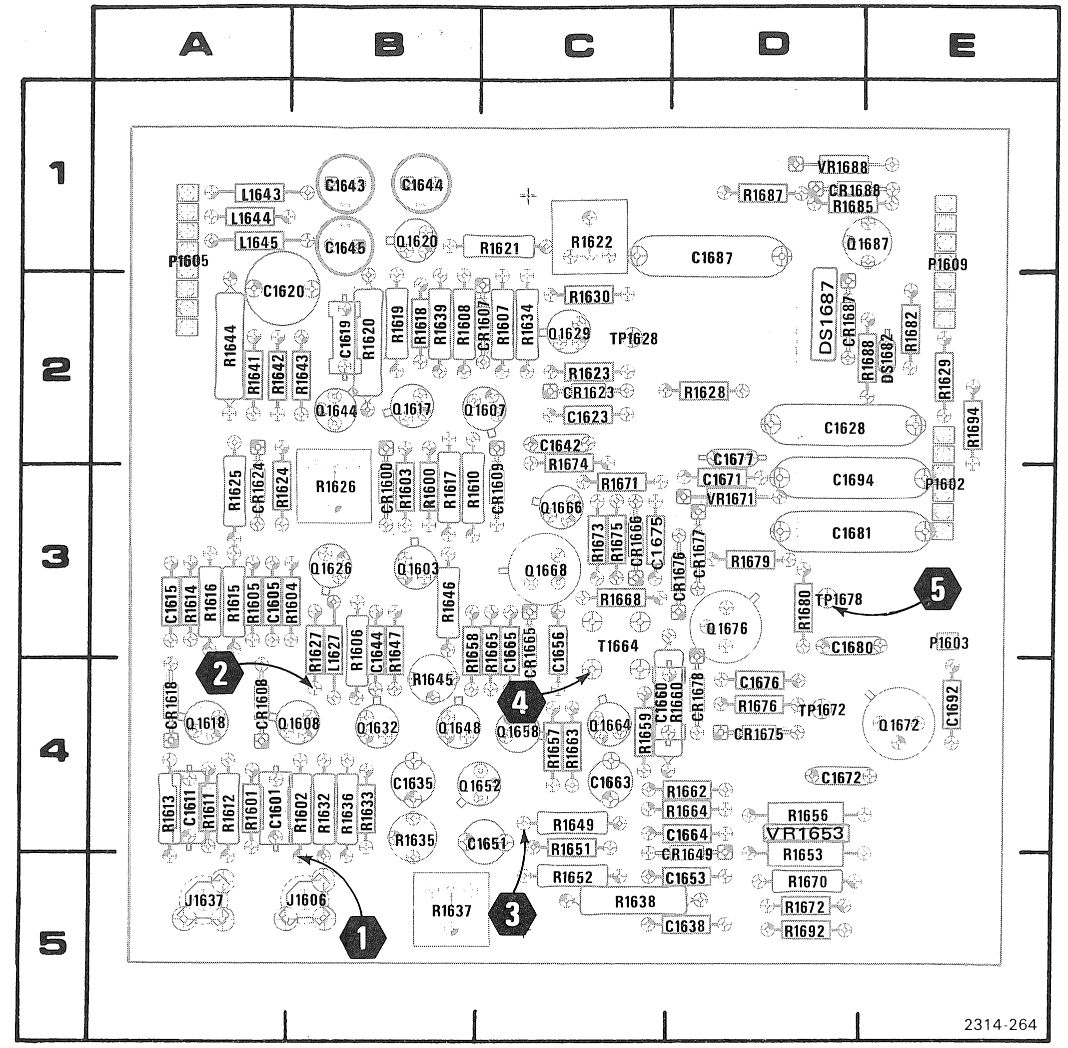
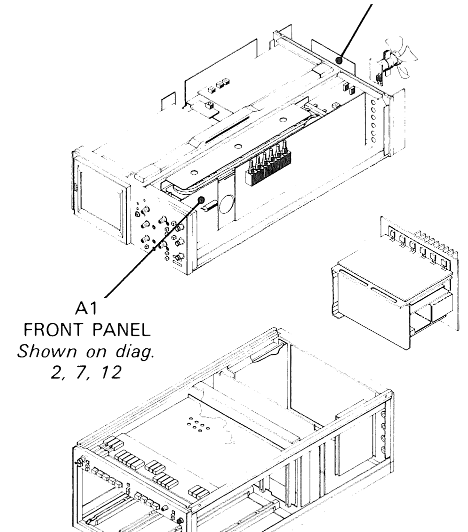


Figure 8-16. A21—Z-Axis circuit board assembly.

*See Parts List for serial number ranges.



Locator for Figure 8-16.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1601	4A	L1645	1A	R1630	2C
C1605	3A			R1632	4B
C1611	4A	P1602	3E	R1633	4B
C1615	3A	P1603	3E	R1634	2C
C1619	2B	P1605	1A	R1635	4B
C1620*	2A	P1609	1E	R1636	4B
C1623	2C			R1637	5B
C1628	2D	Q1603	3B	R1638	5C
C1635	4B	Q1607	2C	R1639	2B
C1638	5D	Q1608	4B	R1641	2A
C1642	2C	Q1617	2B	R1642	2A
C1643	1B	Q1618	4A	R1643	2B
C1644	3B	Q1620	1B	R1644	2A
C1645	1B	Q1626	3B	R1645	4B
C1651	4C	Q1629	C	R1646	3B
C1653	5D	Q1632	4B	R1647	3B
C1656	3C	Q1644	2B	R1649	4C
C1660	4C	Q1648	4B	R1651	4C
C1663	4C	Q1652	4B	R1652	5C
C1664	4D	Q1658	4C	R1653*	4D
C1665	3C	Q1664	4C	R1656	4D
C1671	3D	Q1666	3C	R1657	4C
C1672	4D	Q1668	3C	R1658	3B
C1675	3C	Q1672	4E	R1659	4C
C1676	4D	Q1676	3D	R1660	4D
C1677	2D	Q1687	1D	R1662	4D
C1680	3D			R1663	4C
C1681	3D	R1600	3B	R1664	4D
C1687	1D	R1601	4A	R1665	3C
C1692	4E	R1602	4B	R1668	3C
C1694	3D	R1603	3B	R1670	5D
		R1604	3A	R1671	3C
CR1600	3B	R1605	3A	R1672	5D
CR1607	2C	R1606	3B	R1673	3C
CR1608	4A	R1607	2C	R1674	2C
CR1609	3C	R1608	2B	R1675	3C
CR1618	4A	R1610	3B	R1676	4D
CR1623	2C	R1611	4A	R1679	3D
CR1624	3A	R1612	4A	R1680	3D
CR1649	4D	R1613	4A	R1682	2E
CR1665	3C	R1614	3A	R1685	1D
CR1666	3C	R1615	3A	R1687	1D
CR1675	4D	R1616	3A	R1688	2E
CR1676	3D	R1617	3B	R1692	5D
CR1677	3D	R1618	2B	R1694	2E
CR1678	4D	R1619	2B		
CR1687*	2D	R1620	2B	T1664	3C
		R1621	1C		
DS1682	2E	R1622	1C	TP1628	2C
DS1687	2D	R1623	2C	TP1672	4D
J1606	5B	R1624	3A	TP1678	3D
J1637	5A	R1625	3A		
		R1626	3B		
L1627	3B	R1627	3B	VR1653*	4D
L1643	1A	R1628	2D	VR1671	3D
L1644	1A	R1629	2E	VR1688	1D

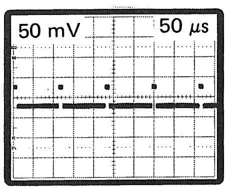
VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY A controls counterclockwise; VERTICAL MODE, LEFT; TRIGGER SOURCE, VERTICAL MODE; HORIZONTAL MODE, B; READOUT INTENSITY, counterclockwise. The intensity limiter voltages were obtained with all intensity controls counterclockwise.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with a readout-equipped 7000-series Oscilloscope).

Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 1 MΩ input impedance and at least 60 MHz bandwidth (TEKTRONIX 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with a 10X probe). A 7B-series time base plug-in was installed in the 7104 B HORIZ compartment and set to free run at 50 microseconds/division. The B INTENSITY control was turned clockwise until the LIMITED VIEWING TIME indicator was lit.

1



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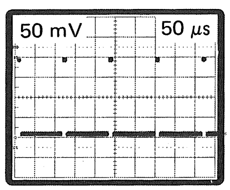
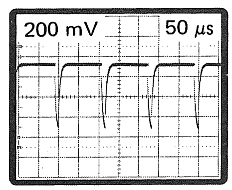


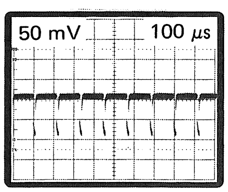
1.5 V

3



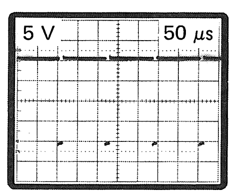
−5.5 V

4

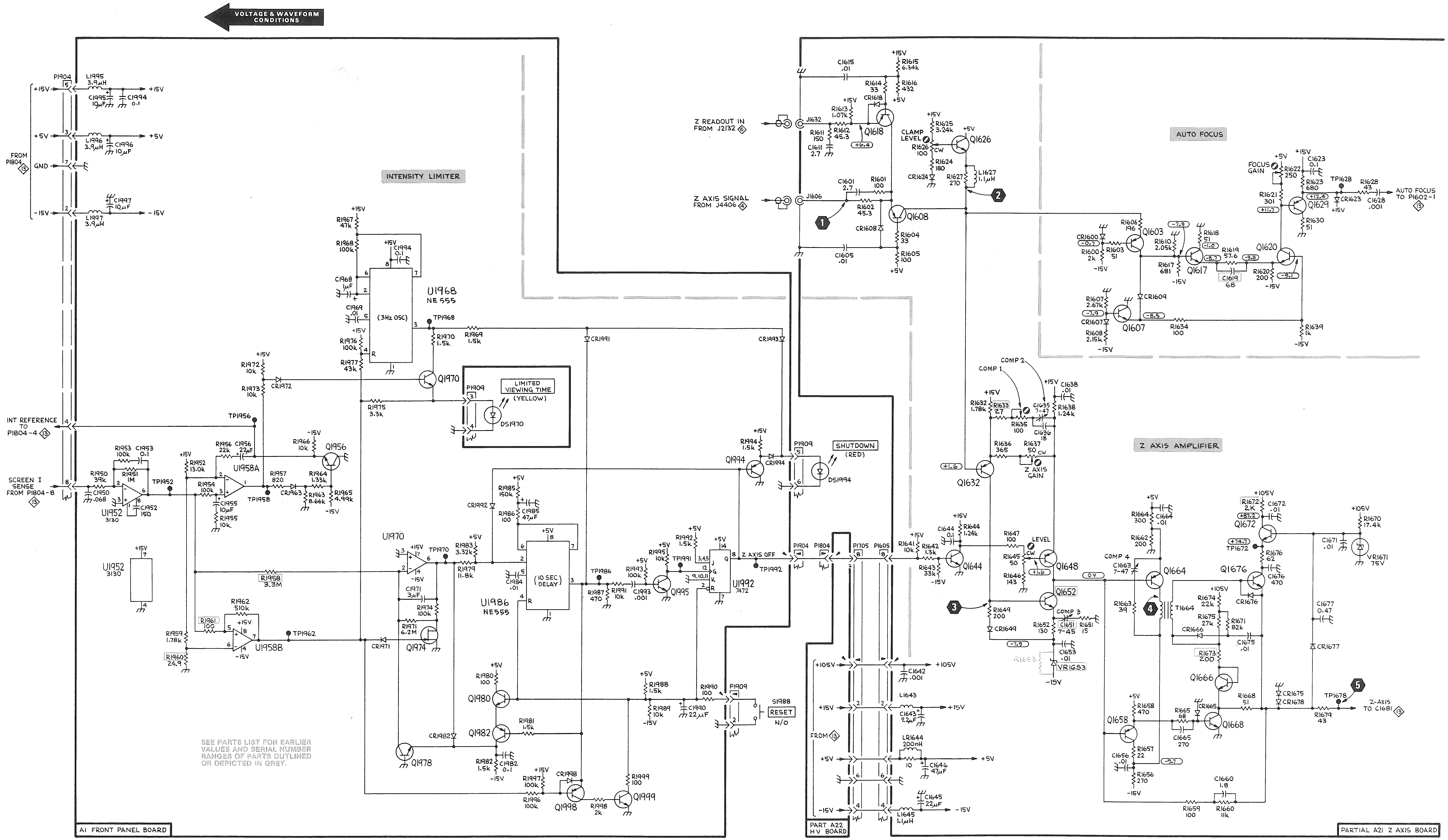


−2.8 V

5



+15 V



2314-292
REV NOV 1981

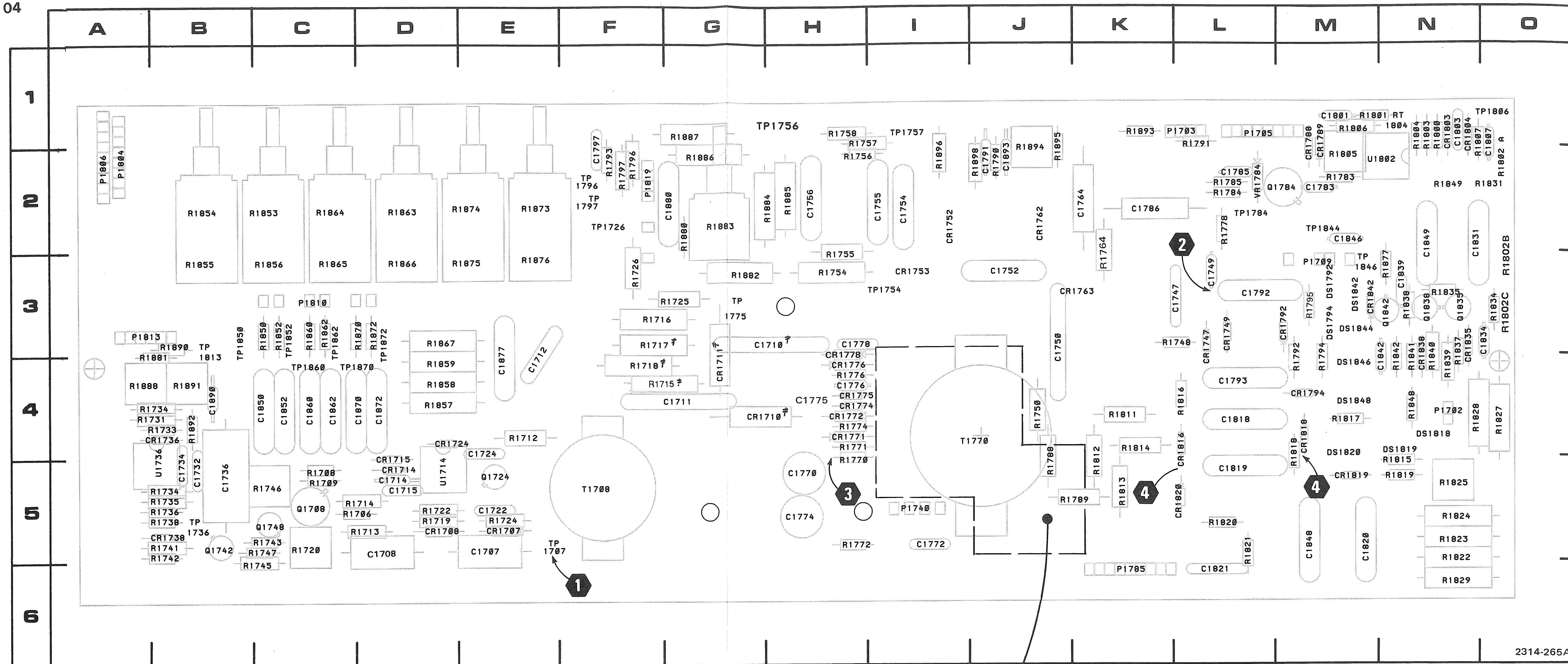
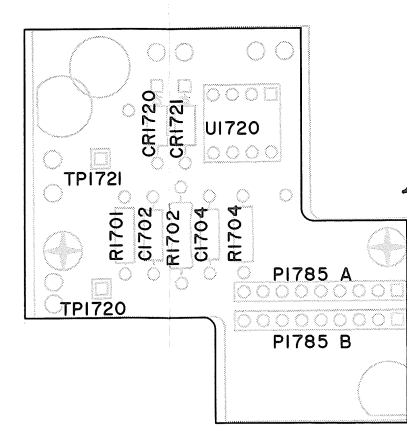
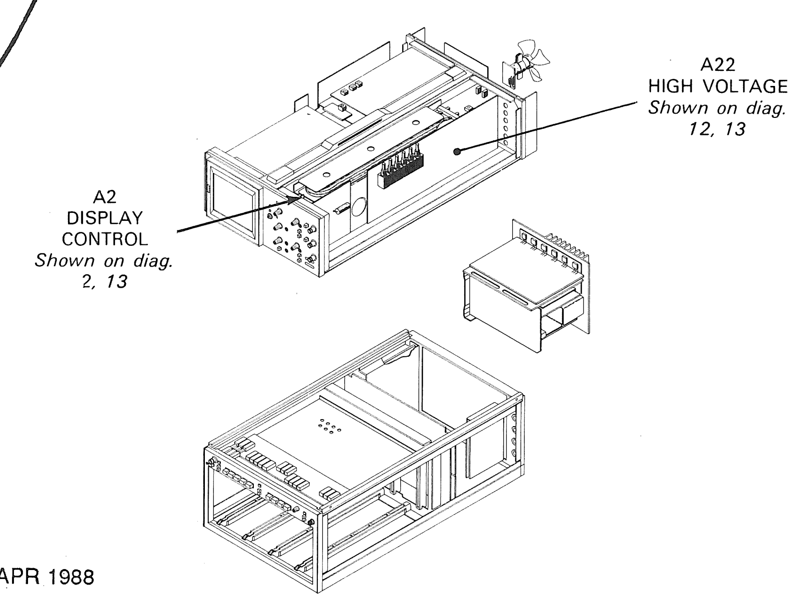


Figure 8-17. A22—High Voltage circuit board assembly.



A22–A1 CRT Protection Board.



Locator For F

CKT NO	GRID COORD
CR2009	2D
CR2019	2D
P2003	2D
P2004	2E
P2005	1D
P2006	1D
R2005	2B
R2007	2D
R2008	2D
R2009	2C

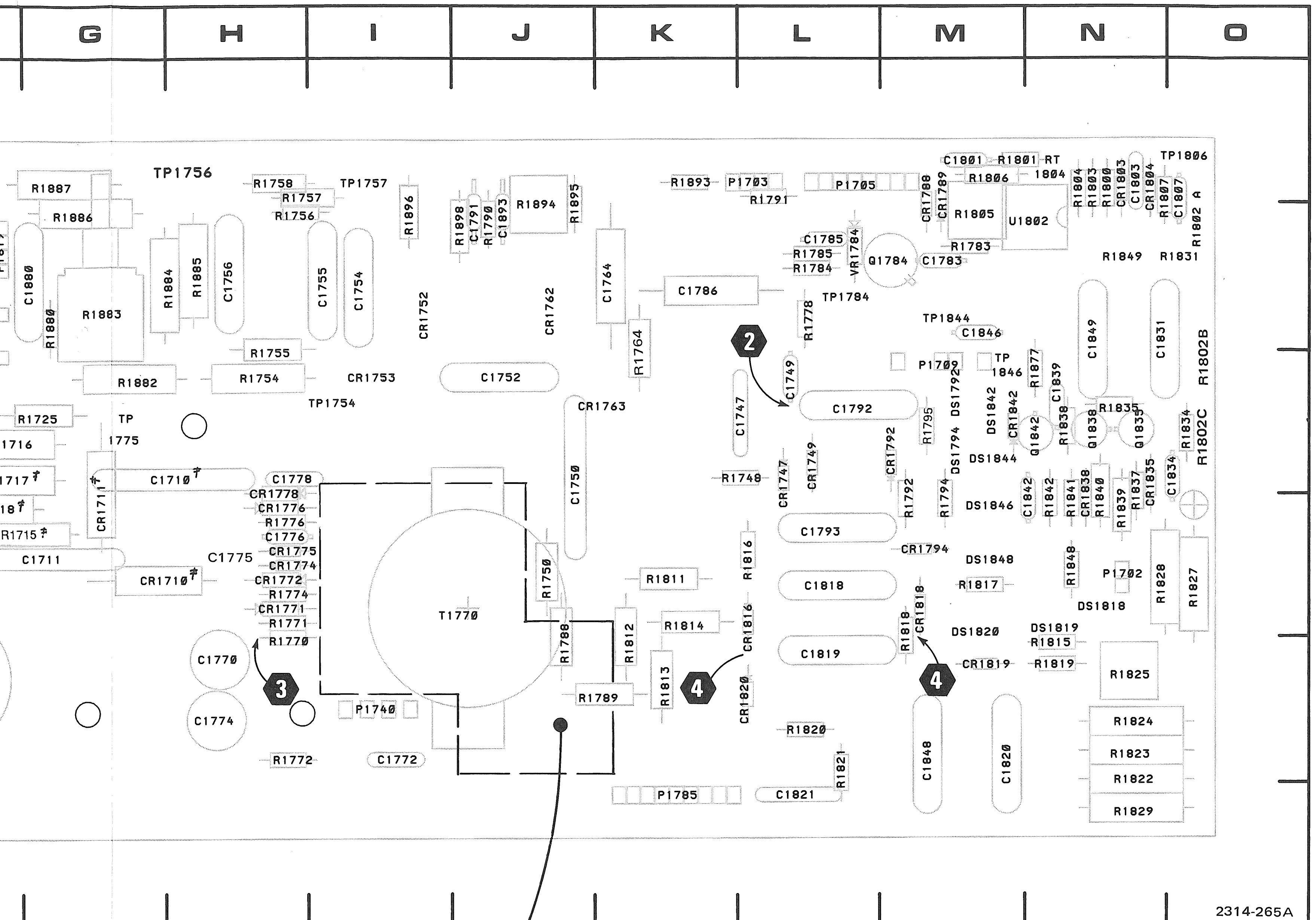


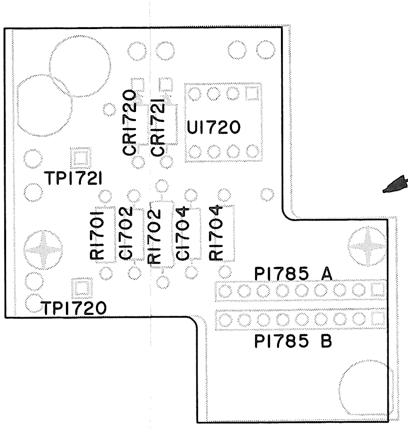
Figure 8-17. A22—High Voltage circuit board assembly.

Locator for Figure 8-17.

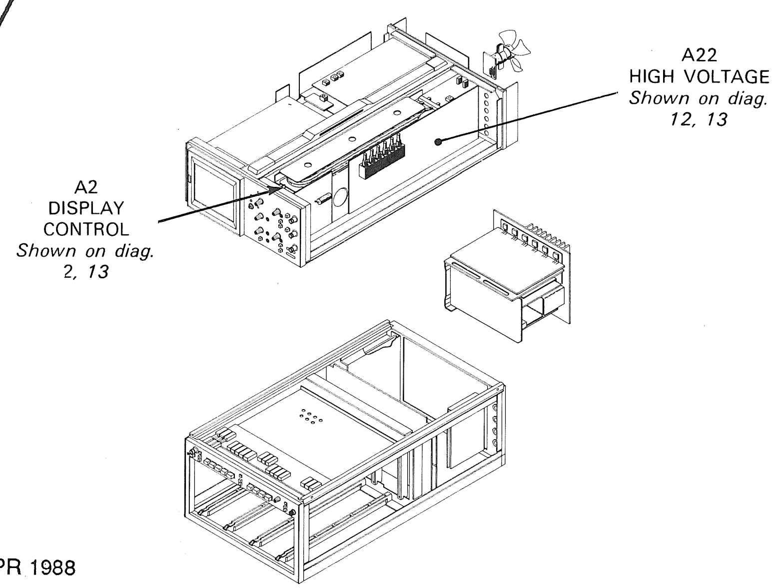
CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1710	3H	C1842	3N	CR1816	4L	R1712	4E	R1788	4H	R1837	3N	R1891	4B
C1711	4G	C1846	2M	CR1818	4M	R1713	5D	R1789	5K	R1838	3N	R1892	4B
C1712	3F	C1848*	5M	CR1819	5M	R1714	5D	R1790	1H	R1839	3N	R1893	1K
C1714	5D	C1849	2N	CR1820	5L	R1715	F3	R1791	1L	R1840	3N	R1894	1H
C1715	5D	C1850	4C	CR1835	4O	R1716	3G	R1792	3M	R1841	3N	R1895	1K
C1722	5E	C1852	4C	CR1838	3N	R1717	3G	R1793	2F	R1842	3N	R1896	1I
C1724	4E	C1860	4C	CR1842	3N	R1718	3F	R1794	3M	R1848	4N	R1898	2J
C1732	4B	C1862	4C			R1719	5D	R1795	3M	R1849	2N		
C1734	4B	C1870	4D	DS1792	3M	R1720	5C	R1796	2F	R1850	3C	RT1804	1N
C1736	5B	C1872	4D	DS1794	3M	R1722	5D	R1797	2F	R1852	3C		
C1747	3L	C1877	3E	DS1818	4N	R1724	5E	R1800	1N	R1853	2C	T1708	5F
C1749	3L	C1880	2G	DS1819	4N	R1725	3G	R1801	1M	R1854	2B	T1770	4H
C1750	3K	C1890	4B	DS1820	4M	R1726	3F	R1802	1O	R1855	2B		
C1752	3H	C1893	1H	DS1842	3M	R1731	4B	R1802B	3O	R1856	2C	TP1707	5F
C1754	2I	CR1707	5E	DS1844	3M	R1733	4B	R1802C	3O	R1857	4D	TP1726	2F
C1755	2I	CR1708	5D	DS1846	3M	R1735	5B	R1803	1N	R1858	4D	TP1736	5B
C1756	2H	CR1710	4H	DS1848	4M	R1736	5B	R1804	1N	R1859	3D	TP1754	3I
C1764	2K	CR1711	3G			R1738	5B	R1805	1M	R1860	3C	TP1756	1H
C1770	4H	CR1714	4D	P1019	2F	R1741	5B	R1806	1M	R1862	3C	TP1757	1I
C1772	5I	CR1715	4D	P1702	4N	R1742	5B	R1807	1O	R1863	2D	TP1775	3G
C1774	5H	CR1724	4E	P1703	1L	R1743	5C	R1811	4K	R1864	2C	TP1784	2L
C1775	4H	CR1736	4B	P1705	1L	R1745	5C	R1812	4K	R1865	2C	TP1796	2F
C1776	4H	CR1738	5B	P1709	2M	R1746	5C	R1813	5K	R1866	2D	TP1797	2F
C1778	3H	CR1747	3L	P1740	5I	R1747	5C	R1814	4K	R1867	3D	TP1806	1O
C1783	2M	CR1749	3L	P1785	5K	R1748	3L	R1815	4N	R1870	3D	TP1813	3B
C1785	2L	CR1752	2I	P1804	2A	R1750	4H	R1816	4L	R1872	3D	TP1844	2M
C1786	2K	CR1753	3I	P1806	2A	R1754	3H	R1817	4M	R1873	2E	TP1846	2M
C1791	1H	CR1762	2H	P1810	3C	R1755	2H	R1818	4M	R1874	2E	TP1850	3C
C1792	3L	CR1763	3K	P1813	3B	R1756	1I	R1819	5N	R1875	2E	TP1852	3C
C1793	4L	CR1771	4H			R1757	1I	R1820	5L	R1876	2E	TP1860	3C
C1797	1F	CR1772	4H	Q1708	5C	R1758	1H	R1821	5L	R1877	3N	TP1862	3C
C1801	1M	CR1774	4H	Q1724	5E	R1764	2K	R1822	5N	R1880	2G	TP1870	3D
C1803	1N	CR1775	4H	Q1742	5B	R1770	4H	R1823	5N	R1881	3B	TP1872	3D
C1807	1O	CR1776	3H	Q1748	5C	R1771	4H	R1824	5N	R1882	3G		
C1818	4L	CR1778	2H	Q1784	2M	R1772	5H	R1825	5N	R1883	2G	U1714	4E
C1819	4L	CR1788	1M	Q1835	3N	R1774	4H	R1827	4O	R1884	2H	U1736	4B
C1820	5N	CR1789	1M	Q1838	3N	R1776	4H	R1828	4O	R1885	2H	U1802	2N
C1821	5L	CR1792	3M	Q1842	3N	R1778	2L	R1829	6N	R1886	1G		
C1831	2O	CR1794	4M	R1706	5D	R1783	2M	R1831	2O	R1887	1G	VR1784	2L
C1834	3O	CR1803	1N	R1708	5C	R1784	2L	R1834	3O	R1888	4B		
C1839	3N	CR1804	1O	R1709	5C	R1785	2L	R1835	3N	R1890	3B		

*See Parts List for serial number ranges.

ǂ These components are "TEPEED" in slightly different configuration than shown on board dolly.



A22–A1 CRT Protection Board.



Locator For Figure 8-18

CKT NO	GRID COORD	CKT NO	GRID COORD
CR2009	2D	R2010	2E
CR2019	2D	R2015	2C
		R2016	2D
P2003	2D	R2017	2D
P2004	2E	R2018	2D
P2005	1D	R2019	2D
P2006	1D	R2020	2C
		R2025	2B
R2005	2B	R2035	1A
R2007	2D		
R2008	2D	S2005	2A
R2009	2C		
		W2005	2B

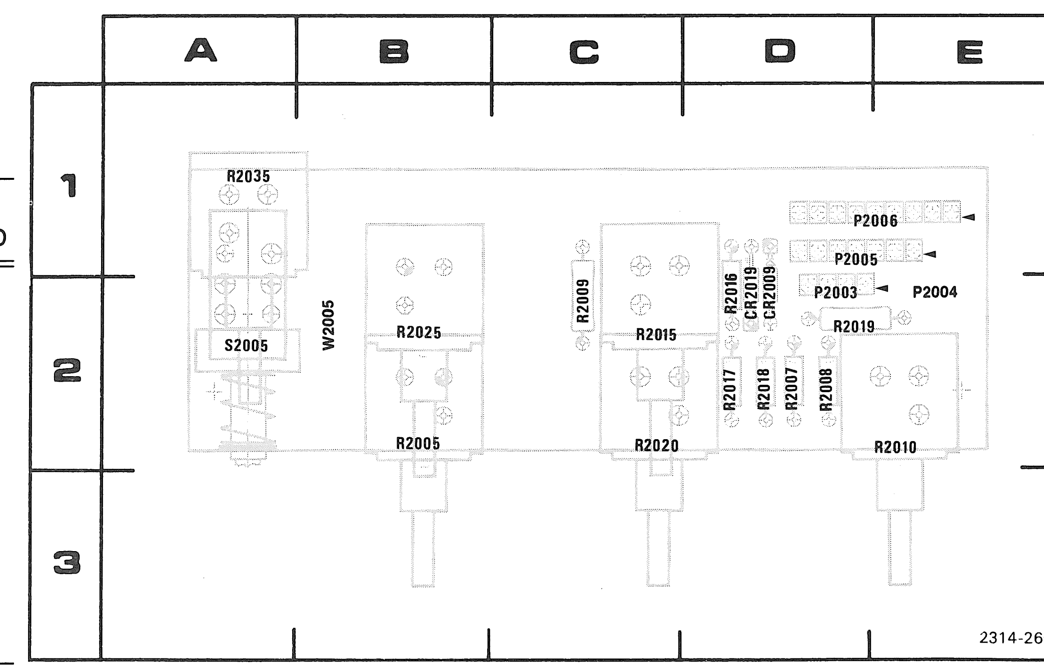
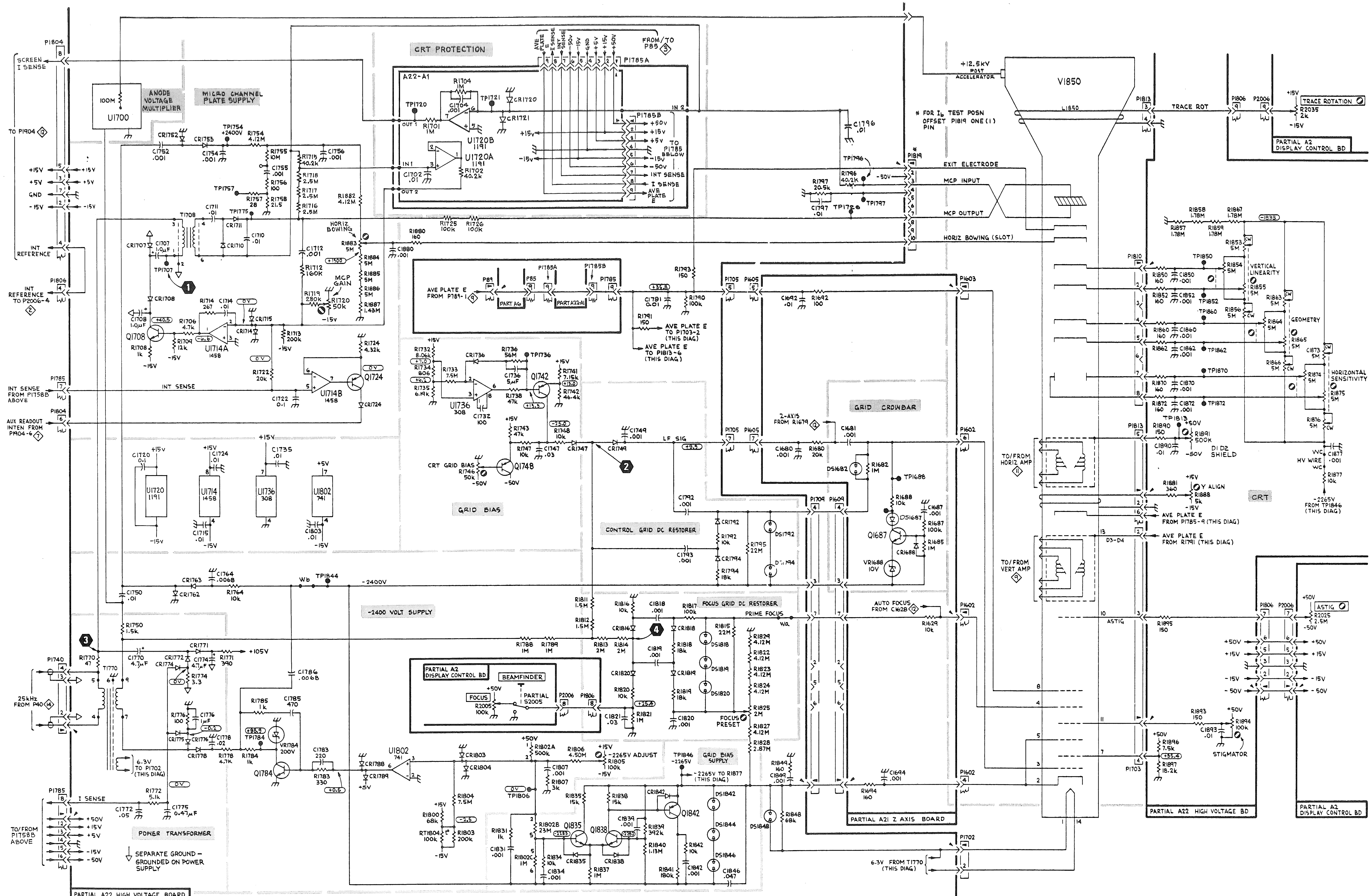


Figure 8-18. A2—Display Control circuit board assembly.



7104

2314-293A
ADD APRIL 1988

CRT CIRCUIT 13
SN B073914 & ABOVE

CRT CIRCUIT (SN B073914-UP) 13

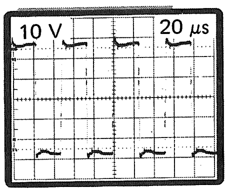
VOLTAGE AND WAVEFORM CONDITIONS

The voltages shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY controls fully counterclockwise; VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B. No plug-in units were installed.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance and a high voltage probe. (Tektronix DM501 Digital Multimeter and Tektronix P6013A, 12 kV, 1000X probe, part number 010-0117-01.)

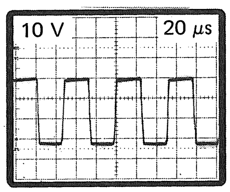
Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 1 MΩ input impedance and at least 60 MHz bandwidth. (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with a 10X probe.)

