TEK SERVICE MANUAL

070-6081-00
Product Group 46

2246
PORTABLE OSCILLOSCOPE
SERVICE

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. REFER TO OPERATORS SAFETY SUMMARY AND SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.

Please Check for CHANGE INFORMATION at the Rear of This Manual

First Printing MAR 1987

Tektronix®
COMMITTED TO EXCELLENCE

INSTRUMENT SERIAL NUMBERS

Each instrument has a serial number on a panel insert, tage, 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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Thanks

Dave & Lynn Henderson
Artek Media

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OPERATORS SAFETY SUMMARY

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

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.

Terms as Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the markings, 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. For maximum input voltage see Table 1-1.

Symbols as Marked on Equipment

DANGER — High voltage.

Protective gound (earth) terminal.

ATTENTION — Refer to manual.

Power Source

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

Grounding the Product

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

Danger Arising from Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulated) can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

For detailed information on power cords and connectors, see Figure 2-1.

Use the Proper Fuse

To avoid fire hazard, use only a fuse of the correct type, voltage rating and current rating as specified in the parts list for your product.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this instrument in an explosive atmosphere.

Do Not Remove Covers or Panels

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

SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary.

Do Not Service Alone

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

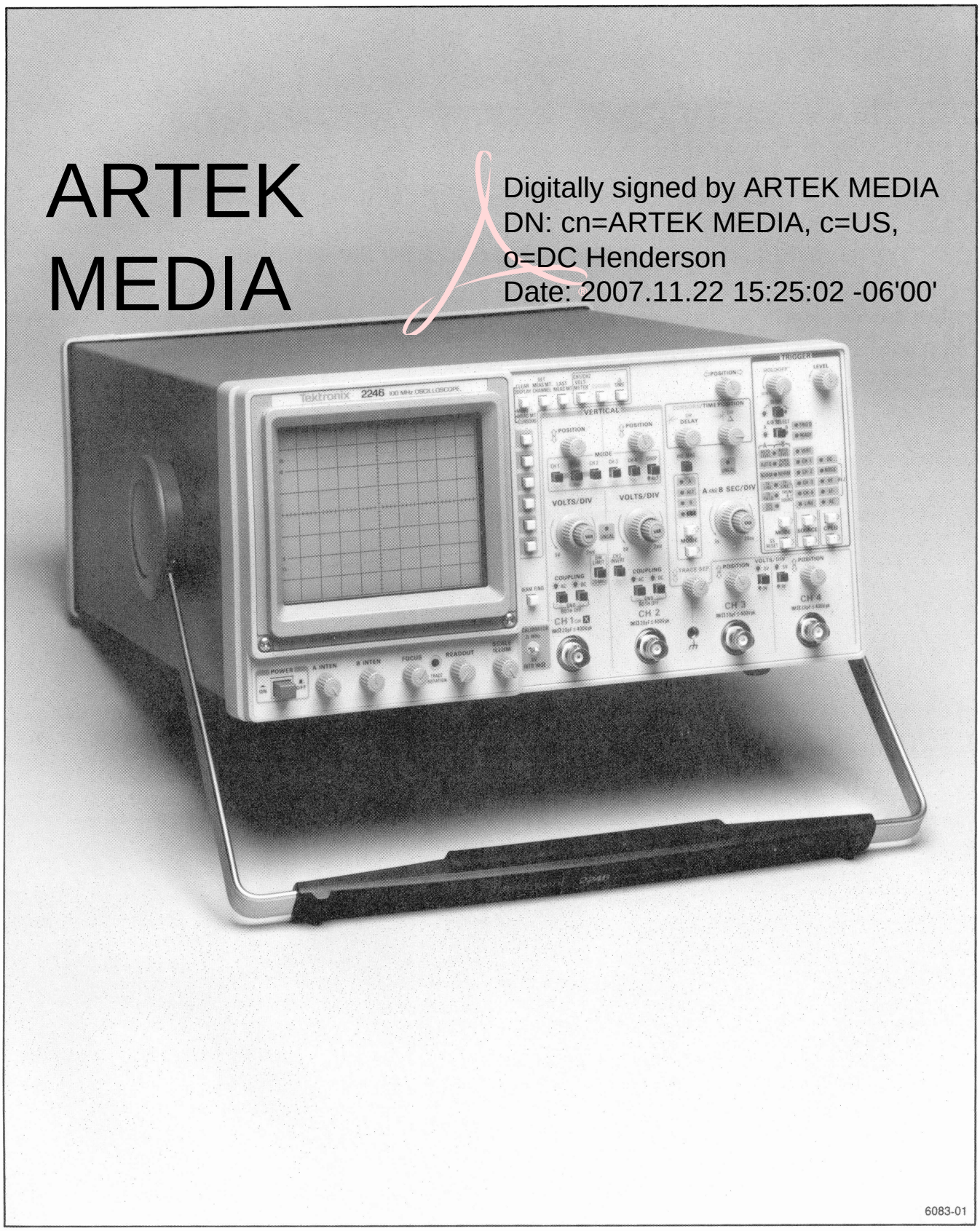
Use Care When Servicing With Power On

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections or 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 does 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 connector in the power cord is essential for safe operation.



The 2246 Portable Oscilloscope.

SPECIFICATION

INTRODUCTION

The TEKTRONIX 2246 Oscilloscope is a portable 100 MHz bandwidth instrument having a four-channel vertical deflection system. The horizontal deflection system provides calibrated sweep speeds from 0.5 s to 20 ns per division and delayed sweep features. The trigger system provides stable triggering over the full bandwidth of the vertical deflection system. Alphanumeric crt readouts of the vertical and horizontal scale factors are displayed at the bottom of the screen. On-screen vertical and horizontal cursors provide accurate voltage, time, frequency, and phase measurements with measurement value readouts displayed at the top of the crt.

The 2246 is microprocessor controlled and features menu-driven waveform measurement processes. The flexible measurement features of the oscilloscope include a choice of either voltmeter measurements for +Peak, −Peak, Peak-to-Peak, and average DC values of the signal applied to a selected measurement channel or positionable cursors for measuring voltage difference, time difference, frequency and phase. Measurement-tracking, trigger-level tracking, and ground-tracking SmartCursors® that provide visual feedback to the user may be placed on the displayed waveforms. Menus called up to make the measurement mode choices are displayed at the right side of the crt next to the menu selection buttons. Delay-time and delta-delay measurements for time, frequency, and phase are available in ALT and B Horizontal Modes.

The vertical deflection system consists of two channels with calibrated deflection factors from 2 mV to 5 V per division in a 1-2-5 sequence of 11 steps and two channels with two basic deflection factors of 0.1 V and 0.5 V. Use of coded probes having attenuation factors of 1X, 10X, and 100X extends the minimum sensitivity to 500 V per division.

VOLTS/DIV readouts are switched to display the correct vertical scale factor when properly coded probes are attached to the vertical input connectors.

STANDARD ACCESSORIES

The following items are standard accessories shipped with the 2246 instrument:

2 Probes, 10X, 1.5 meter, with accessories
1 Power cord
1 Power cord clamp
1 Operators manual
1 Operators guide
1 Crt filter, blue plastic (installed)
1 Fuse, 2 A, 250 V, slow-blow
1 Accessory pouch, Ziploc

For part numbers and further information about standard accessories and a list of the recommended optional accessories, refer to "Options and Accessories" (Section 7) in this manual. For additional information on accessories and ordering assistance, contact your Tektronix representative or local Tektronix Field Office.

PERFORMANCE CONDITIONS

The electrical characteristics of Table 1-1 apply when the 2246 has been calibrated at an ambient temperature between +20°C and +30°C, has had a warmup period of at least 20 minutes, and is operating at an ambient temperature between −10°C and +55°C (unless otherwise noted).

Items listed in the "Performance Requirements" column are verifiable qualitative or quantitative limits that define the measurement capabilities of the instrument.

Environmental Specifications of the 2246 are given in Table 1-2, and Mechanical Specifications are given in Table 1-3.

RECOMMENDED CALIBRATION SCHEDULE

To ensure accurate measurements, check the performance of this instrument every 2000 hours of operation or, if used infrequently, once each year. Replacement of components in the instrument may also necessitate readjustment of the affected circuits.

Table 1-1

Electrical Characteristics

Characteristics	Performance Requirements
VERTICAL DEFLECTION SYSTEM—CH 1 AND CH 2	
Deflection Factor	
Range	2 mV/div to 5 V/div in 1-2-5 sequence.[a]
Accuracy (includes ADD MODE and CH 2 INVERT)	
15 to 35°C	Within ±2%.
−10 to 15°C and 35 to 55°C	Within ±3%.[a]
Variable Range	Increases deflection factor by at least 2.5:1.
Frequency Response (−3 dB bandwidth)	
−10 to 35°C	DC to 100 MHz (at the probe tip).
35 to 55°C	DC to 90 MHz (at the probe tip).[a]
AC Coupled Lower −3 dB Point	
1X Probe	10 Hz or less.
10X Probe	1 Hz or less.[a]
Step Response (5-division step)	
Rise Time	
−10 to 35°C	3.5 ns or less (calculated).[a]
35 to 55°C	3.9 ns or less (calculated).[a] $\text{Rise Time} = \frac{350}{\text{BW (in MHz)}}$
Delay Match (CH 1 to CH 2)	Less than 200 ps difference.
Common Mode Rejection Ratio (CMRR)	At least 10:1 at 50 MHz for signals of eight divisions or less with VOLTS/DIV VAR adjusted for best CMRR at 50 kHz.
Channel Isolation (Attenuation of deselected channel)	***10 MHz*** ***100 MHz***
2 mV/Div to 0.5 V/Div	50 dB or more. 34 dB or more. Channel isolation tested with eight-division input signal.
Trace Shift as VAR VOLTS/DIV Is Turned	1 division or less.
Invert Trace Shift	1 division or less.
Trace Shift Between VOLTS/DIV Switch Positions	0.2 division or less.
Trace Shift Between GND and DC Input Coupling	
−10 to 35°C	Less than 0.5 mV.
35 to 55°C	Less than 2 mV.[a]
Position Range	At least ±11 divisions from graticule center.

[a]**Performance Requirement not checked in manual.**

Table 1-1 (cont)

Characteristics	Performance Requirements
Input Characteristics	
Resistance	1 MΩ ±0.15%.[a]
Capacitance	20 pF ±1 pF.[a]
Capacitance Match Between Any Two VOLTS/DIV Settings in Each Channel	±0.5 pF.[a]
Max Input Volts ⚠	400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less.[a] (See Figure 1-1.)
VERTICAL DEFLECTION SYSTEM—CH 3 AND CH 4	
Deflection Factors	0.1 V per division and 0.5 V per division.[a]
Accuracy	
15 to 35°C	Within ±2%.
−10 to 55°C	Within ±3%.
Frequency Response (−3 dB bandwidth)	
−10 to 35°C	DC to 100 MHz (at the probe tip).
35 to 55°C	DC to 90 MHz (at the probe tip).[a]
Step Response (5-division step)	
Rise Time	
−10 to 35°C	3.5 ns or less (calculated).[a]
35 to 55°C	3.9 ns or less (calculated).[a] $\text{Rise Time} = \frac{350}{\text{BW (in MHz)}}$
Delay Match (CH 3 to CH 4)	Less than 200 ps difference.
Trace Shift Between VOLTS/DIV Settings	1 division or less.
Position Range	At least ±11 divisions from graticule center.
Channel Isolation (attenuation of deselected channel)	34 dB or more at 100 MHz. Channel isolation tested with eight-division input signal.
Input Characteristics	
Resistance	1 MΩ ±1.0%.[a]
Capacitance	20 pF ±1.0 pF.[a]
Max Input Volts ⚠	400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less.[a] (See Figure 1-1.)

[a]**Performance Requirement not checked in manual.**

Table 1-1 (cont)

Characteristics	Performance Requirements
VERTICAL DEFLECTION SYSTEM—ALL CHANNELS	
Bandwidth Limit (−3 dB bandwidth)	20 MHz ±15%.
Low Frequency Linearity (Relative to center screen)	Within ±5%. Linearity is measured by positioning a two-division test signal anywhere on screen and noting the amplitude change.
TRACE SEP Control Position Range	At least ±4 divisions.
CHOP Mode Clock Rate	625 kHz ±10%.[a]
Delay Match (CH 1 or CH 2 to CH 3 or CH 4)	Less than 200 ps difference.

[a]Performance Requirement not checked in manual.

Table 1-1 (cont)

Characteristics	Performance Requirements
HORIZONTAL DEFLECTION SYSTEM	
Sweep Range	
A Sweep	0.5 s/div to 20 ns/div in a 1-2-5 sequence.[a] X10 magnifier extends maximum sweep speed to 2 ns/div.
B Sweep	5 ms/div to 20 ns/div in a 1-2-5 sequence.[a] X10 magnifier extends maximum sweep speed to 2 ns/div.
Accuracy	**Unmagnified** **Magnified**
15 to 35°C	±2% ±3%
−10 to 15°C and 35 to 55°C	±3%[a] ±4%[a]
	Sweep Accuracy applies over the center eight divisions. Excludes the greater of either the first 1/4 division or 25 ns from sweep start of the magnified sweep and anything beyond the 100th magnified division.
SWEEP LINEARITY (relative to center two displayed divisions)	±5%.
POSITION Control Range	
Normal Displays	Able to move the start of the sweep to the right of the center vertical graticule; able to move a time mark corresponding to the end of the tenth division of an unmagnified sweep to the left of the center graticule.
X-Y Displays	At least ±13 divisions.[a]
X10 Magnifier	Expands the normal sweep by ten times around that portion of the sweep positioned at the center vertical graticule line.[a]
Registration	
X10 to X1	0.5 division or less shift.
Variable Control Range	Continuously variable between calibrated SEC/DIV switch settings. Extends both the A and B sweep time per division by at least a factor of 2.5.
Sweep Length	Greater than 10 divisions.
Delay Time	
Delay Control Range	Less than 0.1 division to 10 times the A SEC/DIV switch setting. Maximum value does not exceed end of the A Sweep.
Jitter	1 part in 20,000, or less, peak-to-peak, during a two-second time interval.
Delta Time	
Delta Control Range	0 to greater than 9.9 divisions to the right of setting of DELAY control, but maximum value does not exceed end of the A Sweep.
Dot Marker Width (A SEC/DIV = B SEC/DIV; SWEEP MODE in ALT)	
Max	0.2 division + 50 ns.[a]
Min	0.1 division.[a]

[a]**Performance Requirement not checked in manual.**

Table 1-1 (cont)

Characteristics	Performance Requirements
A AND B TRIGGER	
Sensitivity—CH 1 through CH 4: AUTO LEVEL, NORM, AND SINGLE SEQUENCE	Trigger sensitivity is defined as the minimum peak-to-peak sine-wave trigger signal amplitude required to show the test signal with horizontal jitter of less than 3.0% of one period (p-p viewed over two seconds).
COUPLING	
DC	0.35 division from DC to 25 MHz, increasing to 1.0 division at 150 MHz.
NOISE REJECT	1.4 division from DC to 25 MHz; increasing to 2.2 division at 100 MHz. 0.5 division or less will not trigger.
HF REJECT	0.35 division from DC to 50 kHz; attenuates signals above upper −3 dB cutoff frequency of 70 kHz.
LF REJECT	0.35 division from 100 kHz to 25 MHz, increasing to 1.0 division at 150 MHz; attenuates signals below the lower −3 dB cutoff frequency of 50 kHz.
AC	0.35 division from 50 Hz to 25 MHz, increasing to 1.0 division at 150 MHz; attenuates signals below the lower −3 dB cutoff frequency of 20 Hz.
TV LINE, TV FIELD	0.5 division of composite sync will achieve a stable display.
AUTO LEVEL Lowest Usable Frequency	10 Hz.[a]
LEVEL Control Range	±20 divisions referred to the appropriate vertical input. This range is sufficient to allow triggering at any point on a displayed waveform for all modes except ADD. In ADD, the combined range of the two position controls exceeds the trigger level range, making it possible (though unlikely) to pull a signal on screen for display but fail to trigger on it due to insufficient trigger level range.
TRIGGER LEVEL READOUT Accuracy	±(0.3% of reading + 10% of one vertical division).[a]
VAR HOLDOFF Control Range	Increases A Sweep holdoff time by at least a factor of 10.[a]

[a]**Performance Requirement not checked in manual.**

Table 1-1 (cont)

Characteristics	Performance Requirements
FUNCTIONS WITH DIGITAL READOUT	
	Specifications for functions with digital readout are valid only when the ambient temperature is within ±10°C of the temperature at the time of the last SELF CAL. For maximum performance, a recent SELF CAL is recommended.
VOLTMETER FUNCTIONS	
DC VOLTS	
Accuracy	±(0.5% of reading + 2% of one vertical division + 250 μV).
Normal Mode Rejection Ratio	Greater than 50 dB at 50 or 60 Hz.
PLUS or MINUS PEAK	
Accuracy—Full Bandwidth	
25 Hz to 25 MHz	±(2.0% of reading + 10% of one vertical division + 1 mV).
Greater Than 25 MHz to 100 MHz	+0.5 dB/−3 dB ±1 mV. Follows the trigger system frequency response curve.
Accuracy—Bandwidth Limited	
25 Hz to 10 MHz	±(2.0% of reading + 10% of one vertical division + 0.3 mV).
Gated Region Minimum Width (when gated)	(0.2 division + 50 ns) or less.
PK-PK VOLTS	
Accuracy—Full Bandwidth	
25 Hz to 25 MHz	±(2.0% of reading + 10% of one vertical division + 1.5 mV).
Greater Than 25 MHz to 100 MHz	+0.5 dB/−3 dB ±1.5 mV. Follows the trigger system frequency response curve.
Accuracy—Bandwidth Limited	
25 Hz to 10 MHz	±(2.0% of reading + 10% of one vertical division + 0.5 mV).
Gated Region Minimum Width (when gated)	(0.2 division + 50 ns) or less.
CURSOR FUNCTIONS	
⊢ SEC ⊣ (manually positioned cursors)	
Accuracy	±(0.5% of reading + 2% of the SEC/DIV setting).
⊢ 1/SEC ⊣ (manually positioned cursors)	
Accuracy	Readout calculated from ⊢ SEC ⊣ cursor positions.
⫛ VOLTS ⊣ (manually positioned cursor)	
Accuracy	±(0.5% of reading + 2% of the VOLTS/DIV setting + high-frequency display errors).
⊢ VOLTS ⊣ (manually positioned cursors)	
Accuracy	±(0.5% of reading + 2% of the VOLTS/DIV setting + high-frequency display errors).
⊢ PHASE ⊣ (manually positioned cursors)	
Accuracy	Readout calculated from ⊢ SEC ⊣ cursor positions.

Table 1-1 (cont)

Characteristics	Performance Requirements
FUNCTIONS WITH DIGITAL READOUT (cont)	
CURSOR FUNCTIONS (cont)	
TRACK MEASUREMENT	
Position Accuracy (Cursor position on waveform versus digitally displayed measurement value)	Within ±0.05 vertical division.
TRACK TRIG LEVEL	
Position Accuracy (Cursor position on waveform versus digitally displayed trigger level value)	Within ±0.05 vertical division.
TRACK GROUND	
Position Accuracy (Cursor position on waveform versus baseline displayed with grounded input)	Within ±0.05 vertical division.
DELTA TIME FUNCTIONS	
DELTA TIME	
Accuracy	± (0.5% of reading + 1.0% of one division of the A Sweep).
Delay Accuracy, A Sweep Trigger Point to Start of B Sweep	± (0.5% of reading + 5% of one division of the A Sweep + 25 ns).

Table 1-1 (cont)

Characteristics	Performance Requirements
X-Y OPERATION	
Deflection Factors	Same as Vertical deflection system with the VOLTS/DIV variable controls in calibrated detent position.[a]
Accuracy	
Y Axis	
15 to 35°C	Within ±2%.
−10 to 15°C, 35 to 55°C	Within ±3%.[a]
X Axis	
15 to 35°C	Within ±3%.
−10 to 15°C, 35 to 55°C	Within ±4%.[a]
Horizontal (X-Axis) −3 dB Bandwidth	3 MHz or more.
Phase Match (DC Coupled)	±3 degrees from DC to 50 kHz.
EXTERNAL Z-AXIS INPUT	
Active Region Lower Threshold (intensity decreases above this voltage)	+1.8 volts or less.
Signal Required to Blank an A or B Trace	+3.8 volts or less at maximum intensity. External Z-Axis signal does not affect the readout or intensified zone intensity.
Max Input Voltage ⚠	30 V (dc + peak ac); 30 V p-p ac at 1 kHz or less.[a]
Input Loading	Represents less than one LSTTL load.[a]
CALIBRATOR OUTPUT	
Overshoot (rising and falling edge)	0.1% or less.
Output Voltage on CALIBRATOR Jack	0.5 V ±2% into 1MΩ load.
Repetition Rate	1 kHz ±25%.

[a]**Performance Requirement not checked in manual.**

Table 1-1 (cont)

Characteristics	Performance Requirements
FRONT PANEL SETUP MEMORY	
Data Retention Time	At least three years.[a]
Battery	3.0 V, 1200 mAH, Type BR-2/3A-E2P, Lithium.[a] **WARNING** *To avoid personal injury, observe proper precautions for handling and disposal of lithium batteries. Improper handling may cause fire, explosion, or severe burns. Don't recharge, crush, disassemble, heat the battery above 212°F (100°C), incinerate, or expose contents of the battery to water. Dispose of battery in accordance with local, state, and national regulations.* *Typically, small quantities (less than 20) can be safely disposed of with ordinary garbage in a sanitary landfill.* *Larger quantities must be sent by surface transport to a hazardous waste disposal facility. The batteries should be individually packaged to prevent shorting and packed in a sturdy container that is clearly labeled "Lithium Batteries—DO NOT OPEN."*
POWER SOURCE	
Line Voltage Range	90 Vac to 250 Vac.[a]
Line Frequency	48 Hz to 445 Hz.[a]
Line Fuse	2 A, 250 V, fast blow.[a]
Max Power Consumption	80 Watts (110 VA).[a]
CRT DISPLAY	
Display Area	8 by 10 cm.[a]
Geometry	
Vertical	± 1/2 minor (0.1 div) at 8 by 8 cm centered area.
Horizontal	± 1/2 minor (0.1 div) at 8 by 10 cm centered area.
Trace Rotation Range	Adequate to align trace with center horizontal graticule line.
Standard Phosphor	P31.[a]
Y-Axis Orthogonality	0.1 division or less, over eight vertical divisions. No adjustment.
Nominal Accelerating Voltage	16.5 kV.[a]

[a]**Performance Requirement not checked in manual.**

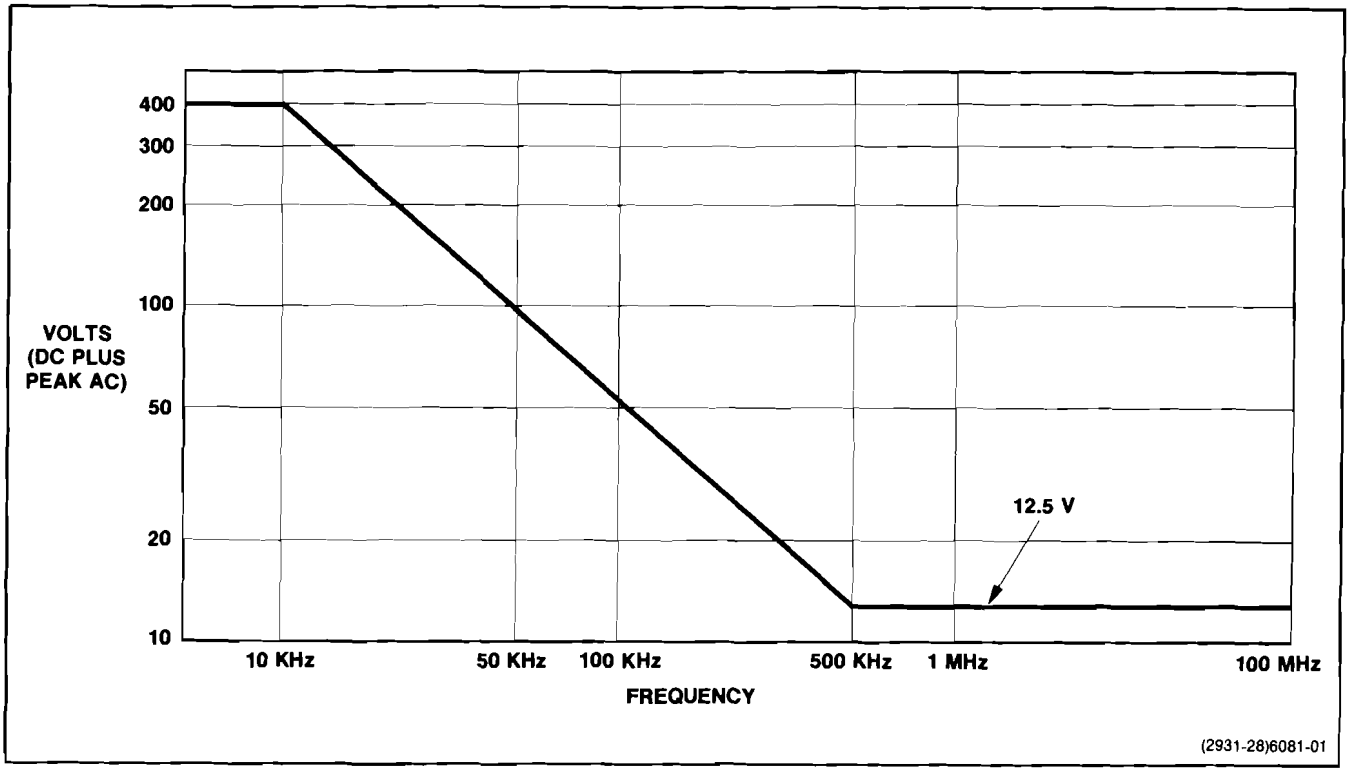


Figure 1-1. Maximum input voltage vs frequency derating curve for the CH 1, CH 2, CH 3, or CH 4 input connectors.

Table 1-2

Environmental Characteristics

Characteristics	Description
STANDARD INSTRUMENT	
Environmental Requirements	Instrument meets or exceeds the environmental requirements of MIL-T-28800D for Type III, Class 3, Style D equipment.
Temperature	
Operating	−10°C to +55°C (+14°F to +131°F).[a]
Nonoperating	−51°C to + 71°C (−60°F to 160°F).[a] Tested to MIL-T-28800D paragraphs 4.5.5.1.3 and 4.5.5.1.4, except in 4.5.5.1.3, steps 4 and 5 (−10°C operating test) are performed ahead of step 2 (−51°C nonoperating test). Equipment shall remain off upon return to room ambient during step 6. Excessive condensation shall be removed before operating during step 7.
Altitude	
Operating	To 4,570 m (15,000 ft). Maximum operating temperature decreases 1°C/1000 ft above 5000 ft.[a]
Nonoperating	To 15,240 m (50,000 ft).[a]
Humidity (Operating and Nonoperating)	Five cycles (120 hours) referenced to MIL-T-28800D paragraph 4.5.5.1.2.2, for type III, class 3 instruments.[a] Nonoperating and operating at 95%, −0% to +2% relative humidity. Operating at +30°C and +55°C for all modes of operation. Nonoperating at +30°C to +60°C.
Radiated and Conducted Emission Required per VDE 0871	Meets Category B.[a]
Electrostatic Discharge	Conforms to Tektronix Standard 062-2862-00.[a]
Vibration (Operating)	15 minutes along each of 3 major axis at a total displacement of 0.025 inch p-p (4 g at 55 Hz) with frequency varied from 10 Hz to 55 Hz in 1-minute sweeps. Hold for 10 minutes at 55 Hz in each of the three major axis. All major resonances must be above 55 Hz.[a]
Bench Handling Test	Four-inch drop per Tektronix standard 062-2858-00.[a]
Shock (Operating and Nonoperating)	30 g, half-sine, 11 ms duration, 3 shocks per axis each direction, for a total of 18 shocks.[a]
Transportation	
Packaged Vibration Test	Meets the limits of Tektronix Standard 062-2858-00.[a]
Package Drop Test	Meets the limits of Tektronix Standard 062-2858-00.[a]

[a]**Performance not checked in manual.**

Table 1-3

Mechanical Characteristics

Characteristics	Description
STANDARD INSTRUMENT	
Weight	
Instrument Alone	7.6 kg (16.8 lb).
Instrument with Probes, Power Cord, and Manual	8.3 kg (18.2 lb).
Shipping Weight	
Domestic	11.7 kg (25.8 lb).
Overall Dimensions	See Figure 1-2 for a dimensional drawing.
Height	
With Feet and Accessories Pouch (empty)	177 mm (7 in).
Without Accessories Pouch	164 mm (6.44 in).
Width	
With Handle	362 mm (14.25 in).
Depth	
With Front Cover On	446 mm (17.6 in).
With Handle Extended	521 mm (20.53 in).
Cooling	Forced air circulation; no air filter.
Finish	Tek Blue, pebble-grain finish painted on aluminum cabinet.
Construction	Aluminum alloy chassis. Plastic-laminate front panel.