1



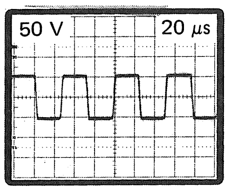
0 V

2



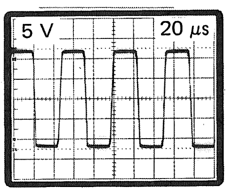
0 V

3



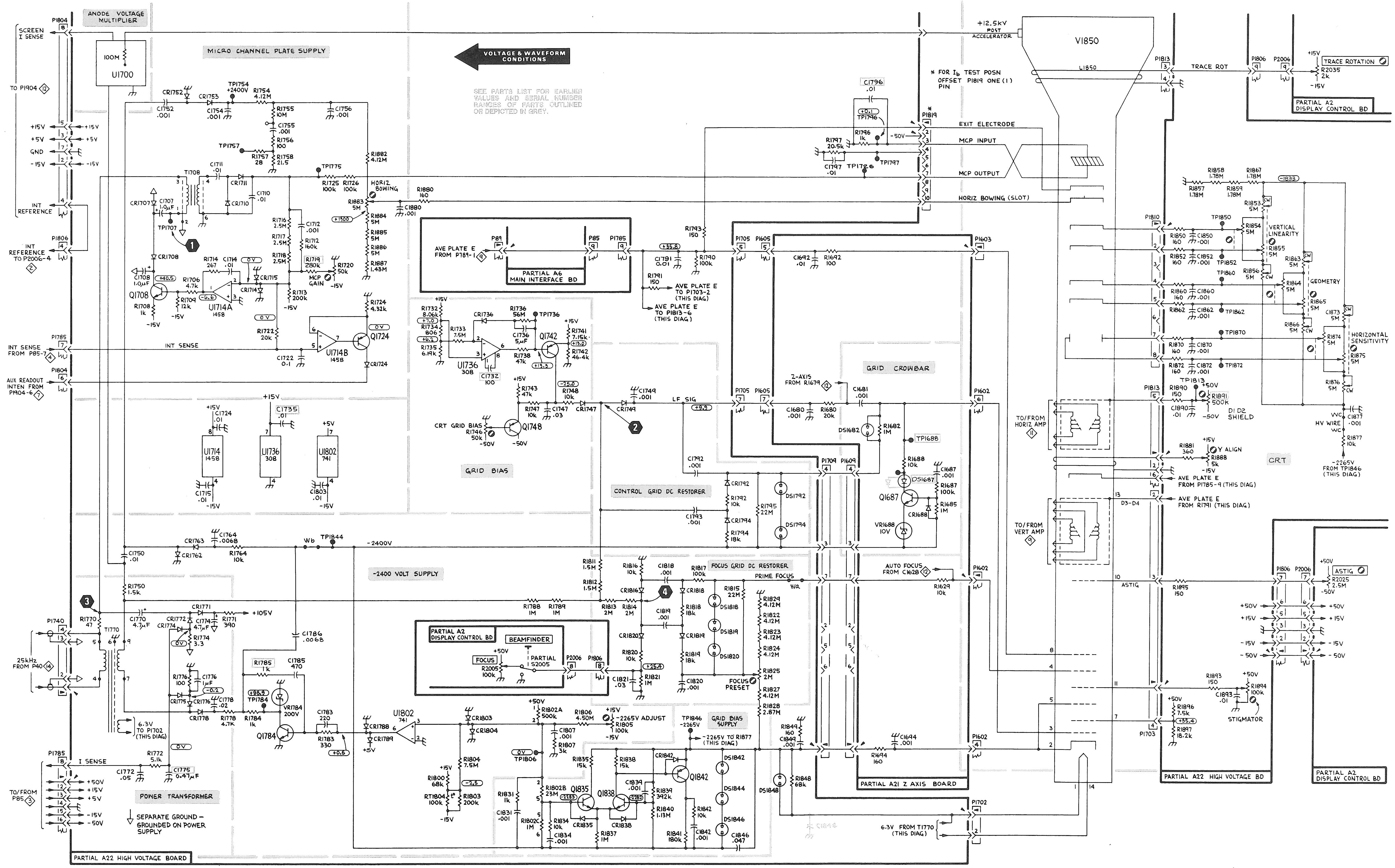
0 V

4



10.5 V

CRT CIRCUIT (SN B073918-BELOW)



7104

2314-293
REV FEB 1988

CRT CIRCUIT 13
SN B073913 & BELOW

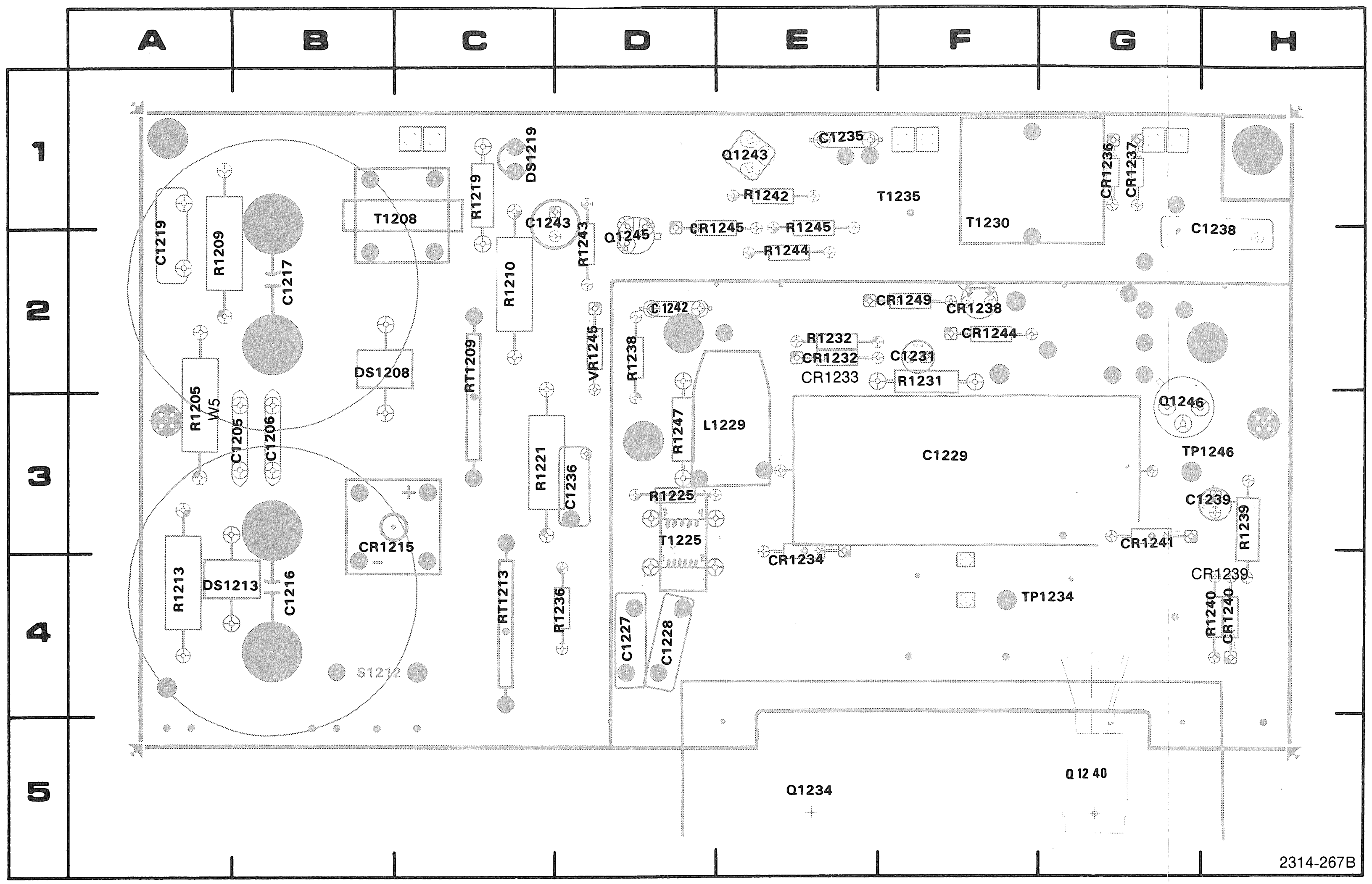
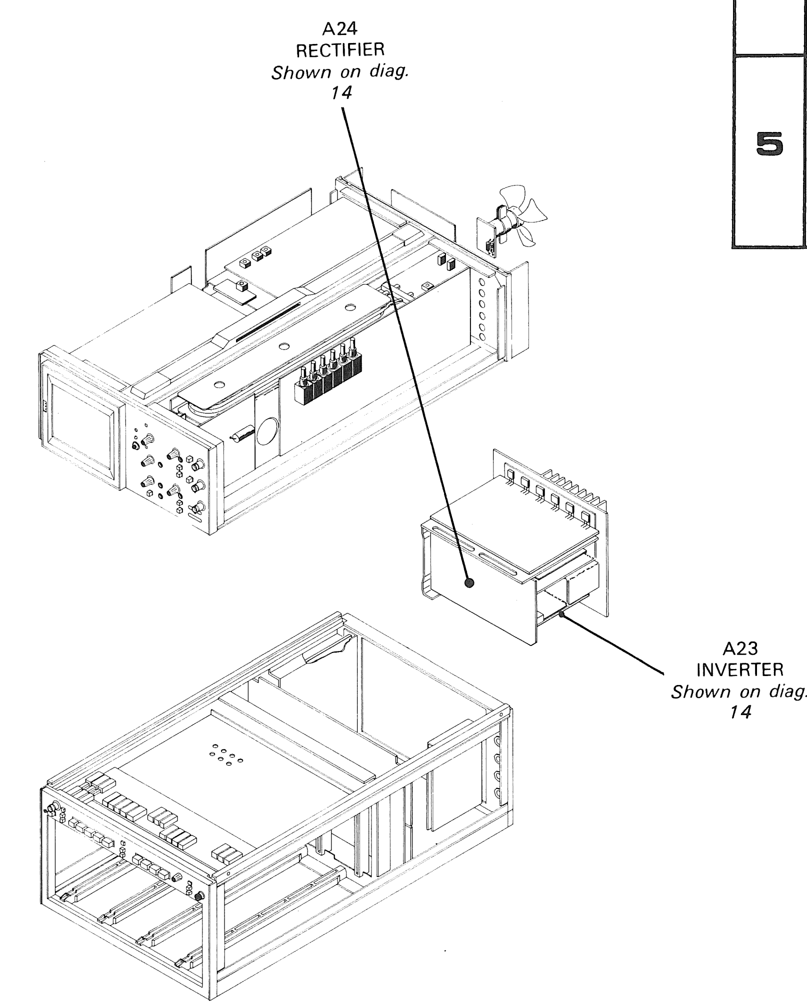
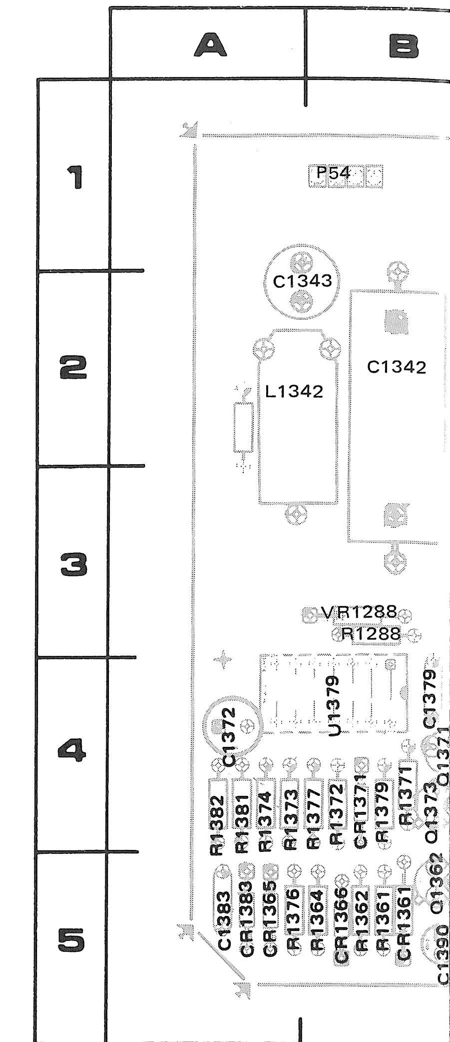


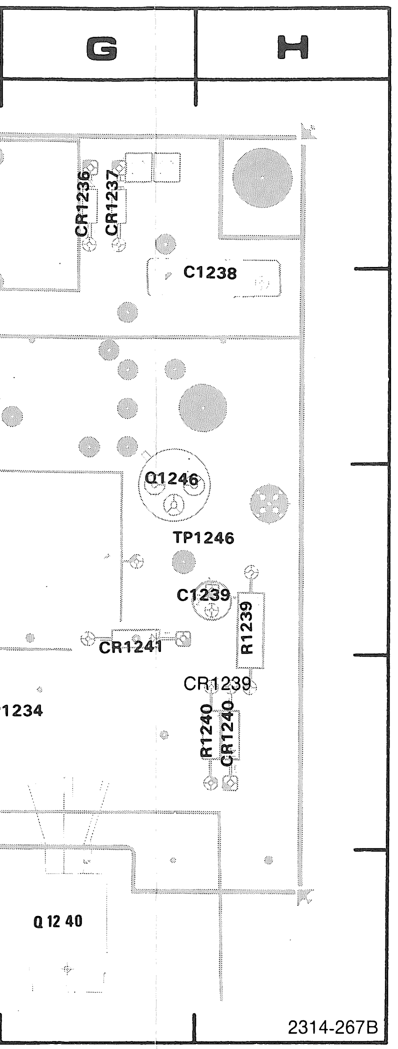
Figure 8-19. A23—Inverter circuit board assembly.

*See Parts List for serial number ranges.

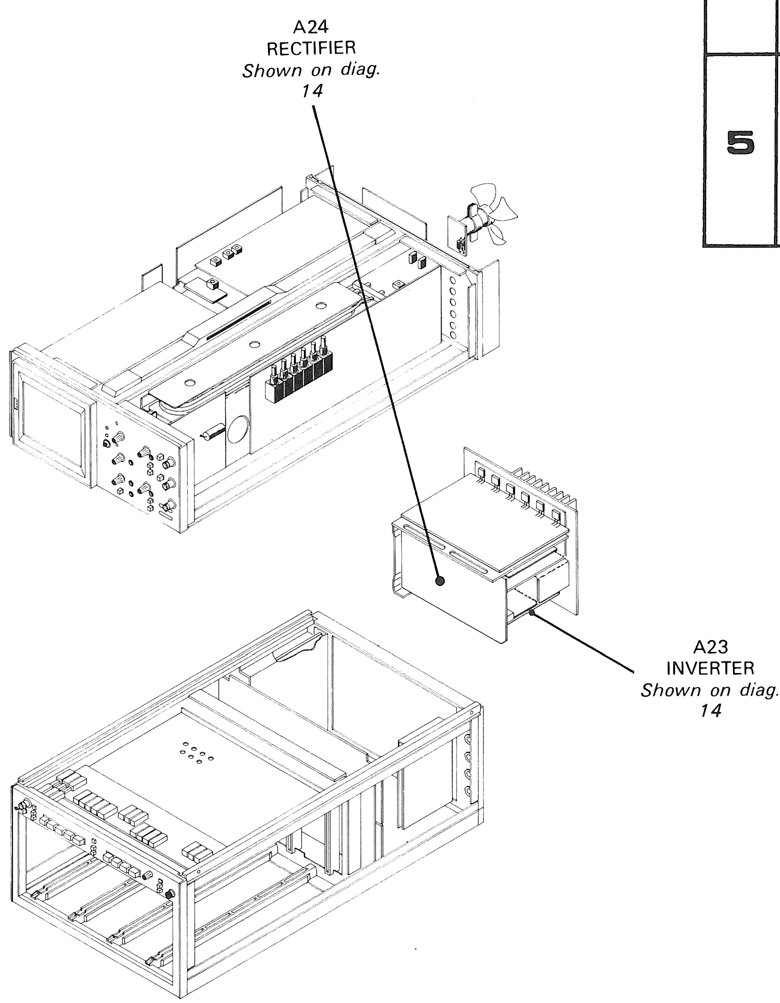
CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1205	3B	CR1215	3B	DS1213	4A	R1221	3C	RT1213	4C
C1206*	3B	CR1232	2E	DS1219	1C	R1225	3D		
C1216	4B	CR1233*	3E			R1231	2F	S1212	4B
C1217	2B	CR1234	4E	L1229	3E	R1232	E		
C1219	2A	CR1236	1G	Q1234	5E	R1236	4D	T1208	1C
C1227	4D	CR1237	1G	Q1240	5G	R1238	2D	T1225	3D
C1228	4D	CR1238	2F	Q1243	1E	R1239	3H	T1230	1F
C1229	3F	CR1239*	4H	Q1245	2D	R1240	4H	T1235	1F
C1231	2F	CR1240	4H	Q1246	3G	R1242	1E		
C1235	1E	CR1241	3G			R1243	2D		
C1236	3D	CR1244	2F	R1205*	3A	R1244	2E	TP1234	4G
C1238	2H	CR1245	2D	R1209	2A	R1245	1E	TP1246	3G
C1239	3G	CR1249	2F	R1210	2C	R1247	3D	VR1245	2D
C1242	2D			R1213	4A				
C1243	1C	DS1208	2B	R1219	1C	RT1209	2C	W5*	3A







*See Parts List for
serial number ranges.



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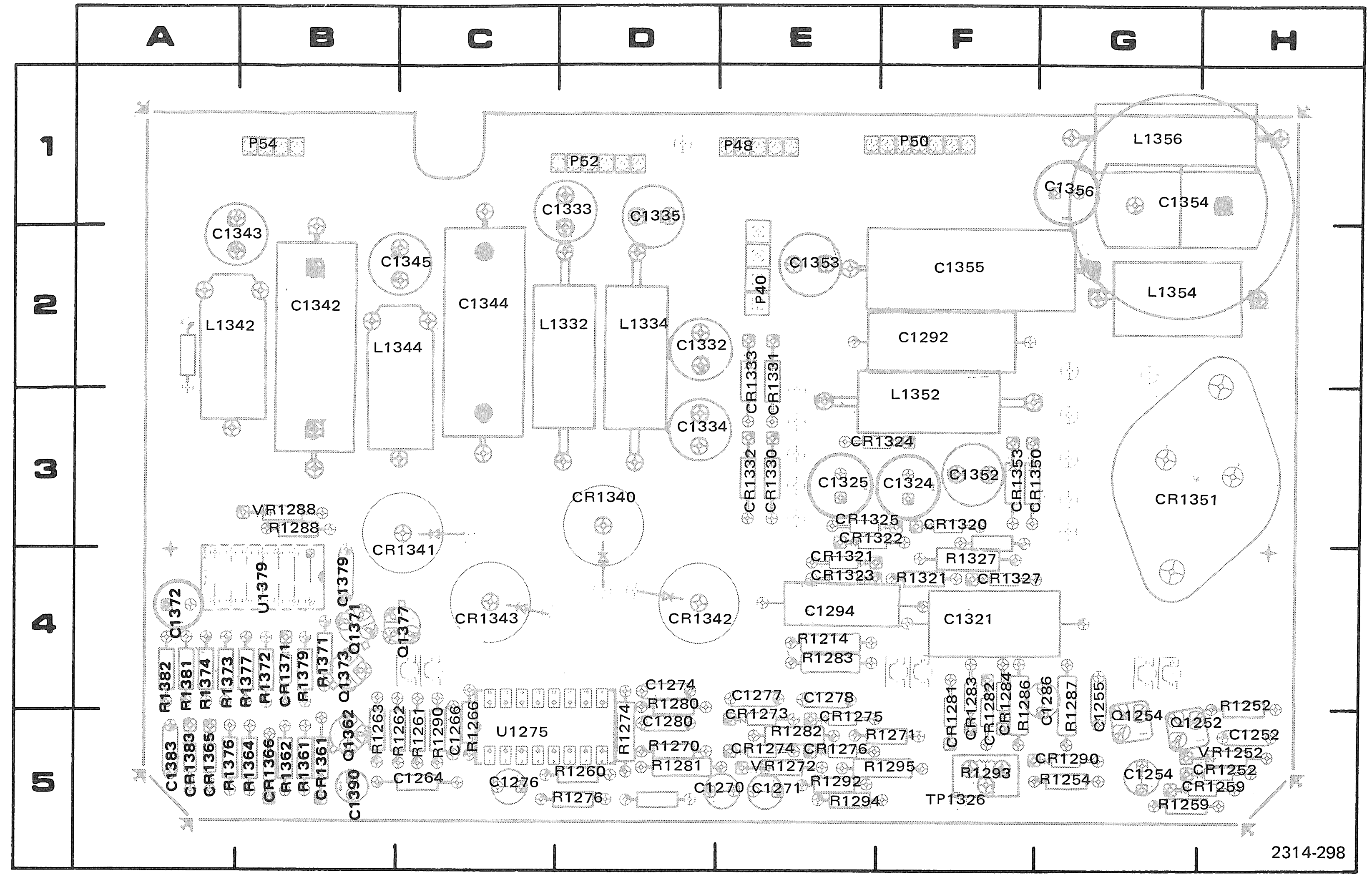


Figure 8-20A. A24—Rectifier circuit board assembly (SN B031930 & up).

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1252	5H	C1352	3F	CR1327	4F	P50	1F	R1287	4G
C1254	5G	C1353	2E	CR1330	3E	P52	1D	R1288	3B
C1255	5G	C1354	1G	CR1331	2E	P54	1B	R1290	5C
C1264	5C	C1355	2F	CR1332	3E			R1292	5E
C1266	5C	C1356	1G	CR1333	2E	Q1252	5G	R1293	5F
C1270	5E	C1371	4B	CR1340	3D	Q1254	5G	R1294	5E
C1271	5E	C1372	4A	CR1341	4C	Q1362	5B	R1295	5F
C1274	4D	C1374	4B	CR1342	4D	Q1371	4B	R1321	4F
C1276	5C	C1379	4B	CR1343	4C	Q1373	4B	R1327	4F
C1277	4E	C1383	5A	CR1350	3F	Q1377	4C	R1361	5B
C1278	4E			CR1351	3G			R1362	5B
C1280	5D	CR1252	5G	CR1353	3F	R1214	4E	R1364	5B
C1286	5G	CR1259	5G	CR1361	5B	R1252	4H	R1371	4B
C1290	5B	CR1273	5E	CR1365	5A	R1254	5G	R1372	4B
C1292	2F	CR1274	5E	CR1366	5B	R1259	5G	R1373	4A
C1294	4E	CR1275	5E	CR1371	4B	R1260	5D	R1374	4A
C1321	4F	CR1276	5E	CR1383	5A	R1261	5C	R1376	5A
C1324	3F	CR1281	5F			R1262	5B	R1377	4B
C1325	3E	CR1282	5F	L1332	2D	R1263	5B	R1379	4B
C1332	2D	CR1283	5F	L1334	2D	R1266	5C	R1381	4A
C1333	1D	CR1284	5F	L1342	2A	R1270	5D	R1382	4A
C1334	3D	CR1290	5G	L1344	2B	R1271	5F		
C1335	1D	CR1320	3F	L1352	3F	R1274	5D	TP1326	5F
C1342	2B	CR1321	4E	L1354	2G	R1276	5D		
C1343	2B	CR1322	3E	L1356	1G	R1280	4D	U1275	5C
C1344	2C	CR1323	4E			R1281	5D	U1379	4B
C1345	2C	CR1324	3F	P40	2E	R1282	5E		
		CR1325	3E	P48	1E	R1283	4E	VR1252	5H
						R1286	5F	VR1272	5E
								VR1288	3B

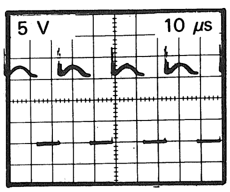
VOLTAGE AND WAVEFORM CONDITIONS

The voltages shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY controls fully counterclockwise; VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B. No plug-in units were installed.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance. (Tektronix DM501 Digital Multimeter.)

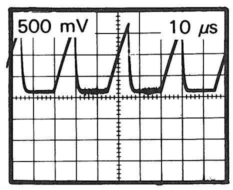
Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 1 MΩ input impedance and at least 60 MHz bandwidth. (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with a 10X probe.)

1



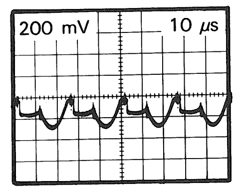
1.1 V

2

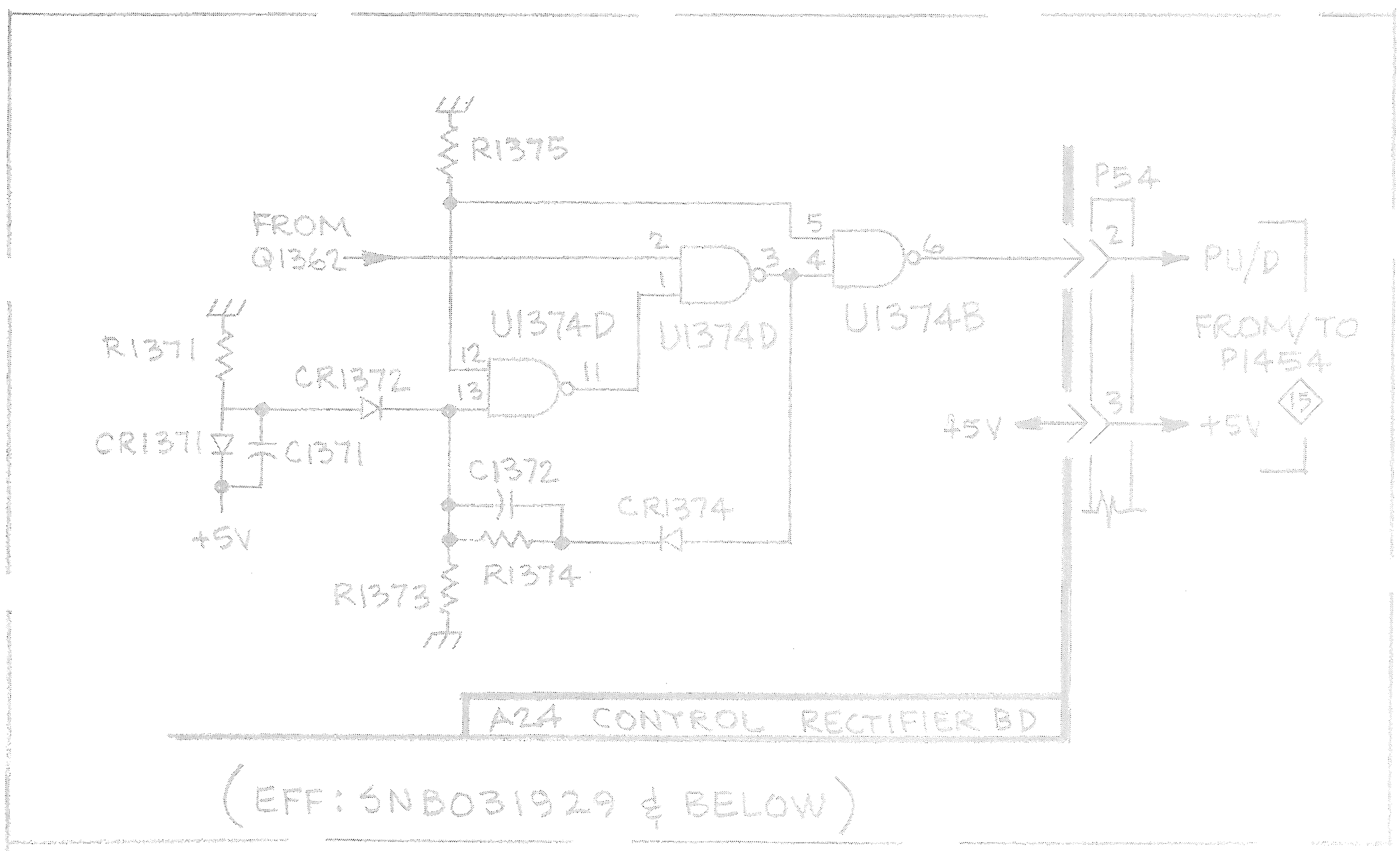


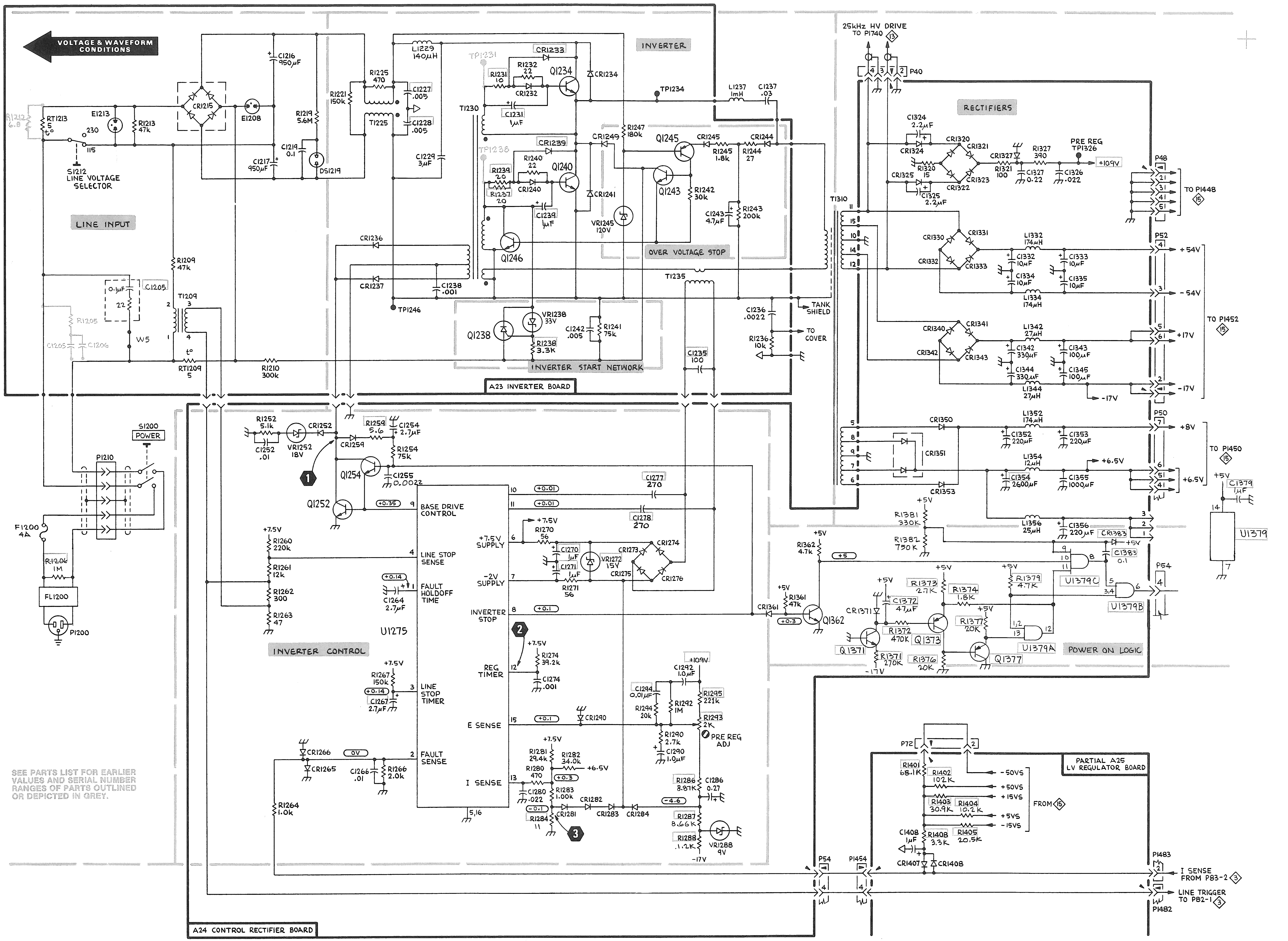
0 V

3



0 V





CONTROL RECTIFIER

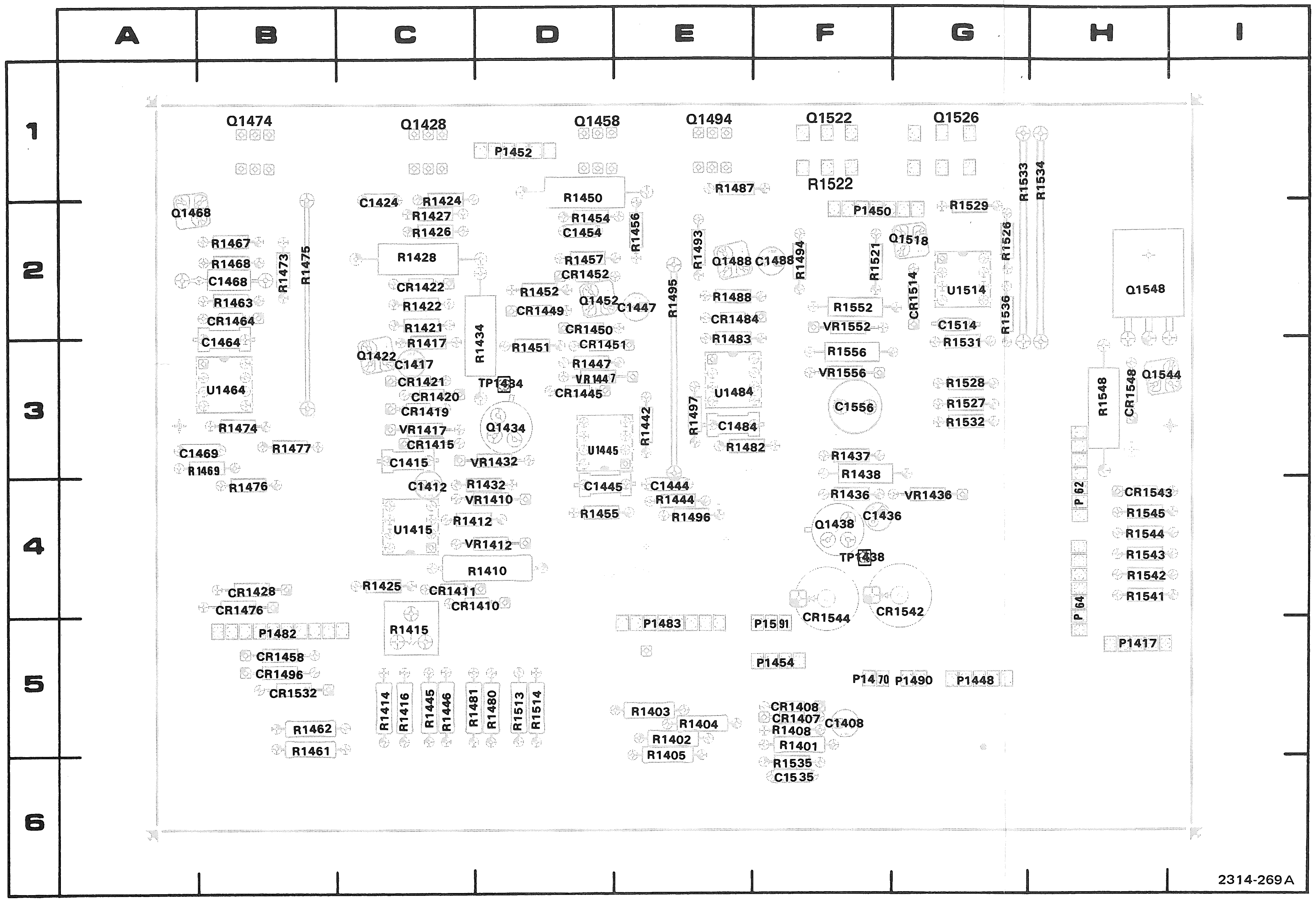
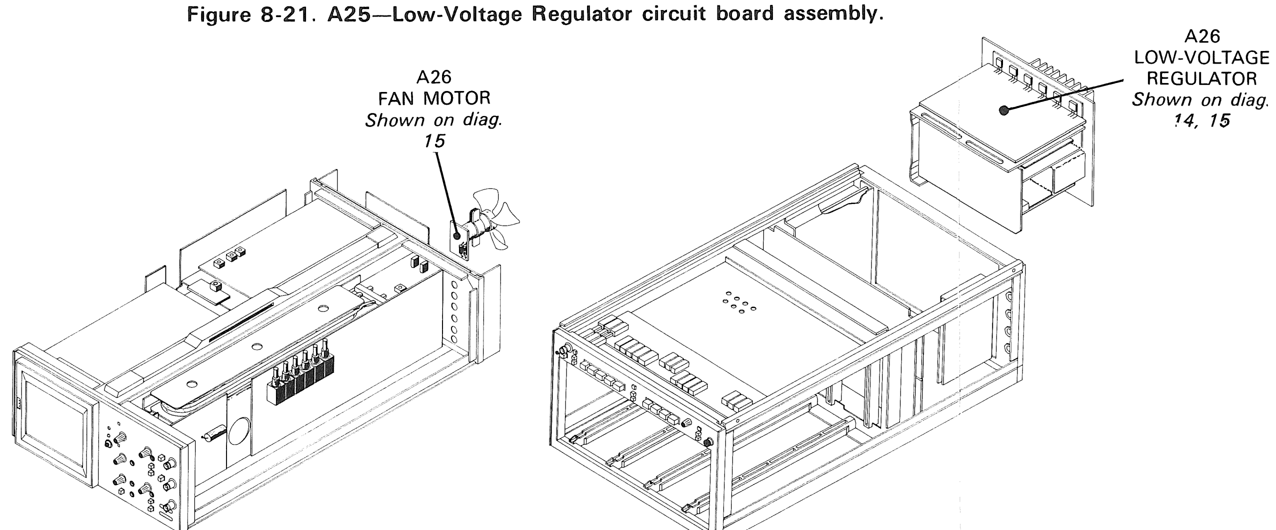


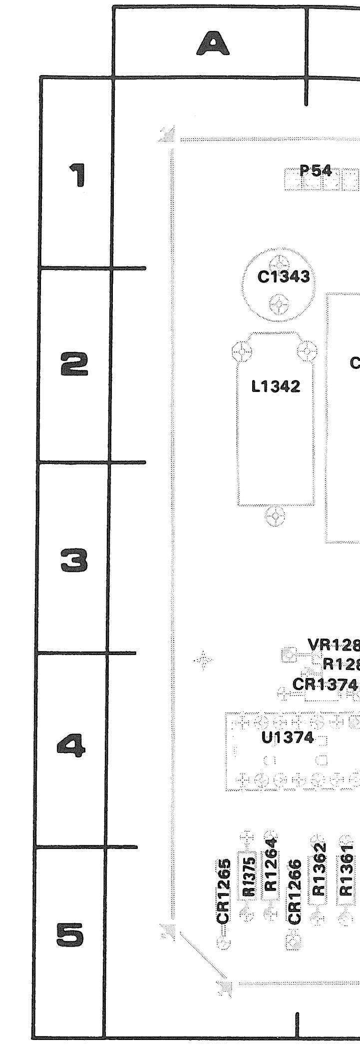
Figure 8-21. A25—Low-Voltage Regulator circuit board assembly.



ASSEMBLIES A25 &
A24 (SN B031929 & BELOW)

Locator for Figure 8-21

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1408	5F	Q1428	1C	R1473	2B
C1412	4C	Q1434	3D	R1474	3C
C1415	3C	Q1438	4F	R1475	2B
C1417	3C	Q1452	2D	R1476	4B
C1424	2C	Q1458	1D	R1477	3C
C1436	4F	Q1468	2B	R1480	5D
C1444	4E	Q1474	1B	R1481	5C
C1445	4D	Q1488	2E	R1482	3E
C1447	2E	Q1494	1E	R1483	3E
C1454	2D	Q1518	2G	R1485	2E
C1464	3C	Q1522	1F	R1487	1E
C1468	2B	Q1526	1G	R1488	2E
C1469	3C	Q1544	3H	R1493	2E
C1484	3E	Q1548	2H	R1494	2F
C1488	2F			R1496	4E
C1514	2G	R1401	5F	R1497	3E
C1535	6F	R1402	5E	R1513	5D
C1556	3F	R1403	5E	R1514	5D
		R1404	5E	R1521	2F
CR1407	5F	R1405	5E	R1522	1F
CR1408	5F	R1408	5F	R1526	2G
CR1410	4C	R1410	4D	R1527	3G
CR1411	4C	R1412	4C	R1528	3G
CR1415	3C	R1414	5C	R1529	2G
CR1419	3C	R1415	4C	R1531	3G
CR1420	3C	R1416	5C	R1532	3G
CR1421	3C	R1417	3C	R1533	1G
CR1422	2C	R1421	2C	R1534	1H
CR1428	4B	R1422	2C	R1535	6F
CR1445	3D	R1424	2C	R1536	2G
CR1449	2D	R1425	4C	R1541	4H
CR1450	2D	R1426	2C	R1542	4H
CR1451	3D	R1427	2C	R1543	4H
CR1452	2D	R1428	2C	R1544	4H
CR1458	5B	R1432	4D	R1545	4H
CR1464	2B	R1434	3D	R1548	3H
CR1476	4B	R1436	4F	R1552	2F
CR1484	2E	R1437	3F	R1556	3F
CR1496	5B	R1438	3F	TP1438	4F
CR1514	2G	R1442	3E	TP1484	3D
CR1532	5B	R1444	4E		
CR1542	4G	R1445	5C	U1415	4C
CR1543	4H	R1446	5C	U1445	3D
CR1544	5F	R1447	3D	U1464	3C
CR1548	3H	R1450	2D	U1484	3E
		R1451	3D	U1514	2G
P62	4H	R1452	2D		
P1417	5H	R1454	2D	VR1410	4D
P1448	5G	R1455	4D	VR1412	4D
P1450	2F	R1456	1E	VR1417	3C
P1452	1D			VR1432	3D
P1454	5F			VR1436	4G
P1470	5F	R1457	2D	VR1447	3D
P1482	5B	R1461	5B	VR1552	2F
P1483	5E	R1462	5B	VR1556	3F
P1490	5C	R1463	2B		
P1591	5F	R1467	2B		
		R1468	2B		
Q1422	3C	R1469	3C		



CKT NO
C125
C125
C125
C126
C126
C127
C127
C127
C127
C127
C127
C128
C128
C129
C129
C129
C132
C132
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C133
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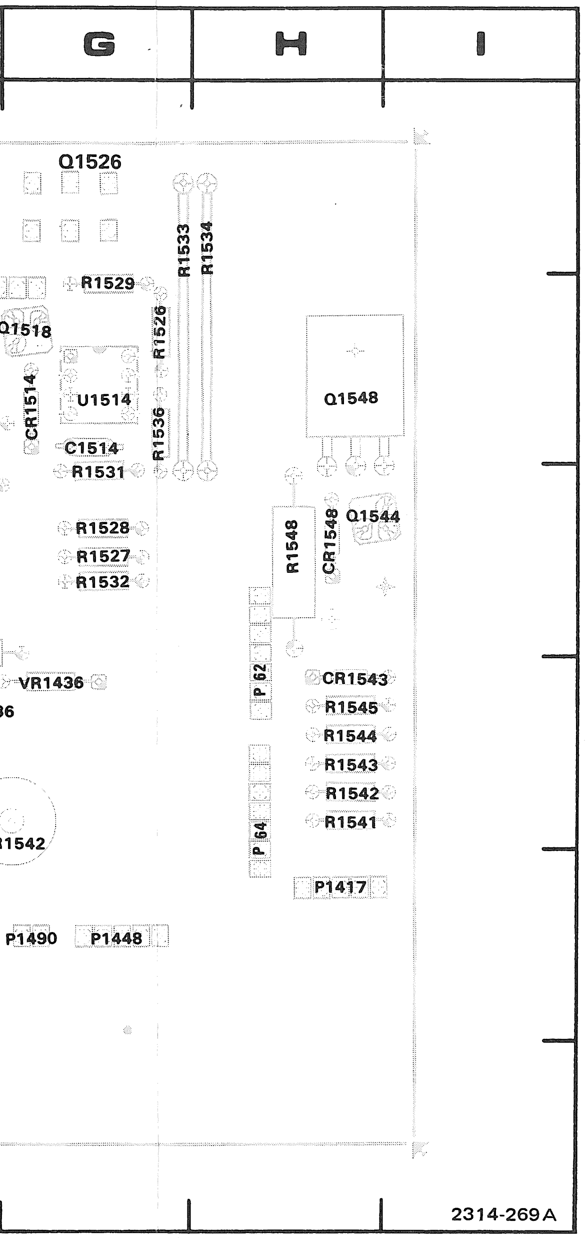
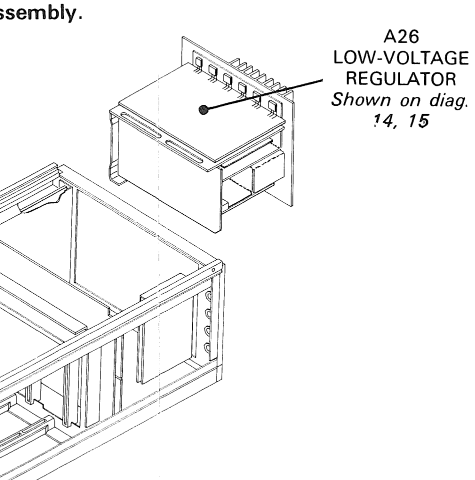
C133
C134
C134
C134
C134



ssembly.