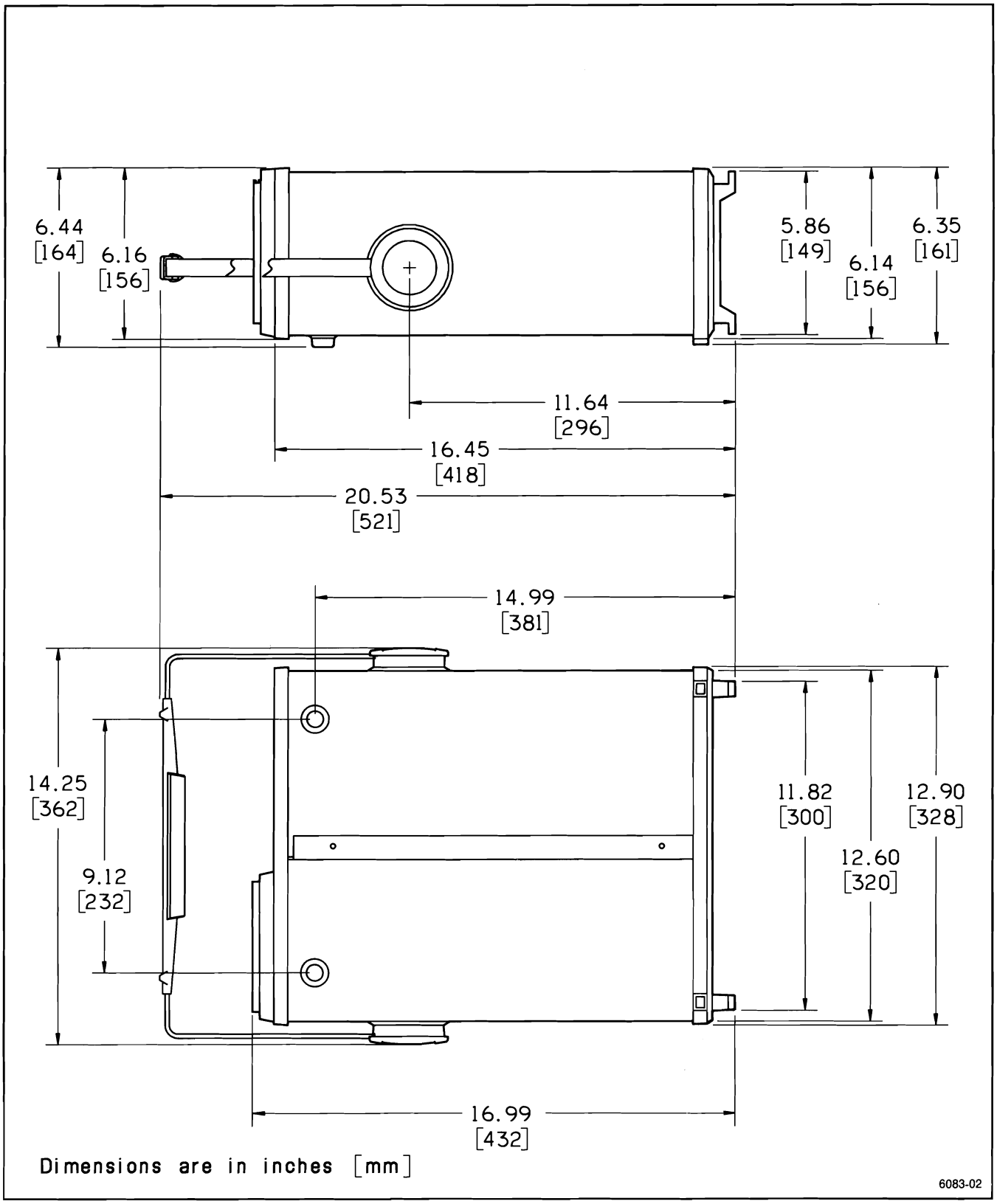


Figure 1-2. Dimensional drawing.

PREPARATION FOR USE

SAFETY

This section tells how to prepare for and to proceed with the initial start-up of the TEKTRONIX 2246 Oscilloscope.

Refer to the Safety Summary at the front of this manual for power source, grounding, and other safety considerations pertaining to the use of the instrument. Before connecting the oscilloscope to a power source, read this section and the Safety Summary.

LINE VOLTAGE AND POWER CORD

The 2246 operates on line voltages from 90 to 250 V with line frequencies ranging from 48 to 440 Hz. No line voltage selecting is necessary. The detachable power cord may have to be changed to match the power source outlet (see Figure 2-1).

The detachable three-wire power cord has a three-contact plug for connection to both the power source and the protective ground. The power cord is secured to the rear panel by a securing clamp. The protective ground contact on the plug connects (through the power cord protective grounding conductor) to the accessible metal parts of the instrument. For electrical-shock protection, insert this plug into a power-source outlet that has a properly grounded protective-ground contact.

Instruments are shipped with the required power cord as ordered by the customer (see Figure 2-1). Contact your Tektronix representative or local Tektronix Field Office for additional power-cord information.

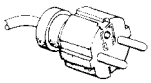
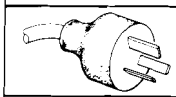
LINE FUSE

CAUTION

The instrument may be damaged if operated with the wrong type and rating line fuse installed.

To verify the proper value of the power-input fuse for the 2246, use the following procedure.

1. Disconnect the ac-power source from the instrument.

Plug Configuration	Usage	Line Voltage	Reference Standards	Option Number
	North American 120V/ 15A	120V	ANSI C73.11 NEMA 5-15-P IEC 83	A0
	Universal Euro 240V/ 10-16A	240V	CEE (7),II,IV,VII IEC 83	A1
	UK 240V/ 13A	240V	BS 1363 IEC 83	A2
	Australian 240V/ 10A	240V	AS C112	A3
	North American 240V/ 15A	240V	ANSI C73.20 NEMA 6-15-P IEC 83	A4
	Switzerland 220V/ 6A	220V	SEV	A5

Abbreviations:
ANSI — American National Standards Institute
AS — Standards Association of Australia
BS — British Standards Institution
CEE — International Commission on Rules for the Approval of Electrical Equipment
IEC — International Electrotechnical Commission
NEMA — National Electrical Manufacturer's Association
SEV — Schweizevischer Elektrotechischer Verein

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Figure 2-1. Optional power cords.

2. Press in the fuse-holder cap with a straight-bladed screwdriver, then release it with a slight counterclockwise rotation.

3. Pull cap (containing fuse) out of fuse holder.

4. Check that the fuse is of type and rating as specified on the rear panel.

5. If the installed fuse is not of the correct type and rating, replace it with a proper fuse and reinstall the fuse-holder cap.

INSTRUMENT COOLING

To prevent instrument damage from overheated components, adequate internal airflow must be maintained. Before turning on the power, first verify that ventilation holes on the bottom and right side of the cabinet are free of any obstruction to airflow. After turning the instrument on, verify that air is being exhausted from the right side ventilation holes.

START-UP

At power on, the instrument performs a self-diagnostic routine. If the instrument fails to come on and operate normally, the TRIGGER MODE LEDs may be flashing to indicate the circuit location of a start-up error. Also, under certain conditions, the Tektronix Part Number of the device where the error exists may be displayed on the screen. Refer to Troubleshooting in the Maintenance section of this manual for an explanation of the start-up error codes.

When the instrument is turned on, a self-cal routine may run to set the voltage- and timing-measurement constants. During normal operation, the power-on self cal happens only if the stored constants have been lost as the result of a dead memory back-up battery. The instrument may be used with no reduction in the measurement accuracy by running the SELF CAL MEASUREMENTS routine from the SERVICE MENU after the instrument has warmed up for at least 20 minutes. Refer the instrument to a qualified service person to have the battery changed.

To run the SELF CAL MEASUREMENTS routine:

Press menu-select buttons 1 and 6. Select INTERNAL SETTINGS MENU, then SELF CAL MEASUREMENTS. Press RUN to start the routine, then QUIT to return to the normal oscilloscope mode.

DETAILED OPERATING INFORMATION

For operating information relating to specific instrument functions, refer to the 2246 Operators Manual.

THEORY OF OPERATION

INTRODUCTION

SECTION ORGANIZATION

This section contains general and detailed descriptions of the 2246 Oscilloscope circuitry. First, general operation of the instrument functional circuits are described in the Block Diagram Description. Then, each major circuit is explained in detail in the Detailed Circuit Description. Functional block diagrams and schematic diagrams are used to show the interconnections between parts of the circuitry and to show circuit components. The circuit descriptions are arranged in the same order as the schematic diagrams.

The detailed block diagrams and the schematic diagrams are located in the Diagrams section at the rear of this manual. Smaller functional diagrams are contained within this section near the associated text. The particular schematic diagram associated with each circuit description is identified in the text. For optimum understanding of the circuit being described, refer to both the applicable schematic diagram and the functional block diagrams.

INTEGRATED CIRCUIT DESCRIPTIONS

Digital Logic Conventions

Digital logic circuits perform many functions within the instrument. Functions and operation of the logic circuits are represented by logic symbology and terminology. Most logic functions are described using the positive-logic convention. Positive logic is a system where the more positive of two levels is the TRUE (or 1) state; the more negative level is the FALSE (or 0) state. In this logic description, the TRUE state is HI, and the FALSE state is LO. The specific voltages which constitute a HI or a LO state vary between specific devices. For specific device characteristics of common parts, refer to the manufacturer's data book.

Hybrids

The Channel 1 and Channel 2 attenuators and input buffers in this instrument are hybrid devices combining thick-film and semiconductor technologies. These specialized electronic devices are made with interconnected circuitry on a single ceramic carrier and have improved performance characteristics over a more discrete type circuit.

Linear Devices

The operation of individual linear integrated circuit devices is described in this section using waveforms or graphic techniques when needed to illustrate their circuit action.

BLOCK DIAGRAM DESCRIPTION

INTRODUCTION

The Block Diagram Description gives an overview of the schematic circuit functions as illustrated in Figure 3-1. It is provided as an aid in understanding the overall operation of the 2246 Oscilloscope circuitry before the individual circuits are discussed in detail. The Simplified Block Diagram illustration shows the basic interconnections for signal flow and control signals. Schematic diagram numbers that are referred to in the text are shown by a diamond symbol in each block of the figure.

VERTICAL INPUTS (diagram 1)

The signals to be viewed or used for triggers are applied to the CH 1 through CH 4 vertical input BNC connectors either by coaxial cables or probes. Channels 1 and 2 have a choice of AC or DC input coupling or GND; Channels 3 and 4 have DC input coupling only. Scaling of the Channel 1 and Channel 2 input signals has a range of 2 mV per division to 5 V per division without the use of external attenuators. Channels 3 and 4 are more specifically limited in choices for TTL signals and have two input attenuator choices: 0.1 V per div and 0.5 V per div.

Scaling of the Channel 1 and Channel 2 signals is done by a series of switchable attenuators that provide either no attenuation, X10 attenuation, or X100 attenuation of the input signal. A low-impedance attenuator following an input signal buffer produces X1, X2, and X5 attenuation steps. Additional control of input signal scaling is provided by the selectable gain Vertical Preamplifiers (shown in diagram 2).

Channel 3 and Channel 4 input signals are buffered by high input impedance FET amplifiers; no input attenuation of the signal is provided. The gain choices for Channel 3 and Channel 4 are selected by the choice of Vertical Preamplifier gain setting only.

The Measurement Processor controls the operation of much of the switchable circuitry of the 2246 via a common shift register data line (SR DATA). Data bits loaded into the attenuator control and gain shift register (designated SR0) set the magnetic relay switches for the input coupling and attenuator settings and select the gain settings of the Preamplifiers.

VERTICAL PREAMPS AND OUTPUT AMPLIFIER (diagram 2)

Each vertical channel has identical selectable-gain Preamplifiers. The calibrated gain for each is manually set during adjustment. Enabling of the Preamplifiers to display a channel input signal is controlled by the Display Processor (U2400, diagram 9). Preamplifier gain settings are controlled by the Measurement Processor via control bits loaded into the attenuator control and gain shift register (diagram 1). Vertical channel trigger signal outputs are produced by each of the Preamplifiers for triggering the sweep from the applied signal.

The vertical outputs of each preamplifier are connected to a summing node at the input to the Delay-Line Driver. There, the signal current (from the enabled Preamplifiers) and the no-signal standing currents (from the disabled Preamplifiers) are added with the current from the position signal switching circuit.

The signal current for the enabled channel (vertical channel signal plus its position offset) or the readout position current (enabled to the summing node during text and cursor displays) is applied to the Delay-Line Driver. There, it is buffered and compensated to drive the vertical delay line. The delay line produces enough delay in the signal to permit the trigger circuitry to start the sweep before the vertical signal arrives at the crt deflection plates, and the rising edge of the triggering signal may be viewed.

From the output of the delay line, the signals are applied to the Vertical Output integrated circuit. The Vertical Output IC (U701) has provisions for vertical BEAM FIND, bandwidth limiting, and vertical centering of the readout displays. External filter elements on the Vertical Output IC produce the bandwidth limiting when switched into the amplifier circuitry. The output signal from U701 is then applied to the Vertical Output Amplifier where it gets its final boost in power to drive the vertical crt deflection plates.

An auxiliary Vertical Comparator circuit (U702 and Q703) is shown in diagram 2. Its purpose is to measure the gains and offsets during SELF CAL to determine the vertical calibration constants needed for the measurements and tracking cursor displays.

A AND B TRIGGER SYSTEM (diagram 3)

The A and B Trigger System provides the circuitry for trigger source, slope, coupling, and bandwidth selection; trigger level comparison; tv trigger detection; and dc measurements of the measurement source signal.

Trigger selection signals from the Display Logic IC (U600, diagram 4) drive the switching circuitry internal to U421 and U431. The signals select the correct trigger source, slope, and coupling choice for the present front-panel control setting. For VERT MODE triggering with more than one vertical channel displayed, the trigger source selection changes as each channel is displayed. When the ADD Vertical Mode is selected, a special amplifier arrangement in U421 (for A) or U431 (for B) sums the CH 1 and CH 2 signals to provide an ADD trigger signal for display of the ADD waveform.

The Trigger CPLG (coupling) selections are AC, DC, HF REJ (high-frequency reject), LF REJ (low-frequency reject), and NOISE REJ. Of these, all but NOISE REJ coupling are produced by selecting a filter path with the necessary bandwidth characteristics. NOISE REJ coupling is done in the Trigger Level Comparator circuit by decreasing the sensitivity of the comparator.

When the trigger signal level crosses the comparator threshold set by the Trigger LEVEL and SLOPE control settings, the comparator output changes states. That state change is applied to the Trigger Logic IC (U602, diagram 4). The Trigger Logic circuitry then produces the gating that starts the A or B Sweep as appropriate.

Separate A and B Trigger bandwidth limit circuits before the Trigger Level Comparators allow the flexibility that is needed for using the B Trigger circuitry as the measurement signal channel. Even when the B Trigger signal itself is bandwidth limited, full bandwidth is used for making measurements. Signals are measured by using the B Trigger Level Comparator as a successive-approximation analog-to-digital converter to determine the peaks or dc level of the applied signal. When making a measurement, the B Trigger Level signal is driven in a binary search by the Measurement Processor (via the DAC system, diagram 9) while the output of the B Trigger Level Comparator is monitored. When the smallest resolution output of the DAC system causes the comparator output to change states, the Measurement Processor stops the search and uses the DAC input value at that point as the measured value of the applied signal.

Video signal processing to obtain either Field or Line triggering is done in the TV Trigger Detector. Peak detectors determine the negative or positive peaks of the applied video signal. Those levels set the voltage at the reference input of the video signal comparator at a level that strips off all the video information (when the slope selection is correct for the polarity of the applied signal). The remaining composite sync signal is applied directly to the trigger system for Line triggering. Field triggering is obtained by filtering the composite sync to obtain only the vertical sync pulse.

The operating modes of the Trigger circuitry are controlled by the Measurement Processor. Auxiliary Data Shift Register U1103 (the last device in shift register 1) is serially loaded with control bits from the SR DATA line by the SR1 TTL clock. The state (HI or LO) of the control bits select the bandwidth setting of the A and B Triggers, TV LINE or TV FIELD triggering for the A Trigger system, and either the TV FIELD signal or the average DC voltage of the measurement channel for the B Trigger system. Additional control bits output from the Auxiliary Data Shift Register are the MAG signal (X10 Magnification on or off), $\overline{\text{X-Y}}$ signal (X-Y or Y-T displays), and the $\overline{\text{VERT COMP EN}}$ signal (when vertical SELF CAL is done).

The average dc voltage of a signal being measured is found by filtering all the ac signal components from the measurement channel signal. That dc level is then applied to the B Trigger Level Comparator where its value is determined by successive approximation as described earlier.

DISPLAY AND TRIGGER LOGIC AND PROCESSOR INTERFACE (diagram 4)

Control of the display states and the trigger system is done by two special devices. The Display Logic IC (U600, also know as SLIC or slow-logic IC) controls activities that enable the vertical channels for display and select the A and B Trigger System operating states. The Trigger Logic IC (U602, also know as FLIC or fast-logic IC) monitors the A and B Trigger signals, the A and B SWP END signals, the DLY END 0 and DLY END 1 signals, and controlling

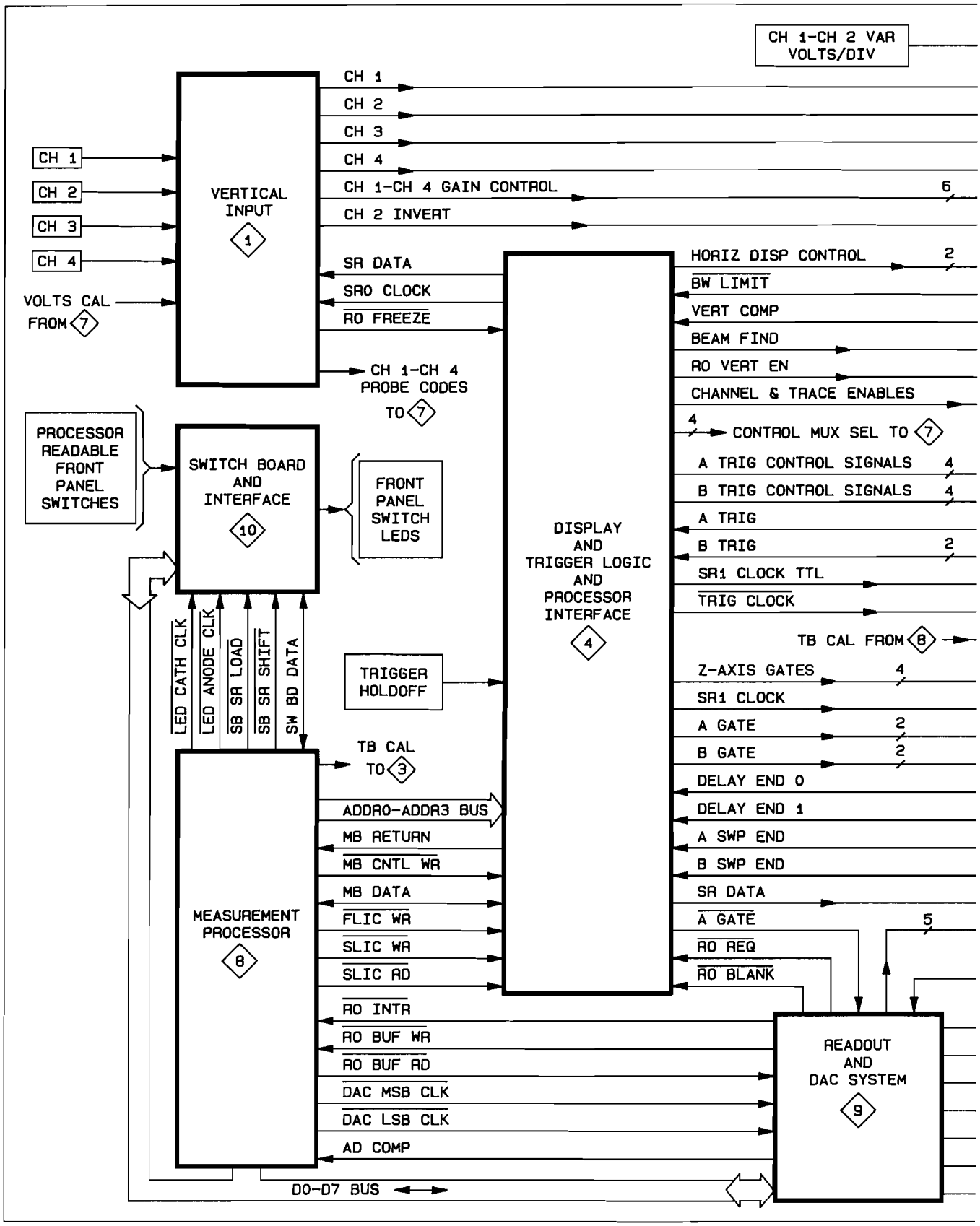

Figure 3-1. Simplified block diagram.

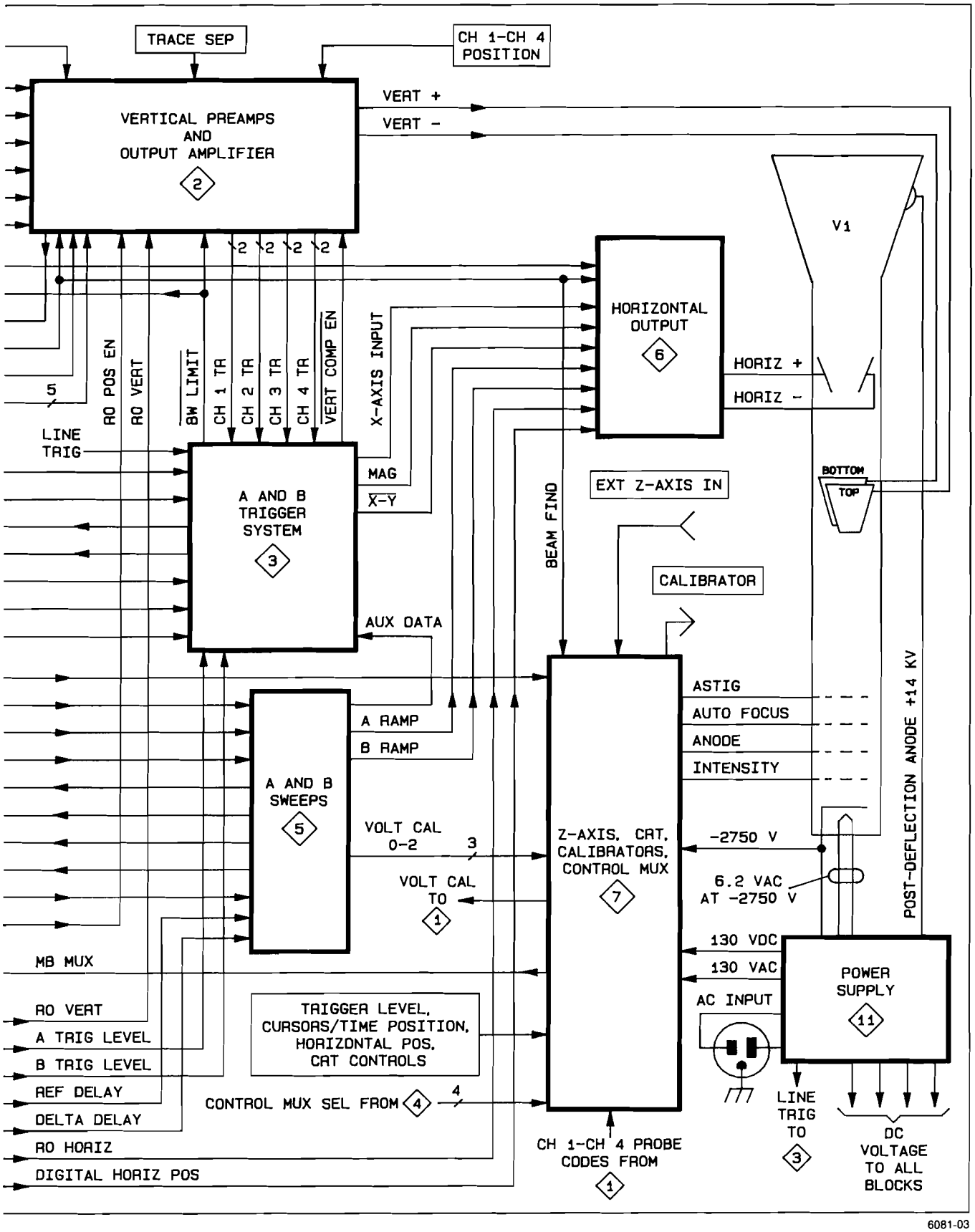

Figure 3-1. Simplified block diagram (cont).

signals from the Display Logic IC. It outputs the A and B GATE and the Z-Axis signals that start the sweeps and unblank the crt at the appropriate times.

Setup data to the internal registers of the two logic devices is sent from the Measurement Processor over the MB DATA line. A register is enabled for loading by the address that is latched on the ADDR0-ADDR3 lines (from diagram 8). Data bits are written to U600 with the $\overline{\text{SLIC WR}}$ strobe, and to U602 with the $\overline{\text{FLIC WR}}$ strobe. The contents of the internal registers of the Display Logic IC may also be read by the Measurement Processor using the $\overline{\text{SLIC RD}}$ strobe.

The Processor Interface portion of diagram 4 handles the serial communications between the serial shift registers and the Measurement Processor. This circuitry is the Measurement Processor's means of controlling the circuit hardware setups in response to a front panel control setting. Data controlling the state of the serial data bit to be loaded into the shift registers is placed on the ADDR0-ADDR2 bus lines. That address is decoded to produce either a HI or a LO that is latched on the SR DATA signal line. The appropriate shift register clock is then generated to load the latched bit. Each bit is loaded in succession until all the control bits of a shift register are loaded.

Control bits that select the front panel potentiometer or probe code voltage to be input to the A-to-D converter are loaded into a dual-purpose shift register (U502) from the serial MB DATA signal line. The four-bit parallel output of the shift register (placed on the AD MUX BUS) drives the multiplexers (U505 and U506, diagram 7) that do the signal switching.

The second purpose of the dual-purpose shift register is to permit the Measurement Processor to read back the outputs of the shift registers for diagnostic purposes and the output of the Vertical Comparator during vertical SELF CAL. The last bit from shift register 0 and shift register 1 ($\overline{\text{RO FREEZE}}$ and $\overline{\text{BW LIMIT}}$ respectively) and the Vertical Comparator (VERT COMP) state are loaded in parallel and serially shifted out onto the MB RETURN line to be read by the Measurement Processor.

A AND B SWEEPS AND DELAY COMPARATORS (diagram 5)

The A and B Sweep circuitry sets the timing and produces the A and B ramp signals to drive the crt horizontal deflection plates. The Measurement Processor sets the hardware states using control bits loaded into shift register 1. One register (U302) holds the bits for selecting the A Sweep timing resistors and capacitors and one register (U303) holds the B Sweep control bits. The timing resistors are selected by multiplexers (U307 and U308 for A Sweep timing; U310 and U311 for B Sweep timing) that are switched by the states of the control bits; timing capacitors are selected directly by the control bits.

The starting level of the sweeps is held steady by a Baseline Stabilizing circuit, and the sweep ends are determined by two Sweep-End Comparators. A and B GATE signals from the Trigger Logic IC (U602, diagram 4) control the start of the sweep ramps. A constant charging current to the timing capacitors produces a linear voltage rise across the capacitors. That voltage is buffered by the A and B Sweep Buffers for application to the Horizontal Output Amplifier (diagram 6).

The SEC/DIV VAR control, when out of the calibrated detent position, changes the rate of charging current to the sweep timing capacitors proportional to its rotation. Decreasing the current lengthens the ramp to decrease the sweep speed.

Two comparator circuits are used to check the A Sweep ramp amplitude against the Reference Delay and Delta Delay voltages. Both Delay End Comparator outputs are applied to the Trigger Logic IC (U602, diagram 4). The Trigger Logic IC monitors the delays to determine when the B Sweep may either run (for RUNS AFTER B Trigger Mode) or accept a B Trigger (for any of the triggered B Sweep modes).

HORIZONTAL OUTPUT AMPLIFIER (diagram 6)

Deflection signals applied to the Horizontal Preamplifier (U802) are the A Sweep Ramp, the B Sweep Ramp, the horizontal readout, and the X-Axis input signal for X-Y displays. Mode control signals HD0 and HD1 (from Display Logic IC U600 to the Horizontal Preamplifier) select the horizontal display mode (A Sweep only, B Sweep only, Alternate, or X-Y display). Other control signals to the Horizontal Preamplifier are the MAG signal (for X10 magnification of the sweep), the BEAM FIND signal (decreases horizontal gain), and the horizontal position signal for positioning the display. The X-Y signal controlling U301B reduces the range of the Horizontal POSITION signal delivered to the Horizontal Preamplifier when in the X-Y display mode.

Five manual adjustments are associated with the Horizontal Preamplifier. They are the X10 and X1 gain, the Readout gain, the X-Axis signal gain, and Mag Registration. Mag Registration compensates for offset between X10 and X1 gains, but it is primarily used to center the readout displays horizontally.

The active single-ended deflection signal input to the Horizontal Preamplifier is amplified and converted to a differential output signal. That signal is further amplified and compensated by the Horizontal Output Amplifier to drive the horizontal deflection plates of the crt. The final output amplifier consists of four MOSFET transistors (Q801, Q802, Q805, and Q806). Two transistors are used for each deflection plate (left and right) to divide the power handling requirements.

Z-AXIS, CRT, CALIBRATORS, AND CONTROL MUX (diagram 7)

This block of circuitry is divided into four major functions and one minor function. The largest division is the Z-Axis and CRT circuitry. The Z-Axis circuit has inputs from the front panel A INTEN, B INTEN, and READOUT intensity controls. These controls set the associated display intensity. Enabling gates from the Display Controller (diagram 4) select the appropriate Z-Axis input signal for application to the Z-Axis amplifier as the different display types are enabled. The amplified Z-Axis signals are then level shifted to the negative voltage of the crt cathode (−2.7 kV) in a dc restorer circuit. A similar dc restorer circuit provides auto focusing (at the fixed focus level set by the front panel FOCUS control) in response to the intensity level changes. The intensity and auto focus control voltages are applied to the crt where they modulate the electron beam flow that produces the display seen on the screen.

The second largest block of circuitry is the Control Multiplexers (U505 and U506). These analog switches are used by the Measurement Processor to scan the front panel potentiometers and the probe code lines to check for a change. Signal selection for routing through the Multiplexers is controlled by the four bits on the ADMUX0-ADMUX3 bus lines from the Processor Interface (diagram 4). Outputs from the Multiplexers are routed to the DAC System A-to-D Converter (U2306, diagram 9) where a digital value representing their analog voltage level is determined. That value is checked against the previously obtained value for a selected potentiometer to determine if a change has occurred and, if so, the amount and direction of the change. The Measurement Processor uses that information to generate new control voltages to the circuitry affected by the change. The VOLTS/DIV VAR and SEC/DIV VAR controls are checked only to determine if they are set to the calibrated (detent) position. The Vertical POSITION, TRACE SEP, and HOLDOFF controls are not checked by the Measurement Processor.

There are two voltage calibrator circuits. The first produces the front panel CALIBRATOR output for use in compensating voltage probes and checking the vertical deflection system of the oscilloscope. A second voltage-calibration circuit (U931 and an associated precision voltage divider) provides the accurate dc voltage levels used during vertical SELF CAL to check the gain and offset of the measurement channels.

A minor circuit shown on diagram 7 is the Scale Illumination circuit. The SCALE ILLUM potentiometer sets the bias level on (and thereby the current through) the current source transistors for the incandescent graticule illumination lamps.

MEASUREMENT PROCESSOR (diagram 8)

Many of the oscilloscope circuitry functions are directed by the Measurement Processor (U2501). The Measurement Processor, under firmware control, monitors the front-panel controls and sets up the circuitry under its control according to the settings made and the instructions contained in the System ROM.

The Measurement Processor communicates directly with the devices on its eight-bit data bus. The Measurement Processor selects the device to transfer data to or from by placing the address of the device on the Measurement Processor Address Bus. That address is decoded to produce a strobe that enables the bus device corresponding to the address. Writing to or reading from the enabled device is controlled by write or read ($\overline{WR}$ and $\overline{RD}$) pulses from the Measurement Processor. Communication on the data bus is usually limited to high speed data transfer only (to and from the System RAM and from the System ROM) and not to directly control of any circuit functions.

For controlling most of the circuit operating states, the Measurement Processor places serial bits on the bidirectional MB DATA line. Appropriate enabling strobes and clocks are generated either in its address decoding circuitry or by the Processor Interface circuitry (diagram 4) to load the control data into 32-bit shift registers. The

outputs of these registers control such things as attenuator settings, preamplifier gains, sweep timing, and trigger operating modes; all circuit operating functions that either change with front panel settings only or at a slow rate.

Scanning of the front panel controls and lighting of the front-panel LED's that back light the buttons is under control of the Measurement Processor. These events occur at long intervals (compared to the operating speed of the Measurement Processor). The front-panel switch-closures are read by the Measurement Processor over a serial communication line (SW BD DATA).

READOUT AND DAC SYSTEM (diagram 9)

Readout System

The Readout Processor (U2400) controls the display of text and cursor readouts as directed by the Measurement Processor. The ASCII code of each character (blanks included) in a full screen of readout (one field) is loaded into the appropriate memory location of the Character Code RAM (U2406) by the Measurement Processor. It is then up to the Readout Processor to control the display process.

When the Readout Processor addresses the Character Code RAM for display of the loaded characters, the address of a memory location dictates the place that the addressed character will appear on the face of the crt. The ASCII code found at the addressed location in the Character Code RAM then accesses the character to be displayed from the Character Dot Position ROM (U2400). The screen position of an individual dot within an addressed character is directed by the character data obtained from the Character Dot Position ROM.

The data bits specifying the character position on screen and the dot position within a given character are converted to analog vertical and horizontal position signals by the readout DACs (U2412 for vertical and U2413 for horizontal). For cursors and cursor related text, voltages representing the cursor positions are added in the output mixer circuitry (U2414, U2415, and U2416) to place the readout correctly on screen. Vertical position information needed for the measurement-tracking cursors and readouts is added in the Vertical Position Switching circuit (diagram 2).

The dots are continually refreshed to maintain a flicker-free readout. When the readout data needs changing, the Measurement Processor halts the refreshing and loads the new screen of data into the Character Code RAM.

DAC System

The DAC system is the Measurement Processor's control link to the analog circuitry. When a control voltage needs to be generated, the Measurement Processor places a data byte on its AD bus that represent the analog voltage level. That byte is converted to an analog signal currents by the DAC (U2302). That current is converted to an analog control voltage and directed to the appropriate circuit to be controlled. When the Measurement Processor does a scan to determine the front panel control settings, the DAC system drives the input to the A-to-D converter comparator (U2306) in a binary search pattern to determine the voltage level applied to the other input of the comparator. The smallest incremental change in the DAC input data that produces a switch in the comparator's output identifies the digital value of the unknown voltage.

SWITCH BOARD AND INTERFACE (diagram 10)

Most of the front panel switches that can be read by the Measurement Processor are "soft" switches; they are not connected directly into the circuit to be controlled. The front-panel control physical parameters of capacitance, leakage resistance, and inductance; therefore, cannot affect the operation of the controlled circuit. The wiper voltage of the potentiometers is digitized, and that digitized data is used by the Measurement Processor to set up the circuitry under its control as dictated by the control change.

The momentary push-button switches are rapidly scanned at short intervals by the Measurement Processor to check if one is being pressed. When a switch closure is detected, the Measurement Processor makes the necessary circuit or display changes as directed by its firmware instructions for that button and the existing operating states.

Functions are shown to be on by turning on the LED (light-emitting diode) that back lights the push button or panel label. The Measurement Processor controls the lighting via control registers (U2523 and U2524) that it reloads with control data to enable the correct LED with each button or mode change.

POWER SUPPLY (diagram 11)

The low and high voltages required to power the 2246 are produced by a high-efficiency, switching power supply. Input ac voltage from 90 to 250 volts and from 48 to 445 Hz is converted to a dc voltage that powers a preregulator circuit. The preregulator supplies regulated power to an inverter switching circuit in the primary of the power transformer (T2204). The secondary voltages produced at the secondary windings of the transformer are rectified and filtered to provide the low voltage power requirements of the instrument.

High voltage to drive the crt is generated by a multiplier circuit (U2203) that provides the +14 kV post-deflection anode voltage and the −2.7 kV to the cathode. The 6.2 Vac heater voltage is supplied by a isolated secondary winding from the power transformer that is referenced to the −2.7 kV cathode voltage.

DETAILED DESCRIPTION

VERTICAL INPUTS (diagram 1)

Channel 1 and Channel 2 input circuits on this schematic diagram are arranged identically. Only Channel 1 circuit numbers are referred to in the discussion. CH 3 and CH 4 are also arranged identically to each other and described separately from CH 1 and CH 2.

Input Coupling

Signals applied to the CH 1 BNC connector are coupled to the CH 1 attenuator via the CH 1 Input Coupling circuit. Relay K100 switches between direct (DC) and capacitative coupling (AC) of the input signal; K101 switches between connecting the applied input signal and the VOLT CAL signal to the input of the attenuator. The VOLT CAL signal line provides either the ground for GND Coupling in normal oscilloscope operation or a test voltage input for characterization during vertical SELF CAL. With the Input Coupling set to GND (both AC and DC off), the signal path is bypassed by C113. That capacitor filters any noise from the VOLT CAL signal when it is injected into the attenuator inputs. There is no precharge of the input coupling capacitor (C112) when the coupling is in ground (GND). Resistor (R111), in series with the BNC input, is a damping resistor.

The probe coding signal (CH1 PRB) is applied to a multiplexer (U500, diagram 7) where it is selected to be digitized in turn with the other probe-code signals and the front panel potentiometers. The Measurement Processor determines, from the digitized value of the voltage, the attenuation factor of any attached coded probe (Tektronix coded probes). The scale factor of the VOLTS/DIV readout is then switched to reflect the correct scaling of the displayed signal. Uncoded probes and coaxial cables are interpreted as having no attenuation for setting the readout scale factors.

High-Impedance Attenuator

Switching relays K102 and K103 control the signal path through the high-impedance attenuator, AT117. Signal attenuation is done by two 10X attenuator sections; for 100X attenuation, the two sections are cascaded. The 1 MΩ termination resistance at the output of the attenuator is divided into two parts: 750 kΩ and 250 kΩ. An output taken across the total resistance is applied to the buffer amplifier fast-path input; another output taken across the 250 kΩ section is applied to the slow-path input. Low-frequency compensation for the hybrid attenuators is adjusted by C10 and C11 (parts are part of the hybrid circuit on the ceramic carrier); input C is adjusted using C114.

Input Buffer Amplifier and 1X, 2X, 5X Attenuators

Input Buffer Amplifier U112 (for CH 1) is a hybrid device. The amplifier portion of the circuitry is a fast-path/slow-path buffer having unity voltage gain that presents a high-resistance, low-capacitance load to the signal from the high-impedance attenuator and a low output impedance to the low-impedance attenuator at the output of the amplifier. The switchable low-impedance,

voltage divider network of U112 provides 1, 2, and 5 times attenuation of the output signal for application to the Vertical Preamplifier.

The input signal is applied to pin 2 (fast-path input) and pin 4 (slow-path input) of U112 from the 1 MΩ divider at the output of the high-impedance attenuator. Internal circuitry of U112 isolates the signal from loading of the low-impedance attenuator and provides the slow-path and fast-path signal amplification. The fast amplifier path quickly passes the fast leading and falling edges of an input signal with the slow path catching up to complete the signal transfer. The output of the buffer sees a 300 Ω input impedance to the low-impedance attenuator, and the preamplifier sees a 75 Ω output impedance at pin 8 of U112 for all VOLTS/DIV switch settings.

Attenuator and Vertical Mode Control Registers

The switching relays of Channel 1 are driven by transistor array U174. Drive to each of the transistors in the array to switch the relay states is supplied by the Measurement Processor (U2501) via U171. That device is a portion of a shift register formed by U171, U172 (for channel 2 relays), and U173 (for Preamplifier gains). The devices are connected in series to form one long shift register (designated Shift Register 0). Serial data bits for the entire register string are loaded at pin 2 of U171 from the SR DATA line by the SR0 CLOCK applied to pin 3 of all three devices. See Table 3-1 for data bit assignments. Tables 3-2, 3-3, 3-4, and 3-5 define the bit states for controlling the switching.

CH 3 and CH 4 Input Amplifiers

The CH 3 and CH 4 input buffer amplifier are identical discrete FET amplifiers. Input coupling for these two vertical inputs is always DC; there is no coupling switch. The 1 MΩ input is formed by a series voltage divider that attenuates the input signal by five times for application to the gate of the input FETs. The VOLTS/DIV setting (either 0.1 V or 0.5 V) is made in the Preamplifier stage of the channel. Operation of CH 3 is described; like components in CH 4 do the same job.

From the gate of Q131A, diode CR131 provides protection from negative overvoltages exceeding about −8 V. Input C is adjusted by C134 for low-frequency compensation. High-frequency response is compensated by C138 across load resistor R137. Step balance is adjusted by R141 in the source lead of Q131B. The single-ended output of U131A is applied via R139 (a 75 Ω resistor) to the CH 3 Preamplifier. The impedance seen by the other differential input of the Preamplifier (U230, pin 8, diagram 2) is matched by the parallel combination of R158 and C159 in series with R160.

The probe-coding signal, CH 3 PRB, is read the same way as the CH 1 and CH 2 probe-coding signals. The VOLTS/DIV readout for Channel 3 is switched to correctly match the probe attenuation factor (when properly coded probes are used).

From the gate of Q131A, diode CR131 provides protection from negative overvoltages exceeding about −8 V. Input C is adjusted by C134 for low-frequency compensation. High-frequency response is compensated by C138 across load resistor R137. Step balance is adjusted by R141 in the source lead of Q131B. The single-ended output of U131A is applied via R139 (a 75 Ω resistor) to the CH 3 Preamplifier. The impedance seen by the other differential input of the Preamplifier (U230, pin 8, diagram 2) is matched by the parallel combination of R158 and C159 in series with R160.

VERTICAL PREAMP AND OUTPUT AMPLIFIER (diagram 2)

Vertical Preamplifiers

Each input channel has it own Vertical Preamplifier (CH 1-U210, CH 2-U220, CH 3-U230, CH 4-U240). The gain setting of the Preamplifier is controlled by Measurement Processor U2501 via the assigned control bits from Shift Register 0 (see Table 3-2). Channel 1 and Channel 2 gains require two controls bits (on pins 1 and 2 of the Preamplifiers) to set three different gains for 2 mV, 5 mV, and 10 mV VOLTS/DIV scaling. From 10 mV per division and up, the gain of the CH 1 and CH 2 Vertical Preamplifiers is set to 10 mV per division. The 1, 2, 5 scaling sequence for the remaining VOLTS/DIV switch settings is obtained by switching the high- and low-impedance attenuators. Gain of the CH 3 and CH 4 preamplifiers is controlled by one bit each (on pin 2), since there are only two scaling settings (0.1 V and 0.5 V per division) to select (see Table 3-5 for the gain-control bit states).

The internal circuitry of each Vertical Preamplifier is matched for the 2 mV, 5 mV, and 10 mV gain settings and the dc offsets. The output gain of each Preamplifier is adjusted by varying the common-mode resistance across the output pins (pin 13 to pin 14) to produce calibrated gain for each of the vertical channels.

Table 3-1
Shift Register 0 Bit Assignment

Pin	Signal	Controls
	U171	
4	CH 1 GND	K101—CH 1 GND Coupling (last bit)
5	CH 1 AC	K100—CH 1 AC Coupling
6	CH 1 X10.1	K102—CH 1 X10 Attenuator 1
7	CH 1 X10.2	K103—CH 1 X10 Attenuator 2
14	CH 1 X1	K105—CH 1 X1 Buffer Attenuation
13	NOT USED	No Connection
12	CH 1 X5	K104—CH 1 X5 Buffer Attenuation
11	CH 1 PREAMP1	U210—CH 1 Preamplifier Gain
	U172	
4	CH 1 PREAMP0	U210—CH 1 Preamplifier Gain
5	CH 2 GND	K108—CH 2 GND Coupling
6	CH 2 AC	K107—CH 2 AC Coupling
7	CH 2 X10.1	K109—CH 2 X10 Attenuator 1
14	CH 2 X10.2	K110—CH 2 X10 Attenuator 2
13	CH 2 X1	K112—CH 2 X1 Buffer Attenuation
12	NOT USED	No connection
11	CH 2 X5	K111—CH 2 X5 Buffer Attenuation
	U173	
4	CH 2 PREAMP1	U220—CH 2 Preamplifier Gain
5	CH 2 PREAMP0	U220—CH 2 Preamplifier Gain
6	CH 2 INVERT	U220—CH 2 Preamplifier Invert
7	CH 3 PREAMP1	U230—CH 3 Preamplifier Gain
14	CH 4 PREAMP1	U240—CH 4 Preamplifier Gain
13	ZERO HYST	U431C—B Trigger Comparator Hysteresis
11	$\overline{\text{RO FREEZE}}$	U509C—Controls Readout for SELF CAL (first bit loaded)

Each Vertical Preamplifier has a trigger pickoff (pins 17, 18, 19, and 20) for supplying the internal trigger signal to the A and B Trigger Source Selector Multiplexers. Capacitor coupling from pins 17 and 18 to pins 19 and 20 provides a fast-path signal into a duplicate, but level-shifted, slow-path signal line. The negative side of the differential trigger signal is terminated in a capacitor to ground (from pin 19) to provide a balance for the transmission line.

The VOLTS/DIV VAR controls for CH 1 and CH 2 (R2101 and R2103) directly vary the gain of the Vertical

Table 3-2
Input Coupling Control Bit States

Coupling	GND	AC
GND/CAL	0	1
AC	1	1
DC	1	0

Table 3-3
CH 1 and CH 2 Attenuator and Gain Control Bit States

VOLTS/DIV	X10.1	X10.2	X1	NC	X5	PREAMP1	PREAMP0
2 mV	1	0	1	0	0	0	0
5 mV	1	0	1	0	0	0	1
10 mV	1	0	1	0	0	1	0
20 mV	1	0	0	1	0	1	0
50 mV	1	0	0	0	1	1	0
100 mV	1	1	1	0	0	1	0
200 mV	1	1	0	1	0	1	0
500 mV	1	1	0	0	1	1	0
1 V	0	1	1	0	0	1	0
2 V	0	1	0	1	0	1	0
5 V	0	1	0	0	1	1	0

Table 3-4
CH 2 INVERT Control Bit

Setting	CH 2 INV
Normal	0
INVERT	1

Table 3-5
CH 3 and CH 4 Gain Control Bit

VOLTS/DIV	PREAMP1
0.1 V	0
0.5 V	1

Preamplifiers between the calibrated VOLTS/DIV settings. The Measurement Processor merely detects whether the VAR control for a channel is in or out of its detent position; and, if not, a greater-than symbol (>) is placed in front of the VOLTS/DIV readout to show that the channel is uncalibrated.

Each Preamplifier produces a standing current of about 11 mA into a common summing node. Output of the vertical signal from a Preamplifier is controlled by enabling signals (CH 1 EN through CH 4 EN) from Display Logic IC U600 (shown on diagram 4). The enabling signal that turns on a vertical channel signal also enables the position signal current for that channel through the Vertical Position Switching circuit (either U202 or U201) into the summing node.

Delay Line Driver

The Delay Line Driver is a differential amplifier that provides the signal amplification needed to drive the delay line. The circuit is compensated to produce the needed circuit response at the output of the delay line. Both sides of the differential amplifier are identical and circuit operation of the positive side components is described.

Transistors Q250 and Q252 are arranged as a feedback amplifier. The parallel combination of R250F and R250G supplies the feedback from the emitter of Q252 back to the base of Q250. Diode CR260 provides a one-diode voltage drop in the feedback loop for proper biasing of the base-to-collector junction of the input transistor (Q250). Gain of the amplifier is set by the value of common-mode resistor R270 (there is a small dc voltage gain). If the Vertical Preamplifier and Vertical Position circuit output currents are exactly 11 mA (no signal and no offsets) the feedback current is zero. Some standing feedback current will be present if the sum of the input

currents is not exactly 55 mA. A 1 mA current change of the input base current to Q250 produces a 41 mV change at the collector of Q252. The no-signal dc output voltage from Q252 is +7.5 V, and the standing current is about 15 mA. The differential voltage between the positive and negative side of the delay line with no signal input is 0 V ±0.5 V. The differential signal voltage input to the delay line is about 29 mV per graticule division of deflection.

Biasing of the input transistor bases is supplied by R262 and R264 (for Q250) and R263 and R265 (for Q251). Two resistors in series are used to provide the power handling needed (they are low-wattage precision resistors). The dc voltage at the bases of Q250 and Q251 is maintained at 7.5 V by a bias stabilization circuit. Operational amplifier U260 compares the common-mode voltage at the junction of R254 and R255 to the +7.5 V supply on its pin 3 input. If the base voltage is too low, U260 raises the common-mode emitter voltage (and thereby the base voltage) of the two input transistors.

Compensation components peak up the circuit response to counteract the roll-off effects of the delay line. The three series-rc combinations (C272 and R272, C273 and R273, and C274 and R247) between the emitters of Q252 and Q253 compensate different frequency ranges to correctly shape the circuit response. The series-rc circuit between the collectors of Q252 and Q253 (C275 and R275) damps the gain at high frequencies to prevent oscillation. Impedance matching and input termination of the 75 Ω delay line is done by the parallel-series combination of R278, R279, R280 and R281.

Vertical Position Switching

The Vertical Position Switching circuit consists of buffer amplifiers for the four vertical channel position signals (U203A, B, C, and D), two solid state switch arrays (U201 and U202), and a transistor paraphase amplifier circuit (U280, Q284, and Q285).

The vertical positioning voltages from the front panel POSITION controls are applied to the noninverting inputs of the four voltage-follower buffer amplifiers (U203A through U203D). The inputs and outputs of the amplifiers are capacitively bypassed to eliminate noise from the position signals. The buffered output signals are applied to switching arrays U201 and U202 for selection at the correct time for positioning the displayed trace and position-related readouts.

POSITION VOLTAGE SWITCHES. Selection of the channel or readout position signals to be supplied to the paraphase amplifier summing node is controlled by several sources. The vertical channel enable signals (CH1 EN through CH4 EN) from Display Controller U600 (diagram 4) turn on the appropriate channel position signal for the enabled Vertical Preamplifier when displaying waveforms. The nominal position range of the vertical signal is ±12 divisions.

When position-dependent readout (labeled cursors that follow the vertical channel position controls) is displayed, the RO CH 1 POS EN through RO CH 4 POS EN signals from tri-state latch U2403 (shown on diagram 9) enable the appropriate vertical position signal into the summing node at the input to the paraphase amplifier. The Readout Position Enable signal lines are tri-stated (open) during display of the channel signals so that the Vertical Channel Enable signals have control of the position enable lines. Also, the Readout Position signals cannot override the Vertical Channel Enable signal levels to turn on a Vertical Channel Preamplifier with the series resistors (R212, R222, R232, and R242) in the signal path. The vertical position of the enabled vertical channel is added to the position of the readout so that the cursors appear at the correct vertical position in the display.

When non-position tracking readout is displayed (i.e., menus and scale-factor readouts), the vertical screen position of the readout is conveyed by the RO VERT signal only. The RO VERT signal is enabled into the summing node input of the paraphase amplifier by the RO VERT EN signal for both readout types (position-tracking or fixed). Extra noise bypassing provided by decoupling components R205, R207, and C268 on the RO VERT signal line reduces jitter of the readout display.

During vertical SELF CAL, the RO CH 1 POS EN through RO CH 4 POS EN signals enable the appropriate vertical position signal into the summing node at the input to the paraphase amplifier without turning on a channel Vertical Preamplifier. The gain and offset of the voltage followers and position switches may then be calculated independently from the vertical channel signal. The computed offsets are then used by the Measurement Processor to correctly place the position-tracking readouts (cursors) on the display relative to the vertical position of the waveform.

The TRACE SEP EN and RO TR SEP EN signals operate the same as described for the channel enable and readout position enable signals. A slight difference between the channel vertical position signals and the TRACE SEP signal is that TRACE SEP is attenuated more. The higher value of R206 on pin 13 of U201 reduces the TRACE SEP range to ±4 divisions as compared to ±12 divisions for the vertical signals.

POSITION PARAPHASE AMPLIFIER. The Position Paraphase amplifier circuitry is formed by a transistor array (U280) driving two discrete transistors (Q284 and Q285). The circuit is configured as two negative-feedback amplifiers that produce a differential output current from the summed single-ended input current. Transistors U280B and U280E are constant-current sources for their associated amplifier pairs in the array. The feedback path for the U280A-U280F amplifier combination is via R286 from the emitter of Q284. The no-signal feedback current through R286 is 1 mA. Feedback for the U280C-U280D combination is via R289 from the emitter of Q285. Feedback current in R289 is 100 μA. Both Q284 and Q285 are high beta transistors requiring little base-drive current. The overall vertical displacement response from the input (at the base of U280F) to the output is 200 μA per division of vertical screen displacement.

The signal applied to the base of U280C is the inverted position signal developed across R290 in the emitter of Q284. The signal is again inverted by U280C to drive the base Q285 in the opposite direction from the signal at the base of Q284. The standing dc current (no signal input) output current into the delay line input summing node is 11 mA, the same as the output of the vertical preamplifiers. Vertical centering of the menu and readout displays within the graticule area is done using VERTICAL READOUT CENTERING potentiometer R260.

Vertical Output Amplifiers

WARNING

Vertical Output IC U701 runs hot and can burn you if touched. The metal tab on top of the device is NOT ground; it is the −5 V supply to the IC.

Vertical Output IC U701 buffers the signal output of the delay line and provides the circuitry for the BW LIMIT and BEAM FIND functions and for the vertical signal gain adjustment. The inputs to the Vertical Amplifier are terminated in 75 Ω by external resistors R706 and R707. External filter components C707, L701, and L702 produce the bandwidth limiting of the vertical signal when internally switched into the output amplifier circuitry of U701.

Manual calibration of the vertical signal display to the crt graticule is done using VO Gain potentiometer R703. The components between pins 12 and 22 of U701 (Q704, R726, R727, and R728) provides gain correction for the small difference in gain between full bandwidth and bandwidth-limited operation of the Vertical Output IC. Correction for a thermal change between display of the signal and display of the readout is provided by the RO Jitter adjustment (R724).