Locator for Figure 8-21

CKT NO	GRID COORD
C1408	5F
C1412	4C
C1415	3C
C1417	3C
C1424	2C
C1436	4F
C1444	4E
C1445	4D
C1447	2E
C1454	2D
C1464	3C
C1468	2B
C1469	3C
C1484	3E
C1488	2F
C1514	2G
C1535	6F
C1556	3F
CR1407	5F
CR1408	5F
CR1410	4C
CR1411	4C
CR1415	3C
CR1419	3C
CR1420	3C
CR1421	3C
CR1422	2C
CR1428	4B
CR1445	3D
CR1449	2D
CR1450	2D
CR1451	3D
CR1452	2D
CR1458	5B
CR1464	2B
CR1476	4B
CR1484	2E
CR1496	5B
CR1514	2G
CR1532	5B
CR1542	4G
CR1543	4H
CR1544	5F
CR1548	3H
P62	4H
P1417	5H
P1448	5G
P1450	2F
P1452	1D
P1454	5F
P1470	5F
P1482	5B
P1483	5E
P1490	5C
P1591	5F
Q1422	3C

CKT NO	GRID COORD
Q1428	1C
Q1434	3D
Q1438	4F
Q1452	2D
Q1458	1D
Q1468	2B
Q1474	1B
Q1488	2E
Q1494	1E
Q1518	2G
Q1522	1F
Q1526	1G
Q1544	3H
Q1548	2H
R1401	5F
R1402	5E
R1403	5E
R1404	5E
R1405	5E
R1408	5F
R1410	4D
R1412	4C
R1414	5C
R1415	4C
R1416	5C
R1417	3C
R1421	2C
R1422	2C
R1424	2C
R1425	4C
R1426	2C
R1427	2C
R1428	2C
R1432	4D
R1434	3D
R1436	4F
R1437	3F
R1438	3F
R1442	3E
R1444	4E
R1445	5C
R1446	5C
R1447	3D
R1450	2D
R1451	3D
R1452	2D
R1454	2D
R1455	4D
R1456	1E
R1457	2D
R1461	5B
R1462	5B
R1463	2B
R1467	2B
R1468	2B
R1469	3C

CKT NO	GRID COORD
R1473	2B
R1474	3C
R1475	2B
R1476	4B
R1477	3C
R1480	5D
R1481	5C
R1482	3E
R1483	3E
R1485	2E
R1487	1E
R1488	2E
R1493	2E
R1494	2F
R1496	4E
R1497	3E
R1513	5D
R1514	5D
R1521	2F
R1522	1F
R1526	2G
R1527	3G
R1528	3G
R1529	2G
R1531	3G
R1532	3G
R1533	1G
R1534	1H
R1535	6F
R1536	2G
R1541	4H
R1542	4H
R1543	4H
R1544	4H
R1545	4H
R1548	3H
R1552	2F
R1556	3F
TP1438	4F
TP1484	3D
U1415	4C
U1445	3D
U1464	3C
U1484	3E
U1514	2G
VR1410	4D
VR1412	4D
VR1417	3C
VR1432	3D
VR1436	4G
VR1447	3D
VR1552	2F
VR1556	3F

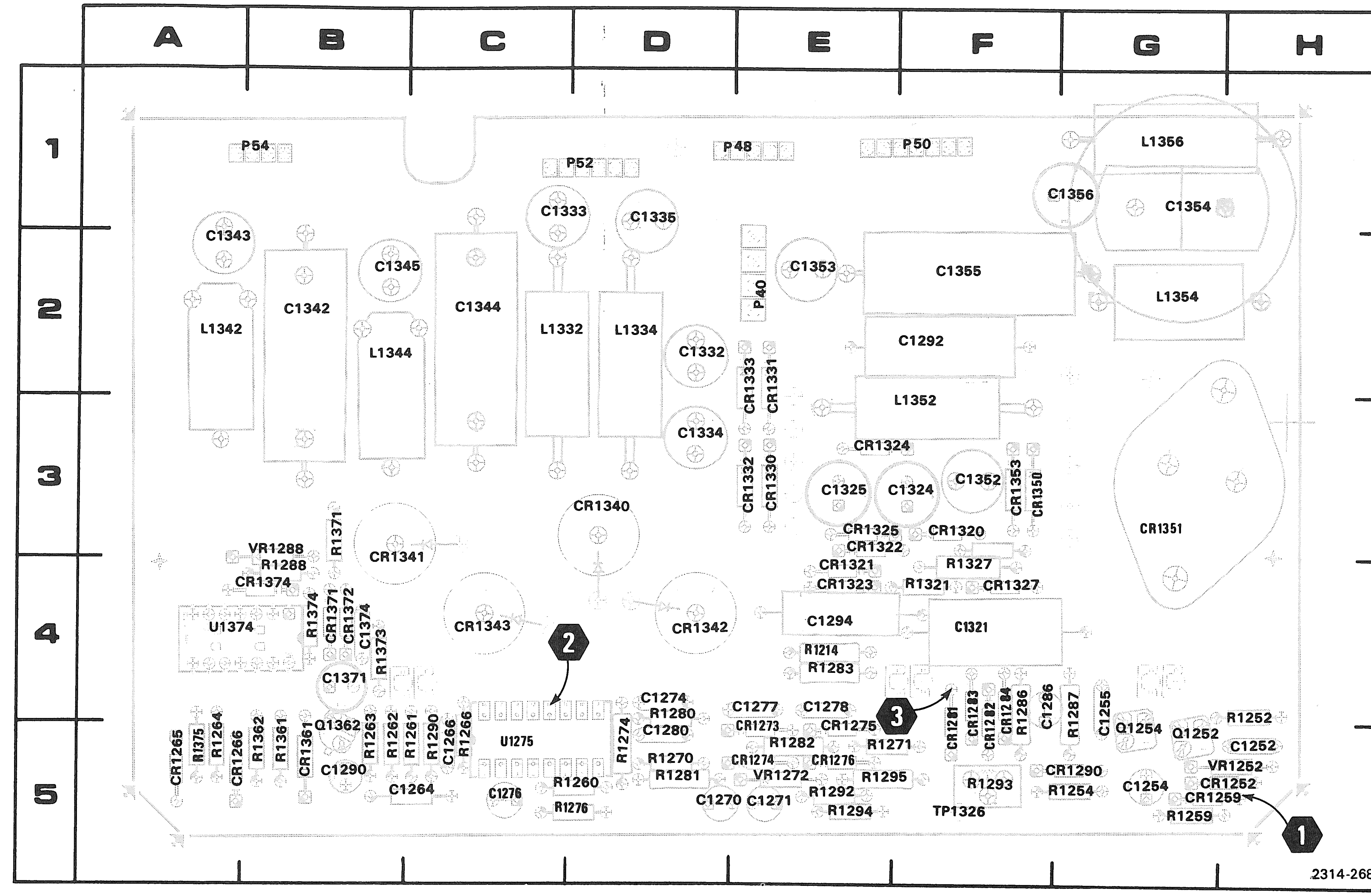


Figure 8-20B. A24—Rectifier circuit board assembly (SN B031929 & below).

CKT NO	GRID COORD
C1252	5H
C1254	5G
C1255	4G
C1264	4C
C1266	4C
C1270	5D
C1271	5E
C1274	4D
C1276	4C
C1277	4E
C1278	4E
C1280	5D
C1286	4F
C1290	5B
C1292	2F
C1294	4E
C1321	4F
C1324	3F
C1325	3E
C1332	2D
C1333	1C
C1334	3D
C1335	1D
C1342	2B
C1343	2A
C1344	2C
C1345	2B

CKT NO	GRID COORD
C1352	3F
C1353	2E
C1354	1G
C1355	2F
C1356	1G
C1371	4B
C1374	4B
CR1252	5G
CR1259	5G
CR1265	5A
CR1266	5A
CR1273	5E
CR1274	5E
CR1275	5E
CR1276	5E
CR1281	4F
CR1282	4F
CR1283	4F
CR1284	4F
CR1290	5G
CR1320	3F
CR1321	4E
CR1322	3E
CR1323	4E
CR1324	3E
CR1325	3E

CKT NO	GRID COORD
CR1327	4F
CR1330	3E
CR1331	2E
CR1332	3E
CR1333	2E
CR1340	3D
CR1341	4B
CR1342	4D
CR1343	3C
CR1350	3F
CR1351	3G
CR1353	3F
CR1361	5B
CR1371	4B
CR1372	4B
CR1374	4B
L1332	2C
L1334	2D
L1342	2A
L1344	2B
L1352	3F
L1354	2G
L1356	1G
P40	2E
P48	1D

CKT NO	GRID COORD
P50	1F
P52	1C
P54	1B
Q1252	5G
Q1254	5G
Q1362	5B
R1214	4E
R1252	4H
R1254	5G
R1259	5G
R1260	5D
R1261	4C
R1262	5B
R1263	5B
R1264	5A
R1266	4C
R1270	5D
R1271	5E
R1274	5D
R1276	5D
R1280	4D
R1281	5D
R1282	5E
R1283	4E
R1286	4F

CKT NO	GRID COORD
R1287	4G
R1288	4B
R1290	4C
R1292	5E
R1293	5F
R1294	5E
R1295	5E
R1321	4F
R1327	4F
R1361	5B
R1362	5B
R1371	3B
R1373	4B
R1374	4B
R1375	5A
TP1326	5F
U1275	4C
U1374	4A
VR1252	5H
VR1272	5E
VR1288	3B

VOLTAGE CONDITIONS

The voltages shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY controls fully counterclockwise; VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B. No plug-in units were installed.

The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with a readout-equipped 7000-series Oscilloscope).

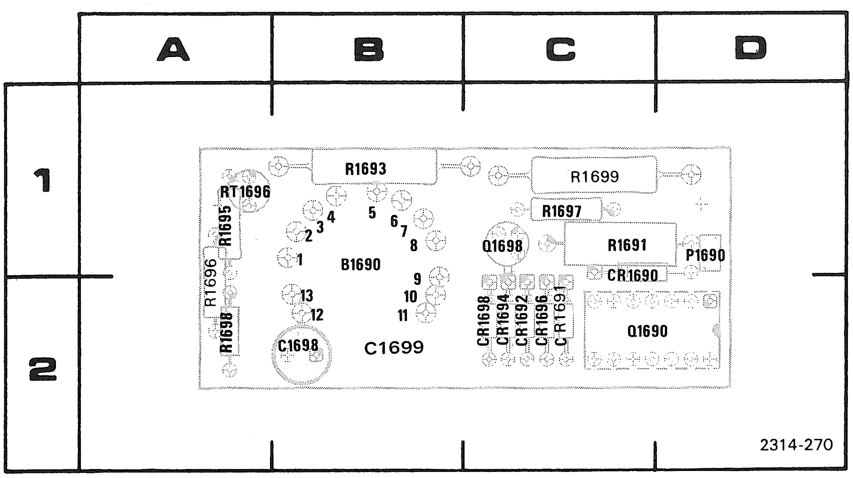
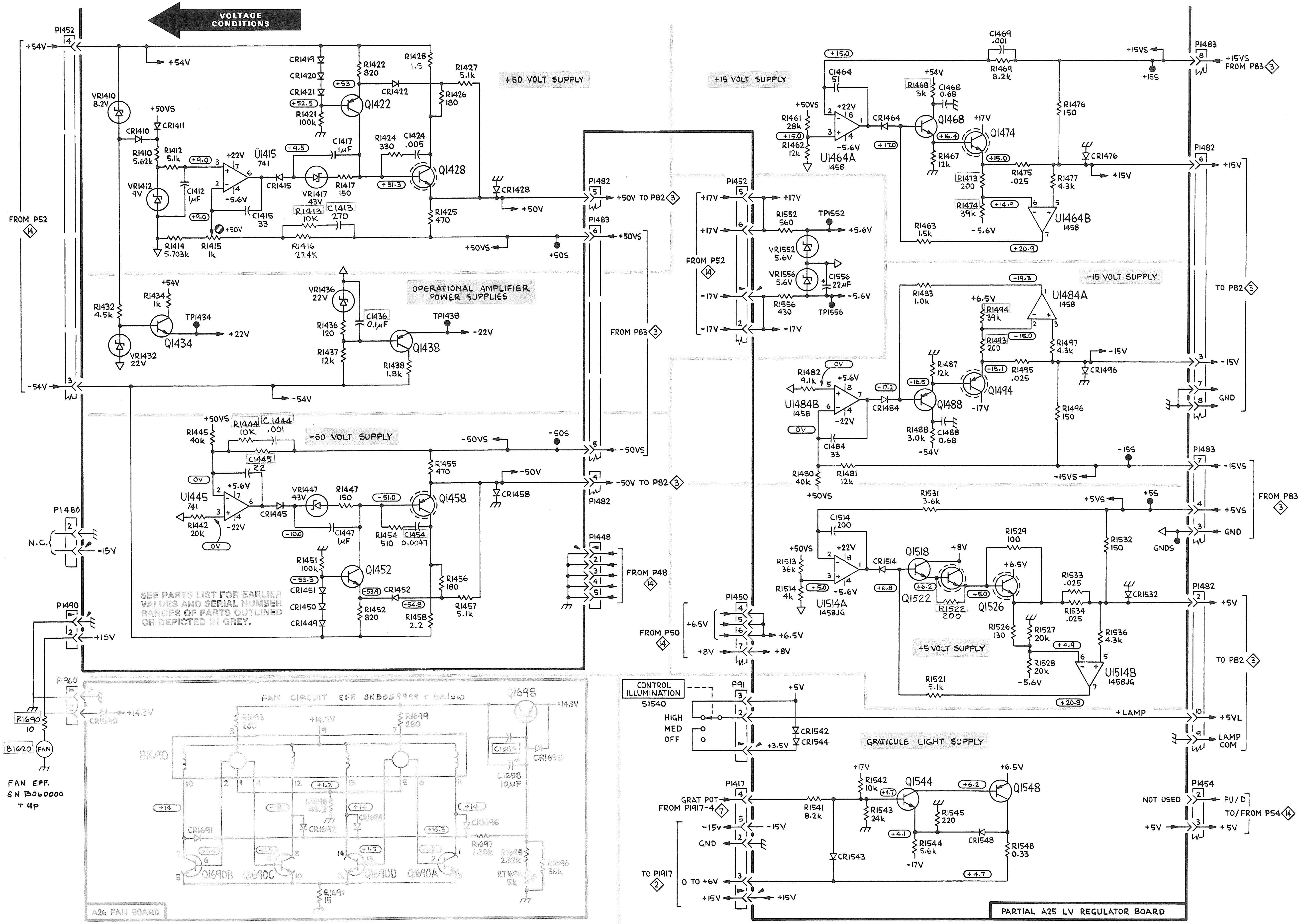


Figure 8-22. A26—Fan Motor circuit board assembly (SN B059999 & Below).

***See Parts List for serial number ranges.**

CKT NO	GRID COORD	CKT NO	GRID COORD
B1690	1B		
		Q1690	2C
C1698	2B	Q1698	1C
C1699*	2B		
		R1691	1C
CR1691	2C	R1693	1B
CR1690	1C	R1695	1A
CR1692	2C	R1696	2A
CR1694	2C	R1697	1C
CR1696	2C	R1698	2A
CR1698	2C	R1699	1C
P1690	1D	RT1696	1A

LV REGULATORS



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LOW VOLTAGE REGULATORS ⟨15⟩

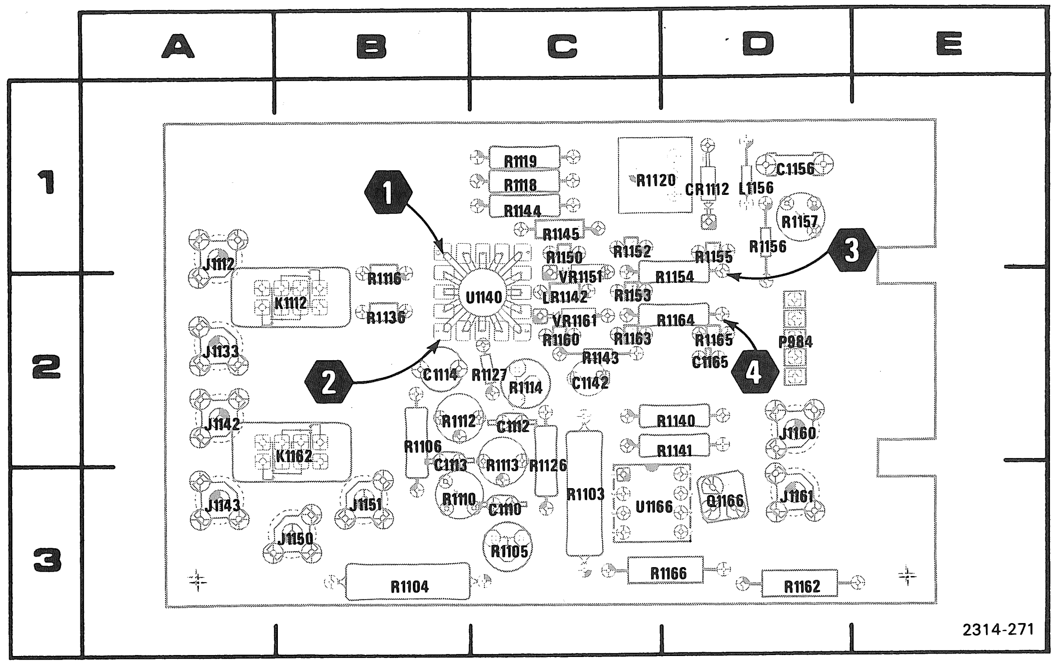
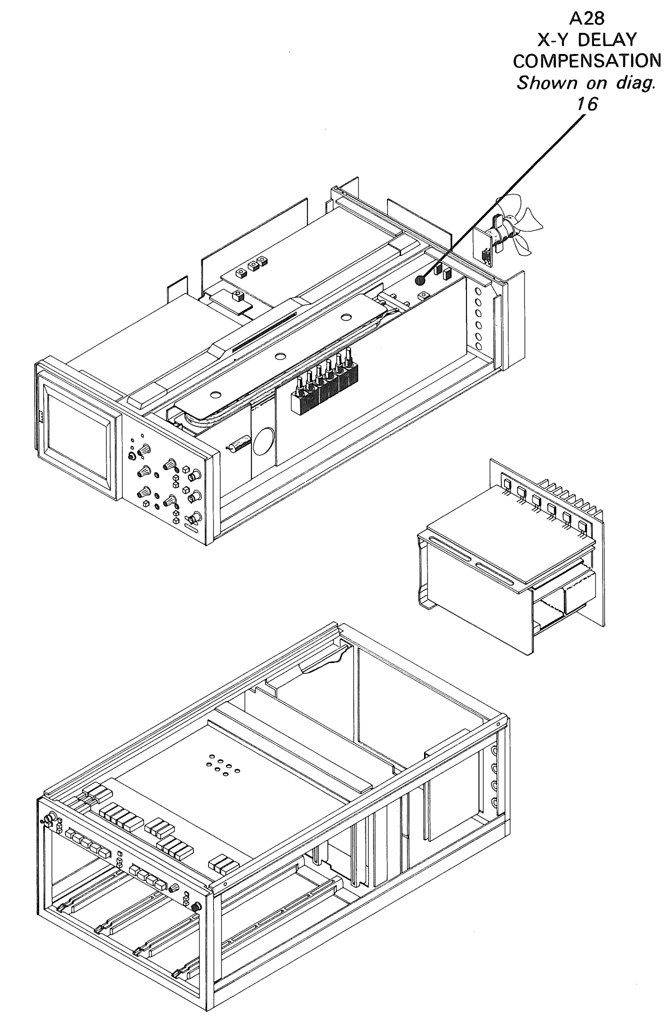


Figure 8-23. A28—X-Y Delay Compensation circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1110	3C			R1141	2D
C1112	2C	LR1142	2C	R1143	2C
C1113	3B			R1144	1C
C1114	2B	P984	2D	R1145	1C
C1142	2C			R1150	1C
C1156	1D	Q1166	3D	R1152	1C
C1165	2D			R1153	2C
		R1103	3C	R1154	2D
CR1112	1D	R1104	3B	R1155	1D
		R1105	3C	R1156	1D
J1112	1A	R1106	2B	R1157	1D
J1133	2A	R1110	3B	R1160	2C
J1142	2A	R1112	2B	R1162	3D
J1143	3A	R1113	3C	R1163	2C
J1150	3B	R1114	2C	R1164	2D
J1151	3B	R1116	2B	R1165	2D
J1160	2D	R1118	1C	R1166	3D
J1161	3D	R1119	1C		
		R1120	1C	U1140	2C
K1112	2B	R1126	3C	U1166	3C
K1162	2B	R1127	2C		
		R1136	2B	VR1151	2C
L1156	1D	R1140	2D	VR1161	2C



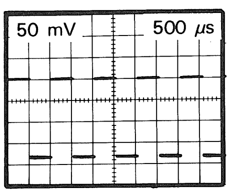
VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the 7104 front panel variable controls at midrange except INTENSITY controls fully counterclockwise; VERTICAL MODE, LEFT; TRIGGER SOURCE, VERT MODE; HORIZONTAL MODE, B; CALIBRATOR, 4V.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 MΩ input impedance (Tektronix DM501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with a readout-equipped 7000-series Oscilloscope).

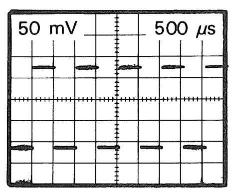
Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 1 MΩ input impedance and at least 60 MHz bandwidth. (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with a 10X probe.) A 7A-series vertical amplifier plug-in was installed in the 7104 B HORIZ compartment and the CALIBRATOR output was connected to the vertical amplifier input. The B INTENSITY control and Vertical Amplifier was set to display 6 to 8 horizontal divisions on the 7104. The test oscilloscope was externally triggered on the +Slope of the CALIBRATOR signal.

1



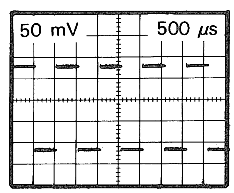
0 V

2



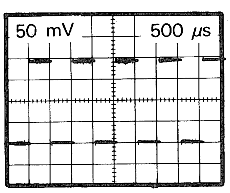
0 V

3

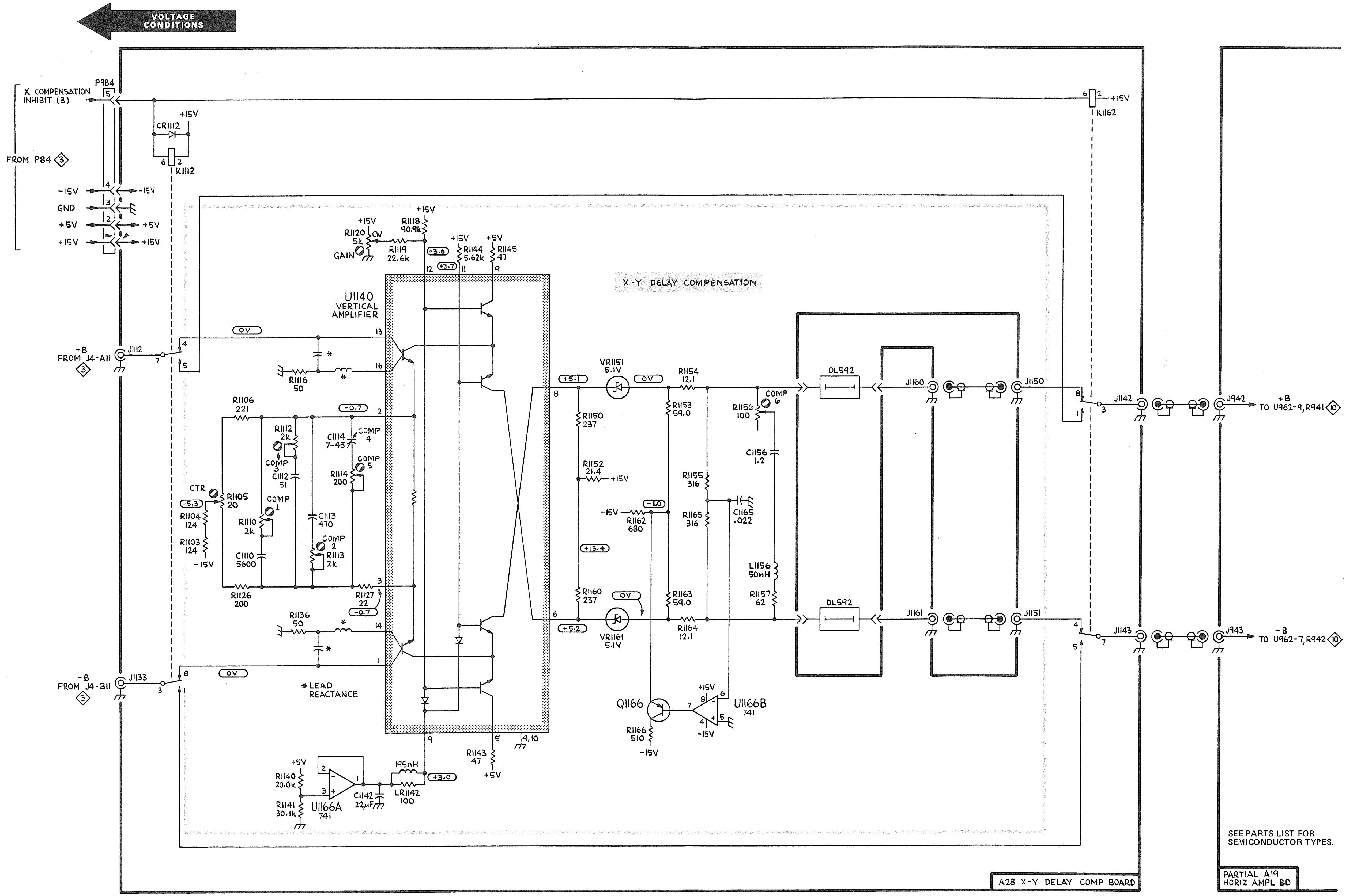


0 V

4



0 V


VOLTAGE CONDITIONS
X COMPENSATION INHIBIT (B)
P984
FROM P84 3
-15V
GND
+5V
+15V
CR1112
K1112
K1162
+B FROM J4-A11 3
J1112
-B FROM J4-B11 3
J1133
U1140 VERTICAL AMPLIFIER
X-Y DELAY COMPENSATION
R1118 90.9k
R1120 5k
GAIN
R1119 22.6k
R1144 5.62k
R1145 47
R1116 50
R1106 221
R1112 2k
COMP 3
C1112 51
C1114 7-45
COMP 4
COMP 5
R1114 200
CTR
R1105 20
R1104 124
R1103 124
COMP 1
R1110 2k
C1110 5600
C1113 470
COMP 2
R1113 2k
R1126 200
R1127 22
R1136 50
* LEAD REACTANCE
R1140 20.0k
R1141 30.1k
U1166A 741
C1142 22µF
195nH
LR1142 100
R1143 47
VR1151 5.1V
R1154 12.1
R1150 237
R1153 59.0
R1156 100
COMP 6
C1156 1.2
R1152 21.4
R1155 316
R1162 680
R1165 316
C1165 .022
L1156 50nH
R1157 62
R1160 237
R1163 59.0
VR1161 5.1V
R1164 12.1
Q1166
R1166 510
U1166B 741
DL592
J1160
J1150
J1161
J1151
J1142
J1143
J942
J943
+B TO U962-9, R941 10
-B TO U962-7, R942 10
SEE PARTS LIST FOR SEMICONDUCTOR TYPES.
A28 X-Y DELAY COMP BOARD
PARTIAL A19 HORIZ AMPL BD

7104 TROUBLESHOOTING CHART

TROUBLESHOOTING CHART INSTRUCTIONS:

1. Beginning at the top left block of the chart proceed downward until the 7104 does not perform as indicated.
2. Then follow the dashed line as the symptom indicates. Each shaded block indicates a circuit which may be the cause of the malfunction. Refer to Section 3, Theory of Operation, for a detailed discussion of the circuit, and Section 8, Diagrams and Circuit Board Illustrations, for the circuit schematic.

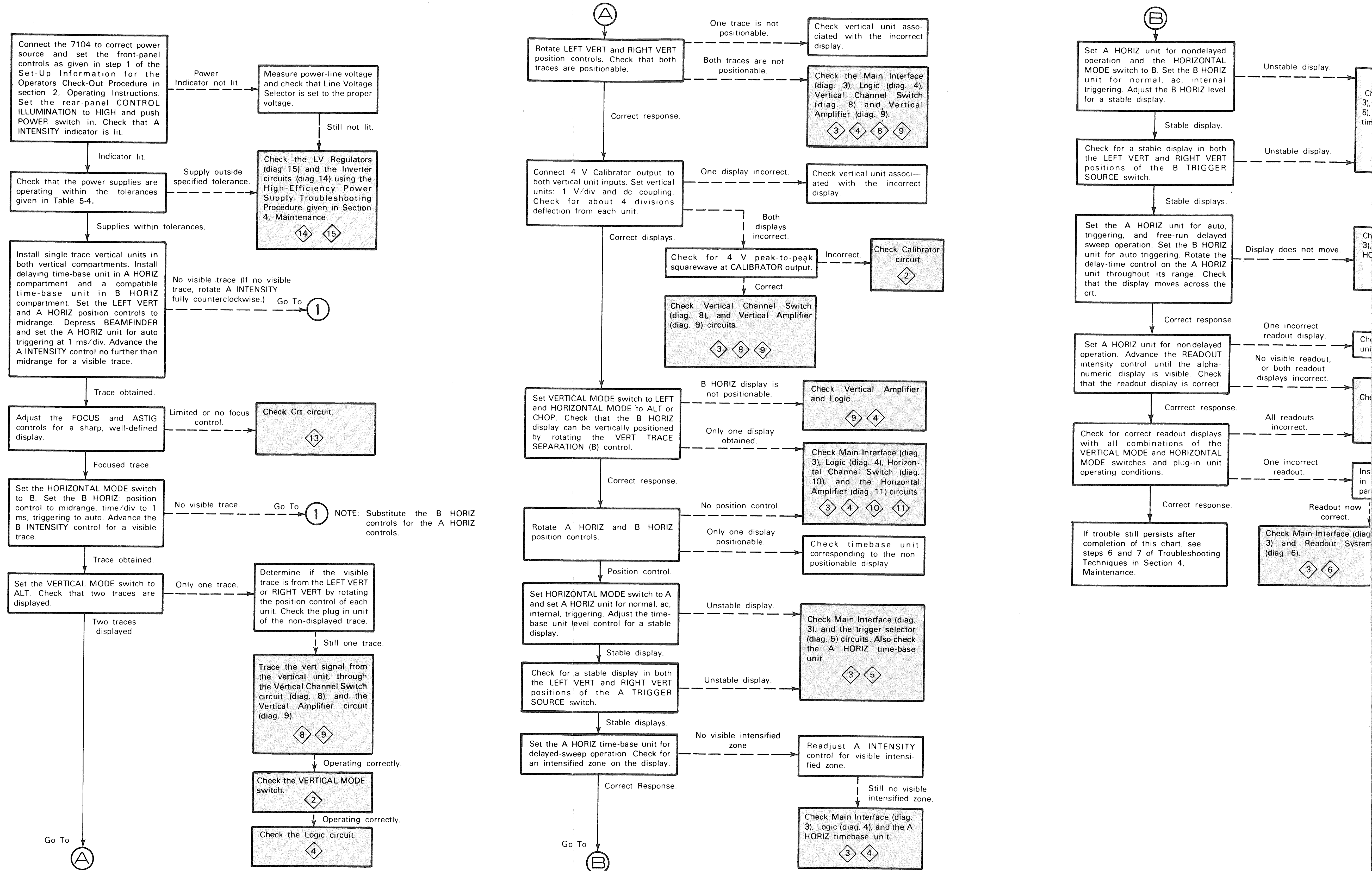
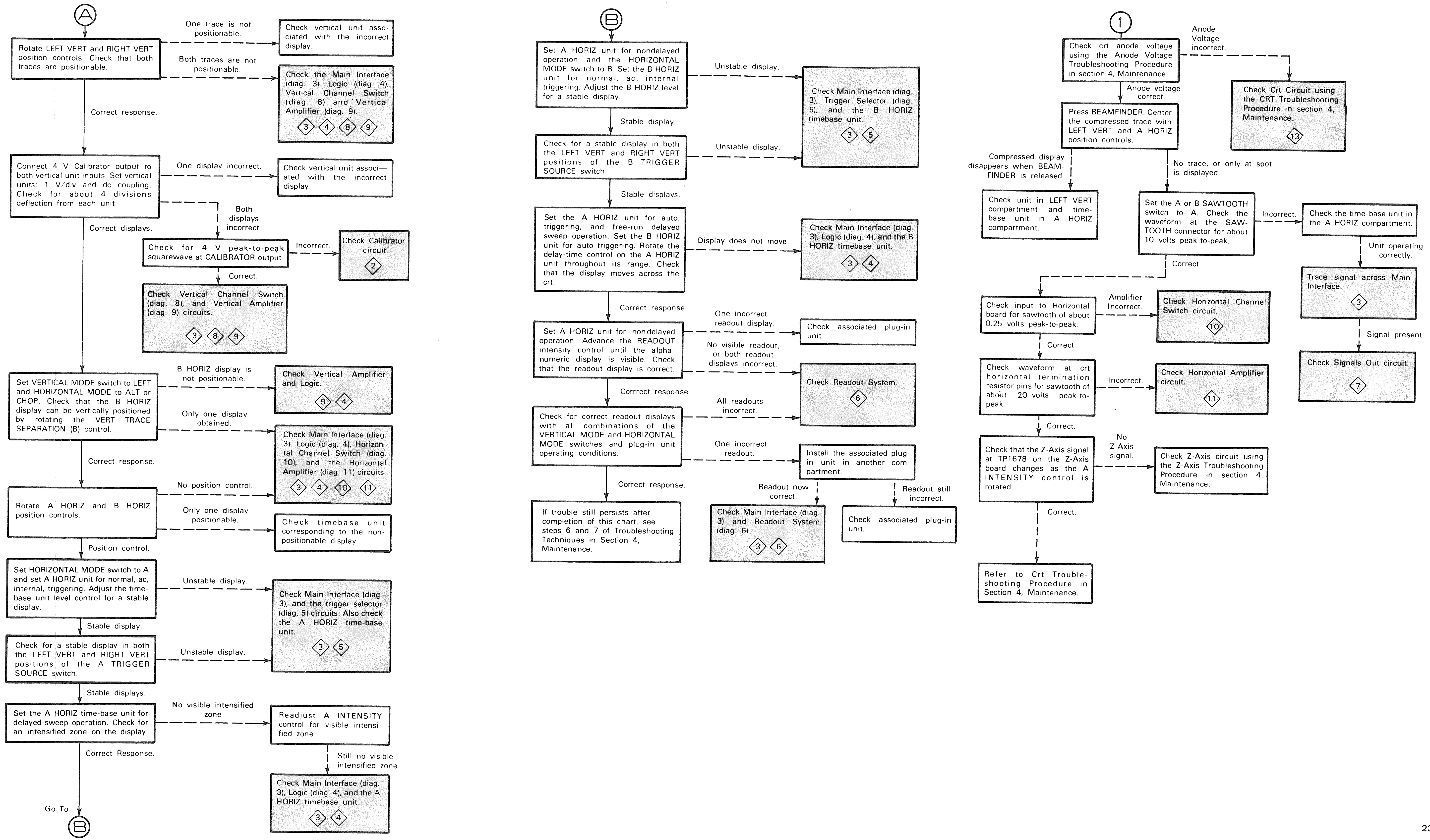


Figure 8-24. 7104 Troubleshooting Chart.

d.
the cause of the malfunction. Refer to Section 3,
strations, for the circuit schematic.

7104 TROUBLESHOOTING CHART



ORIZ
ORIZ

TROUBLESHOOTING CHART

2314-24A

Figure 8-24. 7104 Troubleshooting Chart.

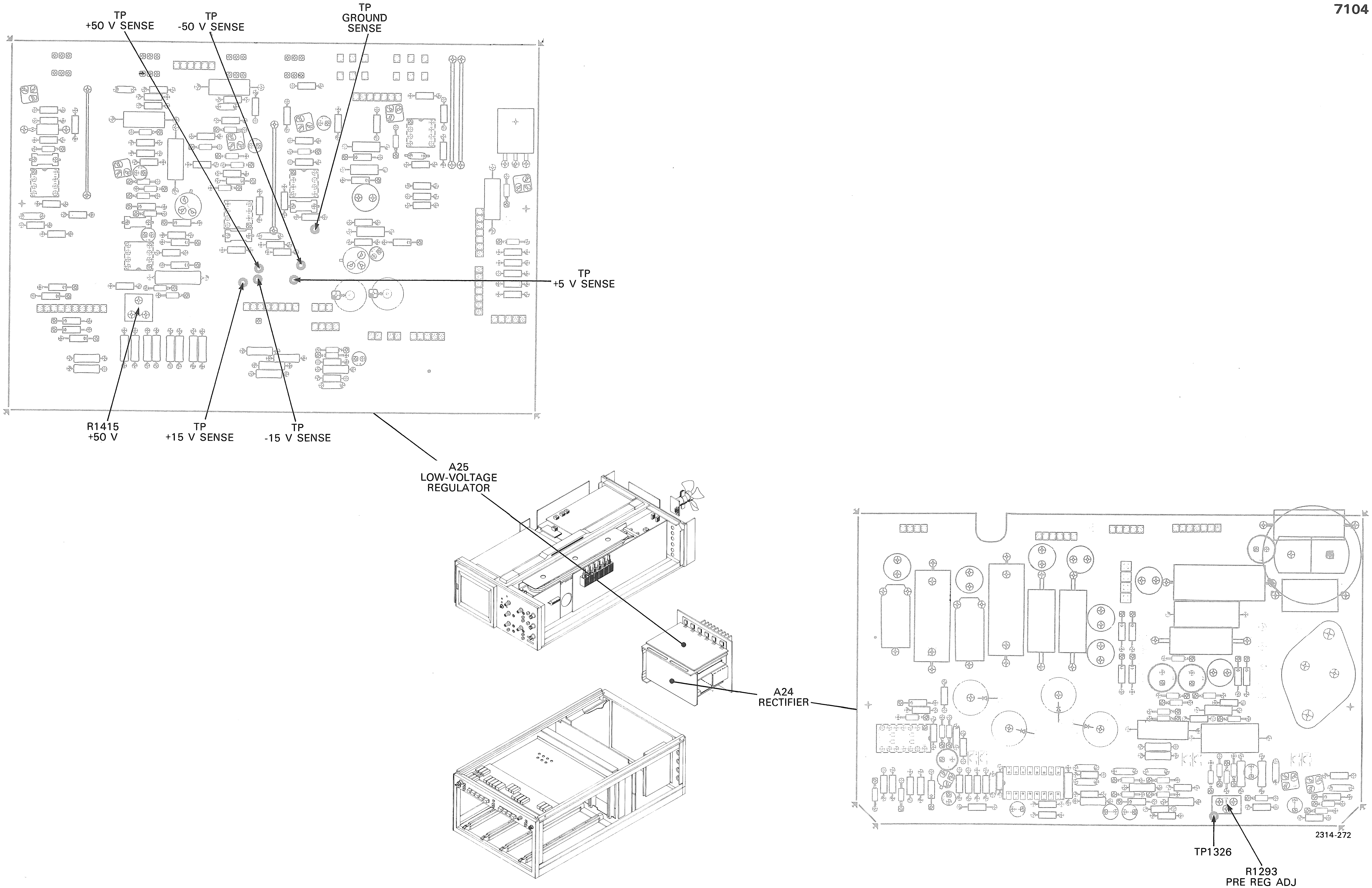


Figure 8-25. Test Point and Adjustment Locations A.