WARNING

Vertical Output Amplifiers Q701 and Q702 run hot and can burn you if touched.

Vertical Output Amplifiers Q701 and Q702 provide the signal gain necessary to drive the vertical crt deflection plates. The deflection plates have a comparatively large capacitance, and to change the voltage as fast as necessary to deflect the crt beam, the Vertical Output Amplifiers have to handle large current demands. A reduction in circuit capacity is made by reducing the collector capacitance of the output transistors. The cases of Q701 and Q702 are NOT the collectors; they are connected to the transistors' base material; the case tabs mark the collector leads. In the collector circuits, T-coils L703 and L704 boost the vertical bandwidth of the output amplifiers; and R731 and R732 are damping resistors.

Vertical Comparator

The Vertical Comparator circuit (U702, Q703, and associated components) allows the Measurement Processor to determine the gain and offset of the vertical system up to the input to the Vertical Preamplifier. The circuit is enabled only during the vertical self characterization routine. Known dc voltage levels are applied to the attenuator inputs, and U702 compares the voltage from the delay line to the DIG HORIZ POS signal which is being driven in a binary search pattern. The output voltage is found by successively narrowing the search levels until the smallest change possible from the DAC system causes the Vertical Comparator output to change states. Using the measured value to compare against the known input voltage, the Measurement Processor determines a Vertical Calibration constant that must be applied to produce accurate voltage measurements.

A AND B TRIGGER SYSTEM (diagram 3)

Most of the trigger signal switching and trigger level comparator circuitry is contained on two integrated circuit devices (U421 and U431). Within the devices is the logic circuitry that drives the selectable variables of Trigger SOURCE, Trigger CPLG, and Trigger SLOPE for both the A and the B Triggers. Selection of the trigger variables is done by control bits generated by Display Sequencer U600 (diagram 4). The remaining portions of the circuitry shown in diagram 3 include the A and B Trigger bandwidth limiting circuitry, the TV Trigger Detector circuitry, the Auxiliary Control Register (part of Shift Register 1), and the DC Filter for the measurement system. The B Trigger circuitry

does double duty in that measurements for the DC, +PEAK, −PEAK, and PEAK-to-PEAK values of a signal are done in the B Trigger channel. Consequently, voltage measurements cannot be done in ALT or B Horizontal Display Modes when the B Trigger circuitry is in use.

A and B Trigger Source Selectors

Analog switching of the Trigger signal sources is done by the circuitry in U421A (for the A Trigger) and U431A (for the B Trigger). The possible Trigger SOURCE selections are the same for both the A and the B Trigger system. They are CH 1, CH 2, CH 3, CH 4, LINE, and VERT. In ALT Vertical MODE, when VERT is the selected source, a trigger is obtained in succession for each displayed channel. A stably triggered display will be obtained for each channel signal without regard to frequency relationships between the applied signals. If ADD VERTICAL MODE is selected, a special adder circuit in U421A and U431A, adds the CH 1 and CH 2 signals to produce an ADD trigger signal composed of the two inputs. The LINE Trigger signal is a sample of the power-line input voltage. Multiplexer U1106A, in the input path for the LINE trigger signal, selects between the LINE signal (for oscilloscope operation) and the TB CAL signal (used for horizontal self characterization).

When a Voltage Measurement is being done, U431A in the B Trigger circuit acts as the measurement channel selector and selects either the CH 1 or the CH 2 input signal to be measured.

A and B Trigger Coupling Selectors

Coupling selections for DC, AC, HF REJ, and LF REJ are done by U421B for the A Trigger and U431B for the B Trigger. The trigger signal path is through a filter circuit having the proper bandpass characteristics for the selected trigger coupling. NOISE REJ coupling is done differently. The two Trigger LEVEL Comparators (U421C and U431C) have selectable sensitivity. For NOISE REJ, the sensitivity is reduced so that a larger signal change is required to produce a state change at the output of the comparators. Trigger Coupling control logic is shown in Table 3-6.

Another signal source selectable in the Trigger Coupling Selectors is the output of the TV Trigger Detector (TV LINE or TV FIELD). An applied composite video signal is separated so that the horizontal line or vertical field sync pulse can be used to trigger the oscilloscope for Television signal display (see TV Trigger Detector description). Selection between LINE or FIELD for the A Trigger source is done by multiplexer U1104A with its output being applied to pin 18 of U421B. Pin 18 of U431B in the B Trigger system has an input of either the TV Line sync signal, for TV triggering of the B Sweep, or the output of the Measurement Signal Low-Pass Filter, when the DC measurement mode is active.

MEASUREMENT SIGNAL LOW-PASS FILTER. The average dc level of a signal is obtained for measurement by filtering the measurement channel signal to remove all but the dc component of the signal. An active RC filter circuit formed by U1101B, R1154, R1155, C1154, and C1155 does the filtering with U1101B buffering the filtered output voltage to isolate it from loading. The dc level is applied back to the Trigger Coupling switch (U431B, pin 18) for input to the B Trigger Comparator (U431C) where the actual measurement is done (see the B Trigger Comparator description).

A and B Trigger Bandwidth Limit Circuits

The A Trigger Bandwidth Limit circuit components (Q440, U441F, CR432, C432, L432, R432, Q444, and U441E) act to roll off the trigger circuit bandwidth when $\overline{\text{BW LIMIT}}$ is active (LO). The B Trigger Bandwidth Limit circuit components do the same job (with some additional compensation components), but can be selected independently of the BW LIMIT front panel setting (by the Measurement Processor using the BW FULL B signal). That is because the B Trigger Channel is used for the Measurement system, and the circuit bandwidth must be full for making measurements. B Trigger Mid-Frequency Compensation components (L464, C465, C464, and R469) produce a flatter bandwidth response curve for the signal measurements. The actual circuit operation for both is the same, and only the A Trigger Bandwidth limiting action is described.

For full trigger bandwidth, the $\overline{\text{BW LIMIT}}$ signal from Auxiliary Register U1103 is written HI by the Measurement Processor. That HI is inverted to a LO by U441E and U441F and applied to the bases of Q440 and Q444. The LO output turns off Q444 and disconnects C444 from ground. The purpose of C444 is to act as part of an LC filter that rolls off the signal. The LO applied to the base of Q440 turns that transistor on pulling the anode of CR432 up and forward biasing it. The trigger signal ac path then bypasses L432 and R432 through CR432 and C432. The dc component of the trigger signal is still via L432 and R432.

When the bandwidth is limited, the $\overline{\text{BW LIMIT}}$ signal is LO. That is inverted to a HI that turns on Q444 (connecting C444 to ground) and turns off Q440 (reverse biasing CR432). The trigger signal path is now through L432 and R432 with C444 to ground to roll off the circuit bandwidth.

Table 3-6
Trigger Selection Logic

Front Panel Coupling Selection	Latched Bit Values				Description
	SLOPE	TS2	TS1	TS0	
A Sweep Mode (U421) Auto Lvl, Auto, Normal, or Single Seq					
DC	0	0	1	0	DC Coupled
Noise	1	0	1	0	DC Coupled, Noise Reject
HF	0	1	0	1	HF Reject
LF	0	0	1	1	LF Reject
AC	0	1	0	0	AC Coupled
A Sweep Mode (U421) TV Line, or TV Field					
DC	1	0	0	0	TV Input, Noise Reject
Noise	1	0	0	0	TV Input, Noise Reject
HF	1	0	0	0	TV Input, Noise Reject
LF	1	0	0	0	TV Input, Noise Reject
AC	1	0	0	0	TV Input, Noise Reject
B Sweep Mode (U431) Runs, Auto Lvl, Auto, or Normal					
DC	0	0	1	0	DC Coupled
Noise	1	0	1	0	DC Coupled, Noise Reject
HF	0	1	0	1	HF Reject
LF	0	0	1	1	LF Reject
AC	0	1	0	0	AC Coupled
B Sweep Mode (U432) TV Line					
DC	1	0	0	0	TV Input, Noise Reject
Noise	1	0	0	0	TV Input, Noise Reject
HF	1	0	0	0	TV Input, Noise Reject
LF	1	0	0	0	TV Input, Noise Reject
AC	1	0	0	0	TV Input, Noise Reject

A Trigger Level Comparator

The Trigger signal is compared with the A Trigger LEVEL setting by U421C to determine the signal level and slope of the trigger signal that produces a sweep trigger. The comparator slope is set internally by the switching logic; the Trigger comparison level is set using the front panel Trigger LEVEL control. A fixed amount of hysteresis in the A Trigger Level Comparator prevents double triggering on noisy signals. Once a level state change occurs, a larger change in the opposite direction is required (because of the circuit hysteresis) to reverse the state change. The differential output of U421C is applied to the Trigger Logic IC (U602, diagram 4) where the gating signals to start the display sweep are generated.

B Trigger Comparator and Measurement A-to-D Converter

For B Trigger signal comparison, the B Trigger Level Comparator (U431C) works the same as the A Trigger Level Comparator. Its differences lay in its use as the Measurement Channel A-to-D Converter for making signal voltage measurements. When a measurement is being done, the ZERO HYST control bit from Shift Register 0 (U173, diagram 1) is set HI. This HI turns off Q480 and disconnects U431C pin 28 from ground. The biasing combination of R476 and R486 between the −5 V supply and ground reduces the hysteresis of the comparator to zero. A small incremental change in signal level to the comparator will then cause it to change output states. The B REF TRIG LVL signal on pin 24 of U431C is driven in a binary search pattern by the Measurement Processor (via the DAC System) while monitoring for state changes at the output. The smallest incremental input change of the B REF TRIG LVL that produces an output change then defines the voltage point being measured (+PEAK, −PEAK, or DC). When peak-to-peak voltage measurement is done, the Measurement Processor merely measures one peak voltage of the signal, then the other.

Auxiliary Shift Register

Auxiliary Shift Register U1103 is the last register in Shift Register 1. Control bits loaded into the register from the AUX DATA signal line (from U303 pin 9, diagram 5) are serially shifted through Sweep Shift Register U302 and U303 (diagram 5). Circuit functions controlled by the bits in U1103 are the following:

B TV TRIG ENABLE: Switches between the B TV Trigger signal and the DC measurement signal voltage (U1106C).

TV FIELD: Switches the A Trigger between TV FIELD and TV LINE (U1104A).

MAG: Controls the X10 Magnification function of the Horizontal Output Preamplifier (U802, diagram 6).

VERT COMP ENAB: Turns on the Vertical Comparator (U702, diagram 2) during voltage self characterization.

TB CAL: Switches the time-base calibration signal into the B trigger system during horizontal self characterization (U1106A).

BW FULL B: Switches between full and limited B Trigger bandwidth.

$\overline{\text{BW LIMIT}}$: Switches between full and limited A Trigger bandwidth. The $\overline{\text{BW LIMIT}}$ signal has a second use. As the last bit in Shift Register 1, it is fed back to the Measurement Processor during diagnostic checks done on the Shift Registers.

$\overline{\text{X-Y}}$: Switches the level of the horizontal position signal (DIG HORIZ POS) between that needed for Y-T display and that needed for X-Y displays (U301B, diagram 6).

Multiplexer (U1106A) normally provides the Line Trigger signal picked off from the Power Supply input. For self characterization (SELF CAL) of the Time Base, the switch outputs the TB CAL signal obtained from the Time Base Calibration Signal Divider (U2509, diagram 8).

TV Trigger Detector

INPUT AMPLIFIER. The signal at pin 19 of U421A is applied to pin 3 of U1101A via a low-pass filter formed by R426, L426, and C426. The filter limits the bandwidth of the X-AXIS signal to about 5 MHz for application to the Horizontal Preamplifier (U802, diagram 6) and to the TV Trigger Detector circuitry. Operational amplifier U1101A provides low-pass gain of the applied composite video signal that further attenuates the video portion of the signal relative to the sync pulses. The output signal from U1101A is applied to the Peak Detectors and the Sync Comparator.

PEAK DETECTORS. The peak detectors determine the positive and negative peaks of the applied composite video signal. Those peaks voltages are applied across a voltage divider circuit used to set the comparison level (slice level)

to one input of a comparator. That level is such that, when the user selects the correct sync polarity for the applied signal, the middle of the sync tips is at the threshold level of the comparator. The output of the comparator then switches only on the sync tips of the applied signal. The peak detectors are complementary in that the positive-peak detector transistors (Q1101, Q1102, and Q1103) and the negative-peak detector transistors (Q1104, Q1105, and Q1106) are complementary types (PNP-NPN). Both detectors are driven from the same input signal; the positive peaks of the video signal forward bias Q1101, and the negative peaks forward bias Q1104. The operation of the positive peak detector is described.

The composite video signal is applied to the emitter of Q1101. A positive-going signal increases the current through Q1101, causing the collector voltage to rise. The rising collector voltage biases on Q1102 harder, and C1114 charges up rapidly following the positive-going signal up to its positive peak. When the input signal starts negative, Q1101 is turned off immediately by the charge held on C1114. That leaves C1114 holding the positive peak voltage of the input signal. Emitter-follower Q1103 applies that peak voltage level to U1104B pin 3 via R1117. R1136 to the −7.5 V from pin 3 provides a fixed offset to the signal level. The negative-peak detector does the same type of operation on the signal to apply the negative peak voltage to pin 5 of U1104B.

When the sync polarity is selected to match the sync of the applied video signal (by the user with the A SLOPE switch), the voltage level at the selected input of U1104B is at the middle of the sync-tip voltage. If the wrong polarity is selected, triggering will take place on the video signal. For signal generator signals, the effect may not be noticeable, except for a shift of the trigger point; but if composite video signals are being viewed, the display will be unstable when the wrong polarity is selected.

SYNC COMPARATOR. The incoming composite video signal is applied to the plus input (pin 3) of the Video Sync Comparator (U1102A). The Video Sync Comparator looks at the signal level on pin 2 and compares it with the incoming video signal level. When the incoming level crosses the comparison threshold, the output of U1102A switches state. That state change occurs at the mid level of the sync pulses. The output signal of U1102A (TV LINE) is applied directly to U1104A pin 2 and U1106C pin 1 to be available for selection for the A and the B Trigger systems for TV LINE triggering.

FIELD SYNC FILTER. The filter circuit composed of R1132, R1133, C1106, C1107, and U1102B processes the output of U1102A further to determine when the vertical field sync signal is present. The time constant of the filter elements is such that the line sync pulses between vertical fields cannot move the voltage on U1102B pin 5 across the comparison threshold (ground on pin 6).

During the vertical field sync pulse, the frequency of the serration pulses (line and equalizing) doubles. The filter capacitors will then be discharged enough to go below ground, and switch the output state of U1102B. That signal is applied to U1104A pin 1 to be available as the TV FIELD Sync trigger signal for the A Trigger system.

SYNC SWITCHING. Solid-state switches U1104A and U1106C provide switching between the TV FIELD and the TV LINE signal for the A Trigger and between TV LINE from A SOURCE and the average DC level of the measurement channel for the B Trigger. The switching states are controlled by the Measurement Processor via the TV FIELD SEL and the B TV TRIG EN control signals from the Auxiliary Control Register (U1103).

DISPLAY AND TRIGGER LOGIC AND PROCESSOR INTERFACE (diagram 4)

The Display Sequencer or SLIC (slow-logic integrated circuit, U600) performs most of the slow-logic functions required to run the display functions. This integrated circuit contains a microprocessor interface, the display sequencer logic circuitry, the trigger holdoff timer, the chop clock, and an interface to the on-screen readout control logic.

The microprocessor interface of U600 provides the capability to serially load the internal control register, write the internal read/write memory, do some limited real-time control over a few sequencer functions, and monitor status information.

The Display Sequencer contains a read/write memory for storing the display states to be sequenced through and logic for sequencing the A and B Sweep displays and trigger sources. The sequencer also provides control signals that are needed to do waveform measurements.

An internal trigger holdoff timer provides a pulse with programmable width that is triggered on at the end of A Sweep, (or at the end of B Sweep). The pulse width may be set from 1 us to greater than 0.5 s, depending on the internal counter divide ratio, and the holdoff oscillator frequency at pin 15.

The chop clock circuit generates a phase-dithered chop clock and blanking signal, derived from an external frequency source. With 10 MHz applied, the chop rate can be 1.25 MHz or 625 kHz, with a blanking time of about 200 ns (625 kHz is used in the 2246).

The readout interface circuit responds to the readout request and readout blanking inputs, and generates a blanking signal (BLANK, pin 18) to control the Z-Axis Amplifier enabling signals from U602. The chop blanking signal also gets routed through this circuit.

Pin Description

The following is a description of Display Sequencer U600 pin functions (see Figure 3-2 for pin numbers).

DIO: Data IO pin. This pin is tied to the Measurement Processor MB DATA line. Data to be clocked into the control register is presented here, and status data can be read out on this pin when the $\overline{RD}$ input is LO (tri-state output). See Table 3-7.

TDI: Trigger data input pin. When A3=A2=1, data on this pin is sent to the DIO pin (when $\overline{RD}$ is LO).

$\overline{RD}$: Read enable input (active LO). Bringing this pin LO causes internal status data (selected with A3-A0) to be presented on the DIO pin for transfer to the Measurement Processor.

$\overline{WR}$: Write enable input (active LO). A negative-going pulse on this pin performs actions described in Table 3-7.

$\overline{SOUT}$: Strobe output pin (active LO). When A3, A2, A1, and A0 = 1111, $\overline{SOUT}$ goes LO when the $\overline{WR}$ pin is pulled LO. Otherwise, $\overline{SOUT}$ is always HI.

A3, A2, A1, A0: Address inputs. The ADDR0-ADDR3 selection bits are latched from the Measurement Processor address bus by U2512, diagram 8.

$\overline{A\ GATE}$: A Sweep Gate input (active LO).

$\overline{B\ GATE}$: B Sweep Gate input (active LO).

TC: Timing clock input.

LFC: Low-frequency clock input. A signal derived from the calibrator circuit is used for skewing the chop-clock phase.

$\overline{ROR}$: Readout request input (active LO). A LO causes the CH1 EN, CH2 EN, CH3 EN, CH4 EN, HD1, HD0, and TS outputs to all go LO, and allows the $\overline{ROB}$ input to have complete control of the BLANK output. If $\overline{ROB}$ is LO when $\overline{ROR}$ goes LO, then the internal timing will be such that the BLANK output will go HI quickly enough to blank the display before switching transients can be shown on screen (see the detailed description of the readout interface).

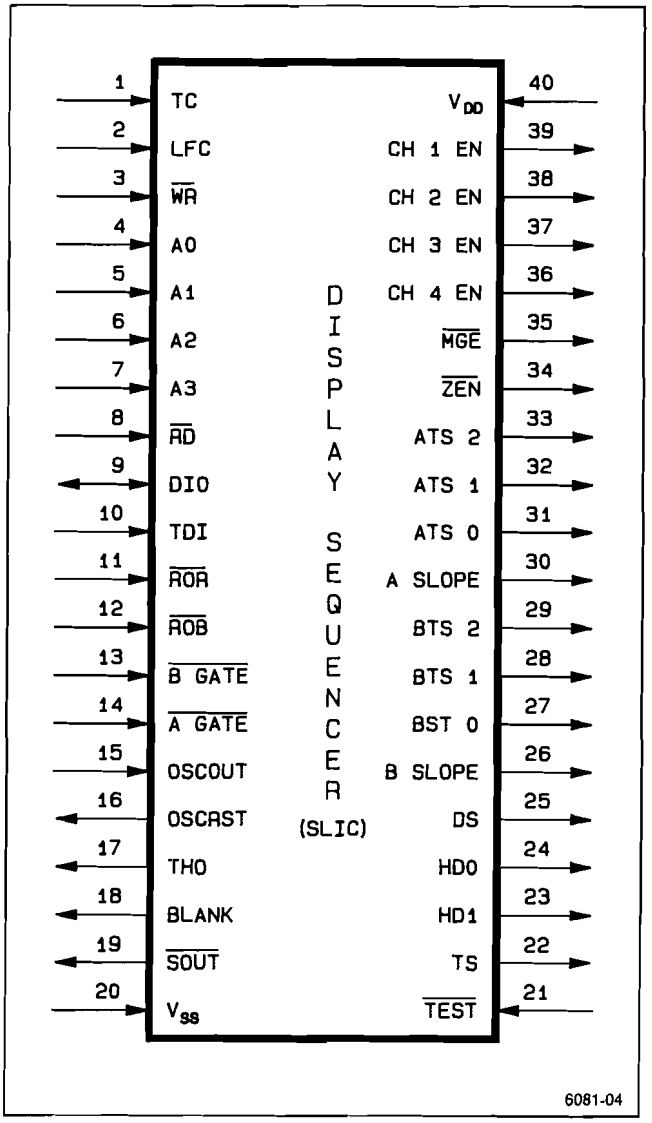

Figure 3-2. Display Sequencer IC (SLIC, U600) pin out diagram.

$\overline{ROB}$: Readout blank input (active LO). During readout active time ($\overline{ROR}$=LO), the $\overline{ROB}$ input is inverted and sent to the BLANK output.

OSC OUT: The external holdoff oscillator output drives this pin. A falling edge causes the internal holdoff counter to increment.

Table 3-7
Display Sequencer (U600) Control Bit Assignments

A3	A2	A1	A0	DIO when $\overline{RD}$ LO	Action when $\overline{WR}$ Strobed
0	0	0	0	Control Reg. msb	DIO clocked into Control Reg. (a)
0	0	0	1	RAM comparator	RAM written from Control Reg.
0	0	1	0	EOSS flag	RAM address incremented (b)
0	0	1	1	EOS signal (c)	RESET is strobed (d)
0	1	0	0	A Gate Detect flag	MRESET is strobed (e)
0	1	0	1	B Gate Detect flag	RAM load mode enabled (f)
0	1	1	0	A Gate Detect flag	A/B GATE-detect flags reset
0	1	1	1	B Gate Detect flag	Set A slope output (g)
1	0	0	0	(h)	Forces B1/B2 Source/Slope/Delay (i)
1	0	0	1	(h)	Forces B Slope output (j)
1	0	1	0	(h)	Sets BLANK output HI (k)
1	0	1	1	(h)	Sets THO output HI (k)
1	1	0	0	TDI data	(see description of $\overline{TEST}$ input)
1	1	0	1	TDI data	(see description of $\overline{TEST}$ input)
1	1	1	0	TDI data	Sets norm B Source/Slope/Delay (l)
1	1	1	1	TDI data	$\overline{SOUT}$ pin gets strobed

NOTES:

(a) Data is clocked into the control register on the rising edge of $\overline{WR}$.

(b) RAM load mode must be enabled; the address increments on the rising edge of $\overline{WR}$.

(c) EOS (end of sequence) goes HI for the last state of any display sequence. EOS is read out for test purposes.

(d) The THO output should be set HI when RESET is strobed for proper initialization. This does the following:

a. It initializes the display sequencer back to the first display state (RAM address 000). In ALT VERT Mode, all vertical enable, horizontal enable, and trig source outputs are initialized. In CHOP VERT Mode, the horizontal enable and trig source outputs are initialized, but the vertical enable outputs continue to cycle at the chop clock rate.

b. It resets the EOSS (end of single sequence) flag.

c. It resets the trigger holdoff timer.

(e) Used for initialization, during testing of the device.

(f) A rising edge on $\overline{WR}$ with DIO = 1 enables the RAM load mode; a rising edge on $\overline{WR}$ with DIO = 0 disables the RAM load mode.

(g) A rising edge on $\overline{WR}$ with DIO = 1 sets the A Slope output HI; a rising edge on $\overline{WR}$ with DIO = 0 sets the A Slope output LO.

(h) Used for device testing only.

(i) A rising edge on $\overline{WR}$ with DIO = 1 forces the B1 Trigger Source, the B1 Slope, and sets the DS output HI; a rising edge on $\overline{WR}$ with DIO = 0 forces the B2 Trigger Source, the B2 Slope, and sets the DS output LO.

(j) A rising edge on $\overline{WR}$ with DIO = 1 forces the B SLOPE output HI; a rising edge on $\overline{WR}$ with DIO = 0 forces the B SLOPE output LO. This forcing function takes precedence over the force B1/B2 Source/Slope/Delay feature described in note (i) above. This forcing function is canceled by applying a negative strobe to the $\overline{WR}$ input with the address = 1110.

(k) A rising edge on $\overline{WR}$ with DIO = 1 sets the output HI; a rising edge on $\overline{WR}$ with DIO = 0 allows the output to behave normally.

(l) A negative pulse on $\overline{WR}$ with address = 1110 will cancel the effects of (i) above and allow the B Source, B Slope, and DS outputs to behave normally.

OSC RST: Oscillator reset output. Internal logic causes this output to go HI to discharge the external holdoff oscillator timing capacitor at the end of holdoff (see detailed description of the holdoff timer operation).

CH1EN: Channel 1 enable output (active HI).

CH2EN: Channel 2 enable output (active HI).

CH3EN: Channel 3 enable output (active HI).

CH4EN: Channel 4 enable output (active HI).

ATS2, ATS1, ATS0: A Trigger Source Select outputs. These bits either correspond to three bits of the control register, or they track with the vertical channel enable outputs (in ALT Vertical Mode with VERT MODE trigger selected). These outputs change state on the rising edge of the THO output, or when RESET is strobed while THO is HI. The encoding scheme is shown in Table 3-8.

Table 3-8
A Trigger Source Select Bits

ATS2	ATS1	ATS0	SOURCE
0	0	0	CH1
0	0	1	CH2
0	1	0	CH1+CH2
0	1	1	CH3
1	0	0	CH4
1	0	1	Line

A SLOPE: A Trigger slope output.

BTS2, BTS1, BTS0: B Trigger Source Select outputs. These bits correspond to either one of two sets of three bits in the control register, or they can track with the vertical channel enable outputs (in ALT Vertical MODE). These outputs normally change state on the rising edge of the THO output, or when RESET is strobed while THO is HI. If B1 or B2 Source/Slope/Delay is being forced, the outputs will correspond directly with one of the two three-bit sets in the control register. The encoding scheme matches that used for the A trigger source select bits shown in Table 3-8.

B SLOPE: B Trigger Slope output. This output is set to either one of two bits in the control register. This output normally changes state on the rising edge of the THO output, or when RESET is strobed while THO is HI. It may also be forced HI or LO by the Measurement Processor via the processor interface.

HD1, HD0: Horizontal display enable outputs. These outputs normally change state on the rising edge of the THO output, or when RESET is strobed while THO is HI. The encoding scheme is shown in Table 3-9.

Table 3-9
Horizontal Display Mode Select Bits

HD1	HD0	Horizontal Mode
0	0	Readout displayed
0	1	A Sweep displayed
1	0	B Sweep displayed
1	1	X-Y mode

DS: Delay select output. This output normally changes state on the rising edge of the THO output, or when RESET is strobed while THO is HI. It may also be forced by the Measurement Processor via the processor interface. DS HI selects the first delay (B1), and DS LO selects the second delay (B2).

TS: Trace separation output. This output changes state on the rising edge of the THO output, or when RESET is strobed while THO is HI. TS goes HI to enable trace separation; TS goes LO during a readout request cycle.

$\overline{\text{ZEN}}$: Z-Axis enable output (active LO). This output goes LO when the ZAP control bit is set HI, or when the selected B trigger source channel (as presented on the BTS2, BTS1, and BTS0 output pins) is the same as the channel being enabled for display.

$\overline{\text{MGE}}$: Measurement gate enable output (active LO). This output behaves the same way as $\overline{\text{ZEN}}$, except in chop vertical mode, in which MGE stays in a LO state. Also, the ZAP control bit has no effect on MGE.

THO: Trigger holdoff output (active HI). Outputs the variable holdoff pulse. In single sequence mode, this output will go HI after the last A Sweep of the sequence and stay HI until RESET is strobed. This output may also be forced HI via the Measurement Processor interface.

BLANK: This output is controlled from three sources. At the end of a readout request cycle (when $\overline{ROR}$ goes HI), the BLANK output will be asserted for four to six timing clock periods (to hide vertical source switching transients). Chop blanking pulses can be routed to this output (however, when $\overline{ROR}$ is LO, chop blanking is automatically inhibited). Lastly, this output may be forced HI via the Measurement Processor interface.