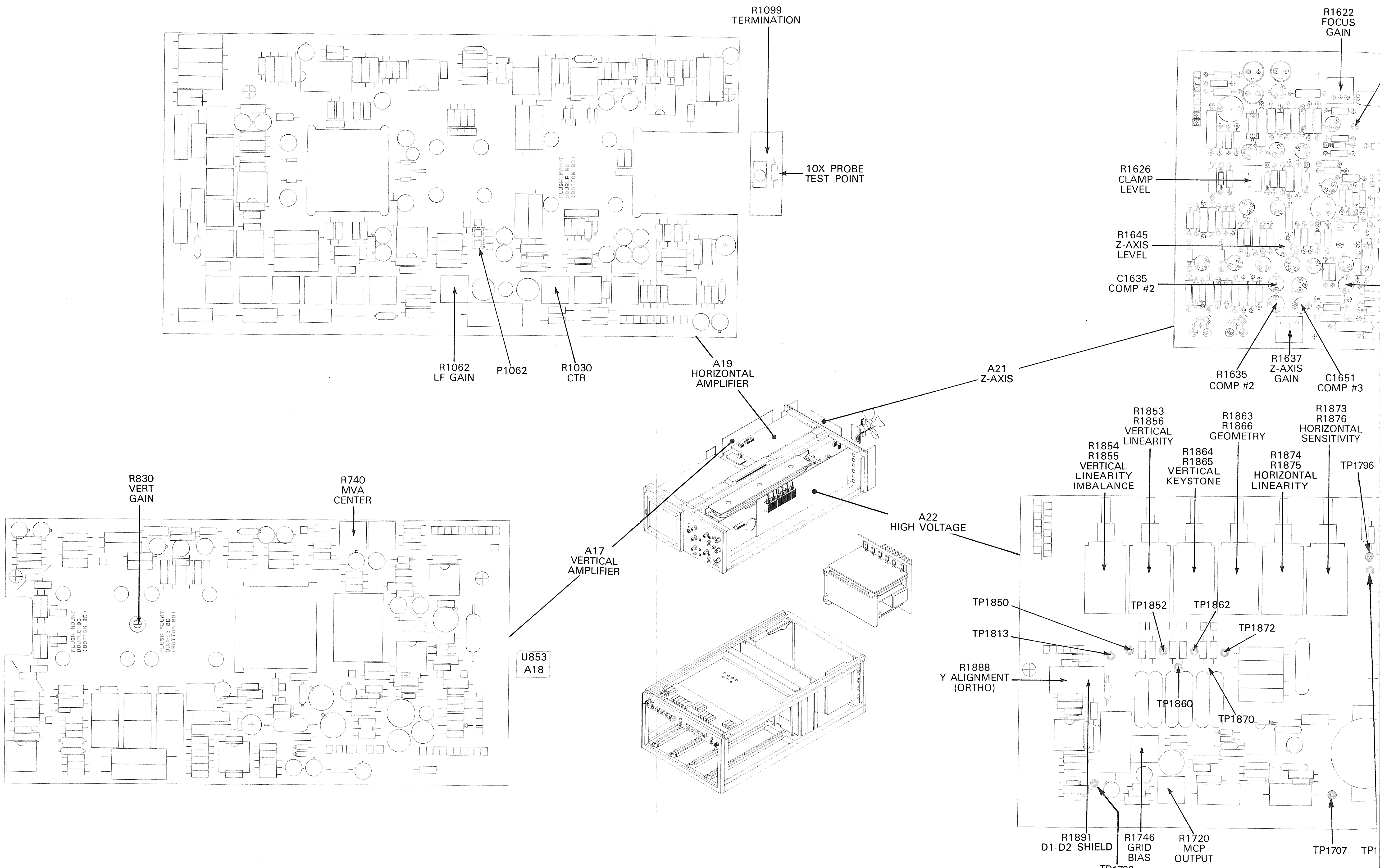


Figure 8-26. Test Point and Adjustment Locations B.

REV FEB 1988

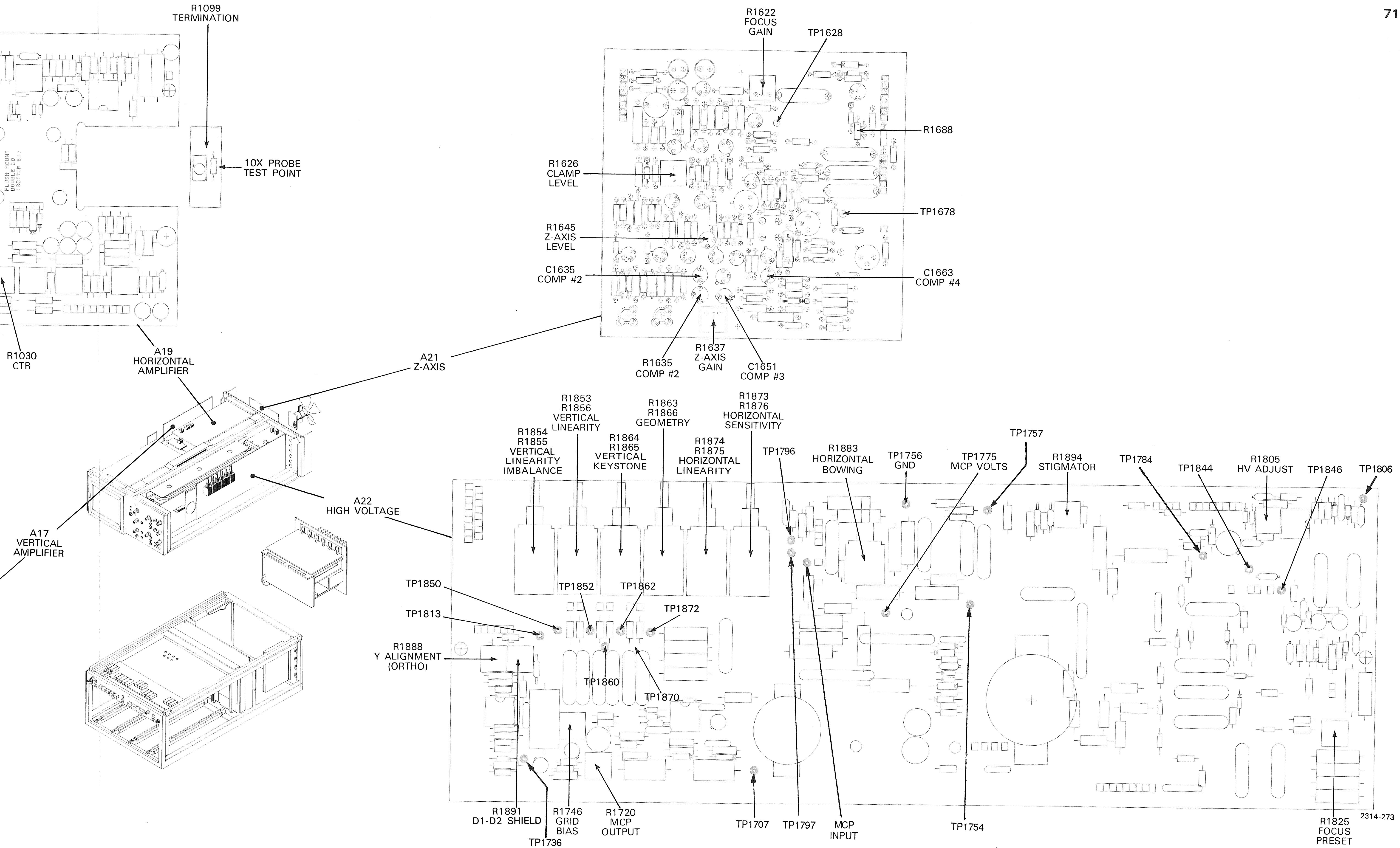
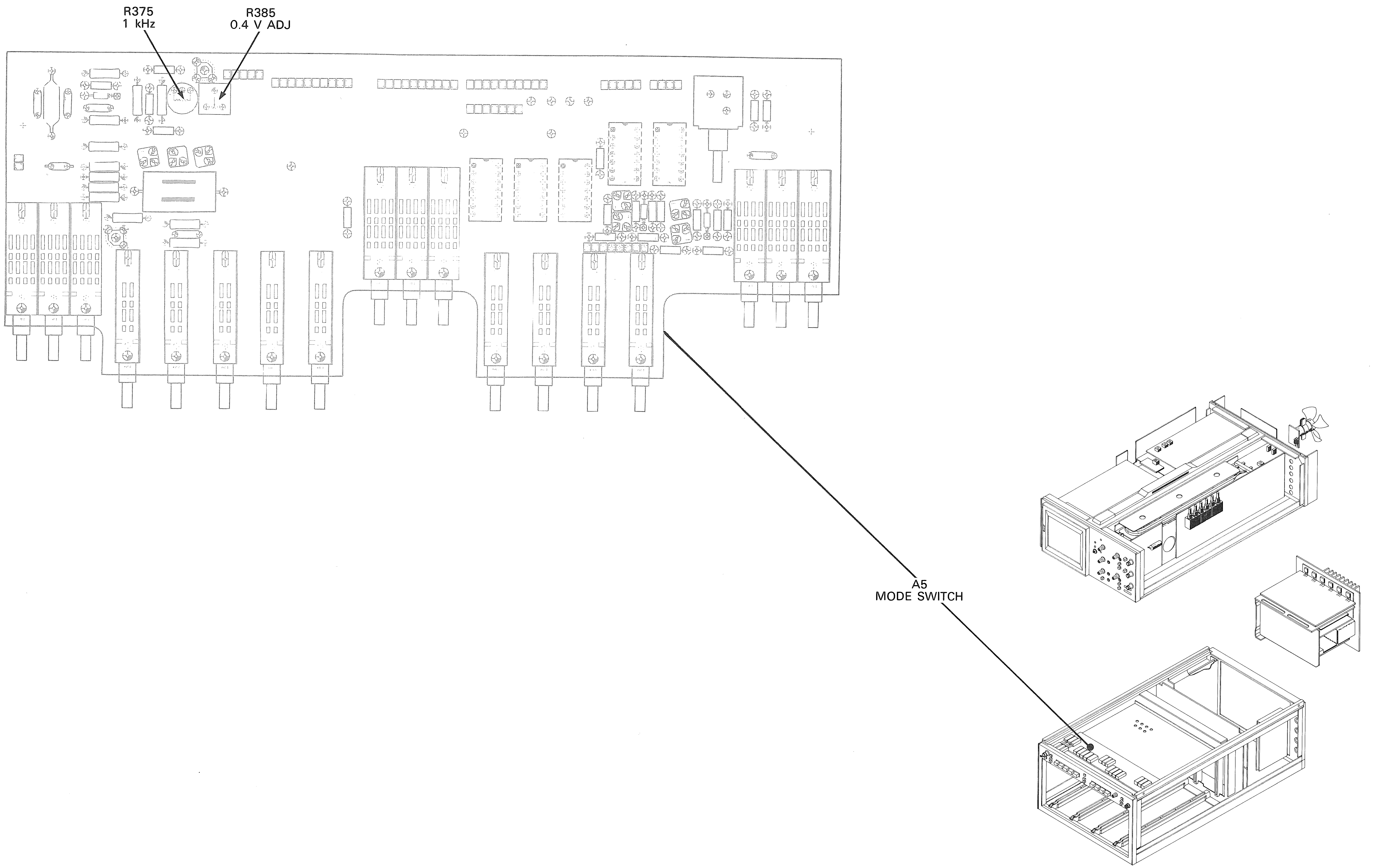


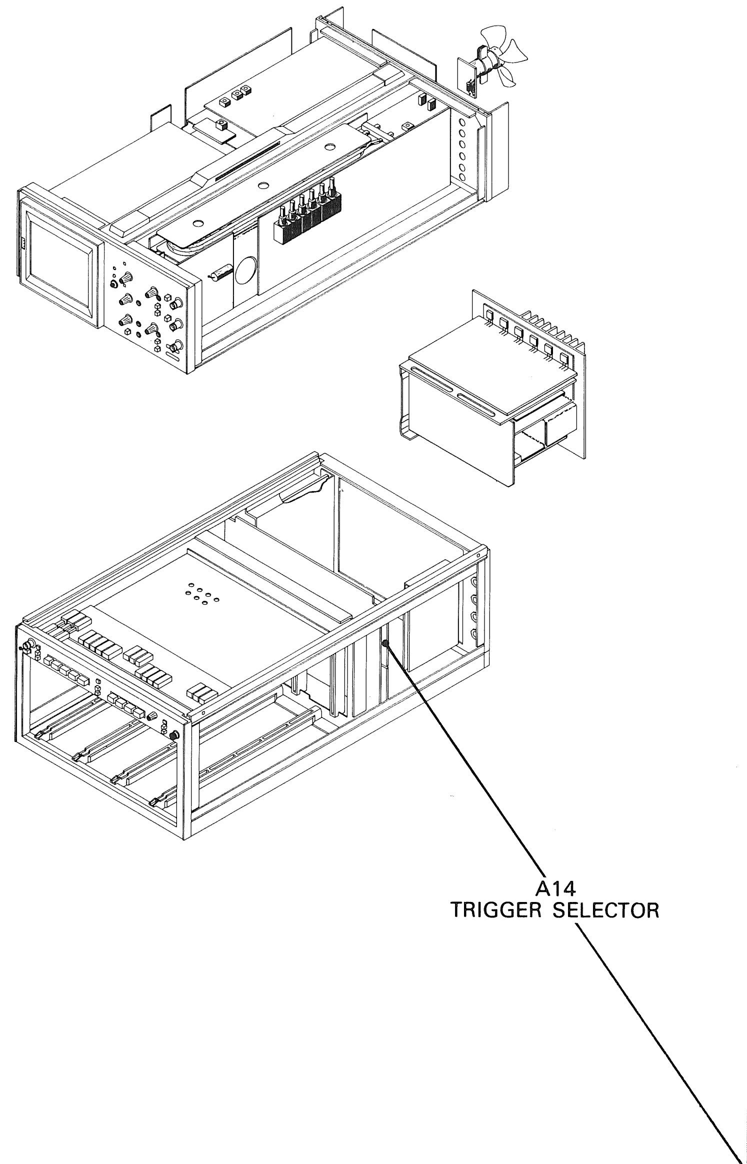
Figure 8-26. Test Point and Adjustment Locations B.

REV FEB 1988



2314-274

Figure 8-27. Test Point and Adjustment Locations C.



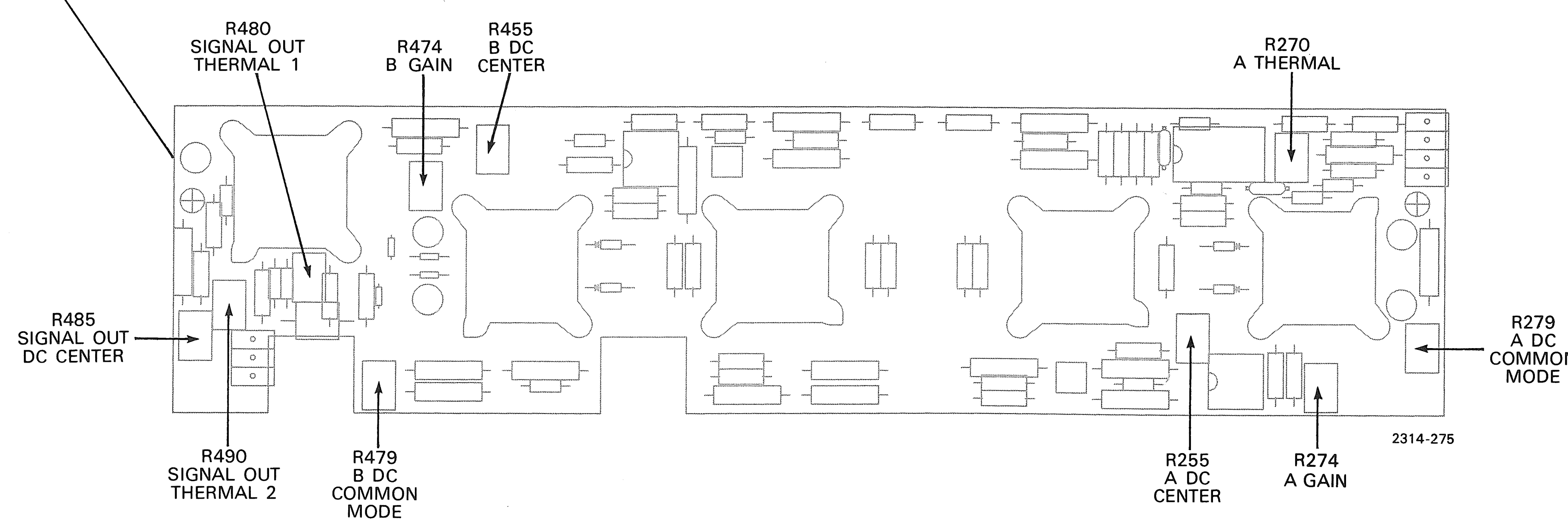


Figure 8-28. Test Point and Adjustment Locations D.

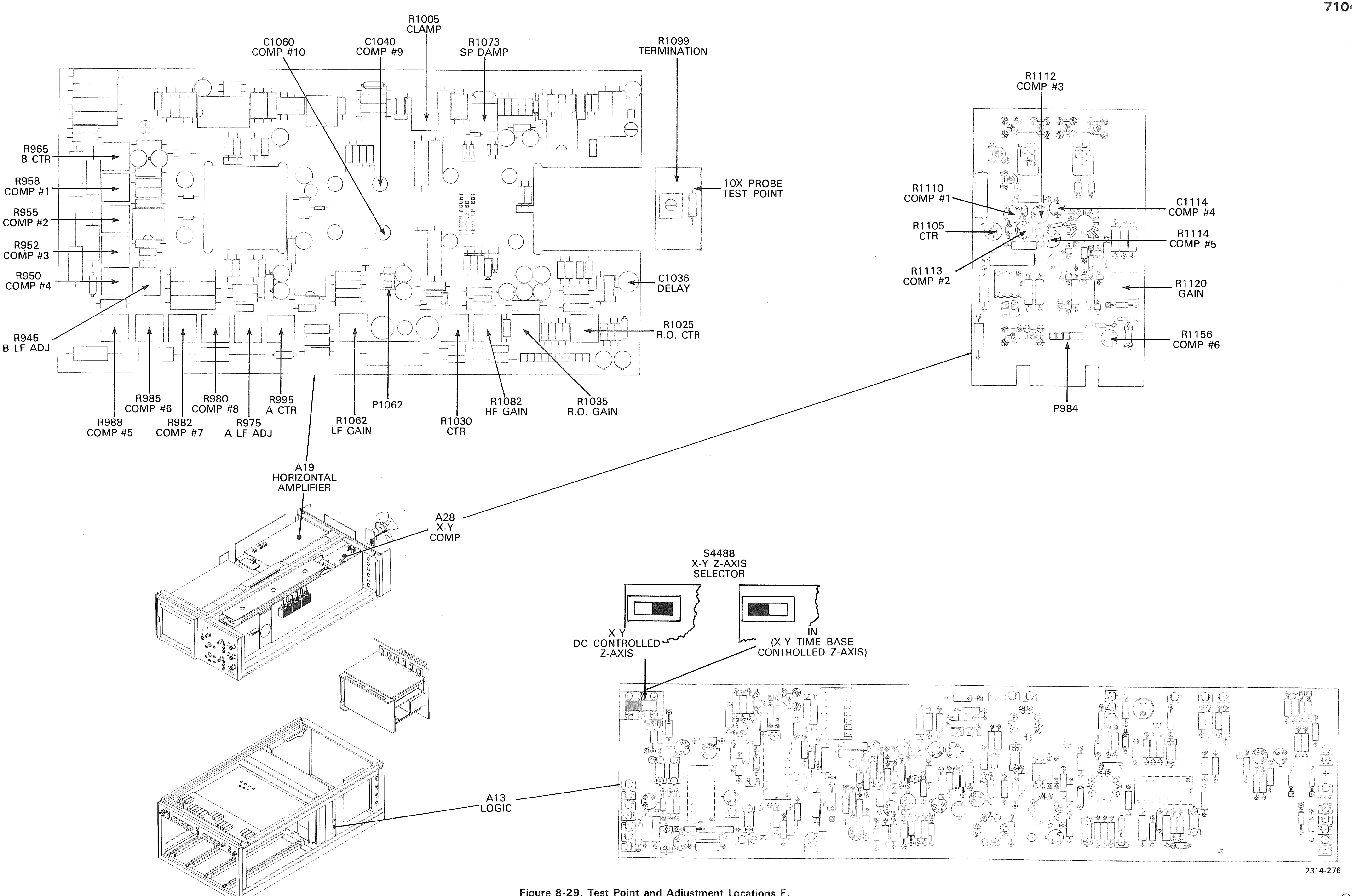


Figure 8-29. Test Point and Adjustment Locations E.

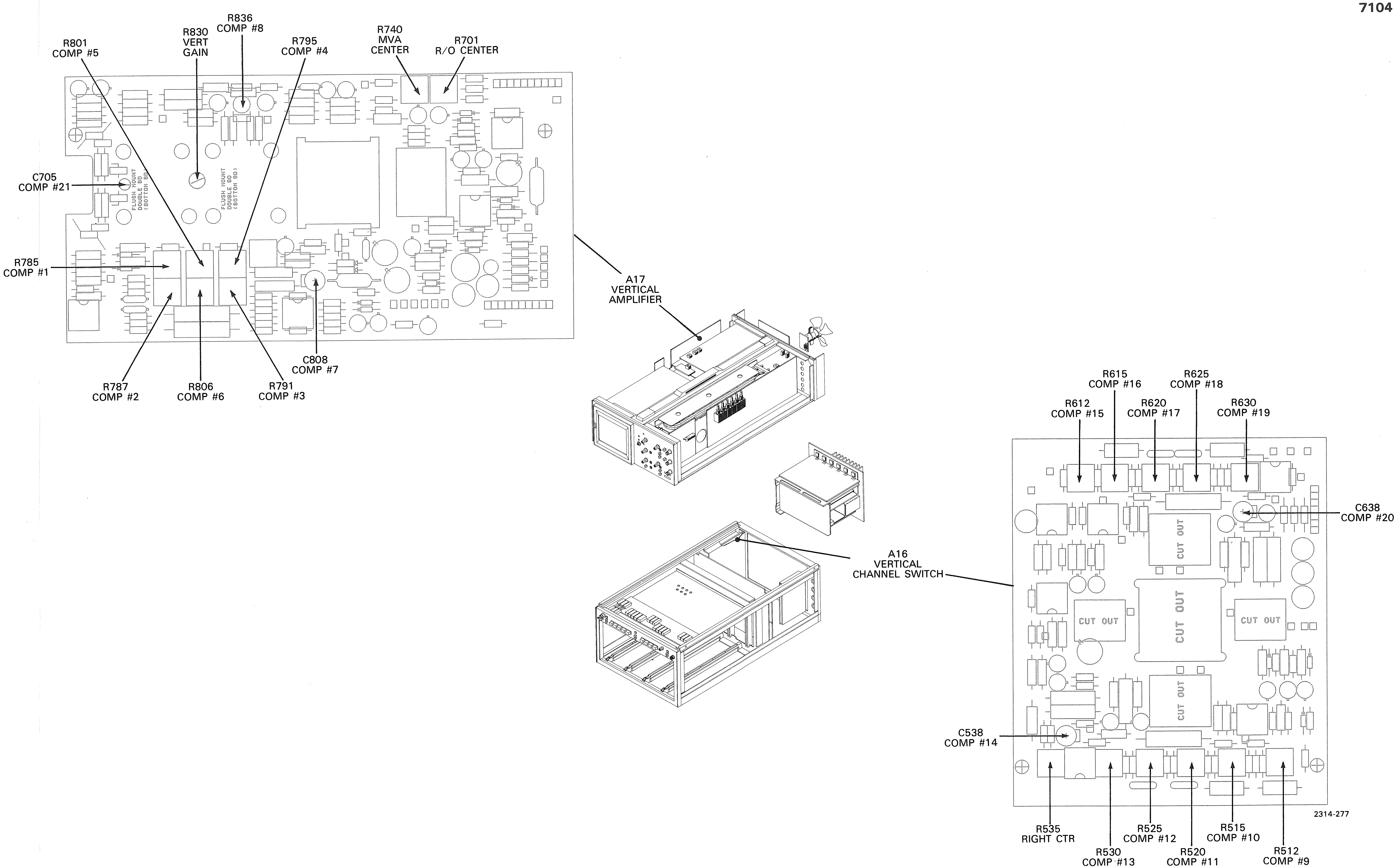


Figure 8-30. Test Point and Adjustment Locations F.

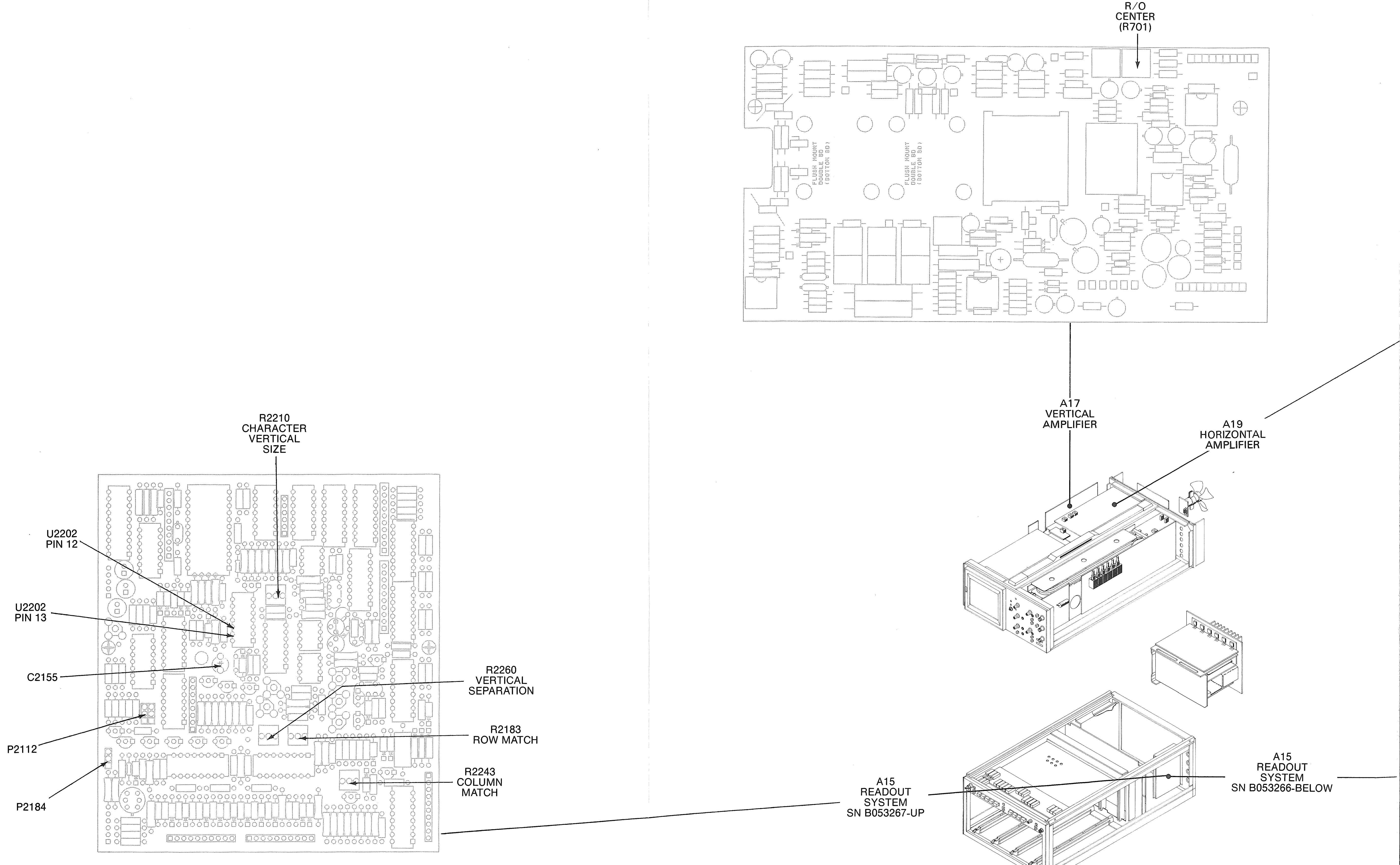
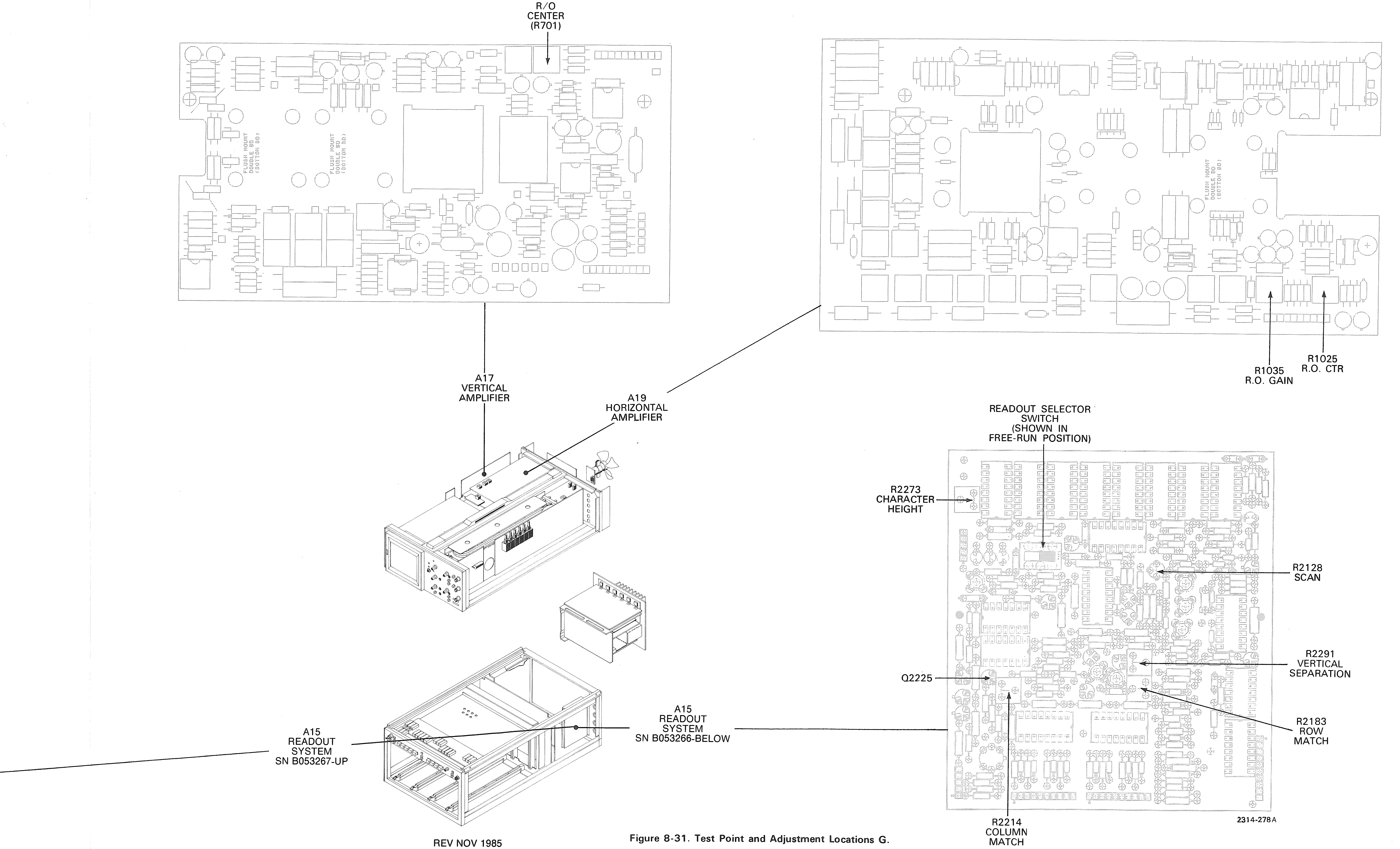


Figure 8-31. Test Point and Adj



REV NOV 1985

Figure 8-31. Test Point and Adjustment Locations G.

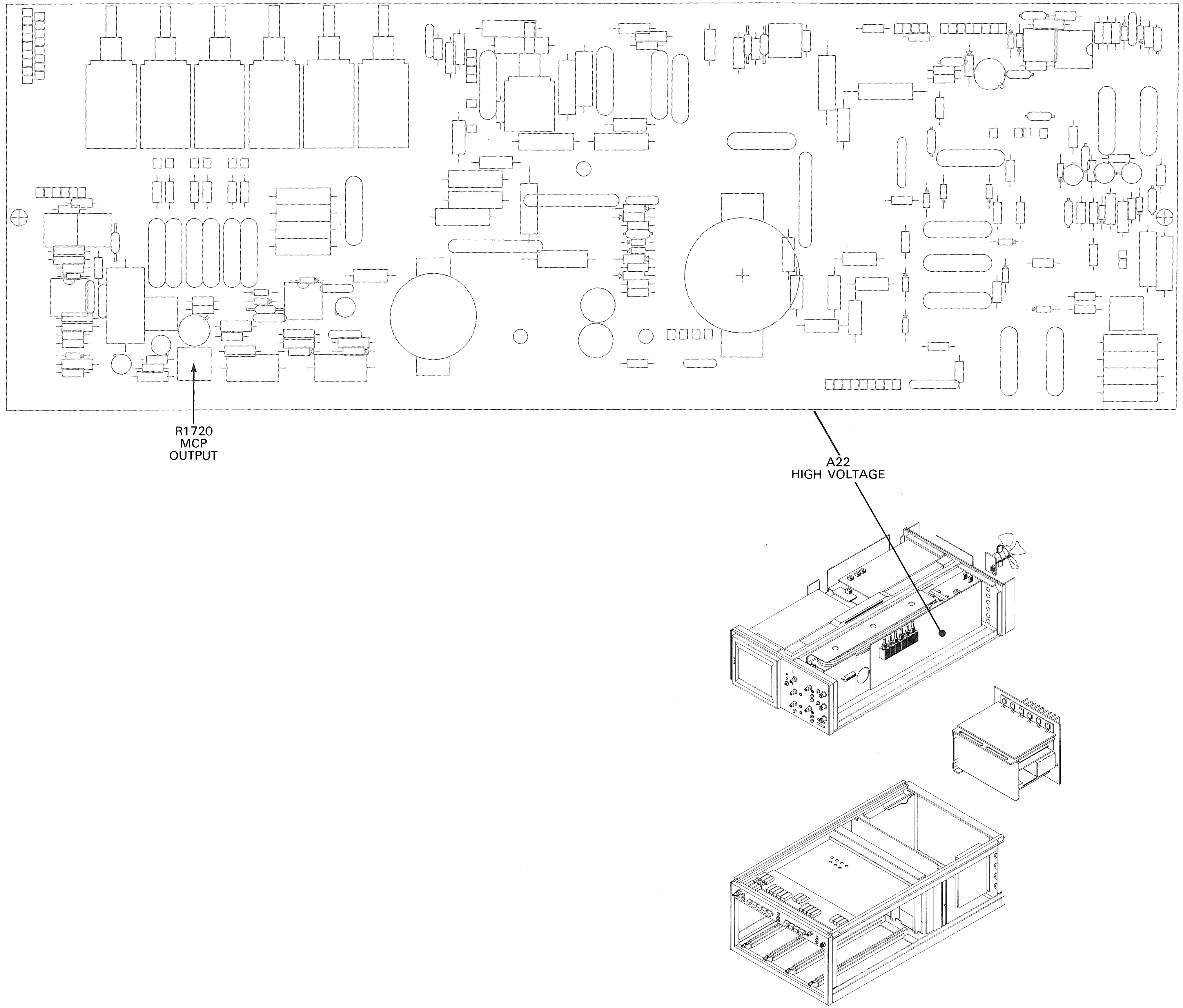


Figure 8-32. Test Point and Adjustment Locations H.

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

ITEM NAME

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

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
**** END ATTACHING PARTS ****
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
**** END ATTACHING PARTS ****
Parts of Detail Part
Attaching parts for Parts of Detail Part
**** END ATTACHING PARTS ****

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Attaching parts must be purchased separately, unless otherwise specified.

ABBREVIATIONS

"	INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
#	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICOND	SEMICONDUCTOR
ADPTR	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
ALIGN	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL	ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEM	ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ASSY	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVING
AWG	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD	BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS	CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP	COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDENT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC	2800 FULLING MILL PO BOX 3608	HARRISBURG PA 17105
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPY PO BOX 655012	DALLAS TX 75265
01536	TEXTRON INC CAMCAR DIV SEMS PRODUCTS UNIT	1818 CHRISTINA ST	ROCKFORD IL 61108
02768	ILLINOIS TOOL WORKS INC FASTEX DIVISION	195 ALGONQUIN ROAD	DES PLAINES IL 60016-6103
04963	MINNESOTA MINING AND MFG CO ADHESIVES COATINGS AND SEALERS DIV	3M CENTER	ST PAUL MN 55101-1428
06383	PANDUIT CORP	17301 RIDGELAND	TINLEY PARK IL 07094-2917
06915	RICHCO PLASTIC CO	5825 N TRIPP AVE	CHICAGO IL 60646-6013
06950	SCREWCORP VSI AEROSPACE PRODUCTS DIV SUB OF FAIRCHILD INDUSTRIES INC	13001 E TEMPLE AVE PO BOX 730	CITY OF INDUSTRY CA 91746-1417
07707	USM CORP SUB OF EMHART INDUSTRIES INC USM FASTENER DIV	510 RIVER RD	SHELTON CT 06848-4517
08261	SPECTRA-STRIP AN ELTRA CO	7100 LAMPSON AVE	GARDEN GROVE CA 92642
09772	WEST COAST LOCKWASHER CO INC	16730 E JOHNSON DRIVE P O BOX 3588	CITY OF INDUSTRY CA 91744
09922	BURNDY CORP	RICHARDS AVE	NORWALK CT 06852
11897	PLASTIGLIDE MFG CORP	2701 W EL SEGUNDO BLVD	HAWTHORNE CA 90250-3318
12327	FREEWAY CORP	9301 ALLEN DR	CLEVELAND OH 44125-4632
13103	THERMALLOY CO INC	2021 W VALLEY VIEW LN PO BOX 810839	DALLAS TX 75381
13511	AMPHENOL CADRE DIV BUNKER RAMO CORP		LOS GATOS CA
16428	COOPER BELDEN ELECTRONIC WIRE AND CA SUB OF COOPER INDUSTRIES INC	NW N ST	RICHMOND IN 47374
18565	CHOMERICS INC	77 DRAGON COURT	WOBURN MA 01801-1039
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS DIV MILITARY PRODUCTS GROUP	515 FISHING CREEK RD	NEW CUMBERLAND PA 17070-3007
24546	CORNING GLASS WORKS	550 HIGH ST	BRADFORD PA 16701-3737
24931	SPECIALTY CONNECTOR CO INC	2100 EARLYWOOD DR PO BOX 547	FRANKLIN IN 46131
26365	GRIES DYNACAST CO DIV OF COATS AND CLARK INC	125 BEECHWOOD AVE	NEW ROCHELLE NY 10802
28205	TAR HEEL MICA CO INC THE	HWY 19 E BOX 8	PLUMTREE NC 28664
28520	HEYCO MOLDED PRODUCTS	750 BOULEVARD P O BOX 160	KENILWORTH NJ 07033-1721
34785	DEK INC	3480 SWENSON AVE	ST CHARLES IL 60174-3450
46384	PENN ENGINEERING AND MFG CORP	OLD EASTON RD PO BOX 1000	DANBORO PA 18916
52792	THORGREN TOOL AND MOLDING CO INC	1100 EVANS AVE PO BOX 210	VALPARAISO IN 46383-3717
70485	ATLANTIC INDIA RUBBER WORKS INC	571 W POLK ST	CHICAGO IL 60607
70903	COOPER BELDEN ELECTRONICS WIRE AND C SUB OF COOPER INDUSTRIES INC	2000 S BATAVIA AVE	GENEVA IL 60134-3325
71159	BRISTOL SOCKET SCREW CO		WATERBURY CT
71279	INTERCONNECTION PRODUCTS INC	2601 S GARNSEY ST	SANTA ANA CA 92707-3338
71590	MEPCO/CENTRALAB INC A NORTH AMERICAN PHILIPS CO	HWY 20 W PO BOX 858	FORT DODGE IA 50501
71785	CINCH CONNECTORS	1501 MORSE AVE	ELK GROVE VILLAGE IL 60007-5723
73743	FISCHER SPECIAL MFG CO	111 INDUSTRIAL RD	COLD SPRING KY 41076-9749
74445	HOLO-KROME CO	31 BROOK ST	ELMWOOD CT 06110-2350
75915	LITTELFUSE INC SUB TRACOR INC	800 E NORTHWEST HWY	DES PLAINES IL 60016-3049
77900	ILLINOIS TOOL WORKS SHAKEPROOF DIV	ST CHARLES RD	ELGIN IL 60120
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF DIV	ST CHARLES ROAD	ELGIN IL 60120

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077-0001
80033	MICRODOT MFG INC PRESTOLE EVERLOCK DIV	1345 MIAMI ST P O BOX 278	TOLEDO OH 43605
81350	JOINT ARMY-NAVY SPECIFICATIONS, PROMULGATED BY MILITARY DEPARTMENTS UNDER AUTHORITY OF DEFENSE STANDARD-IZATION MANUAL 4120 3-M		
83385	MICRODOT MFG INC GREER-CENTRAL DIV	3221 W BIG BEAVER RD	TROY MI 48098
83553	ASSOCIATED SPRING BARNES GROUP INC	15001 S BROADWAY P O BOX 231	GARDENA CA 90248-1819
85471	BOYD CORP	13885 RAMOMA AVE	CHINO CA 91710
85480	BRADY W H CO CORP H Q INDUSTRIAL PRODUCTS DIV	2221 W CAMDEN RD PO BOX 2131	MILWAUKEE WI 53209
86928	SEASTROM MFG CO INC	701 SONORA AVE	GLENDALE CA 91201-2431
87308	FARLEY METALS INC SOUTHERN SCREW DIV	BARKLEY RD P O BOX 1360	STATESVILLE NC 28677-9774
91500	ASHEVILLE-SCHOONMAKER MICA CO	910 JEFFERSON AVE P O BOX 318	NEWPORT NEWS VA 23607-6120
91836	KINGS ELECTRONICS CO INC	40 MARBLEDALE ROAD	TUCKAHOE NY 10707-3420
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61108-5181
95987	BRADY/WECKESSER MFG CO	4444 WEST IRVING PARK RD	CHICAGO IL 60641
98159	RUBBER TECK INC	19115 HAMILTON AVE PO BOX 389	GARDENA CA 90247
98978	INTERNATIONAL ELECTRONIC RESEARCH CORP	135 W MAGNOLIA BLVD PO BOX 7704	BURBANK CA 91502
S3109	FELLER	ASA ADOLF AG STOTZWEID CH8810	HORGEN SWITZERLAND
S3629	SCHURTER AG H C/O PANEL COMPONENTS CORP	2015 SECOND STREET	BERKELEY CA 94170
TK0392	NORTHWEST FASTENER SALES INC	7923 SW CIRRUS DRIVE	BEAVERTON OR 97005-6448
TK0401	SOUND MFG INC	5438 S 228TH PO BOX 280	KENT WA 98031
TK0433	PORTLAND SCREW CO	6520 N BASIN	PORTLAND OR 97217-3920
TK0435	LEWIS SCREW CO	4300 S RACINE AVE	CHICAGO IL 60609-3320
TK0861	H SCHURTER AG DIST PANEL COMPONENTS	2015 SECOND STREET	BERKELEY CA 94170
TK1281	MICRO PLASTICS INC	HWY 178 NORTH	FLIPPIN AR 72634
TK1316	BOYD CORP	6136 NE 87TH AVE PO BOX 20038	PORTLAND OR 97220
TK1373	PATELEC-CEM (ITALY)	10156 TORINO	VAICENTALLO 62/45S ITALY
TK1465	BEAVERTON PARTS MFG CO	1800 NW 216TH AVE	HILLSBORO OR 97124-6629
TK1543	CAMCAR/TEXTRON	600 18TH AVE	ROCKFORD IL 61108-5181
TK2165	TRIQUEST CORP	3000 LEWIS AND CLARK HWY	VANCOUVER WA 98661-2999
TK2278	COMTEK MANUFACTURING OF OREGON (METALS)	PO BOX 4200	BEAVERTON OR 97076-4200

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-1	390-0605-00			1	CAB.SIDE,SCOPE:LEFT	80009	390-0605-00
-2	386-1151-00			2	.CLAMP,RIM CLENC:SPG STL CD PL	83553	ORDER BY DESCR
-3	386-0227-00			4	.STOP,CLP,RIM CL:	80009	386-0227-00
-4	214-0604-00			4	.WASHER,SPR TNSN:0.26 ID X 0.47 OD,SST	80009	214-0604-00
-5	214-0603-01			4	.PIN,SECURING:0.45 DIA X 0.27,ZAMAK CD PL	80009	214-0603-01
-6	390-0603-00			1	CAB.SIDE,SCOPE:RIGHT	80009	390-0603-00
-7	348-0080-01			1	.FOOT,CABINET:CHARCOAL GRAY,POLYURETHANE	80009	348-0080-01
-8	386-1151-00			4	.CLAMP,RIM CLENC:SPG STL CD PL	83553	ORDER BY DESCR
-9	386-0227-00			4	.STOP,CLP,RIM CL:	80009	386-0227-00
-10	214-0604-00			4	.WASHER,SPR TNSN:0.26 ID X 0.47 OD,SST	80009	214-0604-00
-11	214-0603-01			4	.PIN,SECURING:0.45 DIA X 0.27,ZAMAK CD PL	80009	214-0603-01
-12	200-0728-00			2	COVER,HDL END:1.91 X 0.91 X 0.36 BLUE	80009	200-0728-00
-13	367-0108-00			1	HANDLE,CARRYING:19.19 L,BLUE VINYL	80009	367-0108-00
					(ATTACHING PARTS)		
-14	212-0628-00			4	SCREW,SHOULDER:10-32 X 0.4 L,RDH,STL	TK1543	ORDER BY DESCR
-15	386-1624-00			2	PLATE,HDL RTNG:STAINLESS STEEL	80009	386-1624-00
					(END ATTACHING PARTS)		
-16	386-1283-01			2	PLATE,HDL MTG:FRONT	80009	386-1283-01
-17	426-0819-00	B010100	B032289	1	FRAME SECT,CAB.:TOP CENTER	80009	426-0819-00
	426-0819-01	B032290		1	FRAME SECT,CAB.:TOP CENTER	80009	426-0819-01
					(ATTACHING PARTS)		
-18	211-0507-00			4	SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
-19	348-0193-00			1	FLIP-STAND,CAB.:3.438 H,SST	80009	348-0193-00
-20	348-0073-01			2	HINGE BLOCK,STA:L FR,R REAR,BLACK ACETAL	80009	348-0073-01
					(ATTACHING PARTS)		
-21	210-0457-00			4	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
-22	211-0532-00			4	SCREW,MACHINE:6-32 X .750,FILH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-23	348-0074-01			2	HINGE BLOCK,STA:R FR,L REAR,BLACK ACETAL	80009	348-0074-01
					(ATTACHING PARTS)		
-24	210-0457-00			4	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
-25	211-0532-00			4	SCREW,MACHINE:6-32 X .750,FILH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-26	377-0119-00			4	INSERT,FOOT:0.352 X 0.832 X 0.934,PU	80009	377-0119-00
-27	343-0256-00			2	RTNR BLK,SCOPE:PLASTIC	80009	343-0256-00
					(ATTACHING PARTS)		
-28	210-0457-00			4	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
-29	213-0192-00			4	SCREW,TPG,TF:6-32 X 0.5,SPCL TYPE,FILH,STL	87308	ORDER BY DESCR
					(END ATTACHING PARTS)		
-30	390-0555-00			1	CAB.BOT,SCOPE:	80009	390-0555-00
-31	386-1151-00			4	.CLAMP,RIM CLENC:SPG STL CD PL	83553	ORDER BY DESCR
-32	386-0227-00			4	.STOP,CLP,RIM CL:	80009	386-0227-00
-33	214-0604-00			4	.WASHER,SPR TNSN:0.26 ID X 0.47 OD,SST	80009	214-0604-00
-34	214-0603-01			4	.PIN,SECURING:0.45 DIA X 0.27,ZAMAK CD PL	80009	214-0603-01
-35	426-0814-00			2	FRAME SECT,CAB.:BOTTOM LEFT & RIGHT	80009	426-0814-00
					(ATTACHING PARTS)		
-36	210-0457-00			4	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
-37	211-0507-00			4	SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		

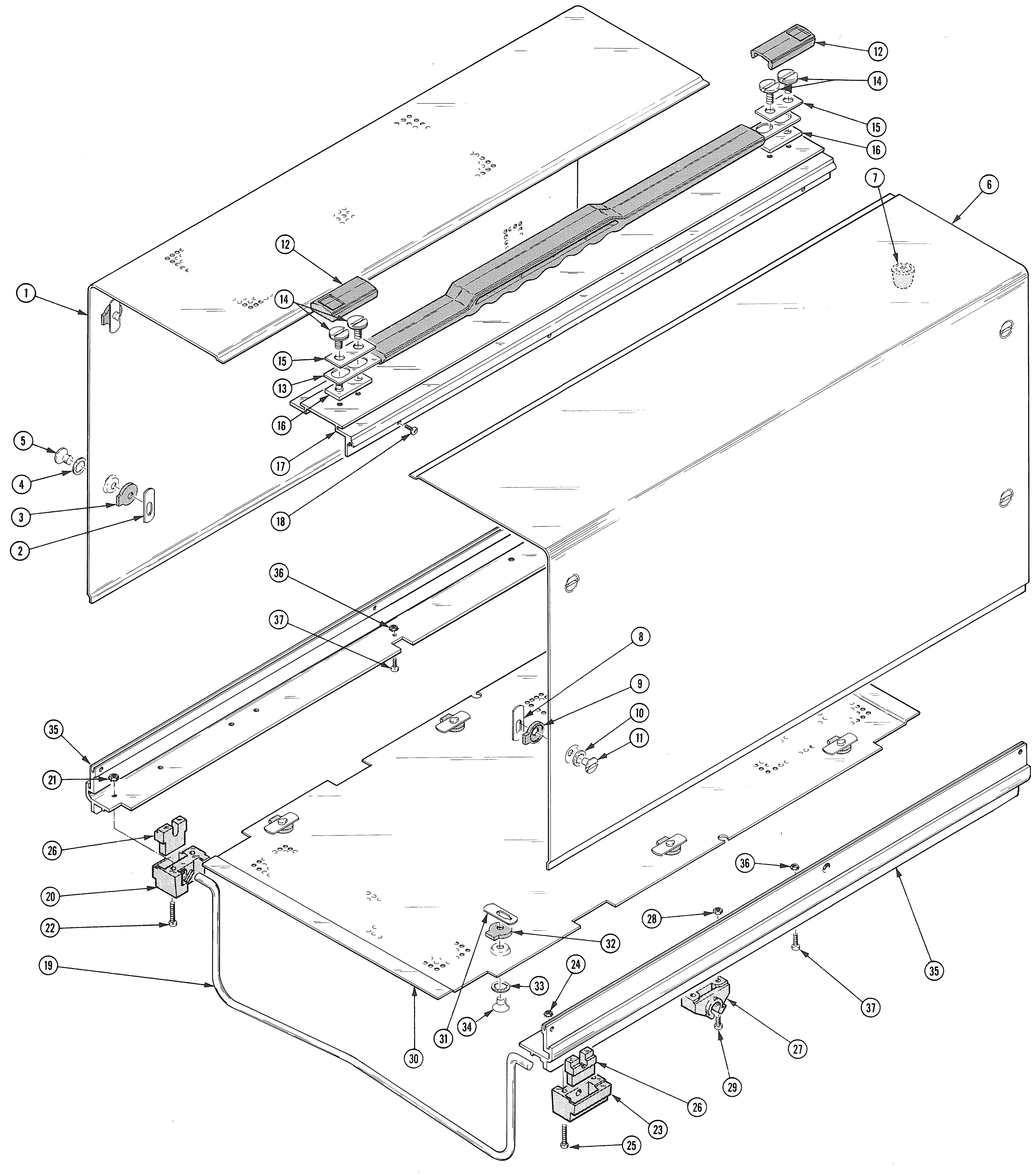

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FIG. 2 UPPER FRONT UNIT & CHASSIS

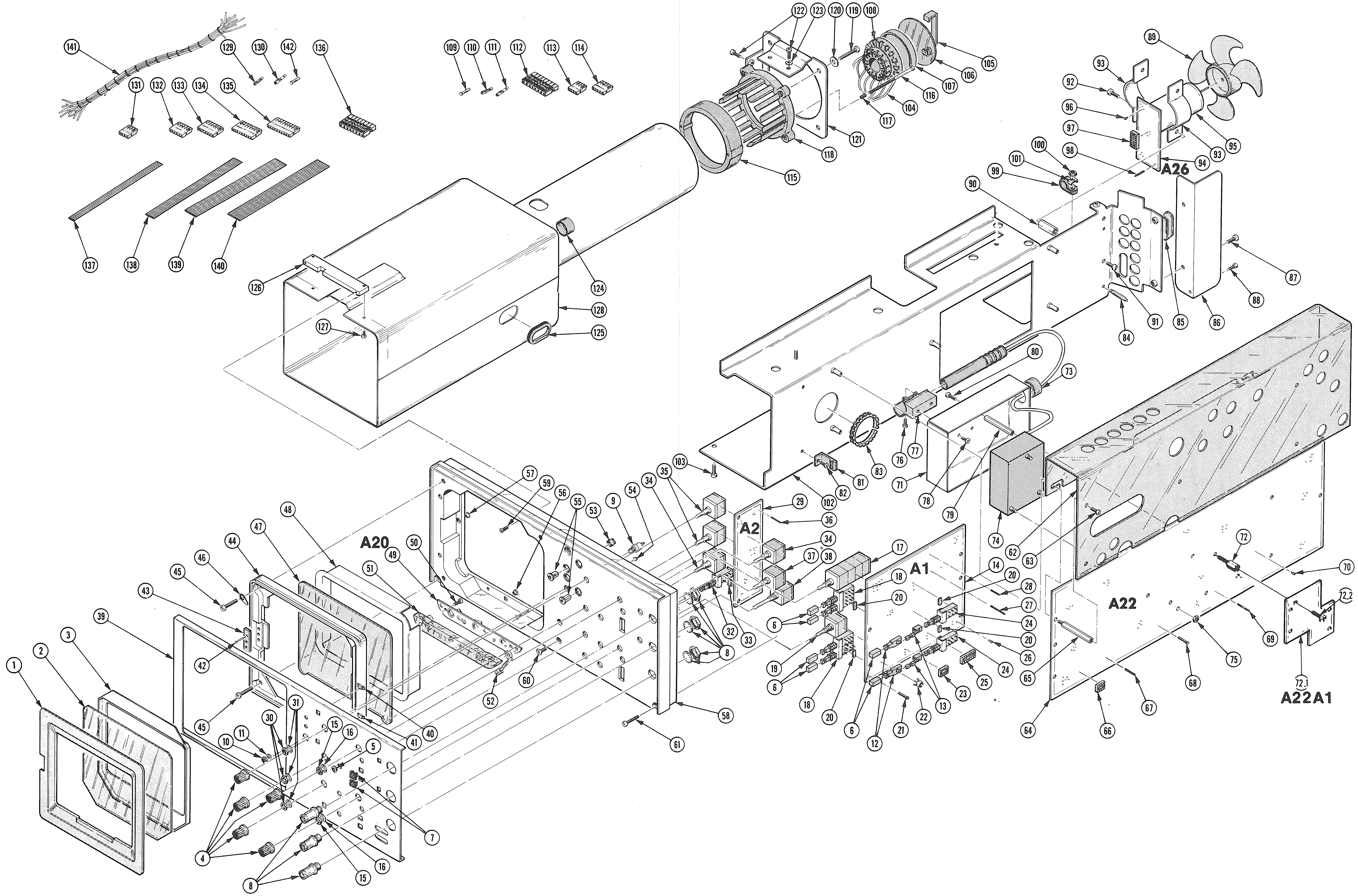

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-1	426-0514-00			1	FRAME,MASK:	80009	426-0514-00
-2	378-0625-00			1	FILTER,LT,CRT:BLUE,5.15 X 4.4 X 0.03	80009	378-0625-00
-3	331-0258-03			1	MASK,CRT SCALE:	80009	331-0258-03
-4	366-1189-00			5	KNOB:GY,0.127 ID X 0.5 OD X 0.531	80009	366-1189-00
	213-0153-00			5	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-5	358-0301-02			5	BUSHING,SLEEVE:0.16 ID X 0.205 OD	80009	358-0301-02
-6	366-1559-00			7	PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
-7	426-1072-00			7	FRAME,PUSH BTN:SILVER GRAY PLSTC	80009	426-1072-00
-8	131-1315-01	B010100	B010164	3	CONN,RCPT,ELEC:BNC,FEMALE	80009	131-1315-01
	131-1315-01	B010165		3	CONN,RCPT,ELEC:BNC,FEMALE	80009	131-1315-01
-9	----- -----			1	SWITCH,PUSH:(SEE S1988 REPL)		
					(ATTACHING PARTS)		
-10	210-0583-00			1	NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL	73743	2X-20319-402
-11	210-0940-00			1	WASHER,FLAT:0.25 ID X 0.375 OD X 0.02,STL	12327	ORDER BY DESCR
					(END ATTACHING PARTS)		
-12	384-1136-00			2	EXTENSION SHAFT:0.95 INCH LONG	80009	384-1136-00
-13	384-1354-00			2	EXTENSION SHAFT:1.585 L,OFFSET,NYLON	80009	384-1354-00
-14	----- -----			1	CKT BOARD ASSY:FRONT PANEL(SEE A1 REPL)		
					(ATTACHING PARTS)		
-15	210-0583-00			2	NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL	73743	2X-20319-402
-16	210-0940-00			2	WASHER,FLAT:0.25 ID X 0.375 OD X 0.02,STL	12327	ORDER BY DESCR
					(END ATTACHING PARTS)		
					CKT BOARD INCLUDES:		
-17	----- -----			1	.RESISTOR,VAR:(SEE R1924,S1924 REPL)		
-18	----- -----			2	.SWITCH,PUSH(SEE S1915,S1920,S1910,		
					.S1905 REPL)		
-19	----- -----			1	.RESISTOR,VAR:SEE(R1900,S1900 REPL)		
-20	361-0542-00			12	.SPACER,PUSH SW:0.078 L,POLYPROPYLENE	71590	PCS-078
-21	214-0579-00	B010100	B042929	11	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-22	131-1003-00			4	.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-23	136-0514-00	B010100	B021599	5	.SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B021600	B042929	5	.SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
	136-0727-00	B042930		3	.SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-24	----- -----			2	.SWITCH,PUSH:(SEE S1930,S1940 REPL)		
-25	136-0269-02	B010100	B021599	1	.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP	09922	DILB14P-108T
	136-0728-00	B021600	B042929	1	.SKT,PL-IN ELEK:MICROCKT,14 CONTACT	09922	DILB14P-108
-26	136-0252-07	B010100	B042929	61	.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-27	131-0589-00	B010100	B042929	8	.TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ	22526	48283-029
	136-0252-07	B042930		7	.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-28	131-0608-00	B010100	B042929	23	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-29	----- -----			1	CKT BOARD ASSY:DSPLY CONTROL (SEE A2 REPL)		
					(ATTACHING PARTS)		
-30	210-0583-00			3	NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL	73743	2X-20319-402
-31	210-0940-00			3	WASHER,FLAT:0.25 ID X 0.375 OD X 0.02,STL	12327	ORDER BY DESCR
					(END ATTACHING PARTS)		
					CKT BOARD INCLUDES:		
-32	----- -----			1	.SWITCH,PUSH:(SEE S2005 REPL)		
-33	361-0608-00			2	.SPACER,PUSH SW:0.17 L,BRN POLYCARBONATE	80009	361-0608-00
-34	----- -----			2	.RESISTOR,VAR:(SEE R2005,R2015 REPL)		
-35	----- -----			2	.RESISTOR,VAR:(SEE R2010,R2020 REPL)		
-36	131-0608-00			20	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-37	----- -----			1	.RESISTOR,VAR:(SEE R2025 REPL)		
-38	----- -----			2	.RESISTOR,VAR:(SEE R2035 REPL)		
	334-4290-00	B020871		1	MARKER,IDENT:MKD MCP CAUTION	80009	334-4290-00
-39	333-2319-00	B010100	B021249	1	PANEL,FRONT:UPPER	80009	333-2319-00
	333-2319-01	B021250		1	PANEL,FRONT:UPPER	80009	333-2319-01
-40	378-0635-01			1	LENS,LIGHT:WHITE,MARKED A	80009	378-0635-01
-41	378-0635-02			1	LENS,LIGHT:WHITE,MARKED B	80009	378-0635-02
-42	131-0765-01			3	TERM,FEEDTHRU:0.584 L X 0.625 OD,BRS	80009	131-0765-01
-43	204-0380-00			1	BODY,TERMINAL:	80009	204-0380-00
-44	200-0939-01			1	RTNR,CRT SCALE:5.55 X 5.068 X 0.475	80009	200-0939-01
					(ATTACHING PARTS)		
-45	213-0270-00			4	SCR,TPG,TF:10-32 X 0.75,SPCL TYPE,FILH,STL	TK1543	234-74658-026
					(END ATTACHING PARTS)		
-46	131-1022-00			2	CONTACT,ELEC:GROUNDING,SST	80009	131-1022-00
-47	337-1159-03			1	SHLD,IMPLOSION:4.75 X 3.93 X 0.7 THK,PLSTC	80009	337-1159-03
-48	331-0441-00			1	MASK,CRT SCALE:	TK0401	ORDER BY DESCR
-49	----- -----			1	CKT BD ASSY:GRATICULE LAMPS(SEE A20 REPL)		

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-					(ATTACHING PARTS)		
-50	211-0062-00			2	.SCREW,MACHINE:2-56 X 0.312,PNH,STL	06950	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-51	378-0614-01			1	.REFLECTOR,LIGHT:INT SCALE ILLUMINATION	80009	378-0614-01
-52	344-0179-00			2	.CLIP,REFL RTNG:ACETAL,NAT	80009	344-0179-00
-53	200-0935-00			4	BASE,LAMPHOLDER:0.29 OD X 0.19 L,BK PLSTC	80009	200-0935-00
-54	331-0262-00			2	DIFFUSER,LIGHT:INDICATOR LIGHTS	80009	331-0262-00
-55	352-0157-00			4	LAMPHOLDER:(1)T-2 UNBASED,WHITE	80009	352-0157-00
-56	348-0031-00			1	GROMMET,PLASTIC:0.127 ID,GRAY ACETAL	80009	348-0031-00
-57	348-0055-00			1	GROMMET,PLASTIC:GRAY,ROUND,0.207 ID	80009	348-0055-00
-58	426-0808-04			1	FRAME PNL,CAB.:UPPER	80009	426-0808-04
					(ATTACHING PARTS)		
-59	211-0038-00			2	SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG,STL	93907	ORDER BY DESCR
-60	211-0538-00			2	SCREW,MACHINE:6-32 X 0.312,FLH,100 DEG,STL	93907	ORDER BY DESCR
-61	213-0270-00			3	SCR,TPG,TF:10-32 X 0.75,SPCL TYPE,FILH,STL	TK1543	234-74658-026
					(END ATTACHING PARTS)		
-62	337-2416-00			1	SHIELD,ELEC:HIGH VOLTAGE	85471	ORDER BY DESCR
					(ATTACHING PARTS)		
-63	211-0008-00			5	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-64	----- -----			1	CKT BOARD ASSY:HIGH VOLTAGE(SEE A22 REPL)		
					(ATTACHING PARTS)		
-65	129-0676-00			5	SPACER,POST:1.45 L,W/4-40 INT/EXT THD,BRS	80009	129-0676-00
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-66	136-0514-00	B010100	B021599	3	.SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B021600		3	.SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-67	131-0608-00			56	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-68	214-0579-00			20	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-69	131-0589-00			10	.TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ	22526	48283-029
-70	136-0252-07			24	.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-71	337-2418-00			1	.SHIELD,ELEC:HIGH VOLTAGE	80009	337-2418-00
					.(ATTACHING PARTS)		
-72	129-0299-00	B073914		2	.SPACER,POST:0.333 L,0.188 HEX,BRS	80009	129-0299-00
					.(END ATTACHING PARTS)		
-72.1	----- -----			1	.CKT BOARD ASSY:CRT PROT (SEE A22A1 REPL)		
					.(ATTACHING PARTS)		
-72.2	211-0008-00			2	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-73	348-0064-00			1	.GROMMET,PLASTIC:GRAY,ROUND,0.582 ID	80009	348-0064-00
-74	----- -----			1	.SEMICOND DEVICE:(SEE U1700 REPL)		
					.(ATTACHING PARTS)		
-75	220-0835-00			3	.NUT,PLAIN,HEX:10-24,0.375 DIA,NYLON	85480	HNNY-1024NA
-76	211-0012-00	B010100	B021479	1	.SCREW,MACHINE:4-40 X 0.375,PNH,STL	93907	ORDER BY DESCR
	213-0088-00	B021480		1	.SCREW,TPG,TF:4-24 X 0.25,TYPE B,PNH,STL	83385	ORDER BY DESCR
	210-0586-00	B010100	B021479	1	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
	210-0586-00	B021480		2	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
					.(END ATTACHING PARTS)		
-77	352-0217-00			1	.HLDR,ANODE CONN:U/W 0.5,HORIZ MT,BLACK PP	80009	352-0217-00
					.(ATTACHING PARTS)		
-78	211-0008-00			2	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-79	129-0230-00			3	.SPACER,POST:1.375 L,4-40 EA END,BRS,0.188	TK2278	ORDER BY DESCR
					.(ATTACHING PARTS)		
-80	211-0008-00			3	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-81	344-0132-00			2	CLIP,SPR TNSN:CKT BOARD MT,ACETAL BLACK	80009	344-0132-00
					(ATTACHING PARTS)		
-82	211-0007-00			2	SCREW,MACHINE:4-40 X 0.188,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-83	255-0334-00			1	PLASTIC CHANNEL:12.75 X 0.175 X 0.155,NYLON	11897	122-37-2500
-84	386-1559-00			4	SPACER,CKT BD:0.47 H,ACETAL	80009	386-1559-00
-85	348-0253-00			1	GROMMET,PLASTIC:BLACK,OBLONG,3.0 X 0.925	TK2165	ORDER BY DESCR
-86	386-3976-00			1	SUBPANEL,REAR:UPPER RIGHT	80009	386-3976-00
					(ATTACHING PARTS)		
-87	211-0504-00			2	SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
-88	211-0232-00			2	SCREW,MACHINE:4-40 X 0.25,FILH,STL	TK0435	8005-302

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-					(END ATTACHING PARTS)		
-89	369-0035-00			1	IMPLR,FAN,AXIAL:3.5DIA BL,CCW,0.080ID,PLSTC SAFETY CONTROLLED	52792	3500-CCW .080N
-90	361-0076-00			2	SPACER,POST:0.65 L W/ 6-32 THRU,AL,0.25 HEX	80009	361-0076-00
					(ATTACHING PARTS)		
-91	211-0504-00			2	SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
-92	211-0510-00			2	SCREW,MACHINE:6-32 X 0.375,PNH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
-93	343-0411-00			2	STRAP,RETAINING:2.494 X 0.8,STL TIN PL	80009	343-0411-00
-94	----- -----			1	CKT BOARD ASSY:FAN(SEE A26 REPL)		
-95	----- -----			1	.MOTOR,DC:(SEE B1690 REPL)		
-96	136-0252-04			3	.SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-97	136-0269-02	B010100	B021599	1	.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP	09922	DILB14P-108T
	136-0728-00	B021600		1	.SKT,PL-IN ELEK:MICROCKT,14 CONTACT	09922	DILB14P-108
-98	131-0608-00			2	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-99	343-0013-00			1	CLAMP,LOOP:0.375 ID,PLASTIC	06915	ORDER BY DESCR
					(ATTACHING PARTS)		
-100	210-0458-00			1	NUT,PL,ASSEM WA:8-32 X 0.344,STL CD PL	78189	511-081800-00
-101	210-0863-00			1	WSHR,LOOP CLAMP:0.091 ID U/W 0.5 W CLP,STL	95987	C191
					(END ATTACHING PARTS)		
	343-0853-00	B020850		1	CLAMP,LOOP:0.5 DIA,NYLON	34785	021-0500
-102	426-1413-00			1	FRAME SECT,CAB.:RIGHT	80009	426-1413-00
					(ATTACHING PARTS)		
-103	211-0504-00			3	SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-104	136-0692-00			1	SKT,PL-IN ELEK:CRT,10 CONTACTS	80009	136-0692-00
-105	343-0254-00			1	.CLP,ELCTRN TUBE:DELRIN	80009	343-0254-00
-106	367-0117-00			1	.PULL,SOCKET:CRT,PLASTIC	80009	367-0117-00
-107	200-0917-01			1	.COVER,CRT SKT:2.052 OD X 0.291 H,PLASTIC	80009	200-0917-01
-108	136-0304-03			1	.SKT,PL-IN ELEK:ELECTRON TUBE,14 CONTACT	80009	136-0304-03
-109	131-0707-00			9	.CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL	22526	47439-000
-110	131-1810-00			1	.CONTACT,ELEC:WIRE TO PIN,PH BRZ GOLD PL	00779	87124-1
-111	214-2629-00			1	.PIN,ACTUATOR:	80009	214-2629-00
-112	204-0675-00			1	.CONN BODY,PLUG:1 FEMALE CONTACT	00779	87175-2
-113	352-0162-03			1	.HLDR,TERM CONN:4 WIRE,ORANGE	80009	352-0162-03
	352-0164-02			1	.HLDR,TERM CONN:6 WIRE,RED	80009	352-0164-02
-114	352-0169-02			1	.HLDR,TERM CONN:2 WIRE,RED	80009	352-0169-02
	343-0549-00			9	.STRAP,TIEDOWN,E:0.091 W X 4.0 L,ZYTEL	06383	PLT1M
-115	354-0347-00			1	RING,CRT CLAMP:2.127 ID X 2.595 OD X 0.563	80009	354-0347-00
					(ATTACHING PARTS)		
-116	211-0170-00			2	SCREW,MACHINE:4-40 X 2.25,PNH,SST	93907	ORDER BY DESCR
-117	214-1333-00			2	SPRING,HLCPS:0.213 OD X 0.375,CLE,CU-BE	80009	214-1333-00
					(END ATTACHING PARTS)		
-118	343-0205-01			1	RTNR,ELCTRN TU:3.0 DIA X 1.5 L,DELRIN	80009	343-0205-01
					(ATTACHING PARTS)		
-119	211-0510-00			4	SCREW,MACHINE:6-32 X 0.375,PNH,STL	83385	ORDER BY DESCR
-120	210-0949-00			4	WASHER,FLAT:0.141 ID X 0.5 OD X 0.062,BRS	12327	ORDER BY DESCR
					(END ATTACHING PARTS)		
-121	386-3731-00			1	SUPPORT,CRT:REAR	80009	386-3731-00
					(ATTACHING PARTS)		
-122	211-0504-00			4	SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
-123	210-0803-00			4	WASHER,FLAT:0.15 ID X 0.375 OD X 0.032,STL	12327	ORDER BY DESCR
					(END ATTACHING PARTS)		
-124	348-0064-00			1	GROMMET,PLASTIC:GRAY,ROUND,0.582 ID	80009	348-0064-00
-125	348-0085-00			2	GROMMET,PLASTIC:GRAY,U-SHAPE,0.48 ID	80009	348-0085-00
-126	220-0803-00			1	NUT BAR:4-40 X 2.95 X 0.5 X 0.25,AL	80009	220-0803-00
					(ATTACHING PARTS)		
-127	211-0038-00			2	SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-128	337-2419-01			1	SHIELD,CRT:	80009	337-2419-01
	198-3761-00			1	WIRE SET,ELEC:	80009	198-3761-00
-129	131-0707-00			66	.CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL	22526	47439-000
-130	131-1810-00			4	.CONTACT,ELEC:WIRE TO PIN,PH BRZ GOLD PL	00779	87124-1
-131	352-0162-03			1	.HLDR,TERM CONN:4 WIRE,ORANGE	80009	352-0162-03
-132	352-0164-09			1	.HLDR,TERM CONN:6 WIRE,WHITE	80009	352-0164-09
-133	352-0166-04			2	.HLDR,TERM CONN:8 WIRE,YELLOW	80009	352-0166-04
-134	352-0167-06			2	.HLDR,TERM CONN:9 WIRE,BLUE	80009	352-0167-06
-135	352-0168-02			2	.HLDR,TERM CONN:10 WIRE,RED	80009	352-0168-02

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-136	204-0675-00			4	.CONN BODY,PLUG:1 FEMALE CONTACT	00779	87175-2
-137	175-0827-00			AR	.CABLE,SP,ELEC:4,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-954
-138	175-0829-00			AR	.CABLE,SP,ELEC:6,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-973
-139	175-0831-00			AR	.CABLE,SP,ELEC:8,26 AWG,STRD,PVC INSUL,RBN	08261	111-2699-971
-140	175-0832-00			AR	.CABLE,SP,ELEC:9,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-956
-141	179-2612-00			1	WIRING HARNESS:HIGH VOLTAGE	80009	179-2612-00
-142	214-2629-00			2	.PIN,ACTUATOR:	80009	214-2629-00
	352-0164-09			2	.HLDR,TERM CONN:6 WIRE,WHITE	80009	352-0164-09
	352-0166-05			2	.HLDR,TERM CONN:8 WIRE,GREEN	80009	352-0166-05
	131-0707-00			24	.CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL	22526	47439-000
	343-0549-00			6	.STRAP,TIEDOWN,E:0.091 W X 4.0 L,ZYTEL	06383	PLT1M

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
3-1	----- -----			1	CKT BOARD ASSY:VERT FLEX OUTP(SEE A32 REPL)		
					(ATTACHING PARTS)		
-2	136-0388-00			2	.SOCKET,PIN TERM:U/W 0.04 DIA PINS	71279	4503704010300
-3	----- -----			1	RES,FXD,FILM:(SEE R1099 REPL)		
-4	211-0504-00			2	SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-5	210-0205-00			1	TERMINAL,LUG:0.172 ID,LOCKING,BRS TIN PL	86928	5442-7
-6	----- -----			2	CKT BD ASSY:CRT FLEX INP(SEE A29,A30 REPL)		
-7	136-0388-00	B010100	B031958	4	.SOCKET,PIN TERM:U/W 0.04 DIA PINS	71279	4503704010300
	195-0581-00	B031959	B053474	4	LEAD,ELECTRICAL:26 AWG,1.5 L,9-1	80009	195-0581-00
	195-0093-02	B053475		4	LEAD,ELECTRICAL:26 AWG,2.0 L,9-7	80009	195-0093-02
-8	----- -----			1	CKT BOARD ASSY:CRT TERMINATOR(SEE A18 REPL)		
					(ATTACHING PARTS)		
-9	211-0259-00			2	SCR,ASSEM WSHR:2-56 X 0.437,PNH,STL,POZ	01536	4821-00021
-10	211-0260-00			2	SCR,ASSEM WSHR:2-56 X 0.687,PNH,STL,POZ	01536	ORDER BY DESCR
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-11	131-0589-00	B010100	B010162	1	.TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ	22526	48283-029
-12	214-2543-00			1	HT SK,MICROCKT:MICROCIRCUIT,AL	80009	214-2543-00
-13	426-1351-00			1	FRAME,MICROCKT:1.75 CM	80009	426-1351-00
-14	131-1937-00			1	CONTACT,GROUND:GROUNDING,CU BE CD PL	80009	131-1937-00
-15	----- -----			1	SWITCH,THRMSTC:(SEE S70 REPL)		
					(ATTACHING PARTS)		
-16	211-0007-00			2	SCREW,MACHINE:4-40 X 0.188,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-17	----- -----			2	CKT BRD ASSY:VERT CRT FLEX(SEE A31 REPL)		
					.EACH CKT BOARD INCLUDES:		
-18	136-0388-00			3	.SOCKET,PIN TERM:U/W 0.04 DIA PINS	71279	4503704010300
-19	----- -----			1	CKT BOARD ASSY:VERTICAL AMP(SEE A17 REPL)		
					(ATTACHING PARTS)		
-20	211-0116-00	B010100	B020844	4	SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,NP,POZ	77900	ORDER BY DESCR
	211-0008-00	B020845		4	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-21	211-0260-00			4	SCR,ASSEM WSHR:2-56 X 0.687,PNH,STL,POZ	01536	ORDER BY DESCR
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-22	136-0514-00	B010100	B021599	4	.SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B021600		4	.SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-23	214-0579-00			15	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-24	426-1351-00			3	.FRAME,MICROCKT:1.75 CM	80009	426-1351-00
					.(ATTACHING PARTS)		
-25	211-0259-00			12	.SCR,ASSEM WSHR:2-56 X 0.437,PNH,STL,POZ	01536	4821-00021
-26	220-0797-00			12	.NUT,CAPTIVE:2-56 X 0.218 DIA,STL CD PL	46384	CKF2-256
					.(END ATTACHING PARTS)		
-27	131-1967-00			3	.CONT SET,ELEC:MICROCKT,1.75 CM,RUBBER	80009	131-1967-00
-28	131-0608-00			20	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-29	131-0589-00			7	.TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ	22526	48283-029
-30	131-2269-00			1	.CONTACT,ELEC:GROUNDING,COPPER,GOLD PL	80009	131-2269-00
-31	131-2020-00			1	.CONTACT,ELEC:DUAL,TOP,BERYLLIUM COPPER	80009	131-2020-00
					.(ATTACHING PARTS)		
-32	210-0629-00			3	.EYELET,METALLIC:0.059 OD X 0.093 L,BRS	80009	210-0629-00
					.(END ATTACHING PARTS)		
-33	136-0252-00			2	.SOCKET,PIN TERM:U/W 0.018 DIA PINS	00779	2-330808-7
-34	136-0252-04			51	.SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-35	131-2022-00			1	.CONTACT,ELEC:DUAL,BOTTOM,CU BE	80009	131-2022-00
-36	214-2543-00			1	.HT SK,MICROCKT:MICROCIRCUIT,AL	80009	214-2543-00
-37	----- -----			1	CKT BOARD ASSY:HORIZONTAL AMP(SEE A19 REPL)		
					(ATTACHING PARTS)		
-38	211-0116-00	B010100	B020844	6	SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,NP,POZ	77900	ORDER BY DESCR
	211-0008-00	B020845		6	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-39	211-0260-00			4	SCR,ASSEM WSHR:2-56 X 0.687,PNH,STL,POZ	01536	ORDER BY DESCR
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-40	131-0608-00			13	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-41	426-1351-00			2	.FRAME,MICROCKT:1.75 CM	80009	426-1351-00
					.(ATTACHING PARTS)		
-42	211-0259-00			4	.SCR,ASSEM WSHR:2-56 X 0.437,PNH,STL,POZ	01536	4821-00021
					.(END ATTACHING PARTS)		
-43	131-1967-00			2	.CONT SET,ELEC:MICROCKT,1.75 CM,RUBBER	80009	131-1967-00