$\overline{TEST}$: Test mode enable input (active LO). $\overline{TEST}$ is held HI and not used in normal operation. This pin is pulled HI to force normal operation, but may be pulled LO to enable the test mode. Enabling test mode does the following:

1. Disables single sequence and B Ends A modes, no matter what code is in the control register.

2. Reconfigures the trigger holdoff timer to make it more easily testable (see control register description for control bits H4-H0).

3. A3, A2, A1, A0 = 1100 allows a negative-going pulse on $\overline{WR}$ to reset only the control register.

4. A3, A2, A1, A0 = 1101 allows a negative-going pulse on $\overline{WR}$ to preset control register bits B1-B6.

Control Register Description

The Display Sequencer internal control register is a 26-bit, serial-shift register that receives control-bit data from the Measurement Processor. Table 3-10 lists the control signal name(s) associated with each register bit. Bit number 1 receives the data from the DIO pin (via the Processor Interface) after one LO-to-HI transition on the $\overline{WR}$ input pin (A3 = A2 = A1 = A0 = 0). Bit number 26 receives this data after 25 more LO-to-HI transitions on the $\overline{WR}$ input. Bit number 26 is the most-significant bit position of the internal shift register.

Table 3-10
Shift Register 1 Control Bit Data

Bit Nr	Control Signal Name(s)		
1	AS2	RD5	AC3
2	AS1	RD4	AC2
3	AS0	RD3	AC1
4	ZAP	RD2	
5	B1S2	RD1	BC3
6	B1S1	RD0	BC2
7	B1S0		BC1
8	B1SLOPE		BC0
9	B2S2		
10	B2S1		
11	B2S0		
12	B2SLOPE		
13	VM1		
14	VM0		
15	HM1		
16	HM0		
17	DD		
18	SSE		
19	B ENDS A		
20	H4		
21	H3		
22	H2		
23	H1		
24	H0		
25	FSEL		
26	CBEN		

RD5-RD0: Data inputs to the internal RAM. The RAM address comes from a three-bit, binary up-counter. To write data into the RAM, the first six bits are loaded into the control register with the RAM data word. With A3, A2, A1, A0 = 0001, a negative-going pulse on the $\overline{WR}$ input will write the data into RAM. To set the RAM address, the RAM load mode must be enabled. In RAM load mode, a LO-to-HI transition on the $\overline{WR}$ input (with A3, A2, A1, A0 = 0010) will increment the RAM address by one. There are eight consecutive RAM locations (addresses 000 to 111); the address counter will increment to 111, then wrap around to 000. Strobing RESET resets the counter to 000. See the Display Sequencer detailed description to find out what the RAM outputs do.

The RD5-RD0 bits also go to the inputs of an internal RAM comparator. The RAM outputs are sensed by the other comparator input. If the two inputs match, the comparator output will be HI. The RAM comparator output can be read by the Measurement Processor through the processor interface.

AC3-AC1: The A Trigger CPLG select bits. BC3-BC0 are the B Trigger CPLG and SLOPE select bits. To write these bits into the trigger coupling circuits, the Measurement Processor loads the control register as follows: Bits 1, 2, and 3 are set to AC3, AC2, and AC1 respectively, and the A SLOPE output is set to AC0. Bits 5, 6, 7, and 8 are set to BC3, BC2, BC1, and BC0

respectively. The RAM load mode is enabled, the force B1/B2 feature is disabled, and THO is strobed once (or RESET is strobed once while THO is HI). At this point, output pins ATS2, ATS1, ATS0, and A SLOPE are set to AC3, AC2, AC1, and AC0 respectively; and output pins BTS2, BTS1, BTS0, and B SLOPE are set to BC3, BC2, BC1, and BC0 respectively. The Measurement Processor then strobes the latches in the Trigger Coupling Select Logic circuits to make the trigger coupling selections. The RAM load mode is then disabled to resume normal Display Sequencer operation.

AS2, AS1, AS0: A Trigger SOURCE select bits. See Table 3-11 for the bit encoding of the control signals when not loading the RAM or coupling circuits.

Table 3-11
Trigger Source Select

AS2	AS1	AS0	Source
0	0	0	CH1
0	0	1	CH2
0	1	0	CH1+CH2
0	1	1	CH3
1	0	0	CH4
1	0	1	Line
1	1	0	--
1	1	1	VERT MODE

For any binary code except 111; AS2, AS1, and AS0 are presented on output pins ATS2, ATS1, and ATS0 respectively after a THO rising edge. For binary code 111, the data on the three output pins will correspond to the channel being enabled for display; it alternates as the channel displays alternate and change state on the rising edges of THO. The RAM load mode is disabled to get the A Trigger SOURCE to alternate.

ZAP: Setting this bit HI forces the $\overline{\text{ZEN}}$ output LO. This bit is LO to allow normal operation of the $\overline{\text{ZEN}}$ output.

B1S2, B1S1, B1S0: B1 Trigger SOURCE select bits. Bit encoding is the same as the encoding for the A Trigger SOURCE select bits.

B2S2, B2S1, B2S0: B2 Trigger SOURCE select bits. Encoded the same as A Trigger SOURCE select bits, except that code 111 does not select VERT Mode trigger. Selection between B1 SOURCE and B2 SOURCE is normally made with the DS (delay select) output signal. DS = 1 selects B1, and DS = 0 selects B2. If the B1 select bits are 111 and the B1 SOURCE is selected (not forced), then the data on output pins BTS2, BTS1, and BTS0 will track with the selected vertical channel (similar to the A Trigger SOURCE select outputs).

B1 SLOPE, B2 SLOPE: B Trigger SLOPE bits. One of these two bits is presented on the B SLOPE output pin (if B SLOPE isn't being forced), in the same way that the B1 and B2 sources are selected. When B1 SOURCE is selected, then B1 SLOPE is also selected, and B2 SLOPE gets selected when B2 SOURCE is selected.

VM1, VM0: Vertical MODE control bits. See Table 3-12 for encoding.

HM1, HM0: Horizontal MODE control bits. See Table 3-13 for encoding.

Table 3-12
Vertical MODE Select

VM1	VM0	MODE
0	0	Not used
0	1	Chop Mode
1	0	Alt Mode (with no measurement)
1	1	Alt Mode (with measurement)

Table 3-13
Horizontal MODE Select

HM1	HM0	MODE
0	0	A only
0	1	ALT
1	0	B only
1	1	X-Y

DD: Dual-delay control bit. DD = 1 for dual delay (delta time), and DD = 0 for single delay.

SSE: SGL SEQ enable. SSE = 1 for single sequence mode or 0 for repetitive mode.

B ENDS A: B ends A enable (active HI).

H4, H3, H2, H1, H0: Holdoff time. Encoded as in Table 3-14. With the $\overline{\text{TEST}}$ pin held HI for normal operation).

Table 3-14
Holdoff Counter Encoding

H4	H3	H2	H1	H0	Count Length	H4	H3	H2	H1	H0	Count Length
0	0	0	0	0	1	1	0	0	0	0	10000
0	0	0	0	1	2	1	0	0	0	1	20000
0	0	0	1	0	5	1	0	0	1	0	50000
0	0	0	1	1	5	1	0	0	1	1	50000
0	0	1	0	0	10	1	0	1	0	0	100000
0	0	1	0	1	20	1	0	1	0	1	200000
0	0	1	1	0	50	1	0	1	1	0	500000
0	0	1	1	1	50	1	0	1	1	1	500000
0	1	0	0	0	100	1	1	0	0	0	100000
0	1	0	0	1	200	1	1	0	0	1	200000
0	1	0	1	0	500	1	1	0	1	0	500000
0	1	0	1	1	500	1	1	0	1	1	500000
0	1	1	0	0	1000	1	1	1	0	0	100000
0	1	1	0	1	2000	1	1	1	0	1	200000
0	1	1	1	0	5000	1	1	1	1	0	500000
0	1	1	1	1	5000	1	1	1	1	1	1[a]

[a]**Strobing RESET presets the holdoff counter to 499999 to simplify testing.**

FSEL: Chop frequency select bit. With 10 MHz on the TC input pin, FSEL = 1 provides a chop frequency of 625 kHz; FSEL = 0 produces 1.25 MHz (625 kHz is used).

CBEN: Chop blank enable bit. CBEN = 1 allows the chop blanking signal to be passed out the BLANK output pin (when $\overline{\text{ROR}}$ is HI); CBEN = 0 inhibits chop blanking.

Display Sequencer Operation

In CHOP mode, the RAM still controls the vertical channel displays, but different logic controls the horizontal display selection.

RAM data bits RD5, RD4, and RD3 are programmed for a particular channel display (see Table 3-15).

Table 3-15
Display Sequencer Channel Select Logic Bits

RD5	RD4	RD3	Channel
0	0	0	CH1
0	0	1	CH2
0	1	0	CH1+CH2
0	1	1	CH3
1	0	0	CH4

Bit RD2 selects between the A Sweep display and the B Sweep display (only used in ALT Vertical Mode (with measurement). The A Sweep is displayed if this bit is set HI (outputs HD1, HD0 = 01), otherwise the B Sweep is displayed (outputs HD1, HD0 = 10). Bit RD1 controls the DS (delay select) output pin in ALT Vertical Mode (with or without measurement). Finally, bit RD0 marks the last state in a display sequence. When the RD0 bit goes HI, the sequencer finishes its current state and jumps back to the initial state (RAM address 000 is the initial state). In ALT Vertical Mode, the sequencer will advance to the next state either on each rising edge of the trigger holdoff pulse (ALT Vertical Mode with measurement), or on every other rising edge of the trigger holdoff pulse (ALT Vertical Mode with no measurement).

The first type of ALT Mode is used when there is an intensified zone (with or without an accompanying B Sweep) for only one or two of the displayed channel(s); every display state can be completely specified by programming the RAM properly (no more than eight display states are ever needed for any measurement display sequence; hence, the RAM is limited to eight addresses). The second type of ALT Mode is used when there are intensified zones and B Sweeps for all channels displayed. In this mode, HD1 and HD0 automatically alternate between the A sweep and the B Sweep on each rising edge of the trigger holdoff pulse. Whenever HD1 and HD0 switch from the B Sweep back to the A Sweep, the vertical sequencer advances to its next state. This second type of ALT Vertical Mode is used only when more than eight RAM locations are needed to define a long display sequence in ALT Horizontal Mode.

In ALT Vertical Mode, the vertical and horizontal display enable outputs are initialized as follows: the trigger holdoff output is forced HI (via the processor interface), RESET is strobed, then trigger holdoff is unforced to allow sweeps to occur. This procedure ensures that the display enable and trigger source outputs are initialized to the first state of the programmed display sequence.

In CHOP Vertical Mode, the leading edge of the chop blanking pulses advance the vertical display enable outputs. RAM bits RD5, RD4, and RD3 still determine the vertical channel displayed, and RAM bit RD0 marks the last display state in the sequence. RAM bits RD2, and RD1 are not used in CHOP Mode. Other circuitry, clocked by the trigger holdoff pulse, drives the horizontal display control outputs. The same initialization procedure as described above for ALT Vertical Mode is used. However, only the trigger source and horizontal display enable outputs are initialized. The vertical-display-enable outputs cycle at the CHOP rate. Table 3-16 specifies the behavior of the horizontal-display-enable outputs for all horizontal and vertical modes.

Trigger Holdoff Timer

When the B ENDS A control bit is LO, the holdoff timer is triggered by the rising edge of $\overline{\text{A GATE}}$. When the B ENDS A control bit is HI, the holdoff timer is triggered by either the rising edge of $\overline{\text{B GATE}}$, or the rising edge of $\overline{\text{A GATE}}$, whichever occurs first. The THO output pin will go HI immediately, and go LO after the programmed number of holdoff oscillator cycles. In SGL SEQ Mode (again, with the $\overline{\text{TEST}}$ input pin HI), the EOSS (end of single sequence) flag will go HI and the THO output will stay HI after the last A Sweep of the programmed sequence. Strobing RESET will reset the EOSS flag, and set the THO output back LO again, if THO hasn't been forced HI via the Measurement Processor interface.

HOLDOFF OSCILLATOR. A relaxation oscillator circuit formed by U601, Q600, Q601 and associated components is connected between the OSC OUT and OSC RST pins to provide the input count pulses to the holdoff timer. The HOLDOFF voltage applied to the base of Q600 sets up a charging current into timing capacitor C600. When the holdoff timer is inactive, the OSC RST output pin is HI, and C600 is held discharged. With the capacitor discharged, the output of the oscillator is held HI. When a rising edge of $\overline{\text{A GATE}}$ (or $\overline{\text{B GATE}}$ in B ends A mode) occurs, the OSC RST output will go LO and allow the voltage across C600 to ramp up. When this voltage crosses an upper threshold, the output of U601 at pin 7 goes LO. This negative transition increments the internal holdoff counter, and causes the OSC RST output to go HI, again discharging C600. When the voltage drops below a lower threshold, the oscillator output again goes HI to repeat the oscillation cycle. After the last negative transition on the OSC OUT pin for a particular count length, the OSC RST output will go HI and stay there until the next time the THO timer is triggered.

Sweep Gate Detection

Display Logic IC U600 also contains sweep gate detect latches that can be read out and reset via the Measurement Processor interface. The A GATE detect latch output will go HI on the rising edge of $\overline{\text{A GATE}}$ after a falling edge of $\overline{\text{A GATE}}$, if the $\overline{\text{MGE}}$ signal is LO (i.e., the latch is armed by $\overline{\text{MGE}}$). The B GATE detect latch output goes HI when $\overline{\text{B GATE}}$ goes LO (level sensitive). The A GATE latch is reset on the leading edge of the A/B RESET signal, so that the latch will not miss an A GATE occurring before the end of the latch reset interval. The B GATE latch resets when the A/B RESET signal is LO.

Table 3-16
Horizontal and Vertical Display Response

Delay and Vertical Modes			HORIZONTAL CONTROL SIGNAL OUTPUTS					
			Signal Names	Readout Inactive ($\overline{ROR}$ = 1)				Readout Active ($\overline{ROR}$ = 0)
				Horizontal Modes (HM1 HM0)				
DD	VM1	VM0		A Only (0 0)	A Alt B (0 1)	B Only (1 0)	X/Y (1 1)	
			NSSS (a)	1	2	1	(b)	(c)
0	0	0	DS	HI	HI	HI	HI	(c)
	or		HD0	HI	(d)	HI	LO	LO
0	0	1	HD1	LO	$\overline{HD0}$	HI	HI	LO
			TS	LO	HD1	LO	LO	LO
			NSSS (a)	2	4	2	(b)	(c)
1	0	0	DS	(d)	(e)	(d)	LO	(c)
	or		HD0	HI	(d)	LO	HI	LO
1	0	1	HD1	LO	$\overline{HD0}$	HI	HI	LO
			TS	LO	HD1	LO	LO	LO
			NSSS (a)	(f)	(f)	(f)	(b)	(c)
			DS	HI	HI	HI	HI	(c)
0	1	0	HD0	HI	(d)	LO	HI	LO
			HD1	LO	$\overline{HD0}$	HI	HI	LO
			TS	LO	HD1	LO	LO	LO
			NSSS (a)	(g)	(g)	(g)	(b)	(c)
			DS	HI	HI	HI	HI	(c)
0	1	1	HD0	HI	(h)	LO	HI	LO
			HD1	LO	$\overline{HD0}$	HI	HI	LO
			TS	LO	HD1	LO	LO	LO
			NSSS (a)	(f)	(f)	(f)	(b)	(c)
			DS	(i)	(i)	(i)	(i)	(c)
1	1	0	HD0	HI	(h)	LO	HI	LO
			HD1	LO	$\overline{HD0}$	HI	HI	LO
			TS	LO	HD1	LO	LO	LO
			NSSS (a)	(g)	(g)	(g)	(b)	(c)
			DS	(h)	(h)	(h)	(h)	(c)
1	1	1	HD0	HI	(h)	LO	HI	LO
			HD1	LO	$\overline{HD0}$	HI	HI	LO
			TS	LO	HD1	LO	LO	LO

NOTES

(a) NSSS = Number of A Sweep cycles in a single sequence.

(b) Not applicable in single sequence mode.

(c) Signal state not affected by readout.

(d) Signal changes state after each rising edge of THO; initialized to a HI state in single sequence mode.

(e) Signal changes state after every other rising edge of THO; it is initialized to a HI state in SGL SEQ mode.

(f) NSSS = Two times the number of states programmed into the vertical sequencer. In ALT Vertical Mode with no measurement, the vertical sequencer advances to its next state at the end of every other A GATE.

NOTES (cont)

(g) NSSS = The number of states programmed into the vertical sequencer.

(h) Programmable with the vertical sequencer.

(i) Programmable with the vertical sequencer. There are two A Sweeps per vertical display state.

Chop Clock

The clock frequency applied to the TC input pin is either divided by 8 (FSEL = 0), or divided by 16 (FSEL = 1), producing a positive-going pulse at the BLANK output pin (when enabled) with a width equal to about two times the period of the clock signal on the TC input. To produce phase skewing, the chop frequency divider circuit is forced to skip ahead by four TC clock periods on a rising edge of $\overline{\text{A GATE}}$. This skipping is gated on and off by applying a low-frequency clock signal (about 1 kHz from the Calibrator circuit) to the LFC (low-frequency clock) input pin. Internally, the LFC signal is divided by two, and when the resulting square wave is HI, count skip-ahead is enabled.

Readout Interface

The Readout Interface accepts inputs from the $\overline{\text{ROR}}$ and $\overline{\text{ROB}}$ pins, and drives the BLANK output pin. When $\overline{\text{ROR}}$ is HI, the BLANK output is controlled by the chop blank signal (when enabled by the CBEN control bit).

When the $\overline{\text{ROR}}$ input is LO, chop blanking is disabled and the $\overline{\text{ROB}}$ input is inverted and allowed to control the BLANK output. When the $\overline{\text{ROR}}$ input goes from LO to HI, the BLANK output remains connected to the readout blank signal for an additional four to six TC clock periods. Normally, the $\overline{\text{ROB}}$ input will be LO during this time so that the BLANK output will be HI to mask vertical source-switching transients. The HD1, HD0, and TS outputs are disabled two to four TC periods after $\overline{\text{ROR}}$ goes LO, and are again enabled two TC periods before the BLANK output is disconnected from the readout blank signal ($\overline{\text{ROB}}$). For any readout request cycle, the $\overline{\text{ROR}}$ input remains LO for greater than six TC clock periods. Relative timing of $\overline{\text{ROR}}$, BLANK, HD0 and HD1 (HDx), TS, and vertical channel enables (CHxEN) is shown in Figure 3-3.

Trigger Logic IC (FLIC)

The Trigger Logic IC or FLIC (fast-logic integrated circuit, U602 diagram 4) does most of the fast logic functions required to run the oscilloscope. The functions are: A Sweep control, B Sweep control and measurement gate generation, Z-Axis control, and trigger status detection.

The A Sweep logic generates the A Sweep gate signal (A GATE), and provides trigger status information about

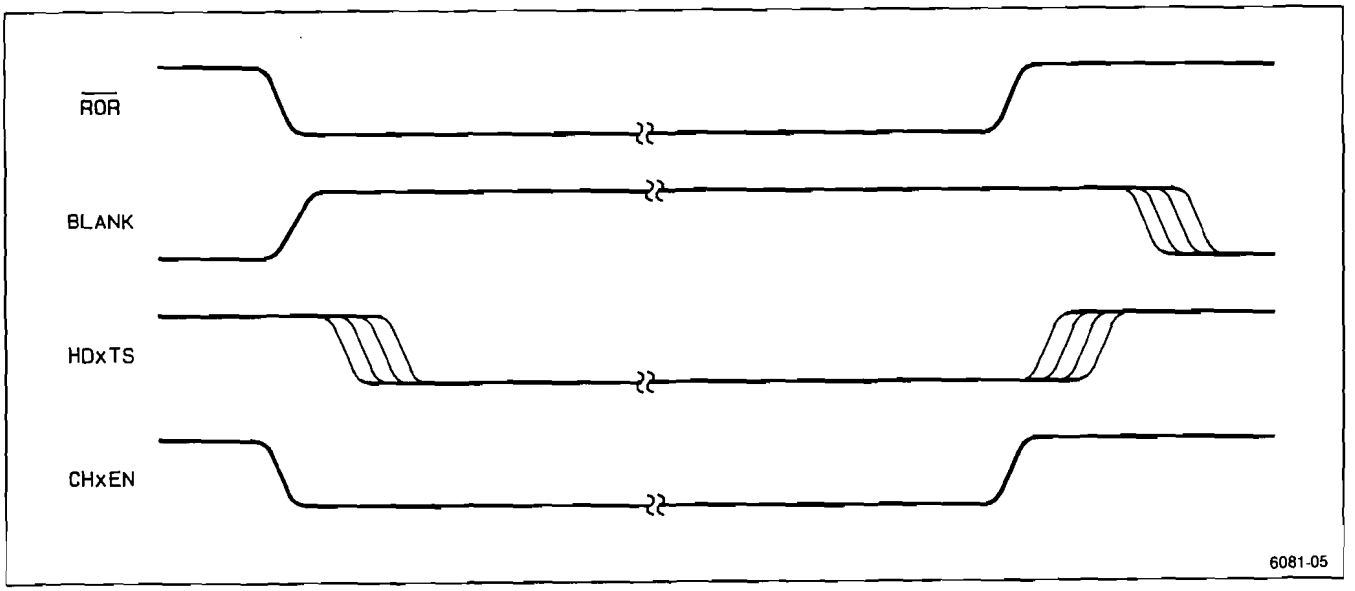

Figure 3-3. Readout interface relative signal timing.

the state of the A Trigger. The B Sweep logic interfaces to the Delay Time Comparators (diagram 3) and generates the B Sweep gate (B GATE) and measurement gate signals. There is also some logic that monitors the B Trigger signal status when making voltage measurements with the B Trigger circuit. The Z-Axis control logic provides outputs for controlling the crt beam intensity.

The Trigger Logic circuit is done in an ECL (emitter-coupled logic) gate array, and all inputs and outputs are compatible with standard ECL components.

Pin Description

The following is a description of the fast logic pin outs (see Figure 3-4).

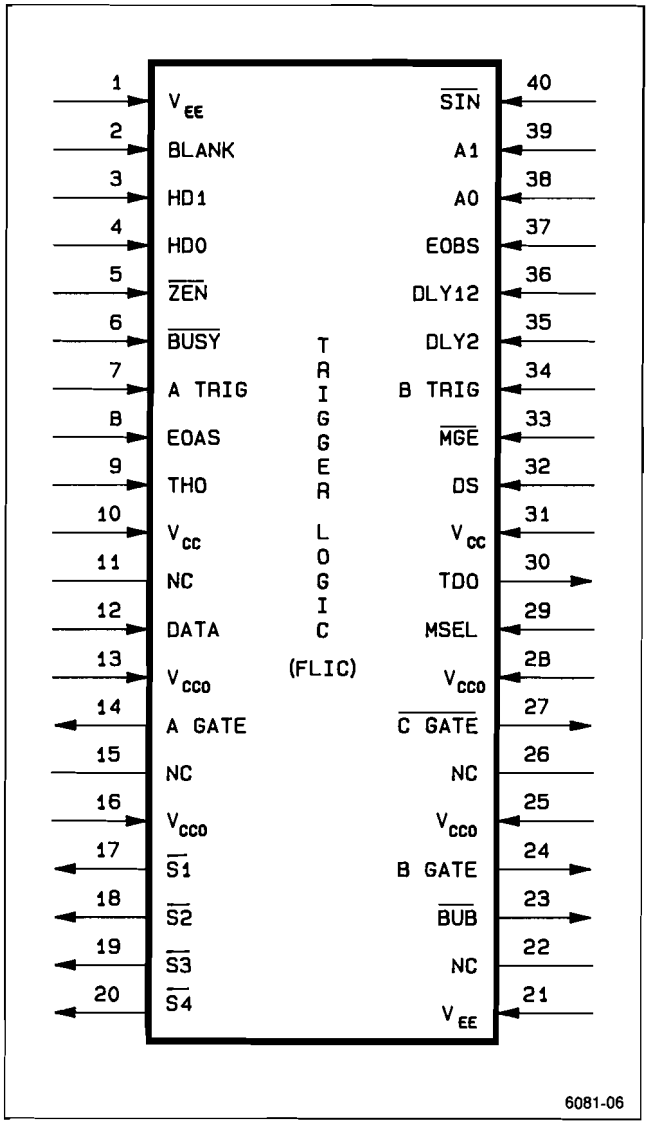

Figure 3-4. Trigger Logic IC (FLIC, U602) pin out diagram.

BLANK: Blanking input, from the Display Logic IC (U600).

HD1, HD0: Horizontal display select inputs, from the Display Logic IC.

$\overline{ZEN}$: Z-Axis enable input, from the Display Logic IC. Active LO.

$\overline{BUSY}$: Counter busy signal. Not used in the 2246.

ATRIG: A Sweep trigger input.

EOAS: End of A Sweep. This signal goes HI when the A Sweep ramp crosses its end-of-sweep threshold.

THO: Trigger holdoff input from the Display Logic IC.

$\overline{SIN}$: Strobe input. Latches data into the internal register. Active LO.

A1, A0: Address inputs. See Table 3-17 for addressing codes.

Table 3-17
Trigger Logic IC Addressing Logic

A1	A0	Output of TDO Pin	Action when $\overline{SIN}$ Strobed
0	0	Strobed Volts Latch	DATA clocked into Control Reg
0	1	Auto baseline Latch	Resets Auto baseline Latch
1	0	A Trigger Latch	Resets A Trigger Latch
1	1	Peak Volts Latch	Resets Peak Volts Latch

EOBS: End of B Sweep. This signal goes HI when the B Sweep ramp crosses its end-of-sweep threshold.

DLY12: Input from first delay comparator. The comparator for the delay input switches from LO to HI after the end of either the first or the second sweep delay.

DLY2: Input from second delay comparator. This comparator normally switches from LO to HI after the end of the second sweep delay (in dual-delay mode).

B TRIG: B Sweep trigger input.

$\overline{MGE}$: Measurement gate enable input from the Display Logic IC. Active LO.

MSEL: Measurement select input. MSEL=1 causes the DLY12 signal rising edges to sample the B TRIG input in strobed volts measurements. MSEL=0 selects the DLY2 signal rising edges.

DS: Delay select signal from the Display Logic IC. DS=1 selects first delay.

DATA: Data input to the internal, control shift register.

$\overline{S1}$: Crt beam-intensity control output. Turns on the beam current for the A Sweep displays. Active LO.

$\overline{S2}$: Crt beam-intensity control output. Turns on the beam current for the B Sweep displays. Active LO.

$\overline{S3}$: Crt beam-intensity control output. Turns on the beam current for the A Sweep intensified zone displays. Active LO.

$\overline{S4}$: Crt beam-intensity control output. Turns on the beam current for the Readout displays. Active LO.

A GATE: A Sweep gate output. Starts the A Sweep ramp. Active HI.

TDO: Trigger data output. Data to be read is selected via the A1 and A0 inputs (see Table 3-17).

B GATE: B Sweep gate output. Starts the B Sweep ramp. Active HI.

$\overline{BUB}$: B Sweep unblanking output. Active LO.

$\overline{C\ GATE}$: Measurement gate output. Not used externally in the 2246.

Trigger Logic IC Control Register Description

The control register of U602 is an 8-bit shift register that receives input from the DATA pin. Bit 1 receives the data on a LO-to-HI transition on the $\overline{SIN}$ pin (A1 = A0 = 0). Bit 8 receives this data after seven more LO-to-HI transitions on the $\overline{SIN}$ pin. Bit 8 is the msb of the control register. Table 3-18 lists the control signal name associated with each control register bit.

DM1, DM0: These bits select the delay mode (see Table 3-19).

BRUN: This bit determines whether the B Sweep is in RUNS AFTER delay mode or Triggered After delay mode. BRUN=1 selects RUNS AFTER Mode.