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
3-44	426-1352-00			1	.FRAME,MICROCKT:1.75 CM,STEPPED	80009	426-1352-00
					.(ATTACHING PARTS)		
-45	220-0797-00			4	.NUT,CAPTIVE:2-56 X 0.218 DIA,STL CD PL	46384	CKF2-256
-46	211-0259-00			4	.SCR,ASSEM WSHR:2-56 X 0.437,PNH,STL,POZ	01536	4821-00021
					.(END ATTACHING PARTS)		
-47	131-1923-00			1	.CONTACT,ELEC:MICROCIRCUIT	80009	131-1923-00
-48	131-0566-00			17	.BUS,CONDUCTOR:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
-49	131-0993-00			1	.BUS,CONDUCTOR:SHUNT ASSEMBLY,BLACK	22526	65474-005
-50	426-1337-00			1	.FRAME,MICROCKT:1.22 CM	80009	426-1337-00
					.(ATTACHING PARTS)		
-51	220-0797-00			4	.NUT,CAPTIVE:2-56 X 0.218 DIA,STL CD PL	46384	CKF2-256
-52	211-0259-00			4	.SCR,ASSEM WSHR:2-56 X 0.437,PNH,STL,POZ	01536	4821-00021
					.(END ATTACHING PARTS)		
-53	131-1968-00			1	.CONT SET,ELEC:MICROCKT,1.75 CM,RUBBER	80009	131-1968-00
-54	136-0252-04			61	.SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-55	214-0579-00			5	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-56	131-1003-00			4	.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-57	131-0589-00			1	.TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ	22526	48283-029
-58	136-0269-02	B010100	B021599	1	.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP	09922	DILB14P-108T
	136-0728-00	B021600		1	.SKT,PL-IN ELEK:MICROCKT,14 CONTACT	09922	DILB14P-108
-59	136-0514-00	B010100	B021599	4	.SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B021600		4	.SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-60	214-2543-00			2	.HT SK,MICROCKT:MICROCIRCUIT,AL	80009	214-2543-00
-61	200-2079-00			1	COVER,PLENUM:	80009	200-2079-00
					(ATTACHING PARTS)		
-62	211-0232-00			4	SCREW,MACHINE:4-40 X 0.25,FILH,STL	TK0435	8005-302
					(END ATTACHING PARTS)		
-63	----- -----			1	CKT BOARD ASSY:Z AXIS(SEE A21 REPL)		
					(ATTACHING PARTS)		
-64	211-0008-00			3	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-65	200-2081-00			1	.COVER,CKT BOARD:	80009	200-2081-00
					.(ATTACHING PARTS)		
-66	211-0040-00			2	.SCREW,MACHINE:4-40 X 0.25,BDGH,NYL	26365	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-67	385-0107-00			2	.SPACER,POST:0.75 L W/4-40 THD THRU,NYL	80009	385-0107-00
					.(ATTACHING PARTS)		
-68	211-0040-00			2	.SCREW,MACHINE:4-40 X 0.25,BDGH,NYL	26365	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-69	136-0252-04			59	.SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-70	214-0579-00	B010100	B010199	4	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
	214-0579-00	B010200	B020814	6	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
	214-0579-02	B020815		6	.TERM,TEST POINT:BRASS,CD PL	80009	214-0579-02
-71	131-1003-00			2	.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-72	131-0608-00			15	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-73	386-1559-00			2	.SPACER,CKT BD:0.47 H,ACETAL	80009	386-1559-00
	214-2593-00	B020815		1	.HEAT SINK,XSTR:TO-5,AL	13103	2257B
-74	348-0253-00			2	GROMMET,PLASTIC:BLACK,OBLONG,3.0 X 0.925	TK2165	ORDER BY DESCR
-75	348-0056-00			1	GROMMET,PLASTIC:GRAY,ROUND,0.332 ID	80009	348-0056-00
-76	386-3727-00			1	SUBPANEL,REAR:UPPER LEFT	80009	386-3727-00
					(ATTACHING PARTS)		
-77	211-0232-00			2	SCREW,MACHINE:4-40 X 0.25,FILH,STL	TK0435	8005-302
-78	211-0504-00			2	SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-79	426-0809-05			1	FRAME PNL,CAB.:UPPER REAR	80009	426-0809-05
					(ATTACHING PARTS)		
-80	213-0270-00			3	SCR,TPG,TF:10-32 X 0.75,SPCL TYPE,FILH,STL	TK1543	234-74658-026
					(END ATTACHING PARTS)		
-81	426-1411-00			2	FRAME SECT,CAB.:BOTTOM	80009	426-1411-00
-82	342-0313-00			2	GROMMET,PLASTIC:0.437 ID X 0.562 OD,NYLON	28520	2066
					DELAY LINE:(SEE DL1155 REPL)		
-83	386-3732-00			2	.PLATE,DLY LINE:ALUMINUM	80009	386-3732-00
					.(ATTACHING PARTS)		
-84	212-0087-00			4	.SCREW,TPG,TC:8-32 X 0.375,TYPE T,TRH,STL	80009	212-0087-00
					.(END ATTACHING PARTS)		
-85	361-0845-00			4	.SPACER,DLY LINE:2.0 L W/8-32 THRU,ACETAL	80009	361-0845-00
					.(ATTACHING PARTS)		

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
3-86	212-0087-00			8	.SCREW,TPG,TC:8-32 X 0.375,TYPE T,TRH,STL	80009	212-0087-00
					.(END ATTACHING PARTS)		
-87	175-2025-00			AR	.CABLE,RF:50 OHM COAX	80009	175-2025-00
-88	386-3732-00			2	.PLATE,DLY LINE:ALUMINUM	80009	386-3732-00
					.(ATTACHING PARTS)		
-89	212-0023-00			4	.SCREW,MACHINE:8-32 X 0.375,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-90	343-0013-00			3	.CLAMP,LOOP:0.375 ID,PLASTIC	06915	ORDER BY DESCR
					.(ATTACHING PARTS)		
-91	210-0458-00			3	.NUT,PL,ASSEM WA:8-32 X 0.344,STL CD PL	78189	511-081800-00
-92	210-0863-00			3	.WSHR,LOOP CLAMP:0.091 ID U/W 0.5 W CLP,STL	95987	C191
					.(END ATTACHING PARTS)		
-93	348-0064-00			1	.GROMMET,PLASTIC:GRAY,ROUND,0.582 ID	80009	348-0064-00
-94	426-1412-00			1	.FRAME SECT,CAB.:CENTER	80009	426-1412-00
					.(ATTACHING PARTS)		
-95	211-0511-00			2	.SCREW,MACHINE:6-32 X 0.5,PNH,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-96	426-1414-00			1	.FRAME SECT,CAB.:LEFT	80009	426-1414-00
					.(ATTACHING PARTS)		
-97	211-0507-00			4	.SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-98	343-0747-00			2	.CLAMP,DLY LINE:TOP,AL	80009	343-0747-00
					.(ATTACHING PARTS)		
-99	211-0578-00			6	.SCREW,MACHINE:6-32 X 0.438,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-100	343-0748-00			2	.CLAMP,DLY LINE:BOTTOM,AL	80009	343-0748-00
					.(ATTACHING PARTS)		
-101	211-0578-00			2	.SCREW,MACHINE:6-32 X 0.438,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-102	343-0691-00			2	.CLAMP,DLY LINE:BOTTOM,ALUMINUM	80009	343-0691-00
					.(ATTACHING PARTS)		
-103	212-0010-00			6	.SCREW,MACHINE:8-32 X 0.625,PNH,STL	83385	ORDER BY DESCR
	210-0069-00	B020550		6	.WASHER,LOCK:#8 SPLIT,0.04 THK STL	86928	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-104	343-0690-00			2	.CLAMP,DLY LINE:TOP,ALUMINUM	80009	343-0690-00
-105	343-0700-00			4	.CLAMP,CABLE:0.319 ID,BRS CU-SN-ZN PL	80009	343-0700-00

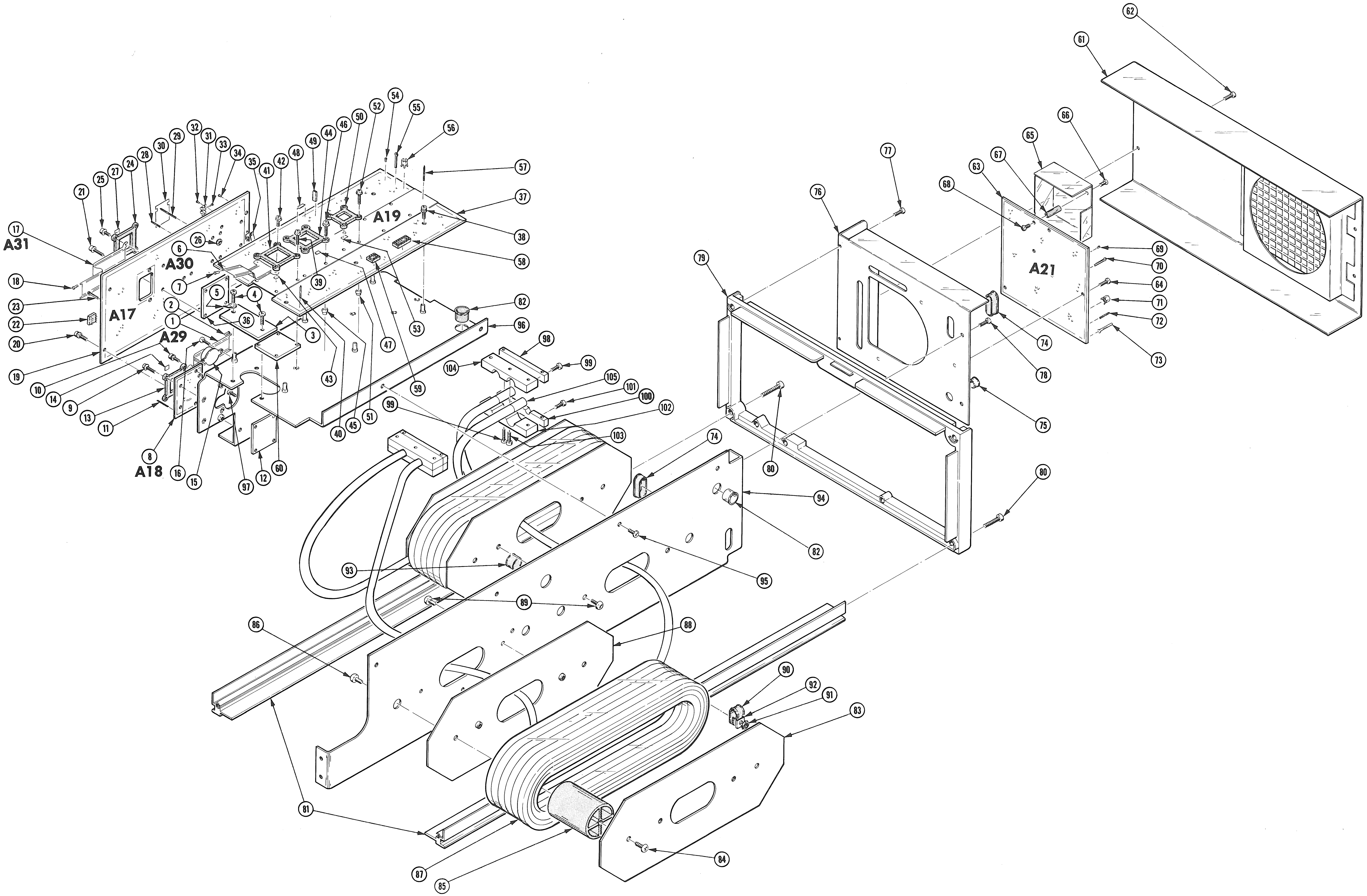

FIG. 3 DELAY LINE & REAR

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FIG. 4 LOWER FRONT UNIT & PLUG-IN HOUSING

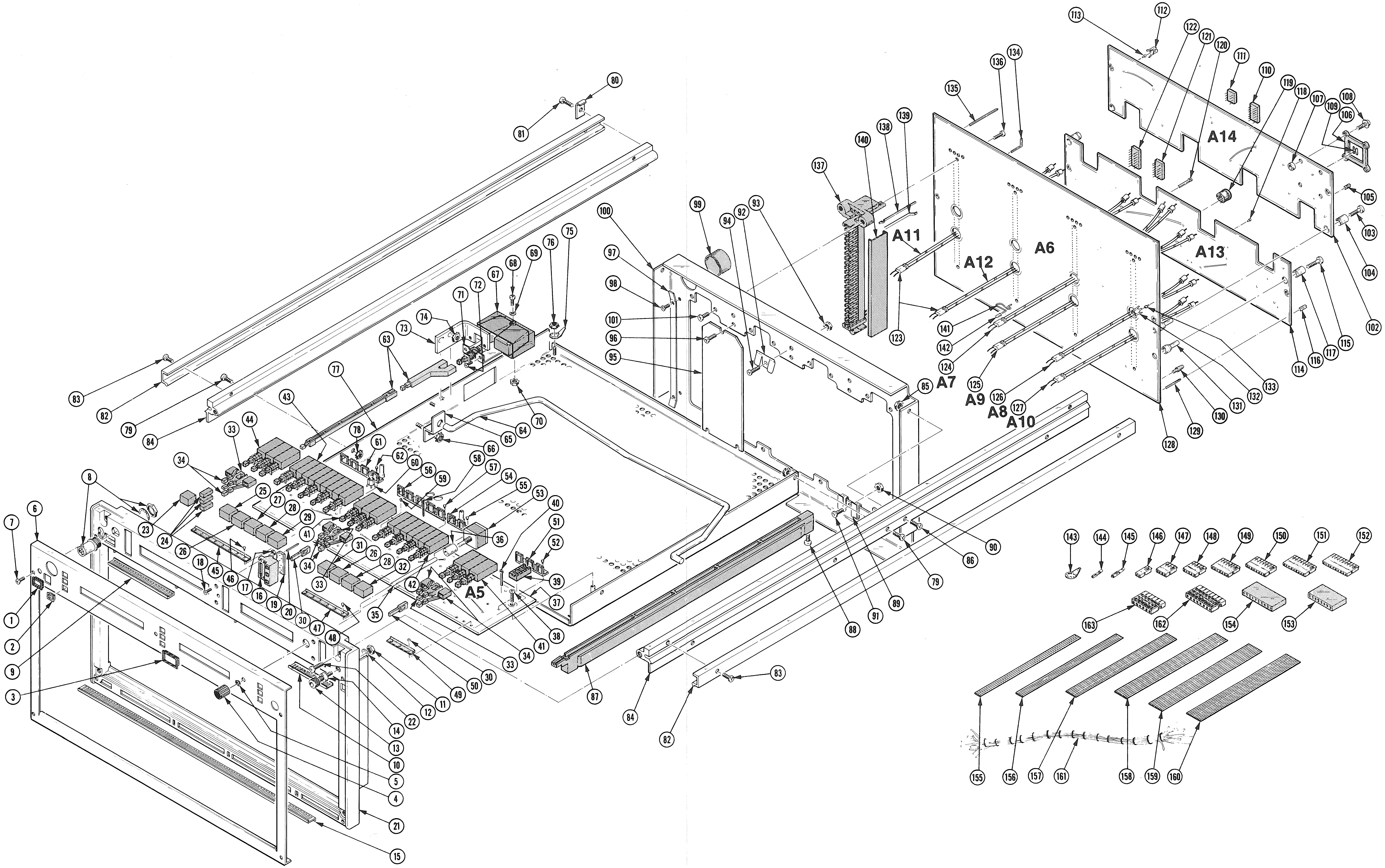

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Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
4-1	426-0681-00			1	FRAME,PUSH BTN:	80009	426-0681-00
-2	426-1072-00			3	FRAME,PUSH BTN:SILVER GRAY PLSTC	80009	426-1072-00
-3	426-0568-00			9	FRAME,PUSH BTN:	80009	426-0568-00
-4	366-1023-01			1	KNOB:GY,0.127 ID X 0.392 OD X 0.531 H	80009	366-1023-01
	213-0246-00			1	.SETSCREW:5-40 X 0.094,STL	71159	ORDER BY DESCR
-5	358-0599-00			1	BUSHING,SLEEVE:0.125 ID X 0.25 OD X 0.234	28520	B-187-125
-6	333-2318-00			1	PANEL,FRONT:LOWER	80009	333-2318-00
					(ATTACHING PARTS)		
-7	213-0055-00			5	SCREW,TPG,TF:2-32 X 0.188,TYPE B,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-8	131-1315-01			1	CONN,RCPT,ELEC:BNC,FEMALE	80009	131-1315-01
					(ATTACHING PARTS)		
	220-0495-00	B042940		1	NUT,PLAIN,HEX:0.375-32 X 0.438 HEX,BRS	73743	ORDER BY DESCR
	210-0012-00	B042940		1	WASHER,LOCK:0.384 ID,INTL,0.022 THK,STL	09772	ORDER BY DESCR
					(END ATTACHING PARTS)		
-9	337-1543-00			1	SHLD GSKT,ELEK:EMI	80009	337-1543-00
-10	337-1542-00			1	SHLD GSKT,ELEK:EMI	80009	337-1542-00
	129-0103-00			1	POST,BDG,ELEC:ASSEMBLY	80009	129-0103-00
					(ATTACHING PARTS)		
-11	210-0583-00			1	NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL	73743	2X-20319-402
-12	210-0046-00			1	WASHER,LOCK:0.261 ID,INTL,0.018 THK,STL	77900	1214-05-00-0541C
					(END ATTACHING PARTS)		
					POST ASSY INCLUDES:		
-13	200-0103-00			1	.NUT,PLAIN,KNURL:0.25-28 X 0.375"OD BRASS	80009	200-0103-00
-14	129-0077-00			1	.STUD,SHOULDERED:0.938 L X 0.375,0.250-28	80009	129-0077-00
-15	348-0204-00			1	SHLD GSKT,ELEK:FINGER TYPE,10.65 L	80009	348-0204-00
-16	351-0509-00			2	GUIDE,PUSH BTN:THREE LAMP	80009	351-0509-00
					(ATTACHING PARTS)		
-17	210-0405-00			4	NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL	73743	12157-50
-18	211-0030-00			4	SCREW,MACHINE:2-56 X 0.25,FLH,82 DEG,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-19	----- -----			2	CKT BOARD ASSY:TRIG LIGHT A & B		
					(SEE A3,A4 REPL)		
-20	131-0608-00			4	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-21	426-0806-03			1	FRAME PNL,CAB.:LOWER FRONT	80009	426-0806-03
					(ATTACHING PARTS)		
-22	213-0270-00			4	SCR,TPG,TF:10-32 X 0.75,SPCL TYPE,FILH,STL	TK1543	234-74658-026
					(END ATTACHING PARTS)		
-23	366-1480-02			1	PUSH BUTTON:BLACK,PWR OFF	80009	366-1480-02
-24	366-1559-00			3	PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
-25	366-1161-57			1	PUSH BUTTON:SIL GY,LEFT	80009	366-1161-57
-26	366-1161-31			2	PUSH BUTTON:SIL GY,ALT	80009	366-1161-31
-27	366-1161-27			1	PUSH BUTTON:SIL GY,ADD	80009	366-1161-27
-28	366-1161-30			2	PUSH BUTTON:SIL GY,CHOP	80009	366-1161-30
-29	366-1161-58			1	PUSH BUTTON:SIL GY,RIGHT	80009	366-1161-58
-30	366-1650-00			6	PUSH BUTTON:CLEAR,0.184 X 0.214 X 8.0	80009	366-1650-00
-31	366-1161-55			1	PUSH BUTTON:SIL GY,A	80009	366-1161-55
-32	366-1161-56			1	PUSH BUTTON:SIL,GY,B	80009	366-1161-56
-33	384-1136-00			3	EXTENSION SHAFT:0.95 INCH LONG	80009	384-1136-00
-34	384-1354-00			6	EXTENSION SHAFT:1.585 L,OFFSET,NYLON	80009	384-1354-00
-35	384-1148-00			1	EXTENSION SHAFT:3.14 L X 0.123 OD,EPOXY GL	80009	384-1148-00
-36	376-0029-00			1	CPLG,SHAFT,RGD:0.128 ID X 0.312 OD,AL	80009	376-0029-00
	213-0075-00			2	.SETSCREW:4-40 X 0.094,STL	74445	ORDER BY DESCR
-37	----- -----			1	CKT BOARD ASSY:MODE SWITCH(SEE A5 REPL)		
					(ATTACHING PARTS)		
-38	211-0116-00			5	SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,NP,POZ	77900	ORDER BY DESCR
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-39	136-0269-02	B010100	B021599	5	.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP	09922	DILB14P-108T
	136-0728-00	B021600		5	.SKT,PL-IN ELEK:MICROCKT,14 CONTACT	09922	DILB14P-108
-40	214-0579-00			8	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-41	----- -----			2	.ACTUATOR ASSY:(SEE S365,S345 REPL)		
-42	----- -----			1	.ACTUATOR ASSY:(SEE S325 REPL)		
-43	----- -----			1	.ACTUATOR ASSY:(SEE S315 REPL)		
-44	----- -----			1	.ACTUATOR ASSY:(SEE S395 REPL)		
-45	343-0495-09			1	.CLIP,SWITCH:FRONT,7.5MM X 9 UNIT	80009	343-0495-09
					.(ATTACHING PARTS)		
-46	210-3033-00			9	.EYELET,METALLIC:0.059 OD X 0.156 L,BRS	07707	SE-25

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
4-					.(END ATTACHING PARTS)		
-47	343-0495-07			1	.CLIP,SWITCH:FRONT,7.5MM X 7 UNIT	80009	343-0495-07
					.(ATTACHING PARTS)		
-48	210-3033-00			7	.EYELET,METALLIC:0.059 OD X 0.156 L,BRS	07707	SE-25
					.(END ATTACHING PARTS)		
-49	343-0496-03			3	.CLIP,SWITCH:FRONT,10MM X 3 UNIT	80009	343-0496-03
					.(ATTACHING PARTS)		
-50	210-3033-00			6	.EYELET,METALLIC:0.059 OD X 0.156 L,BRS	07707	SE-25
					.(END ATTACHING PARTS)		
-51	343-0497-03			3	.CLIP,SWITCH:REAR,10MM X 3 UNIT	80009	343-0497-03
					.(ATTACHING PARTS)		
-52	210-3033-00			6	.EYELET,METALLIC:0.059 OD X 0.156 L,BRS	07707	SE-25
					.(END ATTACHING PARTS)		
-53	----- -----			1	.RES,VAR,NONWW:(SEE R325 REPL)		
-54	343-0499-03	B010100	B021049	1	.CLIP,SWITCH:REAR,7.5MM X 3 UNIT	80009	343-0499-03
	343-0499-12	B021050		1	.CLIP,SWITCH:REAR,7.5MM X 3 UNIT	80009	343-0499-12
					.(ATTACHING PARTS)		
-55	210-3033-00			3	.EYELET,METALLIC:0.059 OD X 0.156 L,BRS	07707	SE-25
					.(END ATTACHING PARTS)		
-56	343-0499-05	B010100	B021049	1	.CLIP,SWITCH:REAR,7.5MM X 5 UNIT	80009	343-0499-05
	343-0499-14	B021050		1	.CLIP,SWITCH:7.5MM X 5 UNIT	80009	343-0499-14
					.(ATTACHING PARTS)		
-57	210-3033-00			5	.EYELET,METALLIC:0.059 OD X 0.156 L,BRS	07707	SE-25
					.(END ATTACHING PARTS)		
-58	131-0608-00			61	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-59	136-0252-07			23	.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-60	131-1003-00			2	.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-61	343-0499-04	B010100	B021049	2	.CLIP,SWITCH:REAR,7.5MM X 4 UNIT	80009	343-0499-04
	343-0499-13	B021050		2	.CLIP,SWITCH:7.5MM X 4 UNIT	80009	343-0499-13
					.(ATTACHING PARTS)		
-62	210-3033-00			8	.EYELET,METALLIC:0.059 OD X 0.156 L,BRS	07707	SE-25
					.(END ATTACHING PARTS)		
-63	384-1876-00	B010100	B021609	1	EXTENSION SHAFT:SAFETY CONTROLLED	80009	384-1876-00
	384-1876-01	B021610		1	EXTENSION SHAFT:	80009	384-1876-01
-64	348-0193-00			1	FLIP-STAND,CAB.:3.438 H,SST	80009	348-0193-00
-65	407-2109-00			2	BRACKET,HINGE:ALUMINUM	80009	407-2109-00
					(ATTACHING PARTS)		
-66	210-0457-00			4	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
					(END ATTACHING PARTS)		
-67	200-1731-00			1	COVER,ELEC SW:1.9 X 1.0 X 0.45 CLR PLSTC	85471	ORDER BY DESCR
					(ATTACHING PARTS)		
-68	211-0034-00			1	SCREW,MACHINE:2-56 X 0.5,PNH,STL	06950	ORDER BY DESCR
-69	210-0850-00			1	WASHER,FLAT:0.093 ID X 0.281 OD X 0.02,STL	12327	ORDER BY DESCR
-70	210-0405-00			1	NUT,PLAIN,HEX:2-56 X 0.188,BRS CD PL	73743	12157-50
					(END ATTACHING PARTS)		
-71	----- -----			1	SWITCH,PUSH:(SEE S1200 REPL)		
					(ATTACHING PARTS)		
-72	211-0008-00			2	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-73	407-1873-00			1	BRACKET,ANGLE:POWER SWITCH,ALUMINUM	80009	407-1873-00
					(ATTACHING PARTS)		
-74	210-0457-00			2	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
					(END ATTACHING PARTS)		
-75	210-0202-00			1	TERMINAL,LUG:0.146 ID,LOCKING,BRZ TIN PL	86928	A-373-158-2
					(ATTACHING PARTS)		
-76	210-0457-00			2	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
					(END ATTACHING PARTS)		
-77	441-1286-01			1	CHAS,PL-IN HSG:TOP	80009	441-1286-01
					(ATTACHING PARTS)		
-78	210-0458-00			4	NUT,PL,ASSEM WA:8-32 X 0.344,STL CD PL	78189	511-081800-00
-79	212-0004-00			4	SCREW,MACHINE:8-32 X 0.312,PNH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-80	407-2093-00			2	BRACKET,ANGLE:HINGE,ALUMINUM	80009	407-2093-00
					(ATTACHING PARTS)		
-81	211-0559-00			1	SCREW,MACHINE:6-32 X 0.375,FLH,100 DEG	TK0435	1593-300
					(END ATTACHING PARTS)		
-82	426-1470-00	B010100	B053324	2	FRAME SECT,CAB.:COUPLING	80009	426-1470-00
	426-0849-02	B053325		2	FRAME SECT,CAB.:COUPLING	80009	426-0849-02

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
4-					(ATTACHING PARTS)		
-83	211-0507-00			2	SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
-84	426-1513-00			2	FRAME SECT,CAB.:TOP RIGHT	80009	426-1513-00
					(ATTACHING PARTS)		
-85	210-0458-00			8	NUT,PL,ASSEM WA:8-32 X 0.344,STL CD PL	78189	511-081800-00
-86	212-0004-00			8	SCREW,MACHINE:8-32 X 0.312,PNH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-87	351-0181-03	B010100	B020604	4	GUIDE,SLIDE:PLUG-IN UNIT,LWR,SFTY CNTRLD	80009	351-0181-03
	351-0181-06	B020605		4	GUIDE,SLIDE:PLUG-IN UNIT,LWR,SFTY CNTRLD	80009	351-0181-06
					(ATTACHING PARTS)		
-88	213-0146-00			4	SCREW,TPG,TF:6-20 X 0.312,TYPE B,PNH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
-89	131-0930-00			3	CONTACT,ELEC:PLUG-IN GND,CU BE HEAT TRTD	80009	131-0930-00
					(ATTACHING PARTS)		
-90	210-0586-00			3	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-91	211-0008-00			3	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-92	131-0799-00			3	CONTACT,ELEC:PLUG-IN GND,BE NI CD PL	80009	131-0799-00
					(ATTACHING PARTS)		
-93	210-0586-00			3	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-94	211-0008-00			3	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-95	337-2514-00			3	SHIELD,ELEC:INTERFACE CIRCUIT BOARD	80009	337-2514-00
					(ATTACHING PARTS)		
-96	211-0008-00			9	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-97	131-0800-00	B010100	B021639	2	CONTACT,ELEC:PLUG-IN GND,BE NI HT TR	80009	131-0800-00
	131-0800-03	B021640		2	CONTACT,ELEC:PLUG-IN GND,BE NI HT TR	80009	131-0800-03
					(ATTACHING PARTS)		
-98	213-0138-00			4	SCREW,TPG,TF:4-24 X 0.188,TYPE B,PNH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-99	358-0566-00			1	GROMMET,PLASTIC:BLACK,ROUND,0.625 ID	28520	2103 (SB 812-10)
-100	426-1487-00			1	FRAME,PL-IN HSG:REAR	80009	426-1487-00
					(ATTACHING PARTS)		
-101	213-0119-00			12	SCREW,TPG,TF:4-24 X 0.375,TYPE B,PNH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
-102	----- -----			1	CRT BOARD ASSY:TRIGGER SELECT(SEE A14 REPL)		
					(ATTACHING PARTS)		
-103	211-0155-00			3	SCREW,EXT RLV:4-40 X 0.375,PNH,SST,POZ	80009	211-0155-00
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-104	361-0238-00			3	.SPACER,POST:0.433 L,0.25 OD	80009	361-0238-00
-105	136-0263-04			7	.SOCKET,PIN TERM:U/W 0.025 SQ PIN	22526	75377-001
-106	426-1352-00			5	.FRAME,MICROCKT:1.75 CM,STEPPED	80009	426-1352-00
					.(ATTACHING PARTS)		
-107	220-0797-00			20	.NUT,CAPTIVE:2-56 X 0.218 DIA,STL CD PL	46384	CKF2-256
-108	211-0259-00			25	.SCR,ASSEM WSHR:2-56 X 0.437,PNH,STL,POZ	01536	4821-00021
					.(END ATTACHING PARTS)		
-109	131-1968-00			3	.CONT SET,ELEC:MICROCKT,1.75 CM,RUBBER	80009	131-1968-00
	131-1968-01			2	.CONT SET,ELEC:MICROCKT,1.75 CM,RUBBER	80009	131-1968-01
-110	136-0269-02	B010100	B021599	1	.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP	09922	DILB14P-108T
	136-0728-00	B021600		1	.SKT,PL-IN ELEK:MICROCKT,14 CONTACT	09922	DILB14P-108
-111	136-0514-00	B010100	B021599	2	.SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B021600		2	.SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-112	131-1003-00			9	.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-113	136-0252-04			15	.SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-114	----- -----			1	CKT BOARD ASSY:LOGIC(SEE A13 REPL)		
					(ATTACHING PARTS)		
-115	211-0155-00			3	SCREW,EXT RLV:4-40 X 0.375,PNH,SST,POZ	80009	211-0155-00
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-116	136-0263-04			40	.SOCKET,PIN TERM:U/W 0.025 SQ PIN	22526	75377-001
-117	361-0238-00			3	.SPACER,POST:0.433 L,0.25 OD	80009	361-0238-00
-118	136-0252-07			55	.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-119	136-0241-00			4	.SKT,PL-IN ELEK:MICROCIRCUIT,10 CONT,PCB MT	71785	133-99-12-064
-120	214-0579-00			10	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-121	136-0269-02	B010100	B021599	1	.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP	09922	DILB14P-108T

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
4-	136-0728-00	B021600		1	.SKT,PL-IN ELEK:MICROCKT,14 CONTACT	09922	DILB14P-108
-122	136-0260-02	B010100	B021599	3	.SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP	09922	DILB16P-108T
	136-0729-00	B021600		3	.SKT,PL-IN ELEK:MICROCKT,16 CONTACT	09922	DILB16P-108T
-123	----- -----			2	CKT BOARD ASSY:FOLLOWER(SEE A11,A12 REPL)		
-124	----- -----			1	CKT BOARD ASSY:FOLLOWER(SEE A7 REPL)		
-125	----- -----			1	CKT BOARD ASSY:FOLLOWER(SEE A9 REPL)		
-126	----- -----			1	CKT BOARD ASSY:FOLLOWER(SEE A10 REPL)		
-127	----- -----			1	CKT BOARD ASSY:FOLLOWER(SEE A8 REPL)		
-128	----- -----			1	CKT BOARD ASSY:MAIN INTERFACE(SEE A6 REPL)		
-129	131-0608-00			103	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-130	386-1558-00			6	.SPACER,CKT BD:0.335 H,ACETAL	80009	386-1558-00
-131	351-0187-00			6	.POST,CKT BD MTG:0.72 L X 0.25 OD,BRS	80009	351-0187-00
-132	131-1003-00			10	.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-133	136-0252-07			13	.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-134	131-0589-00			18	.TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ	22526	48283-029
-135	131-0591-00			47	.TERMINAL,PIN:0.835 L X 0.025 SQ PH BRZ	22526	47332
	131-0767-10			4	.CONN,RCPT,ELEC:CKT BD,38/76 CONTACT	80009	131-0767-10
					.(ATTACHING PARTS)		
-136	213-0232-00			32	.SCREW,TPG,TF:2-32 X 0.312,TYPE B,PNN,STL	01536	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					.EACH CONNECTOR ASSY INCLUDES:		
-137	204-0365-00			4	..CONN BODY,RCPT:PLUG-IN CIRCUIT BOARD	80009	204-0365-00
-138	131-0726-00			24	..CONTACT,ELEC:CKT BD CONN,PH BRZ GOLD PL	80009	131-0726-00
-139	131-0727-00			24	..CONTACT,ELEC:CKT BD CONN,PH BRZ GOLD PL	80009	131-0727-00
-140	200-0950-00			2	..SHLD,ELEC CONN:PLUG-IN CKT BD,PLASTIC	80009	200-0950-00
-141	214-2675-00			6	.SPRING,CKT BD:	80009	214-2675-00
-142	136-0619-00			6	.SOCKET,PIN TERM:U/W 0.026-0.029 DIA PINS	00779	1-331677-0
	198-3762-00			1	WIRE SET,ELEC:	80009	198-3762-00
-143	210-0202-00			2	.TERMINAL,LUG:0.146 ID,LOCKING,BRZ TIN PL	86928	A-373-158-2
-144	131-0707-00			264	.CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL	22526	47439-000
-145	131-1810-00			36	.CONTACT,ELEC:WIRE TO PIN,PH BRZ GOLD PL	00779	87124-1
-146	352-0169-08			1	.HLDR,TERM CONN:2 WIRE,GRAY	80009	352-0169-08
-147	352-0162-00			2	.HLDR,TERM CONN:4 WIRE,BLACK	80009	352-0162-00
	352-0162-06			2	.HLDR,TERM CONN:4 WIRE,BLUE	80009	352-0162-06
-148	352-0163-04			4	.HLDR,TERM CONN:5 WIRE,YELLOW	80009	352-0163-04
	352-0163-07			2	.HLDR,TERM CONN:5 WIRE,VIOLET	80009	352-0163-07
	352-0163-08			2	.HLDR,TERM CONN:5 WIRE,GRAY	80009	352-0163-08
	352-0163-09			2	.HLDR,TERM CONN:5 WIRE,WHITE	80009	352-0163-09
-149	352-0165-00			2	.HLDR,TERM CONN:7 WIRE,BLACK	80009	352-0165-00
	352-0165-05			2	.HLDR,TERM CONN:7 WIRE,GREEN	80009	352-0165-05
	352-0165-07			2	.HLDR,TERM CONN:7 WIRE,VIOLET	80009	352-0165-07
-150	352-0166-06			1	.HLDR,TERM CONN:8 WIRE,BLUE	80009	352-0166-06
-151	352-0167-05			2	.HLDR,TERM CONN:9 WIRE,GREEN	80009	352-0167-05
-152	352-0168-02			2	.HLDR,TERM CONN:10 WIRE,RED	80009	352-0168-02
	352-0168-03			2	.HLDR,TERM CONN:10 WIRE,ORANGE	80009	352-0168-03
	352-0168-05			2	.HLDR,TERM CONN:10 WIRE,GREEN	80009	352-0168-05
	352-0168-06			2	.HLDR,TERM CONN:10 WIRE,BLUE	80009	352-0168-06
	352-0168-07			2	.HLDR,TERM CONN:10 WIRE,VIOLET	80009	352-0168-07
	352-0168-09			4	.HLDR,TERM CONN:10 WIRE,WHITE	80009	352-0168-09
-153	204-0738-00			2	.CONN BODY,PLUG:8 CONTACTS,SGL ROW,LKG CLIP	00779	1-87175-7
-154	204-0760-00			2	.CONN BODY,RCPT:10 CONTACTS	00779	2-87175-1
-155	175-0827-00			AR	.CABLE,SP,ELEC:4,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-954
-156	175-0828-00			AR	.CABLE,SP,ELEC:5,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-955
-157	175-0830-00			AR	.CABLE,SP,ELEC:7,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-972
-158	175-0831-00			AR	.CABLE,SP,ELEC:8,26 AWG,STRD,PVC INSUL,RBN	08261	111-2699-971
-159	175-0832-00			AR	.CABLE,SP,ELEC:9,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-956
-160	175-0833-00			AR	.CABLE,SP,ELEC:10,26 AWG STRD,PVC JKT,RBN	08261	111-2699-970
-161	179-2578-00			1	WIRING HARNESS:SIGNAL OUT	80009	179-2578-00
-162	352-0204-00			1	.HLDR,TERM CONN:8 WIRE,BLACK	80009	352-0204-00
	343-0549-00			5	.STRAP,TIEDOWN,E:0.091 W X 4.0 L,ZYTEL	06383	PLT1M
	179-2579-00			1	WIRING HARNESS:AUXILIARY-Y	80009	179-2579-00
-163	352-0202-00			1	.HLDR,TERM CONN:6 WIRE,BLACK	80009	352-0202-00
	343-0549-00			9	.STRAP,TIEDOWN,E:0.091 W X 4.0 L,ZYTEL	06383	PLT1M

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
5-	620-0283-01	B031930	B039999	1	POWER SUPPLY:LOW VOLTAGE	80009	620-0283-01
	620-0283-02	B040000		1	POWER SUPPLY:	80009	620-0283-02
					(ATTACHING PARTS)		
-1	211-0578-00			4	SCREW,MACHINE:6-32 X 0.438,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
					POWER SUPPLY INCLUDES:		
-2	200-1262-02			1	.COVER,PWR SPLY:LEFT SIDE	80009	200-1262-02
					.(ATTACHING PARTS)		
-3	211-0503-00			4	.SCREW,MACHINE:6-32 X 0.188,PNH,STL	93907	ORDER BY DESCR
-4	211-0504-00			2	.SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-5	255-0334-00			AR	.PLASTIC CHANNEL:12.75 X 0.175 X 0.155,NYLON	11897	122-37-2500
-6	348-0233-00			1	.GROMMET,PLASTIC:GRAY,OBLONG 0.847 X 0.347	80009	348-0233-00
-7	351-0279-00			2	.GUIDE,SHOE:5.18 X 0.375,NYLON	80009	351-0279-00
-8	200-1906-00			1	.COVER,PWR SPLY:BOTTOM & FRONT	80009	200-1906-00
					.(ATTACHING PARTS)		
-9	211-0503-00			5	.SCREW,MACHINE:6-32 X 0.188,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-10	200-1263-01			1	.COVER,PWR SPLY:RIGHT SIDE	80009	200-1263-01
					.(ATTACHING PARTS)		
-11	211-0503-00			1	.SCREW,MACHINE:6-32 X 0.188,PNH,STL	93907	ORDER BY DESCR
-12	211-0507-00			2	.SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-13	----- -----			2	.TRANSISTOR:(SEE Q1428,Q1474 REPL)		
					.(ATTACHING PARTS)		
-14	210-0406-00			2	.NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-15	210-1178-00			2	.WASHER,SHLDR:	13103	7721-7PPS
-16	211-0101-00			2	.SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-17	----- -----			2	.TRANSISTOR:(SEE Q1458,Q1494 REPL)		
					.(ATTACHING PARTS)		
-18	210-0406-00			2	.NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-19	210-1178-00			2	.WASHER,SHLDR:	13103	7721-7PPS
-20	211-0101-00			2	.SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-21	342-0202-00			5	.INSULATOR,PLATE:TRANSISTOR,MICA	91500	10-21-023-106
-22	----- -----			1	.TRANSISTOR:(SEE Q1522 REPL)		
					.(ATTACHING PARTS)		
-23	210-0406-00			1	.NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-24	210-1178-00			1	.WASHER,SHLDR:	13103	7721-7PPS
-25	211-0038-00			1	.SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-26	----- -----			1	.TRANSISTOR:(SEE Q1526 REPL)		
					.(ATTACHING PARTS)		
-27	210-0406-00			1	.NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-28	210-1178-00			1	.WASHER,SHLDR:	13103	7721-7PPS
-29	211-0101-00			1	.SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-30	342-0311-00			1	.INSULATOR,PLATE:TRANSISTOR,MICA	01295	64-21-023-212
-31	----- -----			1	.CKT BOARD ASSY:LV REGULATOR(SEE A25 REPL)		
					.(ATTACHING PARTS)		
-32	211-0008-00			5	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					.CKT BOARD ASSY INCLUDES:		
-33	131-0608-00			51	..TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
	131-0589-00			18	..TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ	22526	48283-029
-34	214-0579-00			6	..TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-35	136-0252-07			24	..SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-36	136-0727-00			5	..SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-37	131-0993-00			1	..BUS,CONDUCTOR:SHUNT ASSEMBLY,BLACK	22526	65474-005
-38	----- -----			1	..TRANSISTOR:(SEE Q148 REPL)		
					..(ATTACHING PARTS)		
-39	211-0097-00			1	..SCREW,MACHINE:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
-40	210-0551-00			1	..NUT,PLAIN,HEX:4-40 X 0.25,ST CD PL	TK0435	ORDER BY DESCR
-41	210-1178-00			1	..WASHER,SHLDR:	13103	7721-7PPS
	342-0311-00			1	..INSULATOR,PLATE:TRANSISTOR,MICA	01295	64-21-023-212
					..(END ATTACHING PARTS)		
-42	348-0023-00			1	.PLUG,HOLE:U/WO.14 DIA HOLE,WHT PLSTC	02768	207090201000101

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
5-43	441-1490-00			1	.CHASSIS,SCOPE:CIRCUIT BOARD	80009	441-1490-00
					.(ATTACHING PARTS)		
-44	211-0008-00			2	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-45	211-0507-00			3	.SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-46	----- -----			1	.CAPACITOR:(SEE C1354 REPL)		
					.(ATTACHING PARTS)		
-47	212-0518-00			2	.SCREW,MACHINE:10-32 X 0.312,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-48	----- -----			1	.CKT BOARD ASSY:CONTROL RECT(SEE A24 REPL)		
					.(ATTACHING PARTS)		
-49	211-0008-00			3	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-50	211-0504-00			1	.SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					.CKT BOARD ASSY INCLUDES:		
-51	136-0252-07			6	..SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-52	136-0729-00			1	..SKT,PL-IN ELEK:MICROCKT,16 CONTACT	09922	DILB16P-108T
-53	136-0263-07			6	..SOCKET,PIN TERM:U/W 0.025 SQ PIN	22526	ORDER BY DESCR
-54	----- -----			4	..SEMICOND DEVICE:(SEE CR1340,CR1341,CR1342,		
					..AND CR1343 REPL)		
					..(ATTACHING PARTS)		
-55	210-0410-00			4	..NUT,PLAIN,HEX:10-32 X 0.312,BRS CD PL	73743	2X-2003-402
-56	210-0056-00			4	..WASHER,LOCK:#10 SPLIT,0.047 THK,SI BRZ	86928	ORDER BY DESCR
-57	210-1003-00			4	..WASHER,FLAT:0.2 ID X 0.438 OD X 0.036 BRS	86928	5714-50-32N
					..(END ATTACHING PARTS)		
-58	386-1559-00			2	..SPACER,CKT BD:0.47 H,ACETAL	80009	386-1559-00
-59	----- -----			1	..SEMICOND DEVICE:(SEE CR1351 REPL)		
					..(ATTACHING PARTS)		
-60	211-0012-00			2	..SCREW,MACHINE:4-40 X 0.375,PNH,STL	93907	ORDER BY DESCR
-61	210-0586-00			2	..NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
					..(END ATTACHING PARTS)		
-62	342-0567-00			1	..INSULATOR,PLATE:TRANSISTOR,SILICONE RUBBER	18565	60-11-4511-167
-63	214-2731-00			1	..HEAT SINK,DIODE:TO-3,AL	80009	214-2731-00
-64	136-0254-01	B010100	B053348	2	..SOCKET,PIN TERM:U/W 0.031 TO 0.04 DIA PIN	00779	1-331892-8
-65	----- -----			2	.CAPACITOR:(SEE C1216,C1217 REPL)		
					.(ATTACHING PARTS)		
-66	212-0518-00			4	.SCREW,MACHINE:10-32 X 0.312,PNH,STL	93907	ORDER BY DESCR
-67	212-0651-00			4	.SCREW,MACHINE:10-32 X 0.312 L,PNH,NYLON	TK1281	011032P031
	210-3057-00			4	.WASHER,FLAT:0.17 ID X 0.35 OD X 0.03,NYL	85480	LWNY-012NA-M
					.(END ATTACHING PARTS)		
-68	342-0419-00			2	.INSULATOR,CAP.:	TK1316	ORDER BY DESCR
-69	407-2111-00			1	.BRACKET,CAP.:ALUMINUM	80009	407-2111-00
-70	342-0452-00	B010100	B042828	1	.INSULATOR,FILM:CIRCUIT BOARD,POLYIMIDE	TK1316	ORDER BY DESCR
-71	----- -----			1	.TRANSFORMER:(SEE T1310 REPL)		
					.(ATTACHING PARTS)		
-72	211-0008-00			4	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-73	348-0023-00			1	.PLUG,HOLE:U/W0.14 DIA HOLE,WHT PLSTC	02768	207090201000101
-74	441-1423-00			1	.CHASSIS,SCOPE:TRANSFORMER	80009	441-1423-00
					.(ATTACHING PARTS)		
-75	211-0097-00			2	.SCREW,MACHINE:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-76	337-1490-02			1	.SHIELD,ELEC:LINE INVERTER,CKT BD BOTTOM	80009	337-1490-02
					.(ATTACHING PARTS)		
-77	211-0558-00			1	.SCREW,MACHINE:6-32 X 0.25,BDGH,NYL	26365	ORDER BY DESCR
-78	210-0055-00			1	.WASHER,LOCK:#6 SPLIT,0.031 THK,STL	81350	ORDER BY DESCR
-79	211-0040-00			1	.SCREW,MACHINE:4-40 X 0.25,BDGH,NYL	26365	ORDER BY DESCR
-80	210-0054-00			1	.WASHER,LOCK:#4 SPLIT,0.025 THK STL	78189	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-81	220-0623-00			1	.NUT BLOCK:6-32 X 0.375 X 0.5 X 0.448	TK1465	ORDER BY DESCR
					.(ATTACHING PARTS)		
-82	211-0503-00			1	.SCREW,MACHINE:6-32 X 0.188,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-83	----- -----			1	.CKT BOARD ASSY:INVERTER(SEE A23 REPL)		
					.(ATTACHING PARTS)		
-84	211-0008-00			4	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					.CKT BOARD ASSY INCLUDES:		

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
5-85	131-0591-00			6	..TERMINAL,PIN:0.835 L X 0.025 SQ PH BRZ	22526	47332
-86	214-1914-00			1	..HEAT SINK,DIODE:(2)0.15 DIA HOLES,AL	98978	PB1-2CB
					..(ATTACHING PARTS)		
-87	211-0012-00			1	..SCREW,MACHINE:4-40 X 0.375,PNH,STL	93907	ORDER BY DESCR
-88	210-0406-00			1	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
					..(END ATTACHING PARTS)		
-89	361-0414-00			1	..SPACER,DIODE:0.238 X 0.64 X 0.425,NYLON	80009	361-0414-00
-90	346-0032-00			1	..STRAP,RETAINING:0.075 DIA X 4.0 L,MLD RBR	98159	2829-75-4
-91	348-0005-00			1	..GROMMET,RUBBER:BLACK,ROUND,0.375 ID	70485	230X-36017
-92	129-0323-00			1	..SPACER,POST:1.0 L,4-40 EA END,AL,0.25 HEX	80009	129-0323-00
					..(ATTACHING PARTS)		
-93	211-0097-00			1	..SCREW,MACHINE:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
					..(END ATTACHING PARTS)		
-94	385-0016-00			1	..SPACER,POST:1.0 L W/6-32 THD THRU,NYLON	80009	385-0016-00
					..(ATTACHING PARTS)		
-95	211-0507-00			1	..SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					..(END ATTACHING PARTS)		
-96	134-0158-00			4	..BUTTON,PLUG:0.187 DIA,NYLON	02768	207-080501-00
-97	337-2533-00			1	.SHIELD,ELEC:LINE INVERT,TOP	80009	337-2533-00
					.(ATTACHING PARTS)		
-98	211-0101-00			4	.SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL	93907	ORDER BY DESCR
-99	211-0504-00			2	.SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-100	344-0118-00			2	.RTNR,CAPACITOR:1.0 DIA,STEEL	80033	E50008 -044
					.(ATTACHING PARTS)		
-101	210-0586-00			2	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-102	211-0008-00			2	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-103	----- -----			2	.TRANSISTOR:(SEE Q1234,Q1240 REPL)		
					.(ATTACHING PARTS)		
-104	211-0034-00			2	.SCREW,MACHINE:2-56 X 0.5,PNH,STL	06950	ORDER BY DESCR
-105	210-0053-00			2	.WASHER,LOCK:#2 SPLIT,0.02 THK STL	78189	ORDER BY DESCR
-106	210-1008-00			2	.WASHER,FLAT:0.09 ID X 0.188 OD X 0.02,BRS	12327	ORDER BY DESCR
-107	342-0421-00			2	.INSULATOR,BSHG:0.089 ID X 0.24 OD 0.23 NYL	80009	342-0421-00
					.(END ATTACHING PARTS)		
-108	342-0420-00			2	.INSULATOR,PLATE:TRANSISTOR,PORCELAIN	80009	342-0420-00
-109	342-0202-00			2	.INSULATOR,PLATE:TRANSISTOR,MICA	91500	10-21-023-106
-110	386-2634-00			1	.PL,CHOKE MTG:	80009	386-2634-00
					.(ATTACHING PARTS)		
-111	211-0619-00			2	.SCREW,MACHINE:6-32 X 1.5,FLH,100 DEG,STL	TK0433	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-112	441-1420-00			1	.CHASSIS,SCOPE:LINE INVERT	80009	441-1420-00
					.(ATTACHING PARTS)		
-113	213-0041-00			2	.SCREW,TPG,TC:6-32 X 0.375,TYPE T,TRH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-114	342-0193-00			1	.INSULATOR,FILM:POWER SUPPLY,POLYIMIDE	80009	342-0193-00
-115	342-0103-00			1	.INSULATOR,BLOCK:HEAT-SINK SHIELD,NYLON	80009	342-0103-00
					.(ATTACHING PARTS)		
-116	210-0457-00			1	.NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
-117	211-0512-00			1	.SCREW,MACHINE:6-32 X 0.5,FLH,100 DEG,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-118	214-1625-00			1	.SPRING,FLAT:2.0 X 0.438,CU BE	80009	214-1625-00
-119	198-3829-00			1	.WIRE SET,ELEC:	80009	198-3829-00
-120	352-0161-09			1	..HLDR,TERM CONN:3 WIRE,WHITE	80009	352-0161-09
					..(A25P99 TO S99)		
-121	352-0162-04			2	..HLDR,TERM CONN:4 WIRE,YELLOW	80009	352-0162-04
					..(A25P54 TO A24P54)		
-122	352-0163-08			2	..HLDR,TERM CONN:5 WIRE,GRAY	80009	352-0163-08
					..(A25P48 TO A24P48)		
-123	352-0164-02			2	..HLDR,TERM CONN:6 WIRE,RED	80009	352-0164-02
					..(A25P52 TO A24P52)		
-124	352-0165-00			2	..HLDR,TERM CONN:7 WIRE,BLACK	80009	352-0165-00
					..(A25P50 TO A24P50)		
-125	352-0200-00			2	..HLDR,TERM CONN:4 WIRE,BLACK	80009	352-0200-00
					..(A25P50 TO A24P50)		
-126	210-0204-00			1	..TERMINAL,LUG:0.142 ID,LOCKING,BRZ TINNED	86928	A373-175
-127	210-0202-00			2	..TERMINAL,LUG:0.146 ID,LOCKING,BRZ TIN PL	86928	A-373-158-2
-128	131-0707-00			47	..CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL	22526	47439-000

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
5-129	131-0622-00			4	..CONTACT,ELEC:28-32 AWG,BRS & CU BE GLD PL	22526	46241-000
	131-0792-00			4	..CONNECTOR,TERM:18-20 AWG,CU BE GOLD PL	22526	46221
-130	131-2065-00			4	..TERM,QIK DISC.:18-22 AWG,BRASS TIN PLATED	00779	2-520181-2
-131	210-0307-00			2	..TERMINAL,LUG:#8,RING,SOLDERLESS,CU TIN PL	09922	BA14E-8M
-132	175-0826-00			AR	..CABLE,SP,ELEC:3,26 AWG,STRD,PVC JKT,RBN	80009	175-0826-00
-133	175-0827-00			AR	..CABLE,SP,ELEC:4,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-954
-134	175-0860-00			AR	..CABLE,SP,ELEC:5,22 AWG,STRD,PVC JKT,RBN	TK0846	05CF22M7-BBT
-135	175-0859-00			AR	..CABLE,SP,ELEC:6,22 AWG,STRD,PVC JKT,RBN	TK0846	06CF22M7-BBT
-136	175-0858-00			AR	..CABLE,SP,ELEC:7,22 AWG,STRD,PVC INSUL,RBN	TK0846	07CF22M7-BBT
-137	175-1091-00			AR	..CABLE,SP,ELEC:4,18 AWG,STRD BRAIDED SHLD	80009	175-1091-00
-138	334-3379-01			1	.MARKER,IDENT:MARKED GROUND SYMBOL	80009	334-3379-01
-139	----- -----			1	.SWITCH,SLIDE:(SEE S1540 REPL)		
					.(ATTACHING PARTS)		
-140	210-0586-00			2	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-141	211-0097-00			2	.SCREW,MACHINE:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-142	210-0204-00			1	.TERMINAL,LUG:0.142 ID,LOCKING,BRZ TINNED	86928	A373-175
					.(ATTACHING PARTS)		
-143	210-0407-00			1	.NUT,PLAIN,HEX:6-32 X 0.25,BRS CD PL	73743	3038-402
					.(END ATTACHING PARTS)		
-144	210-0202-00			1	.TERMINAL,LUG:0.146 ID,LOCKING,BRZ TIN PL	86928	A-373-158-2
					.(ATTACHING PARTS)		
-145	210-0407-00			2	.NUT,PLAIN,HEX:6-32 X 0.25,BRS CD PL	73743	3038-402
					.(END ATTACHING PARTS)		
-146	----- -----			1	.SWITCH,SLIDE:(SEE S1200 REPL)		
					.(ATTACHING PARTS)		
-147	210-0586-00			2	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-148	211-0097-00			2	.SCREW,MACHINE:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-149	200-2264-00			1	.CAP,FUSEHOLDER:3AG FUSES	S3629	FEK 031 1666
-150	204-0832-00			1	.BODY,FUSEHOLDER:3AG & 5 X 20MM FUSES	TK0861	031 1673
-151	210-1039-00			1	.WASHER,LOCK:0.521 ID,INT,0.025 THK,SST	24931	ORDER BY DESCR
-152	----- -----			1	.FILTER,RFI:(SEE FL1200 REPL)		
					.(ATTACHING PARTS)		
-153	210-0586-00			2	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-154	211-0014-00			2	.SCREW,MACHINE:4-40 X 0.5,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-155	214-2932-00	B010100	B063510	1	.HEAT SINK,ELEC:POWER SUPPLY,AL	80009	214-2932-00
	214-2932-01	B063511		1	.HEAT SINK,ELEC:POWER SUPPLY,ALUMINUM	80009	214-2932-01
	334-1377-00			1	MARKER,IDENT:MKD IDENTIFICATION NO.	80009	334-1377-00
					(OPTION 03 ONLY)		
					CKT BOARD ASSY:READOUT PROTECTION #1		
					(SEE A15,A27 REPL)		
					(ATTACHING PARTS)		
-156	211-0008-00			1	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
					READOUT PROT ASSY INCLUDES:		
-157	----- -----			1	.CKT BOARD ASSY:READOUT PROTECTION #1		
					.(SEE A27 REPL)		
-158	253-0160-00			AR	..TAPE,PRESS SENS:POLY SPONGE,0,25 X 0.062	04963	4116 TYPE A
-159	----- -----			1	.CKT BOARD ASSY:READOUT(SEE A15 REPL)		
-160	136-0252-07			45	..SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-161	136-0729-00			14	..SKT,PL-IN ELEK:MICROCKT,16 CONTACT	09922	DILB16P-108T
-162	136-0728-00			3	..SKT,PL-IN ELEK:MICROCKT,14 CONTACT	09922	DILB14P-108
-163	136-0235-00			1	..SKT,PL-IN ELEK:TRANSISTOR,6 CONTACT	71785	133-96-12-062
-164	343-0006-00			2	CLAMP,LOOP:0.5 ID,PLASTIC	06915	ORDER BY DESCR
-165	344-0133-00			4	CLIP,SPR TNSN:CKT BOARD MT,WHITE	80009	344-0133-00
					(ATTACHING PARTS)		
-166	211-0198-00			2	SCREW,MACHINE:4-40 X 0.438,PNH,STL	TK0435	ORDER BY DESCR
	211-0007-00			2	SCREW,MACHINE:4-40 X 0.188,PNH,STL	93907	ORDER BY DESCR
-167	210-0586-00			2	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-168	210-0863-00			2	WSHR,LOOP CLAMP:0.091 ID U/W 0.5 W CLP,STL	95987	C191
					(END ATTACHING PARTS)		
-169	131-0771-00			2	CONN,RCPT,ELEC:2 MALE,2 FEM,PNL MT W/O MTG HDW	91836	1904-2M58
					(ATTACHING PARTS)		
-170	220-0551-00			2	NUT,PLAIN,HEX:9 MM X 1.00,BRS NP	73743	ORDER BY DESCR
-171	210-0012-00			2	WASHER,LOCK:0.384 ID,INTL,0.022 THK,STL	09772	ORDER BY DESCR

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
5-					(END ATTACHING PARTS)		
-172	131-0955-00			3	CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
-173	131-1315-01			3	CONN,RCPT,ELEC:BNC,FEMALE	80009	131-1315-01
-174	441-1377-00			1	CHASSIS,SCOPE:READOUT	80009	441-1377-00
-175	333-2321-00			1	PANEL,REAR:READOUT	80009	333-2321-00
					(ATTACHING PARTS)		
-176	211-0507-00			2	SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
-177	----- -----			1	CKT BOARD ASSY:VERT CHAN SW(SEE A16 REPL)		
					(ATTACHING PARTS)		
-178	211-0292-00	B010100	B043049	4	SCR,ASSEM WSHR:4-40 X 0.29,PNH,BRS NI PL	78189	51-040445-01
	211-0008-00	B040350		4	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-179	211-0260-00			2	SCR,ASSEM WSHR:2-56 X 0.687,PNH,STL,POZ	01536	ORDER BY DESCR
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-180	214-2543-00			1	.HT SK,MICROCKT:MICROCIRCUIT,AL	80009	214-2543-00
					.(ATTACHING PARTS)		
-181	211-0259-00			2	.SCR,ASSEM WSHR:2-56 X 0.437,PNH,STL,POZ	01536	4821-00021
					.(END ATTACHING PARTS)		
-182	131-2033-00			2	.CONTACT,ELEC:SINGLE,BOTTOM,CU BE	80009	131-2033-00
					.(ATTACHING PARTS)		
-183	210-0629-00			4	.EYELET,METALLIC:0.059 OD X 0.093 L,BRS	80009	210-0629-00
					.(END ATTACHING PARTS)		
-184	131-2032-00			2	.CONTACT,ELEC:SINGLE,TOP,CU BE	80009	131-2032-00
-185	426-1351-00			1	.FRAME,MICROCKT:1.75 CM	80009	426-1351-00
-186	131-1967-01			1	.CONT SET,ELEC:MICROCKT,1.75 CM,RUBBER	80009	131-1967-01
-187	131-2022-00			2	.CONTACT,ELEC:DUAL,BOTTOM,CU BE	80009	131-2022-00
					.(ATTACHING PARTS)		
-188	210-0629-00			6	.EYELET,METALLIC:0.059 OD X 0.093 L,BRS	80009	210-0629-00
					.(END ATTACHING PARTS)		
-189	131-2020-00			2	.CONTACT,ELEC:DUAL,TOP,BERYLLIUM COPPER	80009	131-2020-00
-190	136-0252-00			6	.SOCKET,PIN TERM:U/W 0.018 DIA PINS	00779	2-330808-7
-191	388-5349-01			1	.CIRCUIT BOARD:HF VERTICAL CHANNEL SWITCH	80009	388-5349-01
					.(ATTACHING PARTS)		
-192	210-0702-00			15	.EYELET,METALLIC:0.047 OD X 0.125 L	07707	S-6127
					.(END ATTACHING PARTS)		
-193	214-0668-00			1	.HEAT SINK,XSTR:TO-5,AL BLK ANDZ	13103	2211B
					.(FOR Q676)		
-194	441-1378-01			1	CHASSIS,CHAN SW:	80009	441-1378-01
					(ATTACHING PARTS)		
-195	211-0008-00			2	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-196	343-0213-00			3	CLAMP,CABLE:0.2 ID,PLASTIC	80009	343-0213-00
-197	333-2320-00			1	PANEL,REAR:	80009	333-2320-00
					(ATTACHING PARTS)		
-198	211-0507-00			2	SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
-199	426-0807-02			1	FRAME PNL,CAB.:REAR	80009	426-0807-02
					(ATTACHING PARTS)		
-200	213-0270-00			4	SCR,TPG,TF:10-32 X 0.75,SPCL TYPE,FILH,STL	TK1543	234-74658-026
					(END ATTACHING PARTS)		
-201	200-0678-00	B010115		9	COVER,ELEC CONN:BNC,NON-SHORTING	91836	KC89-58TR5
					(OPTION 03 ONLY)		
-202	346-0045-00	B010115		9	STRAP,CONN COV:BNC ONE END,POLYPROPYLENE	80009	346-0045-00
					(OPTION 03 ONLY)		

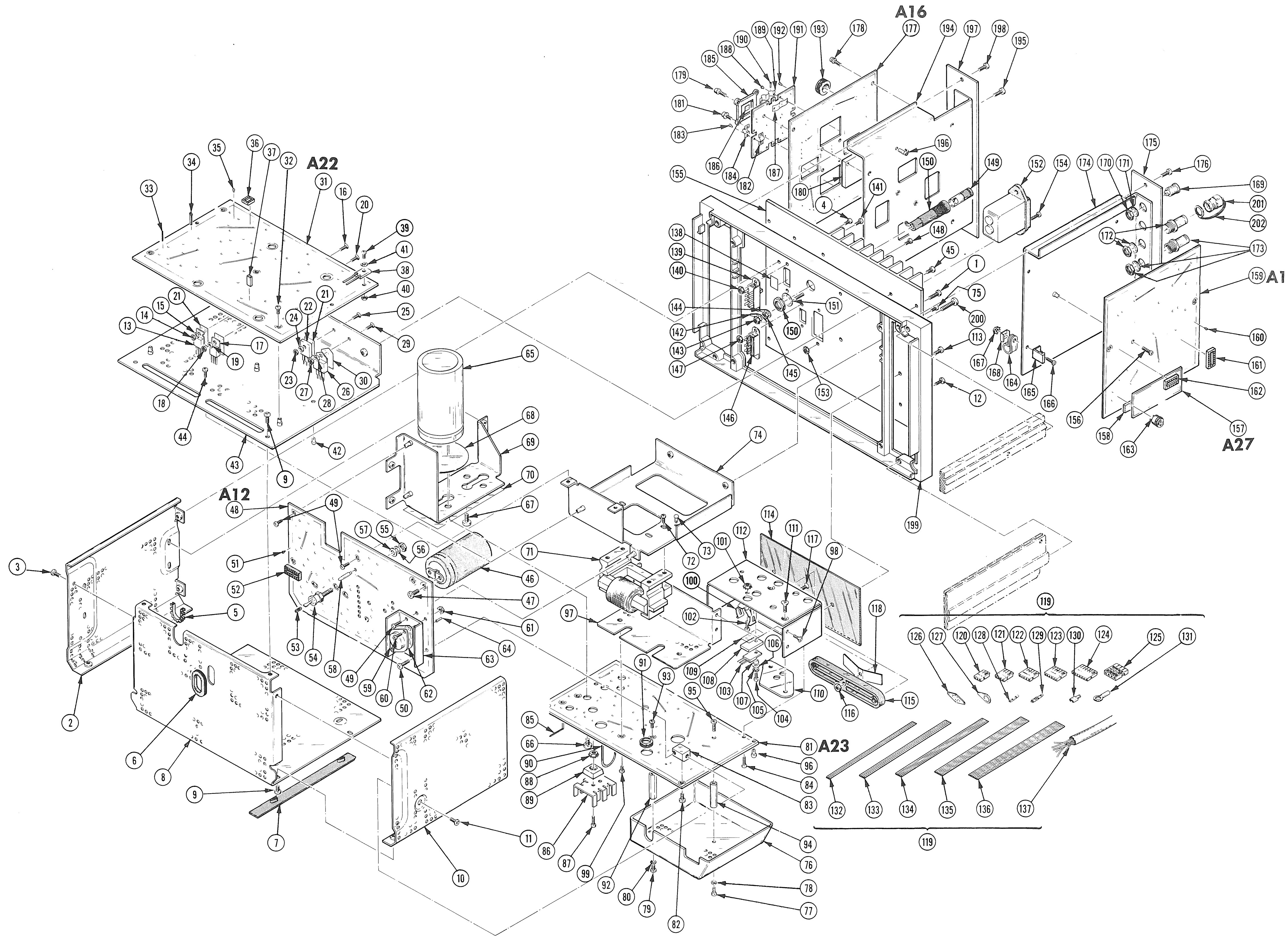


FIG. 5 POWER SUPPLY

FIG 6 POWER SUPPLY

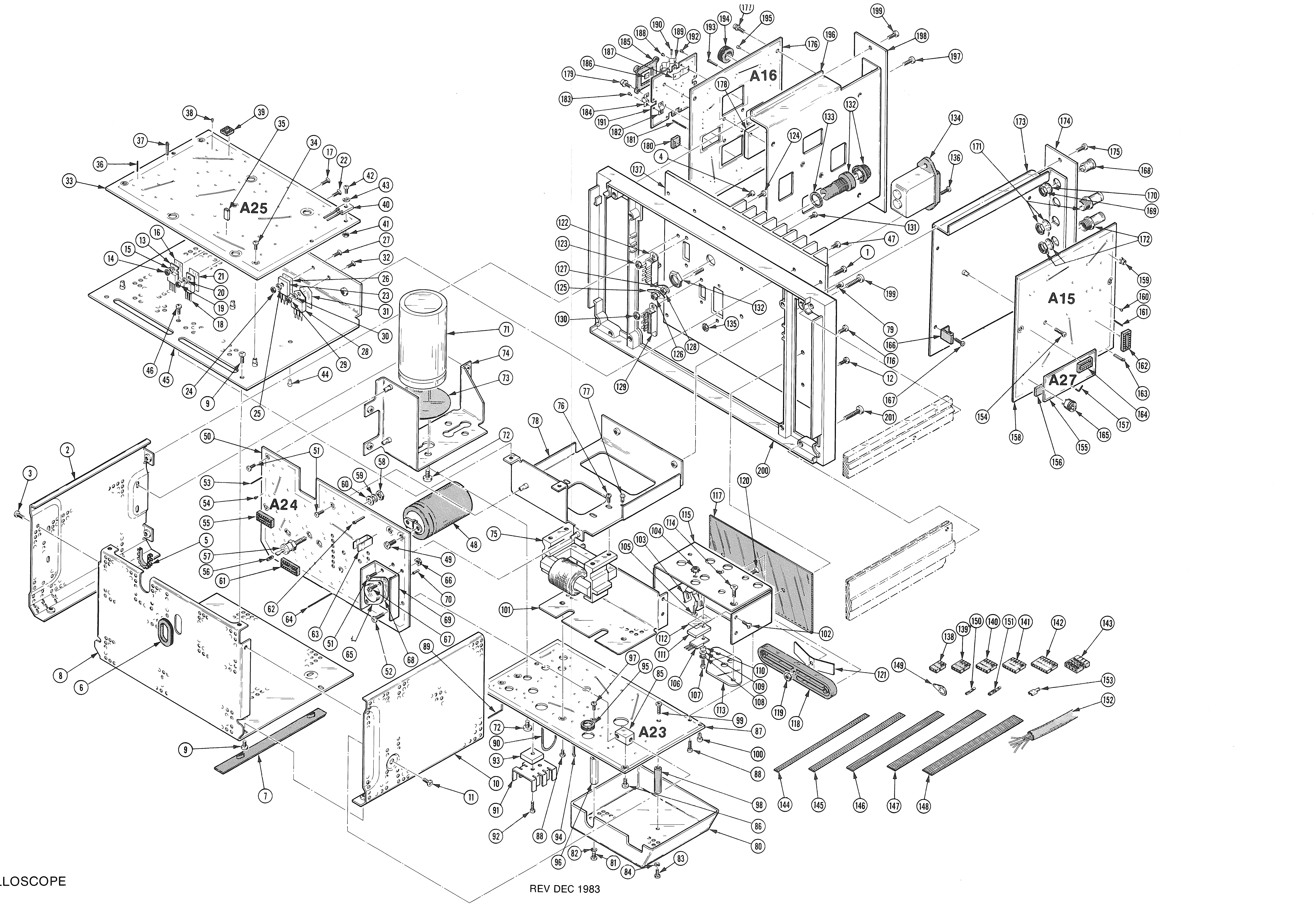


Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
6-	620-0276-00	B010100	B031929	1	POWER SUPPLY:	80009	620-0276-00
					(ATTACHING PARTS)		
-1	211-0578-00			4	SCREW,MACHINE:6-32 X 0.438,PNH,STL	93907	ORDER BY DESCR
					POWER SUPPLY INCLUDES:		
					(END ATTACHING PARTS)		
-2	200-1262-02			1	.COVER,PWR SPLY:LEFT SIDE	80009	200-1262-02
					.(ATTACHING PARTS)		
-3	211-0503-00			7	.SCREW,MACHINE:6-32 X 0.188,PNH,STL	93907	ORDER BY DESCR
-4	211-0504-00			2	.SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-5	255-0334-00			1	.PLASTIC CHANNEL:12.75 X 0.175 X 0.155,NYLON	11897	122-37-2500
-6	348-0233-00			1	.GROMMET,PLASTIC:GRAY,OBLONG 0.847 X 0.347	80009	348-0233-00
-7	351-0279-00			2	.GUIDE,SHOE:5.18 X 0.375,NYLON	80009	351-0279-00
-8	200-1906-00			1	.COVER,PWR SPLY:BOTTOM & FRONT	80009	200-1906-00
					.(ATTACHING PARTS)		
-9	211-0503-00			5	.SCREW,MACHINE:6-32 X 0.188,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-10	200-1263-01			1	.COVER,PWR SPLY:RIGHT SIDE	80009	200-1263-01
					.(ATTACHING PARTS)		
-11	211-0503-00			1	.SCREW,MACHINE:6-32 X 0.188,PNH,STL	93907	ORDER BY DESCR
-12	211-0504-00			2	.SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-13	----- -----			2	.TRANSISTOR:(SEE Q1428,Q1474 REPL)		
					.(ATTACHING PARTS)		
-14	210-0551-00			2	.NUT,PLAIN,HEX:4-40 X 0.25,ST CD PL	TK0435	ORDER BY DESCR
-15	210-1178-00			2	.WASHER,SHLDR:	13103	7721-7PPS
-16	342-0202-00			2	.INSULATOR,PLATE:TRANSISTOR,MICA	91500	10-21-023-106
-17	211-0101-00			2	.SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-18	----- -----			2	.TRANSISTOR:(SEE Q1458,Q1494 REPL)		
					.(ATTACHING PARTS)		
-19	210-0551-00			2	.NUT,PLAIN,HEX:4-40 X 0.25,ST CD PL	TK0435	ORDER BY DESCR
-20	210-1178-00			2	.WASHER,SHLDR:	13103	7721-7PPS
-21	342-0202-00			2	.INSULATOR,PLATE:TRANSISTOR,MICA	91500	10-21-023-106
-22	211-0101-00			2	.SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-23	----- -----			1	.TRANSISTOR:(SEE Q1522 REPL)		
					.(ATTACHING PARTS)		
-24	210-0551-00			1	.NUT,PLAIN,HEX:4-40 X 0.25,ST CD PL	TK0435	ORDER BY DESCR
-25	210-1178-00			1	.WASHER,SHLDR:	13103	7721-7PPS
-26	342-0202-00			1	.INSULATOR,PLATE:TRANSISTOR,MICA	91500	10-21-023-106
-27	211-0038-00			1	.SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-28	----- -----			1	.TRANSISTOR:(SEE Q1526 REPL)		
					.(ATTACHING PARTS)		
-29	210-0551-00			1	.NUT,PLAIN,HEX:4-40 X 0.25,ST CD PL	TK0435	ORDER BY DESCR
-30	210-1178-00			1	.WASHER,SHLDR:	13103	7721-7PPS
-31	342-0202-00			1	.INSULATOR,PLATE:TRANSISTOR,MICA	91500	10-21-023-106
-32	211-0101-00			1	.SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-33	----- -----			1	.CKT BOARD ASSY:REGULATOR(SEE A25 REPL)		
					.(ATTACHING PARTS)		
-34	211-0008-00			5	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					.CKT BOARD ASSY INCLUDES:		
-35	131-0993-00			1	..BUS,CONDUCTOR:SHUNT ASSEMBLY,BLACK	22526	65474-005
-36	131-0608-00			66	..TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-37	214-0579-00			9	..TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-38	136-0252-04			24	..SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-39	136-0514-00	B010100	B021599	5	..SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B021600		5	..SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-40	----- -----			1	..TRANSISTOR:(SEE Q1548 REPL)		
					..(ATTACHING PARTS)		
-41	210-0414-00			1	..NUT,PLAIN,HEX:0.469-32 X 0.562,BRS CD PL	73743	3167-402
-42	211-0097-00			1	..SCREW,MACHINE:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
-43	210-1178-00			1	..WASHER,SHLDR:	13103	7721-7PPS
					..(END ATTACHING PARTS)		
-44	348-0023-00			1	.PLUG,HOLE:U/W0.14 DIA HOLE,WHT PLSTC	02768	207090201000101

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
6-45	441-1421-00			1	.CHASSIS,SCOPE:POST REGULATOR CIRCUIT BD	80009	441-1421-00
					.(ATTACHING PARTS)		
-46	211-0008-00			2	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-47	211-0507-00			3	.SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-48	----- -----			1	.CAPACITOR:(SEE C1354 REPL)		
					.(ATTACHING PARTS)		
-49	212-0518-00			2	.SCREW,MACHINE:10-32 X 0.312,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-50	----- -----			1	.CKT BOARD ASSY:CONTROL/RECT(SEE A24 REPL)		
					.(ATTACHING PARTS)		
-51	211-0008-00			3	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-52	211-0504-00			1	.SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					.CKT BOARD ASSY INCLUDES:		
-53	----- -----			22	..TERMINAL,PIN:(SEE P48,50,52,54 REPL)		
-54	136-0252-07			9	..SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-55	136-0269-02	B010100	B021599	1	..SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP	09922	DILB14P-108T
	136-0728-00	B021600		1	..SKT,PL-IN ELEK:MICROCKT,14 CONTACT	09922	DILB14P-108
-56	136-0263-04			6	..SOCKET,PIN TERM:U/W 0.025 SQ PIN	22526	75377-001
-57	----- -----			4	..SEMICOND DEVICE:(SEE CR1340,CR1341,CR1342,		
					..CR1343 REPL)		
					..(ATTACHING PARTS)		
-58	210-0410-00			4	..NUT,PLAIN,HEX:10-32 X 0.312,BRS CD PL	73743	2X-2003-402
-59	210-0056-00			4	..WASHER,LOCK:#10 SPLIT,0.047 THK,SI BRZ	86928	ORDER BY DESCR
-60	210-1003-00			4	..WASHER,FLAT:0.2 ID X 0.438 OD X 0.036 BRS	86928	5714-50-32N
					..(END ATTACHING PARTS)		
-61	136-0260-02	B010100	B021599	1	..SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP	09922	DILB16P-108T
	136-0729-00	B021600		1	..SKT,PL-IN ELEK:MICROCKT,16 CONTACT	09922	DILB16P-108T
-62	214-0579-00			2	..TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-63	344-0286-00			4	..CLIP,ELECTRICAL:FUSE,SPR BRS	75915	102074
-64	----- -----			4	..TERMINAL,PIN:(SEE P40 REPL)		
-65	----- -----			1	..SEMICOND DEVICE:(SEE CR1351 REPL)		
					..(ATTACHING PARTS)		
-66	210-0586-00			2	..NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-67	211-0012-00			2	..SCREW,MACHINE:4-40 X 0.375,PNH,STL	93907	ORDER BY DESCR
					..(END ATTACHING PARTS)		
-68	386-0786-00			1	..INSULATOR,PLATE:TRANSISTOR,MICA	28205	ORDER BY DESCR
-69	214-2731-00			1	..HEAT SINK,DIODE:TO-3,AL	80009	214-2731-00
-70	136-0254-01			2	..SOCKET,PIN TERM:U/W 0.031 TO 0.04 DIA PIN	00779	1-331892-8
-71	----- -----			2	.CAPACITOR:(SEE C1216,C1217 REPL)		
					.(ATTACHING PARTS)		
-72	212-0518-00	B010100	B020919	8	.SCREW,MACHINE:10-32 X 0.312,PNH,STL	93907	ORDER BY DESCR
	212-0518-00	B020920		4	.SCREW,MACHINE:10-32 X 0.312,PNH,STL	93907	ORDER BY DESCR
	212-0651-00	B020920		4	.SCREW,MACHINE:10-32 X 0.312 L,PNH,NYLON	TK1281	011032P031
	210-3057-00	B020920		4	.WASHER,FLAT:0.17 ID X 0.35 OD X 0.03,NYL	85480	LWNY-012NA-M
					.(END ATTACHING PARTS)		
-73	342-0419-00			2	.INSULATOR,CAP.:	TK1316	ORDER BY DESCR
-74	407-2111-00			1	.BRACKET,CAP.:ALUMINUM	80009	407-2111-00
-75	----- -----			1	.TRANSFORMER:(SEE T1310 REPL)		
					.(ATTACHING PARTS)		
-76	211-0008-00			4	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-77	348-0023-00			1	.PLUG,HOLE:U/WO.14 DIA HOLE,WHT PLSTC	02768	207090201000101
-78	441-1423-00			1	.CHASSIS,SCOPE:TRANSFORMER	80009	441-1423-00
					.(ATTACHING PARTS)		
-79	211-0097-00			2	.SCREW,MACHINE:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-80	337-1490-01	B010100	B020524	1	.SHIELD,ELEC:LINE INVERTER,CKT BD BOTTOM	80009	337-1490-01
	337-1490-02	B020525		1	.SHIELD,ELEC:LINE INVERTER,CKT BD BOTTOM	80009	337-1490-02
					.(ATTACHING PARTS)		
-81	211-0040-00			1	.SCREW,MACHINE:4-40 X 0.25,BDGH,NYL	26365	ORDER BY DESCR
-82	210-0054-00			1	.WASHER,LOCK:#4 SPLIT,0.025 THK STL	78189	ORDER BY DESCR
-83	211-0558-00			1	.SCREW,MACHINE:6-32 X 0.25,BDGH,NYL	26365	ORDER BY DESCR
-84	210-0055-00			1	.WASHER,LOCK:#6 SPLIT,0.031 THK,STL	81350	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-85	220-0623-00			1	.NUT BLOCK:6-32 X 0.375 X 0.5 X 0.448	TK1465	ORDER BY DESCR
					.(ATTACHING PARTS)		