PM1, PM0: These bits select the peak volts detection mode as shown in Table 3-20.

Table 3-18
Control Register Signal-bit Names

Bit	Name
1	DM0
2	DM1
3	BRUN
4	PM0
5	PM1
6	ZM0
7	ZM1
8	ARUN

Table 3-19
Delay Mode Selection Control Bits

DM1	DM0	Delay Mode
0	0	First delay set to zero
0	1	First and second delays set to zero
1	0	Normal delay mode
1	1	B Sweep disabled

Table 3-20
Peak Volts Detection Mode Logic

PM1	PM0	Peak Detection Mode
0	0	Nongated
0	1	Gated from end of delay to end of A Sweep
1	0	Gated with $\overline{C\ GATE}$[a]
1	1	Gated with A GATE

[a] $\overline{C\ GATE}$ not used externally in 2246.

ZM1, ZM0: These bits determine the intensified zone mode. See the Z-Axis logic discussion.

ARUN: This bit determines whether the A Sweep is in the free-run mode or in the triggered mode. ARUN=1 selects the free-run mode.

A Sweep Logic

When ARUN is HI, the A Sweep logic works as follows. A HI on the THO input causes the A GATE output to go LO. As soon as THO goes LO, the A GATE output will go HI and the A Sweep runs. At the end of the A Sweep there is a LO-to-HI transition on the EOAS input. That sets the the internal end-of-A-sweep latch causing the A GATE output to go LO, and the A Sweep shuts off. This state exists during sweep retrace and the baseline stabilization period until the end of holdoff when the THO input once again goes HI. That resets the end-of-A-sweep latch and starts another A Sweep cycle. Normally, the falling edge of A GATE will cause an externally generated pulse to be presented on the THO input, thus completing the loop and allowing the A Sweep to free-run (auto-level and auto triggered mode when the sweep is not triggered).

When ARUN is LO, the operation is similar except that after a pulse on the THO input, A GATE won't go HI until a LO-to-HI transition is presented on the A TRIG input (triggered sweep mode).

For either free-run or triggered modes, THO going HI will cause the A GATE output to immediately go LO, if the end-of-A-Sweep latch is set or not. Once the end-of-A-Sweep latch has been set, no more A Sweeps can happen until the THO input is pulsed (at the end of the holdoff). The end-of-A-Sweep latch can only be set with the EOAS input when A GATE is HI.

The A Sweep logic of U602 also monitors the A TRIG input to latch certain A Trigger events. One latch (the auto-baseline latch) will set on any LO-to-HI transition on the A TRIG input. Another latch (the A Trigger latch) is level sensitive and will set when the A TRIG input is HI. Both latches may be read out through the TDO (trigger-data out) pin, selected by the A1 and A0 address input pins. That data is applied to the TDI (trigger data in) pin of U600 and placed in the Display Logic IC's internal register to be read by the Measurement Processor. Both latches may also be reset via the $\overline{\text{SIN}}$ pin (see description of A1, A0, and $\overline{\text{SIN}}$ input pins).

B Sweep Logic

The B Sweep logic functions about the same as the A Sweep logic, except that more signals must be monitored to determine when the B Sweep can run. When DM1 and DM0 = 11, the B Sweep can't run at all. When DM1 and DM0 = 10, the B Sweep won't be allowed to run or trigger until the DLY12 input goes HI while the A GATE signal is also HI (the normal delayed sweep mode). When DM1 and DM0 = 01, the B Sweep will be allowed to run or trigger immediately after the A GATE signal goes HI (no B Sweep delay). When DM1 and DM0 = 00, then the B Sweep will be allowed to run or trigger immediately after the A GATE signal goes HI, if the DS (delay select) input is HI. If DS is LO, the B Sweep is allowed to run or trigger as soon as the DLY12 input goes HI while the A GATE signal is also HI.

The B Sweep logic behaves as follows. The B GATE signal goes HI and $\overline{\text{BUB}}$ (B Sweep unblanking) goes LO together when the appropriate conditions (described in the preceding paragraph) are met. A LO-to-HI transition on the EOBS input will then set the end-of-B-sweep latch, causing $\overline{\text{BUB}}$ to go HI. B GATE doesn't go LO until the A GATE signal goes LO. $\overline{\text{BUB}}$ is used internally to generate the $\overline{\text{S2}}$ and B ends A mode.

The DLY12 input goes to a level-sensitive latch; if A GATE is HI and DLY12 momentarily goes HI, the latch will be set, so that the DLY12 input does not need to be held HI throughout the sweep cycle. A HI level on the THO input will cause the A GATE signal to go LO. That resets this latch and causes the reset of the rest of the sweep logic, forcing B GATE LO and $\overline{\text{BUB}}$ HI.

The DLY2 input also goes to a level sensitive latch. This second latch also gets reset when A GATE goes LO. Together with the DLY1 latch output, A GATE, and the $\overline{\text{MGE}}$ input, the C GATE output signal gets generated (not used externally in the 2246). $\overline{\text{C GATE}}$ goes LO if A GATE is HI, the DLY1 latch has been set, the DLY2 latch is still reset, and the $\overline{\text{MGE}}$ input is LO.

Peak Volts Logic

The peak volts logic detects the positive and negative peaks of the B TRIG signal. It consists of a level-sensitive latch that can be gated by the $\overline{\text{C GATE}}$ signal, the A GATE signal, the DLY12 latch output, or continuously. The latch may be reset by strobing the $\overline{\text{SIN}}$ input with A1 and A0 set to 11. The latch output can be read at the TDO pin with A1 and A0 set this way. The Measurement Processor reads the state of the peak volts latch to determine when it has found the correct digital value of the signal peak being measured by the B Trigger Level Comparator.

The peak-detect latch output will go HI when the B TRIG input goes HI (if the gating condition selected by

PM1 and PM0 is satisfied). The latch output goes LO when reset.

Strobed Volts Logic

This logic samples the state of the B TRIG signal with the delay comparator outputs when making gated voltage measurements. The strobed volts latch consists of an edge-triggered flip-flop with a multiplexer driving the clock input, and the B TRIG signal driving the D input. When MSEL=1, the DLY12 latch output clocks the flip-flop. When MSEL=0, the DLY2 latch output clocks the flip-flop.

The state of the flip-flop is read out at the TDO pin by the Measurement Processor when A1, A0 = 00. The flip-flop is reset by strobing the $\overline{\text{SIN}}$ input with A1, A0 = 11.

Z-Axis Logic

This logic drives the Z-Axis control outputs ($\overline{\text{S1}}$-$\overline{\text{S4}}$). These outputs have the following control action:

$\overline{\text{S1}}$ Turns on the A intensity current switch (active LO).

$\overline{\text{S2}}$ Turns on the B intensity current switch (active LO).

$\overline{\text{S3}}$ Turns on the A intensified current switch (active LO).

$\overline{\text{S4}}$ Turns on the Readout intensity current switch (active LO).

Table 3-21 describes what the $\overline{\text{S1}}$-$\overline{\text{S4}}$ outputs do as a function of ZM1, ZM0, HD1, HD0, $\overline{\text{A GATE}}$, $\overline{\text{BUB}}$, $\overline{\text{C GATE}}$, $\overline{\text{BUSY}}$, BLANK, and $\overline{\text{ZEN}}$.

Table 3-21
Z-Axis Switching Logic

ZM1	ZM0	HD1	HD0	$\overline{\text{S1}}$	$\overline{\text{S2}}$	$\overline{\text{S3}}$	$\overline{\text{S4}}$	Display Mode
0	0	0	0	1	1	1	(a)	Readout
0	0	0	1	(b)	1	(c)	1	A Sweep intensified by BUSY
0	0	1	0	1	(d)	1	1	B Sweep
0	0	1	1	(a)	1	1	1	X/Y
0	1	0	0	1	1	1	(a)	Readout
0	1	0	1	(b)	1	(e)	1	A Sweep intensified by C GATE
0	1	1	0	1	1	1	1	Blank
0	1	1	1	(a)	1	1	1	X/Y
1	0	0	0	1	1	1	(d)	Readout
1	0	0	1	(b)	1	(d)	1	A Sweep intensified by BUB
1	0	1	0	1	(d)	1	1	B Sweep
1	0	1	1	(a)	1	1	1	X/Y
1	1	0	0	1	1	1	(a)	Readout
1	1	0	1	(b)	1	1	1	A Sweep no intensified zone
1	1	1	0	1	1	1	1	Blank
1	1	1	1	(a)	1	1	1	X/Y

Notes

(a) BLANK

(b) BLANK or $\overline{\text{A GATE}}$

(c) BLANK or $\overline{\text{A GATE}}$ or $\overline{\text{BUSY}}$ or $\overline{\text{ZEN}}$

(d) BLANK or $\overline{\text{A GATE}}$ or $\overline{\text{BUB}}$ or $\overline{\text{ZEN}}$

(e) BLANK or $\overline{\text{A GATE}}$ or $\overline{\text{C GATE}}$ or $\overline{\text{ZEN}}$

ECL-to-CMOS Level Shifters

The Trigger Logic IC U602, is an ECL device. Its output signal swing is the standard ECL range of about 0.6 V. All the ECL logic device in the 2246 are powered from the +5 V supply rather than a −5 V supply. The resulting output voltage swing is from about 4.5 V to about 3.9 V between the HI and LO ECL logic levels. As U602 must pass signals to the Display Sequencer IC (U600) at CMOS HIs and LOs (about 3.9 V and 0 V respectively is this application), logic level translators are required. That job is done by an identical translator circuit for each of the three signals that must be sent. The circuit action of U603C, Q604, and Q605 (the $\overline{\text{A GATE}}$ translator) is described.

The single-ended A GATE output signal of U602 at pin 14 is applied to pin 4 of U603B. With its other input pin left open, U603B is used as a line driver only to produce a differential output signal. That differential signal is applied to the bases of a differential amplifier pair of pnp transistors (Q604 and Q605). The output signal is taken across R612 in the emitter of Q604. The emitter of Q605 is connected directly to ground. When the A GATE output of U602 is HI (at 4.5 V), the voltage applied to the base of Q604 is 4.5 V, and the voltage on the base of Q605 is 3.9 V. These voltage levels bias Q605 on and Q604 off, with a resulting output level across emitter resistor R612 of 0 V to the $\overline{\text{A GATE}}$ (active LO) input of U600. When the A GATE output of U602 goes LO at the end of the sweep, the bias voltage levels on Q604 and Q605 reverse, and Q604 is biased on (and Q605 off). Signal current through emitter resistor R612 develops a voltage of about 3.9 V (the unasserted level) to the $\overline{\text{A GATE}}$ input of U600.

Display Logic Clock

The Display Logic clock signal at 10 MHz is generated by a transistor oscillator circuit composed of Q608, X600, and associated components. The frequency of oscillation is controlled by a ceramic resonator, X600, in the feedback path from the collector to the base of Q606.

A AND B SWEEP GENERATORS AND DELAY COMPARATORS (diagram 5)

Sweep Control Shift Registers

Two serial shift registers provide the control interface between the Measurement Processor and the A and B Sweep circuitry. Control bits loaded into registers U302 for A Sweep and U303 for B Sweep are serially clocked from the SR DATA line by the SR1 CLK pulse. The states of the loaded bits select the A and B Sweep timing by choosing the correct charging current and timing capacitor to provide the full range of sweep speeds. Other control bits loaded into the two registers select the delay voltage applied to the Delay Comparators and the output voltage from the VOLTS CALIBRATOR circuit (used for measurement SELF CAL). Extra bits are shifted through the two shift registers into the Auxiliary Data Register (U1103, diagram 3) via the AUX DATA signal line to control the trigger bandwidth, the TV Sync Detector switching, and the functions of 10X MAG, X-Y display, and Vertical Comparator enabling.

A and B Sweep Timing

Refer to Figure 3-5 for a simplified schematic of the A Sweep circuitry.

TIMING RESISTORS. The Sweep Timing resistors in resistor pack R313 are shared between the A Sweep and the B Sweep circuitry; those in resistors pack R321 are divided between the two sweep circuit. Timing Resistor selection is done by multiplexers U308 and U307 for the A Sweep and by U310 and U311 for the B Sweep. The multiplexers are driven by the Measurement Processor via control bits loaded into Shift Register 1 (U302 and U303). See Table 3-22 for the control bit coding.)

SEC/DIV VAR CIRCUIT. Variable sweep speed is controlled by the TIME VAR voltage applied to operational amplifier U309B. The amplifier controls the current passing through Darlington transistor Q301 to the voltage divider formed by resistor pack R313. The voltages at the taps of the voltage divider set the forward bias on the charging-current pass transistor, Q307, via operational amplifier U304. When the SEC/DIV VAR control is in its detent (calibrated) position, diode CR301 is reverse biased, and the divider formed by R311 and R314 between the +2.5 V reference and ground precisely sets the input voltage to the noninverting input of U309B. With a fixed voltage output from U309B, the current through Q301 and R313 is also a fixed value. When the SEC/DIV VAR control is rotated out of its detent position, the voltage at the junction of R309 and R310 decreases to forward bias CR301. The input voltage to U309B and, therefore, the current to R313 decreases in proportion to the amount of rotation of the SEC/DIV VAR control. A decreasing voltage at the output taps of R313 decreases the charging current through Q307 to increase the sweep ramp time.

A AND B SWEEP TIMING CAPACITORS. The timing capacitor selection circuitry is similar for the A and the B Sweep, but the B Sweep has fewer range steps and doesn't require two selectable capacitors. Only the A Sweep timing capacitor selection is described; like components in the B Sweep circuit do the same job.

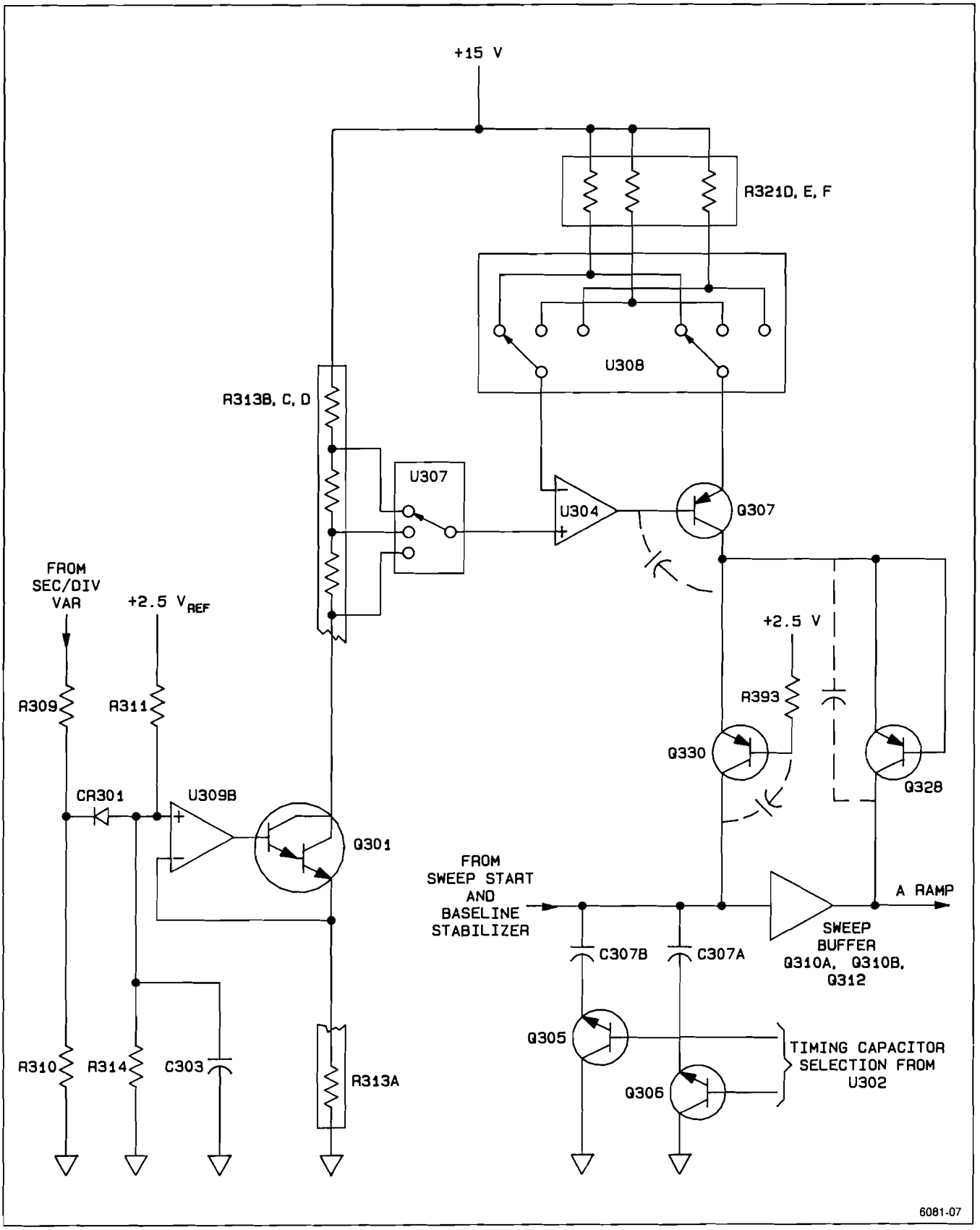

Figure 3-5. Simplified Sweep circuit.

Timing capacitance for the A Sweep is made up of a combination of fixed, variable, stray, and selectable components. Sweep timing for the fastest A Sweep speeds is done with a combination of the fixed, variable, and stray capacitance and the selectable charging current supplied through R321, U308, Q307 and Q330. When the slower sweep speeds are selected, additional capacitors must be switched into the circuit to produce a longer charging time. The capacitors that are always in the A Sweep charging path are C315 (a fixed capacitor), C314 (a variable capacitor used to adjust the A Sweep timing at the fastest sweep speeds), and the stray circuit capacitance.

The base-to-collector junction capacitance of Q330 changes as the voltage between the base and collector of Q330 increases during ramp up. At the fastest A Sweep speeds, that change would affect the timing at the start of the charging ramp. To compensate for the junction-capacity effect of Q330, transistor Q328 (connected as a diode) is added between the charging current path and the A Sweep Buffer output. The capacitive current through the reverse-biased junction of Q328 adds current to the output to make up for the current required to charge the base-to-collector capacity of Q330 in the input of the Sweep Buffer.

The selectable sweep timing capacitors come in a matched set of three capacitors, two for the A Sweep timing (C307A and C307B) and one for the B Sweep timing (C307C). When added capacitance is needed for a sweep speed setting, the Measurement Processor loads selection control bits into Shift Register 1 (U302 for the A Sweep) that turn on either Q305 or Q306 or both. Assume that Q305 is biased on by a HI control bit from pin 5 of U302. Capacitor C307B is then added in parallel to the capacitors in the charging path, and a longer ramp time is needed to reach the end-of-sweep voltage level. Control bits selecting the charging current are also loaded at the same time. See Table 3-22 for the A Sweep timing and control bit selections (as0-as5) and Table 3-23 for the B Sweep bit selections (bs0-bs4).

Baseline Stabilizer

The job of the Baseline Stabilizer circuit (Q302, Q303, and Q304 for the A Sweep and Q315, Q316, and Q317 for the B Sweep) is to tie the start of the sweep ramps to the same fixed level for each sweep. Operation of the A Sweep stabilizer is described.

A differential circuit formed by Q302 and Q303 compares the A Sweep feedback signal on the base of Q303 against the reference voltage on the base of Q302 to control the base bias current to Q304 and, thereby, the sweep baseline level. Operational amplifier U309A generates the fixed reference that the baseline voltage level is compared against. The reference voltage amplifier has a gain of −0.8 (less than one and inverted); and, with +2.5 V applied to the inverting input and the noninverting input grounded, the output level is −2 V. Capacitor C305 filters the output to eliminate noise that could cause sweep start jitter. The filtered voltage is applied to the junction of R317, R354, and C305 and references both Baseline Stabilizer circuits.

A and B Sweep Start

The A and B Sweep Start circuits operate the same way with like components in each doing the same job; only the A Sweep Start circuit is described. Sweep time may be divided into three periods: baseline, run-up, and retrace (see Figure 3-6). Sweep start and length of sweep run-up is controlled by the A GATE and A GATE signals from the Trigger Logic IC (U602, diagram 4).

A GATE SIGNALS. The A GATE and $\overline{\text{A GATE}}$ signals are applied via 8.2 V zener diodes (VR301 and VR302) to the bases of Q308 and Q309 in a differential amplifier configuration. The input circuit to the differential pair level shifts the ECL signals (4.3 V to 3.4 V) to the proper biasing levels (−3.9 V to −4.8 V) for the bases of the differential amplifier transistors. Transistor Q326 in the emitter circuit of Q308 and Q309 is the current source for the differential pair. Transistor Q311 is part of the bias circuit for Q326 and provides feedback to the base of Q326 that controls the current provided to Q308 while the sweep is being held at the baseline level.

BASELINE STATE. In the baseline state (during sweep holdoff), Q308 and Q304 are on and Q309 is off, and the level at the collector of Q308 is held at −2.8 V. That voltage is buffered by the A Sweep Buffer (with about a 0.7 V rise across the base-to-emitter junction of Q312) and fed back to the base of Q303 where it is compared with the -2 V reference produced by operational amplifier U309A. If the baseline voltage is too low compared to the output of U309A, Q303 (the retrace current regulator) is biased on a little harder. Additional base current is available to Q304, and it conducts harder to raise the output baseline voltage to the reference voltage level. The opposite action occurs if the baseline voltage is too high.

A smaller feedback loop formed by Q311 and R305 controls the gain of Q326 so that the standing current available (about 3 mA) is just enough to keep Q304 biased on during the baseline state. When the states of the gate signals reverse, Q309 is turned on and Q308 turns off. The standing current then conducts through Q309 to rapidly

Table 3-22
A Sweep Timing Selections

SPEED	I_{timing}	C_{timing}	as5	as4	as3	as2	as1	as0	Min H.O.
10 ns	4 mA	C314/C315	0	0	1	0	1	0	2.0 μs
20 ns	2 mA	"	0	0	0	1	1	0	2.0 μs
50 ns	800 μA	"	0	0	0	0	1	0	2.0 μs
100 ns	400 μA	"	0	0	1	0	0	1	2.0 μs
200 ns	200 μA	"	0	0	0	1	0	1	2.0 μs
500 ns	80 μA	"	0	0	0	0	0	1	2.0 μs
1 μs[a]	40 μA	"	0	0	1	0	0	0	2.0 μs
2 μs[a]	20 μA	"	0	0	0	1	0	0	4.0 μs
5 μs[a]	8 μA	"	0	0	0	0	0	0	10 μs
1 μs	4 mA	C307B	0	1	1	0	1	0	2.0 μs
2 μs	2 mA	"	0	1	0	1	1	0	4.0 μs
5 μs	800 μA	"	0	1	0	0	1	0	10 μs
10 μs	400 μA	"	0	1	1	0	0	1	20 μs
20 μs	200 μA	"	0	1	0	1	0	1	40 μs
50 μs	80 μA	"	0	1	0	0	0	1	100 μs
100 μs	40 μA	"	0	1	1	0	0	0	200 μs
200 μs	20 μA	"	0	1	0	1	0	0	400 μs
500 μs	8 μA	"	0	1	0	0	0	0	1.0 ms
1 ms	4 mA	C307A	1	0	1	0	1	0	2.0 ms
2 ms	2 mA	"	1	0	0	1	1	0	4.0 ms
5 ms	800 μA	"	1	0	0	0	1	0	10 ms
10 ms	400 μA	"	1	0	1	0	0	1	20 ms
20 ms	200 μA	"	1	0	0	1	0	1	40 ms
50 ms	80 μA	"	1	0	0	0	0	1	100 ms
100 ms	40 μA	"	1	0	1	0	0	0	200 ms
200 ms	20 μA	"	1	0	0	1	0	0	400 ms
500 ms	8 μA	"	1	0	0	0	0	0	1 s

[a]Used only during horizontal characterization.

Table 3-23
B Sweep Timing Selections

SPEED	I_{timing}	C_{timing}	bs4	bs3	bs2	bs1	bs0
10 ns	4 mA	C329/C330	0	1	0	1	0
20 ns	2 mA	"	0	0	1	1	0
50 ns	800 μA	"	0	0	0	1	0
100 ns	400 μA	"	0	1	0	0	1
100 ns	200 μA	"	0	0	1	0	1
100 ns	80 μA	"	0	0	0	0	1
1 μs	40 μA	"	0	1	0	0	0
2 μs	20 μA	"	0	0	1	0	0
5 μs	8 μA	"	0	0	0	0	0
10 μs	4 mA	C307C	1	1	0	1	0
20 μs	2 mA	"	1	0	1	1	0
50 μs	800 μA	"	1	0	0	1	0
100 μs	400 μA	"	1	1	0	0	1
100 μs	200 μA	"	1	0	1	0	1
100 μs	80 μA	"	1	0	0	0	1
1 ms	40 μA	"	1	1	0	0	0
2 ms	20 μA	"	1	0	1	0	0
5 ms	8 μA	"	1	0	0	0	0

pull the base of Q304 down to shut it off. When the base voltage reaches about −2.7 V, Q333 conducts. That action clamps the base voltage of Q304 (and the collector voltage of Q309) at that level and prevents Q309 from saturating so that it will have a short turn-off time when the sweep ends.

RUNUP STATE. With Q304 and Q308 off, the charging current from the timing circuit can begin charging the timing capacitors, and the voltage at the emitter of Q304 ramps up linearly. That ramp is buffered by the A Sweep Buffer (U310A and B and Q312) to drive the Horizontal Output Amplifier. As the ramp is running up, it is being compared with a fixed reference level by the Sweep End Comparators. When the ramp level reaches the comparison level, the A SWP END signal goes HI. That signals the Trigger Logic IC, U602, to end the A GATE signal, and the sweep is switched to the retrace state. The sweep ramp is also being fed back to the base of Q303. At the point in the ramp that the base voltage of Q303 exceeds that on the base of Q302 (the −2 V baseline reference), Q303 is biased off and Q302 conducts. This biasing conditions disables the feedback loop that stabilizes the baseline voltage level, and it remains off until the feedback voltage during the retrace period falls back to near the −2 V baseline reference voltage on the base of Q302.