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
6-86	211-0504-00			1	.SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-87	----- -----			1	.CKT BOARD ASSY:INVERTER(SEE A23 REPL)		
					.(ATTACHING PARTS)		
-88	211-0008-00			4	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					.CKT BOARD ASSY INCLUDES:		
-89	131-0591-00			6	..TERMINAL,PIN:0.835 L X 0.025 SQ PH BRZ	22526	47332
-90	346-0032-00			1	..STRAP,RETAINING:0.075 DIA X 4.0 L,MLD RBR	98159	2829-75-4
-91	214-1914-00			1	..HEAT SINK,DIODE:(2)0.15 DIA HOLES,AL	98978	PB1-2CB
					..(ATTACHING PARTS)		
-92	211-0012-00	B010100	B063589	1	..SCREW,MACHINE:4-40 X 0.375,PNH,STL	93907	ORDER BY DESCR
	211-0014-00	B063590		1	..SCREW,MACHINE:4-40 X 0.5,PNH,STL	93907	ORDER BY DESCR
	210-0006-00	B063590		1	..WASHER,LOCK:#6 INTL,0.018 THK,STL	77900	1206-00-00-0541C
					..(END ATTACHING PARTS)		
-93	361-0414-00			1	..SPACER,DIODE:0.238 X 0.64 X 0.425,NYLON	80009	361-0414-00
-94	214-0579-00			3	..TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-95	348-0005-00			1	..GROMMET,RUBBER:BLACK,ROUND,0.375 ID	70485	230X-36017
-96	129-0323-00			1	..SPACER,POST:1.0 L,4-40 EA END,AL,0.25 HEX	80009	129-0323-00
					..(ATTACHING PARTS)		
-97	211-0097-00			1	..SCREW,MACHINE:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
					..(END ATTACHING PARTS)		
-98	385-0016-00			1	..SPACER,POST:1.0 L W/6-32 THD THRU,NYLON	80009	385-0016-00
					..(ATTACHING PARTS)		
-99	211-0507-00			1	..SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					..(END ATTACHING PARTS)		
-100	134-0158-00			4	..BUTTON,PLUG:0.187 DIA,NYLON	02768	207-080501-00
-101	337-2533-00			1	.SHIELD,ELEC:LINE INVERT,TOP	80009	337-2533-00
					.(ATTACHING PARTS)		
-102	211-0101-00			4	.SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-103	344-0118-00			2	.RTNR,CAPACITOR:1.0 DIA,STEEL	80033	E50008 -044
					.(ATTACHING PARTS)		
-104	210-0586-00			2	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-105	211-0008-00			2	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-106	----- -----			2	.TRANSISTOR:(SEE Q1234,Q1240 REPL)		
					.(ATTACHING PARTS)		
-107	211-0034-00			2	.SCREW,MACHINE:2-56 X 0.5,PNH,STL	06950	ORDER BY DESCR
-108	210-0053-00			2	.WASHER,LOCK:#2 SPLIT,0.02 THK STL	78189	ORDER BY DESCR
-109	210-1008-00			2	.WASHER,FLAT:0.09 ID X 0.188 OD X 0.02,BRS	12327	ORDER BY DESCR
-110	342-0421-00			2	.INSULATOR,BSHG:0.089 ID X 0.24 OD 0.23 NYL	80009	342-0421-00
					.(END ATTACHING PARTS)		
-111	342-0420-00			2	.INSULATOR,PLATE:TRANSISTOR,PORCELAIN	80009	342-0420-00
-112	342-0202-00			2	.INSULATOR,PLATE:TRANSISTOR,MICA	91500	10-21-023-106
-113	386-2634-00			1	.PL,CHOKE MTG:	80009	386-2634-00
					.(ATTACHING PARTS)		
-114	211-0619-00			2	.SCREW,MACHINE:6-32 X 1.5,FLH,100 DEG,STL	TK0433	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-115	441-1420-00			1	.CHASSIS,SCOPE:LINE INVERT	80009	441-1420-00
					.(ATTACHING PARTS)		
-116	213-0041-00			2	.SCREW,TPG,TC:6-32 X 0.375,TYPE T,TRH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-117	342-0193-00			1	.INSULATOR,FILM:POWER SUPPLY,POLYIMIDE	80009	342-0193-00
-118	342-0103-00			1	.INSULATOR,BLOCK:HEAT-SINK SHIELD,NYLON	80009	342-0103-00
					.(ATTACHING PARTS)		
-119	210-0457-00			1	.NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
-120	211-0512-00			1	.SCREW,MACHINE:6-32 X 0.5,FLH,100 DEG,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-121	214-1625-00			1	.SPRING,FLAT:2.0 X 0.438,CU BE	80009	214-1625-00
-122	----- -----			1	.SWITCH,SLIDE:(SEE S1212 REPL)		
					.(ATTACHING PARTS)		
-123	210-0586-00			2	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-124	211-0097-00			2	.SCREW,MACHINE:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-125	210-0204-00			1	.TERMINAL,LUG:0.142 ID,LOCKING,BRZ TINNED	86928	A373-175
					.(ATTACHING PARTS)		
-126	210-0457-00			1	.NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
6-					.(END ATTACHING PARTS)		
-127	210-0202-00			1	.TERMINAL,LUG:0.146 ID,LOCKING,BRZ TIN PL	86928	A-373-158-2
					.(ATTACHING PARTS)		
-128	210-0457-00			1	.NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
					.(END ATTACHING PARTS)		
-129	----- -----			1	.SWITCH,SLIDE:(SEE S1540 REPL)		
					.(ATTACHING PARTS)		
-130	210-0586-00			2	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
-131	211-0097-00			2	.SCREW,MACHINE:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-132	352-0362-00			1	.FUHLR,EXTR POST:3AG,20A,300V	75915	345603W/901-002
-133	210-0873-00			2	.WASHER,FLAT:0.5 ID X 0.688 OD X 0.047,RBR	70485	ORDER BY DESCR
-134	----- -----			1	.FILTER,RFI:(SEE FL1200 REPL)		
					.(ATTACHING PARTS)		
-135	210-0586-00	B010100	B063648	2	.NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
	210-0457-00	B063649		1	.NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
-136	211-0014-00			2	.SCREW,MACHINE:4-40 X 0.5,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-137	214-2788-00	B010100	B031929	1	.HEAT SINK,ELEC:POWER SUPPLY,ALUMINUM	80009	214-2788-00
	214-2932-00	B031930	B063510	1	.HEAT SINK,ELEC:POWER SUPPLY,AL	80009	214-2932-00
	214-2932-01	B063511		1	.HEAT SINK,ELEC:POWER SUPPLY,ALUMINUM	80009	214-2932-01
	198-3829-00	B010100	B042779	1	.WIRE SET,ELEC:	80009	198-3829-00
	198-3829-01	B042780		1	.WIRE SET,ELEC:	80009	198-3829-01
-138	352-0161-06			1	..HLDR,TERM CONN:3 WIRE,BLUE	80009	352-0161-06
-139	352-0162-04			2	..HLDR,TERM CONN:4 WIRE,YELLOW	80009	352-0162-04
-140	352-0163-08			2	..HLDR,TERM CONN:5 WIRE,GRAY	80009	352-0163-08
-141	352-0164-02			2	..HLDR,TERM CONN:6 WIRE,RED	80009	352-0164-02
-142	352-0165-00			2	..HLDR,TERM CONN:7 WIRE,BLACK	80009	352-0165-00
-143	352-0200-00			2	..HLDR,TERM CONN:4 WIRE,BLACK	80009	352-0200-00
-144	175-0826-00			AR	..CABLE,SP,ELEC:3,26 AWG,STRD,PVC JKT,RBN	80009	175-0826-00
-145	175-0827-00			AR	..CABLE,SP,ELEC:4,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-954
-146	175-0860-00			AR	..CABLE,SP,ELEC:5,22 AWG,STRD,PVC JKT,RBN	TK0846	05CF22M7-BBT
-147	175-0859-00			AR	..CABLE,SP,ELEC:6,22 AWG,STRD,PVC JKT,RBN	TK0846	06CF22M7-BBT
-148	175-0858-00			AR	..CABLE,SP,ELEC:7,22 AWG,STRD,PVC INSUL,RBN	TK0846	07CF22M7-BBT
-149	210-0202-00			1	..TERMINAL,LUG:0.146 ID,LOCKING,BRZ TIN PL	86928	A-373-158-2
-150	131-0707-00			45	..CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL	22526	47439-000
-151	131-0622-00			8	..CONTACT,ELEC:28-32 AWG,BRS & CU BE GLD PL	22526	46241-000
	131-0792-00			8	..CONNECTOR,TERM:18-20 AWG,CU BE GOLD PL	22526	46221
-152	175-1091-00			AR	..CABLE,SP,ELEC:4,18 AWG,STRD BRAIDED SHLD	80009	175-1091-00
-153	131-2065-00			4	..TERM,QIK DISC.:18-22 AWG,BRASS TIN PLATED	00779	2-520181-2
	672-0572-00	B010100	B049999	1	CIRCUIT BD ASSY:READOUT PROTECTION #1	80009	672-0572-00
	672-0572-01	B050000	B053266	1	CIRCUIT BD ASSY:READOUT PROTECTION #1	80009	672-0572-01
	672-0572-02	B053267	B063540	1	CIRCUIT BD ASSY:READOUT PROTECTION #1	80009	672-0572-02
	672-0572-05	B063541	B063844	1	CIRCUIT BD ASSY:READOUT PROTECTION #1	80009	672-0572-05
	672-0572-06	B063845	B063938	1	CIRCUIT BD ASSY:READOUT PROTECTION #1	80009	672-0572-06
	672-0572-07	B063939		1	CIRCUIT BD ASSY:READOUT PRO #1	80009	672-0572-07
					(ATTACHING PARTS)		
-154	211-0008-00			1	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-155	----- -----			1	.CKT BOARD ASSY:RDOUT PROT #1(SEE A27 REPL)		
-156	253-0160-00			AR	..TAPE,PRESS SENS:POLY SPONGE,0,25 X 0.062	04963	4116 TYPE A
-157	131-0589-00			20	..TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ	22526	48283-029
-158	----- -----			AR	.CKT BOARD ASSY:READOUT(SEE A15 REPL)		
-159	131-1003-00			6	..CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-160	136-0252-07	B010100	B049999	45	..SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
	136-0252-07	B050000		6	..SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
	136-0751-00	B050000		1	..SKT,PL-IN ELEK:MICROCKT,24 PIN	09922	DILB24P108
	136-0252-01			6	..SOCKET,PIN TERM:U/W 0.0.19 DIA PINS	00779	1-332095-2
-161	131-0608-00			40	..TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
	131-0993-00	B050000		3	..BUS,CONDUCTOR:SHUNT ASSEMBLY,BLACK	22526	65474-005
-162	136-0260-02	B010100	B021449	14	..SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP	09922	DILB16P-108T
	136-0729-00	B021450	B049999	14	..SKT,PL-IN ELEK:MICROCKT,16 CONTACT	09922	DILB16P-108T
-163	214-0579-00	B010100	B049999	21	..TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-164	136-0269-02	B010100	B021449	3	..SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP	09922	DILB14P-108T
	136-0728-00	B021450	B049999	3	..SKT,PL-IN ELEK:MICROCKT,14 CONTACT	09922	DILB14P-108
-165	136-0235-00	B010100	B049999	1	..SKT,PL-IN ELEK:TRANSISTOR,6 CONTACT	71785	133-96-12-062
-166	344-0133-00			4	CLIP,SPR TNSN:CKT BOARD MT,WHITE	80009	344-0133-00

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
6-					(ATTACHING PARTS)		
-167	211-0008-00	B010100	B020849	4	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
	211-0198-00	B020850		2	SCREW,MACHINE:4-40 X 0.438,PNH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
	343-0006-00	B020850		2	CLAMP,LOOP:0.5 ID,PLASTIC	06915	ORDER BY DESCR
					(ATTACHING PARTS)		
	210-0586-00	B020850		2	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
	211-0198-00	B020850		2	SCREW,MACHINE:4-40 X 0.438,PNH,STL	TK0435	ORDER BY DESCR
	210-0863-00	B020850		2	WSHR,LOOP CLAMP:0.091 ID U/W 0.5 W CLP,STL	95987	C191
					(END ATTACHING PARTS)		
-168	131-0771-00			2	CONN,RCPT,ELEC:2 MALE,2 FEM,PNL MT W/O MTG HDW	91836	1904-2M58
					(ATTACHING PARTS)		
-169	220-0551-00			2	NUT,PLAIN,HEX:9 MM X 1.00,BRS NP	73743	ORDER BY DESCR
-170	210-0012-00			2	WASHER,LOCK:0.384 ID,INTL,0.022 THK,STL	09772	ORDER BY DESCR
					(END ATTACHING PARTS)		
-171	131-0955-00			3	CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
-172	131-1315-00	B010100	B010164	2	CONN,RCPT,ELEC:BNC,FEMALE	80009	131-1315-00
	131-1315-01	B010165		2	CONN,RCPT,ELEC:BNC,FEMALE	80009	131-1315-01
-173	441-1377-00			1	CHASSIS,SCOPE:READOUT	80009	441-1377-00
-174	333-2321-00			1	PANEL,REAR:READOUT	80009	333-2321-00
					(ATTACHING PARTS)		
-175	211-0507-00			2	SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
-176	----- -----			1	CKT BOARD ASSY:VERT CHAN SW(SEE A16 REPL)		
					(ATTACHING PARTS)		
-177	211-0116-00			4	SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,NP,POZ	77900	ORDER BY DESCR
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-178	214-2543-00			1	.HT SK,MICROCKT:MICROCIRCUIT,AL	80009	214-2543-00
					.(ATTACHING PARTS)		
-179	211-0259-00			4	.SCR,ASSEM WSHR:2-56 X 0.437,PNH,STL,POZ	01536	4821-00021
					.(END ATTACHING PARTS)		
-180	136-0514-00	B010100	B021599	6	.SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B021600	B032400	6	.SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-181	131-0608-00			7	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-182	131-2033-00			2	.CONTACT,ELEC:SINGLE,BOTTOM,CU BE	80009	131-2033-00
					.(ATTACHING PARTS)		
-183	210-0629-00			4	.EYELET,METALLIC:0.059 OD X 0.093 L,BRS	80009	210-0629-00
					.(END ATTACHING PARTS)		
-184	131-2032-00			2	.CONTACT,ELEC:SINGLE,TOP,CU BE	80009	131-2032-00
-185	426-1351-00			1	.FRAME,MICROCKT:1.75 CM	80009	426-1351-00
-186	131-1967-01			1	.CONT SET,ELEC:MICROCKT,1.75 CM,RUBBER	80009	131-1967-01
-187	131-2022-00			1	.CONTACT,ELEC:DUAL,BOTTOM,CU BE	80009	131-2022-00
					.(ATTACHING PARTS)		
-188	210-0629-00			2	.EYELET,METALLIC:0.059 OD X 0.093 L,BRS	80009	210-0629-00
					.(END ATTACHING PARTS)		
-189	131-2020-00			2	.CONTACT,ELEC:DUAL,TOP,BERYLLIUM COPPER	80009	131-2020-00
-190	136-0252-00			6	.SOCKET,PIN TERM:U/W 0.018 DIA PINS	00779	2-330808-7
-191	388-5349-01			1	.CIRCUIT BOARD:HF VERTICAL CHANNEL SWITCH	80009	388-5349-01
					.(ATTACHING PARTS)		
-192	210-0702-00			14	.EYELET,METALLIC:0.047 OD X 0.125 L	07707	S-6127
					.(END ATTACHING PARTS)		
-193	214-0579-00	B010100	B032400	15	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
	214-0579-00	B032401		16	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-194	214-0668-00			1	.HEAT SINK,XSTR:TO-5,AL BLK ANDZ	13103	2211B
-195	136-0252-07	B010100	B032400	36	.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-196	441-1378-00	B010100	B020849	1	CHASSIS,CHAN SW:	80009	441-1378-00
	441-1378-01	B020850		1	CHASSIS,CHAN SW:	80009	441-1378-01
					(ATTACHING PARTS)		
-197	211-0008-00			2	SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
	343-0213-00	B020850		3	CLAMP,CABLE:0.2 ID,PLASTIC	80009	343-0213-00
-198	333-2320-00			1	PANEL,REAR:	80009	333-2320-00
					(ATTACHING PARTS)		
-199	211-0507-00			2	SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
-200	426-0807-02			1	FRAME PNL,CAB.:REAR	80009	426-0807-02

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
6-					(ATTACHING PARTS)		
-201	213-0270-00			4	SCR,TPG,TF:10-32 X 0.75,SPCL TYPE,FILH,STL	TK1543	234-74658-026
					(END ATTACHING PARTS)		

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
7-	----- -----			1	DELAY LINE,ELEC:(SEE DL1165 REPL)		
-1					.DELAY LINE,ELEC:(SEE DL592 REPL)		
-2	386-3729-00			1	.PLATE,DLY LINE:HORIZONTAL,TOP	80009	386-3729-00
					.(ATTACHING PARTS)		
-3	213-0236-00	B010100	B032406	2	.SCREW,TPG,TF:6-20 X 0.25,TYPE B,TRH,STL	TK0392	ORDER BY DESCR
	213-0124-00	B032407		2	.SCREW,TPG,TF:6-20 X 0.25,TYPE AB,PNH,STL	TK0435	ORDER BY DESCR
-4	211-0007-00			1	.SCREW,MACHINE:4-40 X 0.188,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-5	129-0215-01			2	.SPACER,POST:0.875 L,0.107 DIA,DELRIN,1.0 OD	80009	129-0215-01
					.(ATTACHING PARTS)		
-6	213-0236-00	B010100	B032406	2	.SCREW,TPG,TF:6-20 X 0.25,TYPE B,TRH,STL	TK0392	ORDER BY DESCR
	213-0124-00	B032407		2	.SCREW,TPG,TF:6-20 X 0.25,TYPE AB,PNH,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-7	129-0080-00			1	.SPACER,POST:0.875 L,4-40,NYLON	80009	129-0080-00
					.(ATTACHING PARTS)		
-8	211-0007-00			1	.SCREW,MACHINE:4-40 X 0.188,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-9	175-1056-01			AR	.CABLE,DLY LINE:1.5 NS/FT DLY,100 OHM	80009	175-1056-01
					.(REQUIRES 31 FEET)		
-10	343-0689-00			1	.CLAMP,DLY LINE:ALUMINUM	80009	343-0689-00
					.(ATTACHING PARTS)		
-11	211-0198-00			2	.SCREW,MACHINE:4-40 X 0.438,PNH,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
-12	----- -----			1	.CKT BD ASSY:X-Y DELAY COMP(SEE A28 REPL)		
					.(ATTACHING PARTS)		
-13	211-0008-00			3	.SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
					.(END ATTACHING PARTS)		
					.CKT BOARD ASSY INCLUDES:		
-14	131-1003-00			8	..CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-15	131-0608-00			5	..TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-16	136-0252-04			39	..SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-17	136-0514-00	B010100	B021599	1	..SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B01600		1	..SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-18	386-3730-00			1	.PLATE,DLY LINE:HORIZONTAL,BOTTOM	80009	386-3730-00
					.(ATTACHING PARTS)		
-19	210-0457-00			1	.NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
-20	211-0504-00			1	.SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
					.(END ATTACHING PARTS)		
	175-6195-00			1	CA ASSY,SP,ELEC:5,26 AWG,14.0 L,RIBBON	80009	175-6195-00

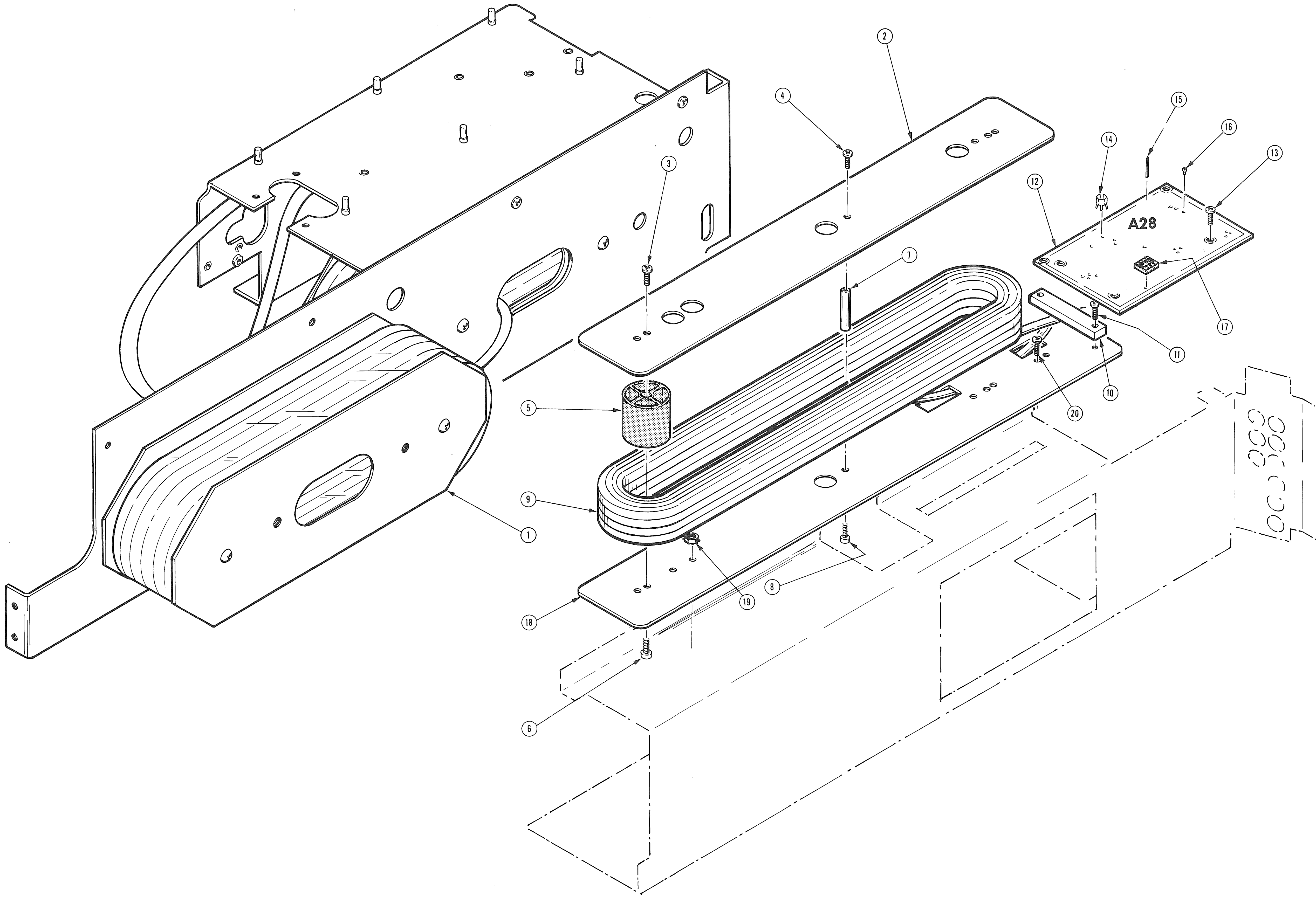


FIG. 7 OPTION 2

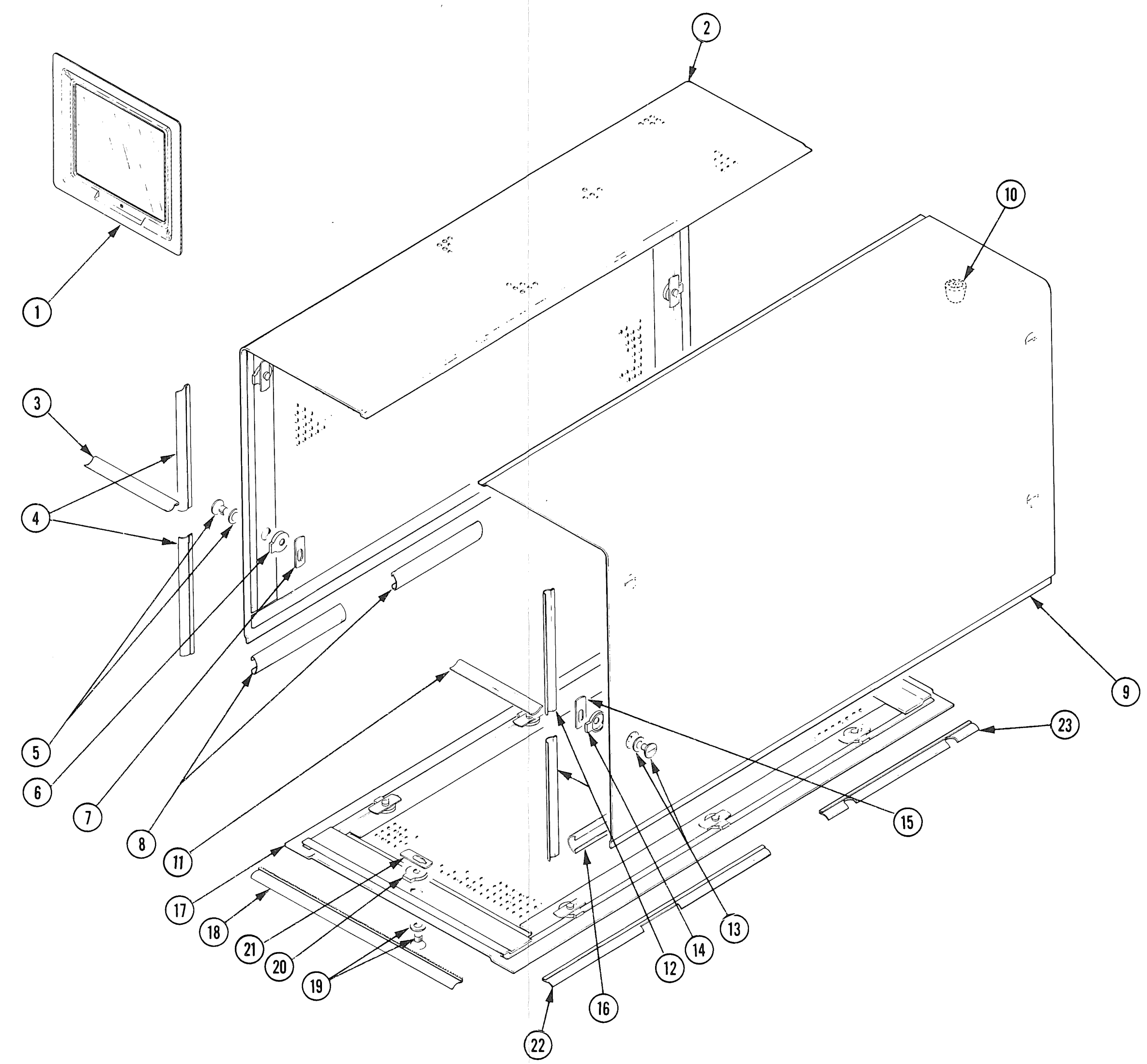
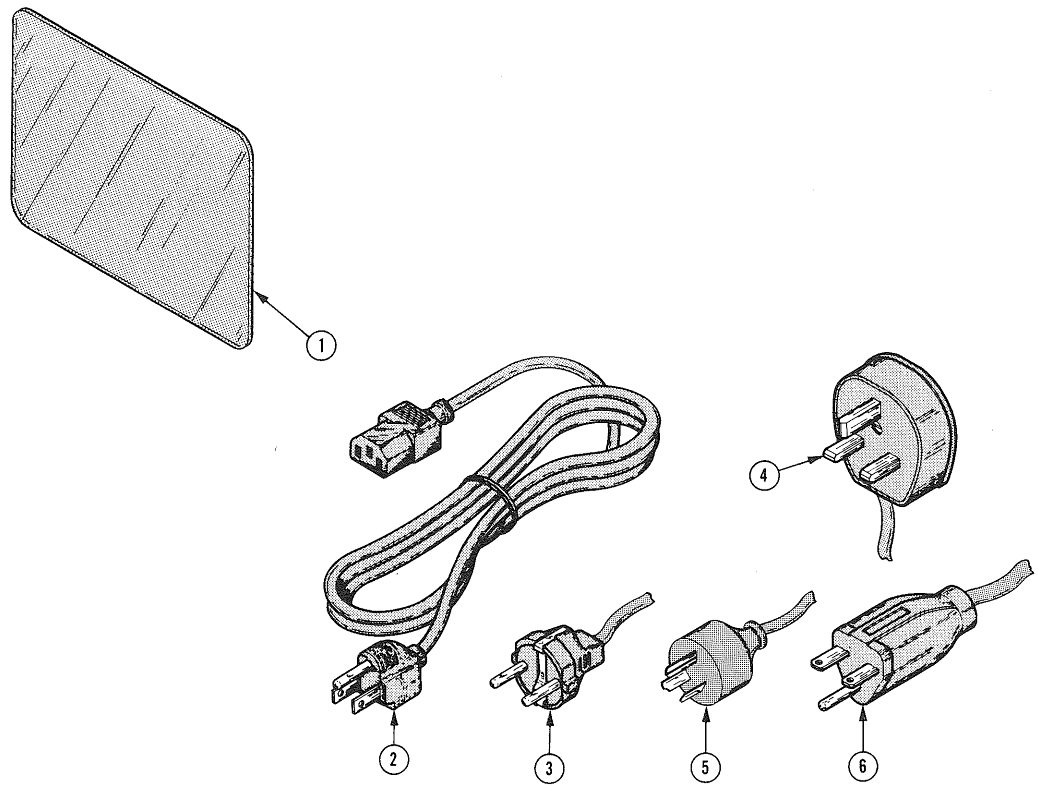


FIG. 8 OPTION 3

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
8-1	378-0603-00			1	FILTER,MESH:EMI	80009	378-0603-00
-2	390-0606-00			1	CAB.SIDE,SCOPE:LEFT,EMI	80009	390-0606-00
-3	348-0332-00			2	.SHLD GSKT,ELEK:SOLID TYPE,4.285 L	80009	348-0332-00
-4	348-0334-00			4	.SHLD GSKT,ELEK:SOLID TYPE,7.64 L	80009	348-0334-00
-5	214-0603-02			4	.PIN ASSY,SECRG:W/SPRING WASHER	80009	214-0603-02
-6	386-1634-00			4	.PLATE,LCH INDEX:ACETAL	TK2165	386-1634-00
-7	386-1633-00			4	.PLATE,LCH LKG:STEEL,CD PL	80009	386-1633-00
-8	348-0336-00			4	.SHLD GSKT,ELEK:SOLID TYPE,9.625 L	80009	348-0336-00
-9	390-0604-00			1	CAB.SIDE,SCOPE:RIGHT,EMI	80009	390-0604-00
-10	348-0180-00			1	.FOOT,CABINET:L FRONT,R REAR,BLACK NYLON	80009	348-0180-00
-11	348-0332-00			2	.SHLD GSKT,ELEK:SOLID TYPE,4.285 L	80009	348-0332-00
-12	348-0333-00			4	.SHLD GSKT,ELEK:SOLID TYPE,4.8 L	80009	348-0333-00
-13	214-0603-02			4	.PIN ASSY,SECRG:W/SPRING WASHER	80009	214-0603-02
-14	386-1634-00			4	.PLATE,LCH INDEX:ACETAL	TK2165	386-1634-00
-15	386-1633-00			4	.PLATE,LCH LKG:STEEL,CD PL	80009	386-1633-00
-16	348-0336-00			4	.SHLD GSKT,ELEK:SOLID TYPE,9.625 L	80009	348-0336-00
-17	390-0554-00			1	CAB.BOT,SCOPE:	80009	390-0554-00
-18	348-0274-02			2	.SHLD GSKT,ELEK:FINGER TYPE,10.55	80009	348-0274-02
-19	214-0603-02			6	.PIN ASSY,SECRG:W/SPRING WASHER	80009	214-0603-02
-20	386-1634-00			6	.PLATE,LCH INDEX:ACETAL	TK2165	386-1634-00
-21	386-1633-00			21	.PLATE,LCH LKG:STEEL,CD PL	80009	386-1633-00
-22	348-0335-00			6	.SHLD GSKT,ELEK:SOLID TYPE,8.65 L	80009	348-0335-00
-23	348-0334-00			2	SHLD GSKT,ELEK:SOLID TYPE,7.64 L	80009	348-0334-00

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
9-1	378-0625-00			1	FILTER,LT,CRT:BLUE,5.15 X 4.4 X 0.03	80009	378-0625-00
-2	161-0066-00			1	CABLE ASSY,PWR,:3,18AWG,115V,98.0 L	16428	CH8481, FH8481
-3	161-0066-09			1	CABLE ASSY,PWR,:3,0.75MM SQ,220V,99.0 L (OPTION A1 ONLY)	S3109	86511000
-4	161-0066-10			1	CABLE ASSY,PWR,:3,0.75MM SQ,240V,96.0 L (OPTION A2 ONLY)	TK1373	24230
-5	161-0066-11			1	CABLE ASSY,PWR,:3,0.75MM,240V,96.0 L (OPTION A3 ONLY)	S3109	ORDER BY DESCR
-6	161-0066-12			1	CABLE ASSY,PWR,:3,18 AWG,250V,99.0 L (OPTION A4 ONLY)	70903	CH-77893
	070-2314-00			1	MANUAL,TECH:INSTRUCTION	80009	070-2314-00
	070-2315-00			1	MANUAL,TECH:OPERATORS	80009	070-2315-00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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. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

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MANUAL CHANGE INFORMATION

Date: 4/20/88 Change Reference: C15/0488

Product: 7104 Oscilloscope Manual Part No.: 070-2314-00

DESCRIPTION Manual Insert for Product Group 42

These changes are effective at serial number B060000.

The following changes to the 7104 Instruction Manual result from the utilization of a different ventilating fan in the 7104 Oscilloscope.

ELECTRICAL PARTS CHANGES

These changes are effective at serial number B60000 which changed with M56709.

REMOVE:

A26	670-2245-04	CKT BOARD ASSY:FAN MOTOR
C1698	290-0804-00	CAP.,FXD,ELCTLT:10UF,+50−10%,25V
CR1690	152-0107-00	SEMICOND DEVICE:SILICON,400V,400MA
CR1691	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA
CR1692	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA
CR1694	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA
CR1696	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA
CR1698	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA
Q1690	156-0281-00	MICROCIRCUIT,LI:4 TRANSISTOR ARRAY
Q1698	151-0342-00	TRANSISTOR:SILICON,PNP
R1691	303-0150-00	RES.,FXD,CMPSN:15 OHM,5%,1W
R1693	323-0140-00	RES.,FXD,FILM:280 OHM,1%,0.5W
R1695	321-0228-00	RES.,FXD,FILM:2.32K OHM,1%,0.125W
R1696	321-0062-00	RES.,FXD,FILM:43.2 OHM,1%,0.125W
R1697	321-0204-00	RES.,FXD,FILM:1.3K OHM,1%,0.125W
R1698	315-0363-00	RES.,FXD,CMPSN:36K OHM,5%,0.25W
R1699	323-0140-00	RES.,FXD,FILM:280 OHM,1%,0.5W
RT1696	307-0124-00	RES.,THERMAL:5K OHM,10%

ADD:

R1690	308-0175-00	RES.,FXD,WW:10 OHM,5%,10W

CHANGE TO:

B1690	119-1545-01	FAN,TUBEAXIAL:12V,4.8W,RPM,35 CFM

Product: 7104 Oscilloscope Part No.: 070-2314-00 Date: 4/20/88 Change Ref.: C15/0488

MECHANICAL PARTS CHANGES

These changes are effective at serial number B60000 which changed with M56709.

REMOVE:

Fig. 2-89	369-0035-00	1	IMPLR,FAN AXIAL:PLASTIC
Fig. 2-90	361-0076-00	2	SPACER,POST:0.65 L W/6-32 THRU,AL,0.25
Fig. 2-91	211-0504-00	1	SCREW,MACHINE:6-32 X 0.375 PNH,STL,CD PL
Fig. 2-92	211-0510-00	2	SCREW,MACHINE:6-32 X 0.375,PNH,STL,CD PL
Fig. 2-93	343-0411-00	2	STRAP,RETAINING:2.494 X 0.8,STL TIN PL
Fig. 2-94	----- -----	-	CKT BOARD ASSY:(SEE A26 REPL)
Fig. 2-95	----- -----	-	.MOTOR,DC:(SEE B1690 REPL)
Fig. 2-96	136-0252-04	3	.SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS
Fig. 2-97	136-0728-00	1	.SKT,PL-IN ELEK:MICROCKT,14 CONTACT
Fig. 2-98	131-0608-00	2	.TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD

ADD:

119-1545-01	1	FAN,TUBEAXIAL:(SEE B20 REPL)
174-0082-00	1	CA ASSY,SP,ELEC:2,26 AWG,8.0 L,RIBBON
210-0202-00	1	TERMINAL,LUG:0.146 ID,LOCKING,BRZ,TIN PL
210-0457-00	4	NUT,PL,ASSEM WA:6-32 X 0.312,STL,CD PL
210-0478-00	1	SPACER,POST:0.66 L W/6-32 THD THRU,AL
210-0601-00	1	EYELET,METALLIC:0.183 OD X 0.192 L,BRASS
211-0510-00	1	SCREW,MACHINE:6-32 X 0.375 PNH,STL,CD PL
211-0530-00	4	SCREW,MACHINE:6-32 X 1.750,PNH,STL,CD PL,POZ
211-0553-00	1	SCREW,MACHINE:6-32 X 1.5,PNH,STL,CD PL
308-0175-00	1	RESISTOR:(SEE R20 REPL)
378-0279-00	1	GRILL,FAN:3.125 DIA SQ

CHANGE TO:

Fig. 3-61	**200-2079-02**	1	COVER,PLENUM:

Product: 7104 Oscilloscope Part No.: 070-2314-00 Date: 4/20/88 Change Ref.: C15/0488

MECHANICAL PARTS CHANGES

These changes are effective at serial number B064041 which changed with M66489.

CHANGE TO:

Component No.	Tektronix Part No.	Name & Description
A15	670-8620-07	CIRCUIT BD ASSY: READOUT
C2161	281-0812-00	CAP,FXD,CER DI:1000PF,10%,100V
C2239	281-0812-00	CAP,FXD,CER DI:1000PF,10%,100V
CR2161	152-0322-00	SEMICOND DVC,DI:SCHOTTKY,SI,15V,DO-35

REMOVE:

C2127	281-0773-00	CAP,FXD,CER DI:0.01UF,10%,100V

ADD:

Q2127	151-0190-00	TRANSISTOR:NPN,SI,TO-92
R2125	315-0103-00	RES,FXD,FILM:10K OHM,5%,0.25W
R2159	315-0102-00	RES,FXD,FILM:1K OHM,5%,0.25W
R2160	315-0102-00	RES,FXD,FILM:1K OHM,5%,0.25W

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MANUAL CHANGE INFORMATION

Date: 5/6/88 Change Reference: C110/0588 Rev 2
Manual Part No.: see product
Product: All 7000 Service manuals Product Group: 42

DESCRIPTION

Effective for all serial numbers.

Revised 9/26/88
Revised 10/13/88

REPLACEABLE ELECTRICAL PARTS LIST CHANGES

The part number has changed for a transistor which may be used in your 7000-Series product. Part number 151-0220-00 has changed to 151-0220-07. Use the new 151-0220-07 part number when ordering a replacement for transistors listed as 151-0220-00 in your Replaceable Electrical Parts List.

Most berg sockets, part number 136-0252-07, have been removed from this 7000-Series instrument to facilitate assembly and improve reliability.

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MANUAL CHANGE INFORMATION

Date: 3/27/87 Change Reference: M61712

Product: 7104 Oscilloscope Manual Part No.: 070-2314-00

DESCRIPTION PG. 42

THESE CHANGES ARE EFFECTIVE FOR SERIAL NUMBER B063819 AND ABOVE.

MECHANICAL PARTS LIST

CHANGE TO:

2-	378-2049-00	GRILL, FAN: 3.07 DIA.

THE ABOVE INFORMATION MAY NOT BE INCORPORATED INTO YOUR MANUAL. IF NOT, PLEASE NOTE CHANGE REFERENCE: M56709. THE FAN WAS ADDED AS PART NO. 378-0279-00, WHICH HAS BEEN CHANGED TO 378-2049-00. ALSO, THIS IS A DIRECT REPLACEMENT PART (TO ENSURE THE CUSTOMER RECEIVES THE CORRECT REPLACEMENT).