RETRACE STATE. At the end of the sweep, the gate signals reverse state. Transistor Q309 is biased off, and Q308 is biased on. Retrace current supplied by Q308 quickly returns the voltage across the timing capacitor to a little below the baseline voltage level. That retrace current is regulated by Q311 and Q326 to produce a rapid, yet

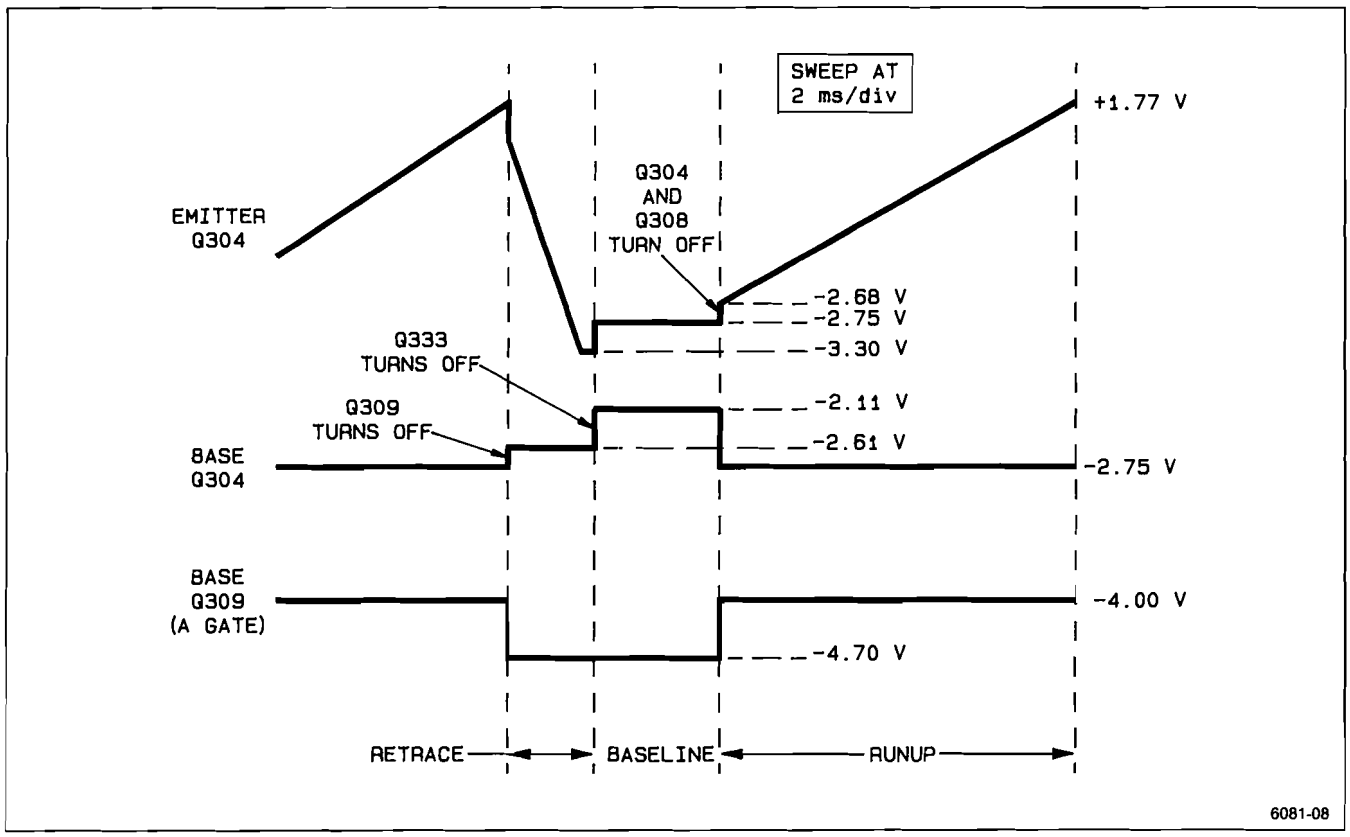

Figure 3-6. A Sweep Start circuit waveforms.

rate-controlled retrace. At the point of the fall in feedback voltage where Q303 starts to turn on, base current becomes available to Q304 to turn it on, and the feedback loop that stabilizes the voltage at the baseline level again becomes active.

A and B Sweep Buffers

The A Sweep Buffer (Q310A and B, and Q312) and B Sweep Buffer (Q323A and B, and Q325) buffer the voltage ramp as the timing capacitors charge. In the A Sweep circuit, Q310A and Q310B are high-impedance FET amplifiers driving emitter follower Q312. The output signal from the emitter of Q312 is applied to the Delay Time Comparators, the End-of-Sweep Comparators, fed back to the Baseline Stabilizer circuit, and sent to the Horizontal Output Amplifier (diagram 6) as the A RAMP horizontal deflection signal.

Sweep End Comparators

The sweep ramp signals must horizontally deflect the electron beam across the entire face of the crt. Comparators U316A, B, C, and D determine when the A and B Sweeps have reached the required amplitude. These comparators check the sweep voltage against the reference level that defines the end of the sweep and generate the A SWP END and B SWP END signals when that level is reached. The sweep-end signals are applied to the Trigger Logic IC (U602) so that device knows when the sweeps are done. The Trigger Logic IC then switches the state of A GATE or B GATE (as appropriate) to reset the sweep circuitry to its baseline level.

Delay Time Comparators

When the A Sweep ramp runs, its amplitude is compared against two delay levels by the comparators of U313. The differential outputs of the REF delay comparator change states when the A Sweep crosses the first delay level. The differential output signal from the delay comparator is applied to ECL line receiver U315C. That device has a high gain and produces a fast-rise signal at an ECL level. When the DLY END 0 (reference delay completed) is received by the Trigger Logic IC (U602, diagram 4), a B GATE is produced to start the B Sweep in RUNS

AFTER B Trigger mode. That B Sweep displays the applied waveform at the first (reference) delay setting. At the end of the delay in TRIG AFTER mode, the Trigger Logic IC begins watching for a B Trigger signal that must occur before a B GATE is produced.

The differential output of the second delay comparator in U313 changes states when the A Sweep ramp at pin 9 crosses the second (delta) delay level applied to pin 6. At that point, the DLY END 1 signal is produced at the output of U315A (pin 2) and applied to U602. A second B GATE signal is then produced to start another B Sweep ramp to display the signal at the delta delay setting.

Delay Time Switching

The DELTA DELAY and REF DELAY voltage level are applied to multiplexer U301 from the DAC circuit. The Measurement Processor established those voltages based on the settings of the CURSOR/TIME POSITION controls made by the user from the front panel. Switch section U301A is held permanently switched to direct the DELTA DELAY signal to its output pin. In early firmware versions, a dot mode display (an intensified dot on the A Sweep in ALT mode with the A and B SEC/DIV settings the same) was available. For those versions, switch section U301A was switched to produce the dot timing; for later versions, the switch position is never changed. Switch section U301C is controlled by the DLY SEL signal, and that switch selects either the first (reference) delay or the second (delta) delay for application to the first delay comparator. The switching circuitry allows the delay to be correctly switched for dual-delay functions in ALT and B Delayed horizontal display modes. Switch section U301B is shown on diagram 6.

HORIZONTAL OUTPUT AMPLIFIER (diagram 6)

Horizontal Preamplifier

Horizontal Preamplifier IC U802 converts single-ended horizontal signals (A sweep, B sweep, horizontal readout, and X-Axis) into differential outputs to drive the crt horizontal deflection plates. The horizontal preamplifier signals are selected by the HD0 and HD1 logic signals from Display Sequencer U600 on diagram 4. Magnified sweep, beam find, horizontal positioning, and horizontal gain adjustments (X1 and X10) are provided in U802 and associated components.

The function of each pin of U802 is as follows:

RO (Pin 1): RO HORIZ. Input for horizontal component of the readout display.

GA1 (Pin 2): Adjustment of R825 sets the horizontal X1 gain.

A RAMP (Pin 3): Input for the A Sweep signal.

GND (Pin 4): Ground connection for U802.

B RAMP (Pin 5): Input for the B Sweep signal.

MAG (Pin 6): Selects X10 magnified sweep when HI or normal sweep when LO. Magnified mode is selected when in X-Y horizontal mode.

X (Pin 7): X-AXIS. This is the X-Axis signal input when in X-Y horizontal mode. The signal source is the CH 1 trigger signal from U421A (diagram 3). Adjustment of R827 sets the gain of the X-Axis signal.

HD0 (Pin 8): Pin 8 (HD0) and pin 11 (HD1) are logic lines that select the horizontal input signal to output differentially at pins 18 and 19. Table 3-24 gives the selection logic.

Table 3-24
HD0 and HD1 Logic

HD1	HD0	Horiz Signal Selected
0	0	RO HORIZ
0	1	A SWEEP
1	0	B SWEEP
1	1	X-AXIS

V_{EE} (Pin 9): -5 V supply to U802.

GA10 (Pin 10): Adjustment of R826 sets the horizontal X10 gain.

HD1 (Pin 11): See the description for HD0 above.

ROUT (Pin 12): Horizontal Preamplifier differential output signal for the right deflection plate.

LOUT (Pin 13): Horizontal Preamplifier differential output signal for the left deflection plate.

BF (Pin 14): The BEAM FIND signal from U503 (diagram 4) switches the Beam Find feature on or off. BEAM FIND on reduces the horizontal deflection to within the graticule area. Vertical deflection is also reduced and the intensity is set to a fixed viewing level to aid in locating off-screen, over-deflected, or under-intensified displays.

POSITION (Pin 15): Input for the horizontal position control signal. Multiplexer section U301B switches to reduce the range of the Horizontal POSITION control to match that of the Vertical POSITION controls when in X-Y horizontal mode. When X-Y display mode is selected, a LO $\overline{XY}$ signal on Pin 9 of U301B connects the pin 5 input to the horizontal position input of U802. The signal at pin 5 is a reduced horizontal positioning signal produced by the R353/R358 voltage divider.

V_{CC} (Pin 16): +7 V supply to U802.

Driver Amplifiers

The differential output current signal from U802 passes through common-base current amplifiers Q809 and Q810. These transistors drive current-to-voltage converters Q803-Q804 and Q807-Q808. Emitter followers Q804 and Q803 convert the current signal to a voltage signal to drive the complementary-FET output amplifiers, Q801 and Q802, to produce the negative-going deflection voltage. Emitter followers Q808 and Q807 convert the other side of the differential current to drive Q805 and Q806 to produce the positive-going horizontal deflection voltage.

The circuit of Q804 and Q803 is configured to respond rapidly to a negative-going feedback signal; the circuit of Q807 and Q808 is configured to respond quickly to the positive-going feedback signal. Zener diode VR802 and associated resistors R843 and R844 maintain the collector bias of Q803 and Q808 at 24 V.

Magnifier registration and horizontal readout centering is set by MAG REG potentiometer R809. Adjustment of R809 is done to balance the currents into the emitters of Q809 and Q810 to obtain the correct horizontal position of the readout within the graticule display area.

Output Amplifier

The differential circuitry of both sides of the Horizontal Output Amplifier is similar; operation of only one side of the amplifier is is described. Complementary-FET amplifiers Q801 and Q802 produce the negative-going horizontal signal to drive the left deflection plate. Two transistors are used to provide adequate power handling. Since the two gates are at different bias levels, signal voltage is applied to the gate of transistor Q801 via C803. Resistor R828, connected between the source and drain of Q801, is a parallel current path around Q801 that balances the power handling requirements of the two FETs. The amplifier FETs are high gain devices, and the overall gain must be reduced to maintain circuit stability at the faster sweep rates. To provide the high-frequency gain reduction, resistor R850 is in series with C802, from the source of Q802 to the drain of Q801, to damp the driving-energy to Q801 supplied by C802 during the sweep retrace transitions. Feedback resistor R806 provides positive feedback and sets the overall gain of the output amplifier stage. A parallel trimmer capacitor across the feedback resistor, C807, adjusts the 2 ns sweep timing for its best linearity. Impedance matching to the deflection plate and additional signal damping is provided by R802.

As the gate voltage of Q802 increases to follow the input ramp signal, the drain voltage goes negative from about 87 V toward the 15 V source voltage. At the same time, the signal on the gate of complementary-FET Q801 is reducing the current through Q801, thereby allowing its source voltage to fall. At the end of the ramp signal, the input voltage falls, and through the positive feedback, Q802 is rapidly biased off. That also biases Q801 on, and the energy stored in C802 quickly returns the deflection plate voltage back to its starting point.

Common-Mode Stabilizer

Operation amplifier U801A compares the node voltage at the junction of R820, R821, and R822 to ground. Its output drives the amplifier input common-mode point (at the junction of R811 and R812). The purpose of this dc feedback circuit is to keep the average voltage level on the right and left horizontal deflection plates set to the center of the amplifier's dynamic operating range (about 70 V).

Z-AXIS, CRT, CALIBRATORS, AND CONTROL MUX (diagram 7)

Z-Axis and Auto Focus Amplifiers

The Z-Axis and Auto Focus Amplifiers operate on the same principle and both get their drive signal from the Z-Axis Focus Driver. However, the differences are enough that both circuits are described.

Z-AXIS AMPLIFIER. Intensity control signal current from the Z-Axis/Focus driver is applied to the Z-Axis amplifier via Q2707. That transistor acts as a current buffer amplifier. The input signal line is clamped at 5.4 V by Q2715 to prevent an overdrive of the Z-Axis circuit. TheZ-Axis Amplifier output transistors consist of Q2701 and Q2702 on one side of the complementary-symmetry totem-pole output amplifier and Q2703 and Q2704 on the other side. Two transistors are used on each side to divide the power handling requirements needed to drive the crt control grid. The crt grid capacity is large, and requires a relatively large amount of power to change the intensity level quickly.

In the base circuit of Q2704, CR2705 prevents the base-to-emitter voltage from exceeding 0.6 V. Zener diode VR2701 dc level-shifts the signal voltage level at the emitter of Q2705 for proper biasing of Q2704. The ac signal components are bypassed around CR2470 by C2703. Base biasing for Q2702 and Q2703 is taken from a series-resistance divider formed by R2711, R2712, R2713, and R2714 between ground and the +130 V supply. Base biasing for Q2701 is provided by R2715 and R2716 in series between ground and the +130 V supply.

A negative-going input signal to the base of Q2705 causes that transistor to decrease conduction, and the voltage at the top of C2705 goes negative following the input signal. Transistor Q2701 is biased on harder by the negative transition, and Q2704 decreases in conduction. At the Z-Axis output signal line (collector of Q2702), the increasing conduction causes the voltage to rise towards the +130 V supply level. A positive-going input signal has the reverse effect on the output signal. The full output-voltage swing of about 60 V is produced by a 3 mA current change of the Z-Axis Focus/Driver signal current.

Gain of the Z-Axis Amplifier stage is set by the feedback through R2708 and R2709 from the collector of Q2702 to the base of Q2705. The amplifier is compensated by the variable capacitor (C2704, Z-Axis Response) in parallel with the feedback resistors.

BEAM FIND. The Z-Axis portion of the BEAM FIND circuit consists of R2705 and Q2706. When BEAM FIND is active, Q2706 is biased on. This clamps the Z-Axis signal line via R2706 and raises the voltage at the base of Q2705 to a level that produces a bright trace.

Auto Focus Amplifier

The Auto Focus Amplifier (Q2708, Q2709, Q2711, Q2712, and Q2712) uses a sample of the Z-Axis/Focus Driver signal current from W2701 to drive the auto-focus circuit. The input signal is inverted by Q2708 to drive Q2711 in a complementary fashion to Q2705 in the Z-Axis Amplifier circuit (as the opposite circuit action must happen to produce the correct auto-focus response). The auto-focus output amplifier is similar to the Z-Axis amplifier, but it uses only one complementary transistor on each side (not as much power is needed to drive the focus grid as needed to drive the intensity grid).

Dc Restorers

The Z-Axis and the Auto Focus Dc Restorers are similar in operation. Both circuits are described, but only the added portions of Auto Focus circuitry are included in the discussion of the Auto Focus circuit.

The Dc Restorers set the crt control-grid and focus-grid biases and couple the ac and dc components of the Z-Axis and the Auto Focus Amplifier outputs to the crt grids. Direct coupling of the Z-Axis and Auto Focus signals to the crt control grid is not employed because of the high potential differences involved. Refer to Figure 3-7 during the following discussion.

Z-AXIS DC RESTORER. Ac drive to the Z-Axis Dc Restorer circuit is obtained from pin 12 of T2204. The drive voltage has a peak amplitude of about ±130 V at a frequency of about 18 kHz and is coupled into the Z-Axis Dc Restorer circuit through R2722 and C2713. The cathode of diode CR2704 is biased by Grid Bias potentiometer R2719 and referenced to ground via R2720. The ac-drive voltage is clamped to the voltage set by the Grid Bias potentiometer wiper whenever the positive peaks forward bias diode CR2704. Capacitor C2710 prevents significant loading of the potentiometer wiper voltage when CR2704 conducts.

The Z-Axis Amplifier output voltage, which varies between +16 V and +66 V, is applied to the Dc Restorer at the anode of CR2703. The ac-drive voltage holds CR2703 reverse biased until the voltage falls below the Z-Axis Amplifier output voltage level. At that point, CR2703 becomes forward biased and clamps the junction of CR2703, CR2704, and C2713 to the Z-Axis output level. Thus, the 18 kHz ac-drive voltage is clamped at two levels to produce a 18 kHz square-wave signal with a positive dc-offset level.

The Dc Restorer is referenced to the −2750 V crt cathode voltage through CR2702 and R2723. Initially, both C2712 and C2711 charge up to a level determined by the difference between the Z-Axis output voltage and the crt cathode voltage. Capacitor C2712 charges from the Z-Axis

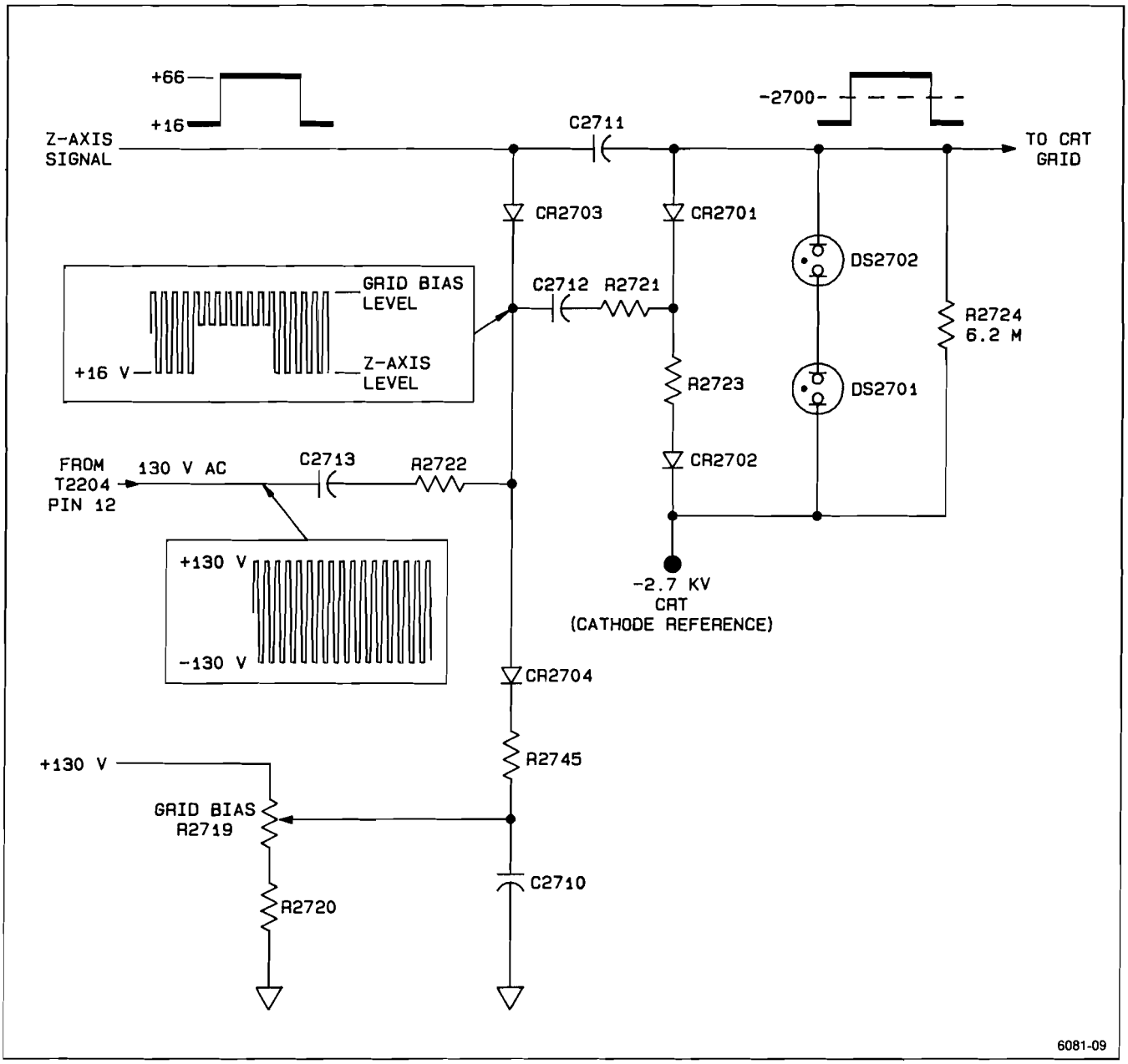

Figure 3-7. Simplified diagram of the DC Restorer circuitry.

output through R2721, R2723, CR2702, and CR2703, to the crt cathode. Capacitor C2711 charges through R2723 (a series damping resistor), CR2702, and CR2701 to the crt cathode.

During the positive transitions of the ac drive (from the lower clamped level toward the higher clamped level) the charge on C2712 increases due to the rising voltage. The voltage increase across C2712 is equal to the amplitude of the positive transition. The negative transition is coupled through C2712 to reverse bias CR2702 and forward bias CR2701. The increased charge of C2712 is then transferred to C2711 as C2712 discharges toward the Z-Axis output level. Successive cycles of the ac input to the Dc Restorer charge C2711 to a voltage equal to the initial level plus the amplitude of the clamped square-wave input.

The charge held by C2711 sets the control-grid bias voltage. If more charge is added to that already present on C2711, the control grid becomes more negative (display dimmer). Conversely, if less charge is added, the control-grid voltage level becomes closer to the cathode-voltage level, and the display becomes brighter. During periods that C2712 is charging, the crt control-grid voltage is held constant by the long time-constant discharge path of C2711 through R2724.

Fast-rise and fast-fall transitions of the Z-Axis output signal are coupled to the crt control grid through C2711 to start the crt writing-beam current toward the new intensity level. The Dc Restorer output level then follows the Z-Axis output-voltage level to set the new bias voltage for the crt control grid.

Neon lamps DS2702 and DS2701 protect the crt from excessive grid-to-cathode voltage if the potential on either the control grid or the cathode is lost for any reason.

AUTO FOCUS DC RESTORER. The action of the Auto Focus circuit has to be in reverse of the action of the Z-Axis circuit. The differential transistor pair of Q2708 and Q2709 provides drive to the Auto Focus Amplifier that is inverted in polarity to the Z-Axis signal. As the intensity increases (more beam current), the focus grid bias must become more positive to maintain the focus of the beam. Also, since the focus grid operates at a less negative level than the control grid, the Auto Focus DC Restorer is referenced to the −2750 V supply via a voltage divider chain.

The FOCUS potentiometer (R2758) voltage is taken across the middle resistor of the divider string to provide an adjustable focus voltage. that sets the nominal focus level. Capacitor C2758 filters the reference supply voltge for the focus circuit.

Volts Cal Signal Source

This circuit provides the precision voltages required for setting the voltage measurement constants during the SELF CAL routine. Ground is connected to the vertical input when GND Input Coupling is selected.

Five voltages are selected from a precision voltage divider, R921, and multiplexed through U931 to the vertical inputs at the appropriate time during the SELF CAL routine. Selection is controlled by three binary coded lines (VOLTS CAL 0, 1, 2) from U303. Those control bits and the selected output voltage may be checked one at a time by running the VOLT REF exerciser from the Service Menu.

Front-Panel Control Multiplexer

Multiplexers U505 and U506, controlled by shift register U502 on diagram 4, direct the front-panel variable control levels to the A-to-D Converter (U2306) on diagram 9. Select data on the AD MUX Bus from U502 switches the analog multiplexer output signal from U505 and U506. The bit coding is shown in Table 3-25. The selected output from U505 and U506 is applied to the A-to-D Converter where it is digitized for application to the Measurement Processor.

Transistor Q501 inverts AD MUX 3 line to allow U505 and U506 to be enabled from the same line. When AD MUX 3 line is HI, U505 is enabled; when LO, U506 is enabled.

Scale Illumination

Front-panel SCALE ILLUM control R905 varies the base current of Q905, Q907, and Q908 to set the intensity

Table 3-25
Front Panel Multiplexer
Channel Select Bits

BITS				Analog Signal Selected
3	2	1	0	
0	0	0	0	CH2 VAR
0	0	0	1	CH1 VAR
0	0	1	0	TIME VAR
0	0	1	1	TRIG LVL
0	1	0	0	REF 0
0	1	0	1	REF 1
0	1	1	0	DELTA 0
0	1	1	1	DELTA 1
1	0	0	0	HORIZ POS
1	0	0	1	RO INTEN
1	0	1	0	CH1 PROBE
1	0	1	1	CH2 PROBE
1	1	0	0	CH3 PROBE
1	1	0	1	CH4 PROBE
1	1	1	0	Analog Gnd
1	1	1	1	Analog Gnd

levels of the scale illumination bulbs (DS901, DS902, DS903).

NOTE

Bulb life is extended by keeping SCALE ILLUM control set low or off except when full intensity is required.

CALIBRATOR Circuit

The Calibrator circuit generates a 0.5 V square wave signal at about 1 kHz. Operational amplifier U930A has a gain of about 4. The +2.5 V reference on its noninverting input produces a little over 10 V at the output pin. That voltage is divided by the voltage divider formed by R936, CR936, and R937 for a peak amplitude of the signal of 0.5 V during the time CR936 is forward biased. When CR936 is reverse biased by the output of U930B, the Calibrator output voltage is pulled down to 0 V through R937 to ground.

Operational amplifier U930B is a free-running oscillator circuit with a period of about 1 ms. The oscillator frequency is determined mainly by the charging time constant of C935 and R935. The voltage divider formed by R938, R934, and R939 divides the +15 V supply to provide a positive voltage on pin 5 of the oscillator to get the circuit into oscillation. (When the circuit is oscillating, the feedback signal switches the pin 5 voltage between about +8 V to 0 V.) The gain of the amplifier is high enough to drive pin 7 to the positive supply voltage level at about 14 V, and the signal voltage level on pin 5 rises to a little over 8 V from the feedback current supplied by R933. The CLK 1K signal taken from the junction of R934 and R939 is supplied to U600 and is used to skew the chop-clock frequency. The skew prevents the oscilloscope from triggering on the chop frequency when displaying multiple traces in CHOP Mode.

At that level CR935 is reverse biased, and CR936 is forward biased (by the output of U930A) to pass the calibrator high level output signal current. Charging current through feedback resistor R934 charges C935 up from 0 V toward the output voltage level. As soon as the charge on C935 (and the voltage on pin 6 of U930B) reaches the voltage level on pin 5, the output level at pin 7 drops to about −5 V, and C935 must then begin discharging to the new voltage level. At that point CR935 is forward biased and that reverse biases CR936 so that the Calibrator output voltage drops to 0 V. Resistor R940, in series with CR935, limits current flow to protect U930 and CR935 in the event of a static discharge to the CALIBRATOR output connector.

CRT

The Trace Rotation adjustment, R911, varies the current through the Trace Rotation coil. The Trace Rotation coil is located between the crt face and the vertical and horizontal deflection plates, and it affects both the vertical and horizontal alignment of the trace.

The Geometry adjustment, R2784, varies the voltage level on the horizontal deflection-plate shields to control the overall geometry of the display (minimizes bowing of the display).

The Astigmatism adjustment, R1788, varies the voltage level on the astigmatism grid to obtain the best-focused display over the whole face of the crt.

MEASUREMENT PROCESSOR (diagram 8)

The Measurement Processor circuitry includes the Processor (U2501), the System RAM (U2521), the System ROM (U2519 and U2520), the Interrupt Vector Latch (U2510), the Processor Interrupt circuitry, the communication bus latches and transceivers, the Address Decoding circuitry, and the Power-On Reset IC (U2502).

Power-On Reset

The +5 V supply is monitored by U2502 to generate the reset signals throughout the instrument. These reset signals initialize the states of the logic devices and ensure that memory writes to any of the RAM spaces cannot occur until the +5 V supply is up to its correct operating level. The RESET signal output at pin 6 is initially HI during power up (as soon as the voltage has reached the operating level of the RESET IC, U2502). That HI signal holds Processor U2501 in its reset state.

The RESET signal is inverted by U2504E to the $\overline{\text{SYS RESET}}$ signal that resets and initializes the Readout Processor (U2400, diagram 9). At pin 5 of U2502, a $\overline{\text{RESET}}$ signal is generated. That signal holds Q2507 off to prevent System RAM U2521 from being selected by any random states that may occur from Address Decoder U2516 as the supply voltage is rising.

About 5 ms after the +5 V supply reaches the operating level required for the Processor, the RESET condition is removed, allowing the Processor to operate. At power off (and for a momentary drop in the +5 V supply), when

the +5 V supply falls below the safe operating level of the logic devices, the RESET condition occurs to prevent random operation.

Measurement Processor

FUNCTION. Measurement Processor U2501 is a multitasking device. Its major functions are the following:

1. It continually refreshes the front panel indicator LEDs. One column of the six-column LED matrix is refreshed every 2.048 ms.

2. It continually scans the front panel switch settings, sensing rotation of rotary switches and closures or openings of momentary-contact switches. One column of the six-column switch matrix (the same column number of LEDs being refreshed) is read every 2.048 ms.

3. The Measurement Processor communicates with the Readout Processor and Readout RAM to set attributes for each readout field, put text into each field, and turn the readout fields on or off.

4. It scans the front panel pots and sets control voltage levels. The Measurement Processor uses the Main Board interconnect to select a pot to be scanned by connecting it to Comparator U2306 in the d-to-a circuitry. The Measurement Processor does a successive-approximation a-to-d conversion on each pot, using the DAC (U2302) to output the search values to the Comparator. Some pot values are scanned only; others are scanned, processed, and converted to analog control values by the DAC. The analog levels from the DAC are output to the controlled devices via sample-and-hold circuits (U2304 and U2305).

5. It sets up the hardware state of the instrument, including shift registers 0 and 1, BEAM FIND, and the operating states of U600 (SLIC) and U602 (FLIC). This setup take place as needed for every change of a front panel momentary-contact or rotary-contact switch.

6. The Measurement Processor keeps track of trigger status and controls the trigger levels when in AUTO LEVEL mode. It uses FLIC (U602) to find the A Trigger status (writing to FLIC to reset the A Trigger latch, and reading from it to get the status). It uses SLIC (U600) to find the B Trigger status (writing to SLIC to reset the B Gate latch, and reading from it to get the status). To reacquire the trigger level (positive and negative peaks of the trigger source waveform) it uses the Trigger ICs (U421 and U431), Trigger Level Sample-and-Hold, and the Trigger Comparators in FLIC (it writes to FLIC to reset the Trigger comparator latches, and reads from FLIC to get the status of the latches). To switch between free-running and triggered mode in AUTO LEVEL and AUTO trigger modes, it writes to the control register in FLIC; it switches to triggered mode when trigger frequency is sufficiently high and to free-run mode when too low.

7. It tracks the trigger level and ground with cursors. The cursors are displayed by directing the Readout system to display cursor characters, and using the DAC system to set the REF CURSOR and DELTA CURSOR level to match the trigger or ground point on the waveform.

8. The Measurement Processor does automated measurements. Some measurements are knob-driven. They are:

|←SEC→|
|←1/SEC→|
|←PHASE→|
|←VOLTS→|
⊓|VOLTS→|

When these measurements are running, a new digital value is displayed, and the cursor or delay-zone position is changed only when the user changes the setting of one of the continuous-rotation CURSOR/TIME POSITION controls. Other measurements are waveform-driven. They are:

DC
+PEAK
−PEAK
PK-PK
GATED
+PEAK
GATED
−PEAK
GATED
PK-PK

When these measurements are running, a new digital value is displayed and the cursor position is changed each time a measurement cycle occurs. These measurements use the B trigger system; and, for DC, the low-pass circuit formed by U1101B and associated filter components (diagram 3).

9. The Measurement Processor calibrates the measurement system. The vertical and horizontal gains of the instrument are set by manual potentiometer adjustments; therefore, the Processor does not control the match between the waveform display and the graticule. However, it does adjust the measurement results to compensate for any error in the vertical or horizontal gain. (An example of this is that there could be more than 0.5% error in matching a time base signal to the graticule, but less than 0.5% error in a time measurement done on that signal).

In the Time Base calibration routine, the Measurement Processor uses the Time Calibration Signal Selector (U2509), the Trigger circuitry, the A Sweep system, and U602 (FLIC) to find the match between the delay levels (REF DELAY and DELTA DELAY) and edges of the calibration signal. In the Vertical System calibration, the Processor uses the Voltage Reference Generator (U931), the Readout System, the Vertical Preamplifiers, the Delay Line Driver, and the Vertical Comparator (U702) to find the match between Readout REF CURSOR and DELTA CURSOR levels and vertical outputs generated by the preamplifiers. It uses the Voltage Reference Generator, the Vertical Preamplifiers, and the Trigger circuitry to find the match between trigger levels and trigger signals picked off from the Vertical Preamplifiers.

MEASUREMENT PROCESSOR SIGNALS. Table 3-26 is a listing of signal name, type, and function of the Measurement Processor signals.

INTERRUPT TIMER. Divider U2508B is clocked by a 500 kHz clock divided down from the 8 MHz Measurement Processor clock by U2409A (diagram 9). The 500 kHz signal is further divided by 8 and applied to 12-bit binary divider U2507 to clock that device. The output frequency from pin 4 of U2507 (488.28 Hz) is applied to U2508A. That divider outputs a positive-going interrupt to the Measurement Processor at regular intervals (every 2 ms). The Measurement Processor addresses U2518 to produce a 250 ns positive-going $\overline{\text{TIMER RESET}}$ pulse to reset the Interrupt Timer when the interrupt is acknowledged. The correct timing on the reset signal should result in a HI interrupt pulse of about 35 μs.

Table 3-26
Measurement Processor Signals

Signal Name	Signal Type	Signal Function
$\overline{\text{SYS RESET}}$	TTL	Master reset for the Processor board.
CLK 8M	HCMOS	8 MHz clock for the Measurement and Readout Processors.
CLK 500K	TTL	500 kHz clock for the counter chain (generates interrupts and time calibration signal).
A19-A0	TTL	Address lines for the Measurement Processor.
AD7-AD0	TTL	Multiplexed address/data lines for the Measurement Processor.
D7-D0	TTL	Data lines for communications Bus 1 (to memory, the Time Cal generator, Readout, and interrupt vector).
ADDR3-ADDR0	TTL	Latched addresses to Main board.
$\overline{\text{INTA}}$	TTL	Interrupt acknowledge. Asserted when INTR pin of the Processor is asserted; it causes U2510 to put the interrupt vector on Bus 1.
$\overline{\text{RO INTR}}$	TTL	Indicates the Readout System is busy when asserted.
MB RET	TTL	Return data from the Main board Shift Register 2.
SW BD DATA	TTL	Data from the switch board.
AD COMP	TTL	Output of the A-to-D Converter Comparator, U2306.
MB DATA	TTL	Bidirectional data line to/from the Main board.

The interrupt causes the Measurement Processor to vector to a hard-wired instruction byte via buffer U2510. With each interrupt, a refresh of time-critical tasks is taken care of; one row of the front panel pots and switches is scanned for activity, one set of DAC outputs is updated, and some queued task (other devices needing attention) are done.

A second output from U2508A is applied to pin 13 of the BUS 0 Buffer (U2515). At power on, that bit is checked to make sure the Interrupt Timer circuit is functioning.

HORIZONTAL MEASUREMENT CALIBRATION. The remaining outputs of U2507 are applied to Calibration Frequency Selector Multiplexer U2509. During characterization of the time base, known frequencies are selected to be applied to the Trigger circuitry to determine the offset and gain errors introduced by the DAC system (the portions producing the Reference and Delta Delay voltages), Delay Comparators, and the Sweep circuitry. Time cursor measurements are then corrected to remove those errors (from the measurement accuracy not from the display-to-graticule match). Frequency selection is under control of the Measurement Processor via Frequency Selector Latch U2511. Four data bus lines supply the four selection bits to U2509. The data is clocked into the latch by the FREQ SEL CLOCK signal from the Address Decode circuitry. The states of the four bits select one of the input frequencies to U2507 for use as the time base calibration signal (output on pin 10).

Interrupt Vector Buffer

The input pins of Interrupt Vector Buffer U2510 are hard-wired for a data byte of 05 hex (0000 0101 binary). The byte vectors the Measurement Processor to the interrupt handling routine. Buffer U2510 is enabled directly by the Measurement Processor by the $\overline{\text{INTA}}$ (interrupt acknowledge) signal from pin 24 of U2501 as a result of an interrupt.

Measurement Processor Clock

The Measurement Processor Clock signal is generated by a ceramic resonator oscillator circuit (U2504C, U2504A, Y2501) and a divide-by-three circuit. The oscillator circuit produces a 24 MHz signal that is buffered by U2504B and divided down to 8 MHz through U2505A and U2505B. A guard run around the oscillator circuitry provides shielding for the circuit. When testing for a signal output from the oscillator, check at U2504B; probing within the guarded circuitry will affect the oscillator frequency. Clock Dividers (U2505A and U2505B) produce the output clock frequency with a 33% duty cycle (HI one third of the time and LO the other two thirds).

Data Buffers

BUS 0 BIDIRECTIONAL BUFFER. Buffer U2515 communicates the serial bit data to and from the Measurement Processor. Six data lines of the eight available are used in this application. The remaining two are connected to the +5 V supply lines to prevent random states and noise from affecting the other data lines in the device. The buffer is permanently enabled with the direction of transfer being controlled by the Bus Arbitration circuit.

BUS 1 BIDIRECTIONAL DATA BUFFER. Data communication to and from the Measurement Processor is via Buffer U2514. Direction of the data transfer is controlled by the DT/$\overline{\text{R}}$ (Data Transmit/$\overline{\text{Receive}}$)) output from the Measurement Processor. Data enabling is controlled by the $\overline{\text{BUS1 DEN}}$ (Bus 1 Data Enable) strobe from the Address Decoding circuitry. The Measurement Processor is isolated from Bus 1 except when $\overline{\text{BUS1 DEN}}$ is strobed LO.

Address Latches

MULTIPLEXED AD BUS ADDRESS LATCH. Since the AD0 through AD7 bits are multiplexed between address and data information, the addressing information needs to be latched to hold it for stable addressing (demultiplexed). The ALE (Address Latch Enable) signal from the Measurement Processor (pin 25) goes HI when the address bits are stable, and the bits are latched into U2513. The device is permanently enabled by the grounded enable pin.

NONMULTIPLEXED ADDRESS BUS ADDRESS LATCH (U2512). Some of the nonmultiplexed address bits are also latched to maintain them between ALE strobes. The latching also prevents address line problems on the Main board from locking up the Measurement Processor. From U2512, latched addresses ADDR0-ADDR3 (A13Q-A16Q) are routed to the Display Controller (U600) for addressing the internal registers in that device. Those address lines are also applied to U501 (diagram 4) for additional decoding to load the Analog Control Shift Registers with the serial data supplied from the MB DATA signal line. Latched addresses from pins 6, 9, and 15 of U2512 (A17Q-A19Q) are decoded by U2516, a one-of-eight decoder, to generate enabling strobes for the remaining decoding circuitry.

Measurement Processor ROM

The operating code for the Measurement Processor is stored in two ROMs (U2519 and U2520). Immediately after the Power On Reset ends, the Measurement Processor fetches the first command from the reset vector and begins running the program.

Measurement Processor RAM

The Measurement Processor RAM (U2521) provides storage space for intermediate-step calculation results, the front-panel settings, and the system calibration constants. The Processor RAM is battery backed up so that data stored during operation remains intact during periods of power off. When the instrument is turned on again, the stored front panel settings return the oscilloscope to the same operating state that was present at power off. The stored calibration constants preserve the accuracy of the measurement system (assuming the instrument is warmed up and was warmed up when the SELF CAL routine was last done). If the backup battery is dead, or if the stored calibration constants are lost for some other reason, the instrument will do a SELF CAL at power on. This restores accuracy to the instrument (unless the problem is a RAM fault), but the battery circuitry should be checked and the battery replaced if necessary. Also, the SELF CAL routine should be run again after the instrument is warmed up to generate accurate calibration constants at the operating temperature. If the power-off front panel settings are lost for any reason, the power-on conditions that are set up are only restored in valid states (but not any predefined setup).

Address Decoder

The Address Decoders (U2516, U2517, U2518, and U2506A, B, and C) allow the Measurement Processor to enable any device on the busses for communication. Enabling signals from U2516 select the ROM that is being read (U2519 or U2520), enable the RAM (U2521) for communication, and select the Address Decoder (either U2517 or U2518) that is actively decoding when the $\overline{WR}$ signal is LO.

BUS ARBITRATION GATES. The Bus Arbitration logic (U2503B and C, and U2506C and D) controls which Bus Buffer is enabled for communication with the Measurement Processor. This control logic is necessary since both buffers cannot be active at the same time. Bus 1 (U2514) is the eight-bit data communication bus, and Bus 0 (U2515) uses five bits to communicate single-bit data to the Measurement Processor. On the Bus 0 AD0 signal line, the Measurement Processor sends the serial MB DATA to each of the operating mode Shift Registers and to SLIC (U600) and FLIC (U602). Additional arbitration is provided by U2503B to produce a SLIC $\overline{RD}$ strobe when the Measurement Processor wants to read the status of the Display Controller.

Backup Battery

To keep the data stored in the Measurement Processor RAM (U2521) during power off, a back-up battery system (BT2501, CR2502, and R2506) is used. The battery supplies the energy to maintain the memory states of the static RAM. The lithium battery is not rechargeable and has an operating life of over three years. When the instrument is on, CR2502 becomes reverse biased to prevent any reverse current; when off, CR2501 is reverse biased to isolate the back-up battery from the +5 V supply. If the battery requires replacement, observe the proper safety precautions in the handling and disposition of the replaced battery (see the WARNING under "Battery" in the Specification).

READOUT AND DAC SYSTEM (diagram 9)

Readout Processor

The Readout Processor (U2400) is an eight-bit microcomputer, containing its own on-board ROM and RAM. The Readout Processor controls the display of text and cursors on the crt. It refreshes each character in the display every 16 ms. When the refresh rate becomes too high, refresh stops until the rate is low enough again. When the refresh rate becomes too low, refresh is done by taking control of the crt beam for a character at a time (Fast mode), until the refresh catches up. When the refresh rate is just right, refresh is done a dot at a time (Slow mode).

Each refreshed dot or character is refreshed with the appropriate display position attributes. The attributes define the characters or dots as:

Stationary text that stays put at a fixed point on screen (examples are scale factor and menu displays);

Cursor-level offset text whose position is determined by the REF CURSOR or DELTA CURSOR control levels only (examples are the time-measurement cursors); or

Cursor-level and position-level offset text whose display position is determined by both the cursor levels and the vertical position controls (an example is the TRACK TRIG LEVEL cursor).

The Readout Processor also communicates with the Measurement Processor system to obtain its RAM programming (for determining the display types) and report its status.

Measurement/Readout Processor Communication Protocol

A data byte is transmitted between the Measurement Processor and Readout Processor as follows:

1. The Measurement Processor waits until $\overline{\text{RO INTR}}$ is unasserted (the Readout Processor is ready to receive);

2. The Measurement Processor writes a byte to tristate Write Latch U2401 by strobing $\overline{\text{RO BUF WR}}$; this asserts $\overline{\text{RO INTR}}$ (from Interrupt Latch U2417C and D) and causes an interrupt to the Readout Processor.

3. The Readout Processor, when interrupted, reads the Write Latch (U2401); it then unasserts $\overline{\text{RO INTR}}$ by clocking the Interrupt Latch to reset it. (This is the same clock used when the Readout Processor writes to tristate Read Latch U2402.)

Communication from the Readout Processor to the Measurement Processor is done for diagnostics only and can be started only by the Measurement Processor. The Measurement Processor may check the communication link by comparing bytes sent to bytes received, query the Character Code RAM contents, and check the Character ROM identification header. The replies are all sent between the Readout Processor and Measurement Processor a byte at a time as follows.

1. The Readout Processor waits until $\overline{\text{RO INTR}}$ is asserted (the Measurement Processor is ready to receive).

2. The Readout Processor writes a byte to tristate latch U2402; the clock that does the write also unasserts $\overline{\text{RO INTR}}$

3. The Measurement Processor waits until $\overline{\text{RO INTR}}$ is unasserted, then reads tristate latch U2402. It then strobes $\overline{\text{RO BUF WR}}$ to assert $\overline{\text{RO INTR}}$ (if another byte is coming from the Measurement Processor).

Display Refreshing

READOUT FIELD. A Readout field is refreshed in this way:

1. The display field is selected by latching the top address bits for the field into U2411 (FLD2-FLD0).

2. The mixing attributes for the field are latched into U2411 (MIX3-MIX0).

3. The position-tracking attributes for the field are latched into U2403 (CH4 POS EN through CH1 POS EN and RO TRACE SEP EN).

4. The starting address for the field (set by communication with the Measurement Processor) is latched into counters U2404 and U2405 (CH7-CH0).

5. One character at a time, all the characters in the field are refreshed until the top address for the field (set by communication with the Measurement Processor) has been refreshed.

READOUT CHARACTER. A Readout character is refreshed in this way:

1. $\overline{\text{RO RUN}}$ is asserted. This tells the Dot Refresher PAL (U2410) to begin the character refresh and releases the reset on the Dot Counter (U2407) and the Dot Refresher divider (U2409B).

2. For each dot in the character, the next dot is refreshed.

3. When the final dot is refreshed, $\overline{\text{EOCH}}$ (end-of-character at U2408 pin 17) becomes asserted, and $\overline{\text{Q EOCH}}$ (the latched version) becomes asserted. The Readout Processor unasserts $\overline{\text{RO RUN}}$, and increments the character address counter lines CH7-CH0.

READOUT DOT. A Readout dot is refreshed in this way:

1. $\overline{\text{RO BLANK}}$ is unasserted (this unblanks the crt beam) briefly to show the dot.

2. $\overline{\text{RO BLANK}}$ is asserted (this blanks the crt beam).

3. $\overline{\text{DOT CLK}}$ is asserted and unasserted (this increments the dot counter lines DOT4-DOT0).

FAST REFRESH. Fast refresh occurs when the Processor asserts $\overline{\text{FAST}}$ (whenever the refresh rate is too low) or when $\overline{\text{A GATE T}}$ is unasserted (the sweep is in holdoff). In this mode, $\overline{\text{RO REQ}}$ is asserted at the start of a character, and unasserted at the end. Whenever $\overline{\text{RO REQ}}$ is asserted, the Readout system controls the crt beam intensity and the vertical and horizontal position of the beam. Dots are refreshed every 1.6 μs during fast refresh.

SLOW REFRESH. Slow refresh occurs when the Processor unasserts $\overline{\text{FAST}}$ (when the refresh rate is not falling behind in refreshing the readout) and $\overline{\text{A GATE T}}$ is asserted. In this mode, $\overline{\text{RO REQ}}$ is asserted before each dot in a character, and unasserted after each dot.

Data flow for the dots in a character is roughly this:

1. FLD2-FLD0 give the current field being refreshed.

2. CH7-CH0 give the position of the character within that field. CH7-CH5 gives the row within the Readout (row 0 at the bottom, and 7 at the top), and CH4-CH0 gives the column (column 0 at the left, column 1f hex at the right).

3. Given the field and character position, the RAM (U2406) outputs the character code (the code for the character that is to be displayed at that position) on R7-R0.

4. DOT4-DOT0 gives the dot that is being refreshed within the character.

5. Given the character code and dot number, ROM U2408 outputs the position of the dot within the character. There are up to 31 dots in a character, in an array of 256 possible dot positions (16 vertical by 8 horizontal). DD6-DD3 gives the vertical position of the dot, and DD2-DD0 gives the horizontal position.

6. Given the row and column containing the character, and the vertical and horizontal position of the dot, U2412 generates the vertical analog current for the dot, and U2413 the horizontal analog current.

7. U2414 sets up the mixing for the vertical output signal (see Readout Position Mixer).

8. U2415 sets up the mixing for the horizontal output signal.

Interrupt Request Latch

When the Measurement Processor wants to write new display data to the Readout Processor or Character Codes RAM (U2406), it latches the new data into the Readout Write Latch (U2401) from the D0-D7 bus lines by issuing the $\overline{\text{RO BUF WR}}$ (readout buffer write) strobe to the Interrupt Request Latch (U2417). The output of U2417D (pin 11) is latched LO and the Readout Processor is interrupted from its display processes ($\overline{\text{RO INTR}}$ goes LO). The Readout Processor enables the Readout Write Latch and reads in the new data. When the character is received, the Readout Processor transfers the byte to the Character Code RAM and resets the Interrupt Request Latch (U2417D) to let RO $\overline{\text{INTR}}$ go HI again.

Communication Latches

Communication from the Measurement Processor and the Readout Processor is done via the Readout Write Latch (U2401). The Readout Read Latch (U2402) is used only for diagnostics communication.

Character Position Address Counter

The starting address of a readout field to be displayed is loaded into the Character Position Address Counter (U2404 and U2405). The counter then sequences through the addresses of the characters loaded in Character Code RAM U2406. The vertical and horizontal position of the character being displayed is also defined by the output of the counter and is supplied to the Vertical and Horizontal DACS on the CH0-CH7 bus lines.

Character Codes RAM

The ASCII codes needed to display a field of readout are loaded into the Character Codes RAM (U2406) from the Measurement Processor via the Readout Writer Buffer (U2401) on the R0-R7 bus lines. When the field is displayed, the RAM is addressed in sequence by the Character Position Address Counter to output those codes for a display refresh. The field of codes accessed by the FLD0-FLD2 address lines defines either text (menus, measurement readouts, and error messages), vertical cursors, or horizontal cursors. Each field has space for up to 255 characters, and each field is superimposable over the others on the crt. The difference between the orientation of the cursors types is done by rotating the character field by 90 degrees. Hexadecimal addresses for a field are shown in Figure 3-8.

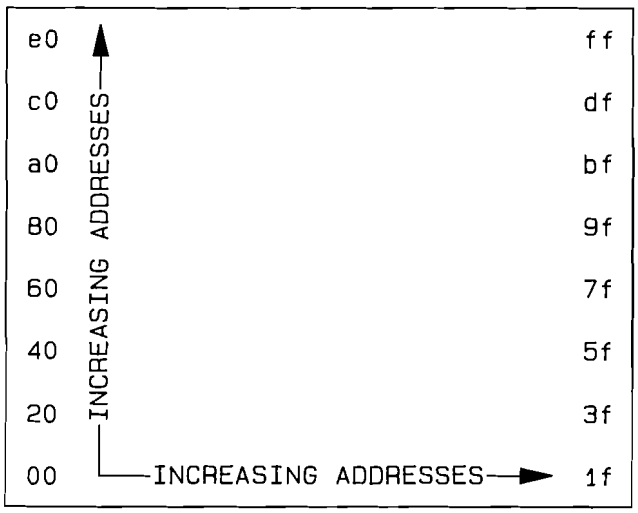

Figure 3-8. Display addresses.

Character Dot Counter

The Character Dot Counter (U2407A and B) is reset before the start of each character display. When $\overline{\text{RO RUN}}$ goes LO (the start of a refresh cycle), the reset is released and the $\overline{\text{DOT CLOCK}}$ signal from the Dot Refresher (U2410) clocks the output of the counter through the number of counts needed to address all the dots in a character stored in the Character Dot Position ROM (U2408).

Character Dot Position ROM

The dot sequence and dot position to display each character is stored in the Character Dot Position ROM (U2408). Character addressing for the display is provided by the Character Codes RAM (U2406) on the R0-R6 bus lines. Addressing of the individual dots within a character is provided from the Character Dot Counter (U2407A and U2407B) on the DOT0-DOT4 signal lines. The pixel information output by the Character Dot Position ROM defines the vertical and horizontal position of the dot to be displayed. At the end of a character display, the $\overline{\text{EOCH}}$ signal is generated from U2408 pin 17 to the Dot Refresher (U2410) to let that device know that the character is finished and the next character can be started.

Dot Refresher

Dot Refresher U2410 is a programmable-AND, fixed-OR logic (PAL) device. It monitors $\overline{\text{RO RUN}}$ for its LO states to determine when a refresh cycle starts. It then assertrs $\overline{\text{RO REQ}}$ to take control of the display for refreshing the displayed character dots. $\overline{\text{RO BLANK}}$ goes HI then LO again for each displayed dot. The $\overline{\text{DOT CLK}}$ signal then goes LO and HI again to clock the Character Dot Counter (U2407A and U2407B) to the address of the next dot in the character being refreshed. In Fast mode (when there is low demand for display time or the refresh rate is getting too slow), each character is completely refreshed. In Slow mode, the dots are refreshed at the rate of only one dot per each readout request.

When all the dots in a character have been refreshed, the $\overline{\text{EOCH}}$ (end-of-character) signal from Character Dot Position ROM U2408 tells U2410 that there are no more pixels to be refreshed in that character. $\overline{\text{RO REQ}}$ is then unasserted to release control of the display system and $\overline{\text{Q EOCH}}$ (U2410, pin 18) is sent to the Readout Processor to tell it that the Dot Refresher is finished with the character.

The Dot Refresher also asserts the $\overline{\text{POSN EN}}$ signal LO (pin 19) when readout associated with any of the traces is being displayed. That signal enables the Readout Position Enable Latch (U2403).

Divider/Counter

The 8 MHz System Clock is divided down to 4 MHz by Divider/Counter U2409A for clocking the Readout Processor and to 2 MHz to clock the Dot Refresher (after inversion by U2417B). The 2 MHz signal also clocks U2409B, a second divider that produces the signals that cycle the Dot Refresher through its internal states.

Readout Position Enable Latch

When the readouts must follow the Channel Vertical POSITION controls or the TRACE SEP control, the vertical position information must be added to the readout position. This job is done in the Vertical Position Switching circuitry (diagram 2). The time of enabling and the readout position that is enabled is determined by the Readout Processor. The correct enabling data for the next field of characters to be displayed is latched into U2403 from the R0-R7 (bits 0-4 only) bus by the $\overline{\text{POS STB}}$ signal (U2403, pin 11). See Table 3-27. When a field is being refreshed, the outputs of U2403 are enabled by the $\overline{\text{POS EN}}$ signal from the Dot Refresher, U2410 pin 19.

Readout DACs

Vertical Character and Dot position data bytes are converted to analog current for eventual application to the Vertical Delay Line by Vertical Readout DAC U2412. The vertical signal current is applied to both signal mixer multiplexers (U2414 and U2415). When fixed position text is displayed, the output mixer selects a fixed position value

Table 3-27
Position Enable Bit Assignment

b4	b3	b2	b1	b0	Value
x	x	x	x	0	Disable CH 1 position current
x	x	x	x	1	Enable CH 1 position current
x	x	x	0	x	Disable CH 2 position current
x	x	x	1	x	Enable CH 2 position current
x	x	0	x	x	Disable CH 3 position current
x	x	1	x	x	Enable CH 3 position current
x	0	x	x	x	Disable CH 4 position current
x	1	x	x	x	Enable CH 4 position current
0	x	x	x	x	Disable Trace Sep current
1	x	x	x	x	Enable Trace Sep current

to mix with the horizontal output signal to define the readout position on the display. When positionable text is displayed (such as time cursors), the cursor position signal is mixed with the horizontal output signal. That summed signal then defines (vertically) where a character (dot) is displayed on the crt. Vertical Readout that follow the Channel Vertical POSITION controls (tracking cursors and associated text) has that added position information added in the Vertical Position Switching circuitry (diagram 2) just before to the Delay Line Driver.

Horizontal Character and Dot position data bytes are converted to analog current for application to the Horizontal Preamplifier (U802, diagram 6) by Horizontal Readout DAC U2413. The horizontal signal current is applied to both signal mixer multiplexers (U2414 and U2415). When fixed position text is displayed, the output mixer selects a fixed position value to mix with the horizontal output signal to define the readout position on the display. When positionable text is displayed (such as time cursors), the cursor position signal is mixed with the horizontal character position signal. That summed signal then defines (horizontally) where a character dot is displayed on the crt. None of the readout (text or cursors) is positionable using the Horizontal POSITION control.

Field and Mixer Control Latch

Selection signals for switching the Readout Position Mixer multiplexers (U2414 and U2415) are latched into Field and Mixer Control Latch U2411 by the MIX STB output from the Readout Processor (U2400 pin 25). Three field selection bits used in addressing the Character Code RAM are also loaded from the data byte output from U2400 on the R0-R7 data bus. The MIX3-MIX0 bits select the combination of fixed, positionable, and character (dots) signals that are mixed to produce the required readout positions on the crt.

The Field signals (FLD0, FLD 1, and FLD2) access the type of characters that are displayed (menus and readout labels, vertical cursors, or horizontal cursors). Each of the three fields contains space for 255 characters. Characters from each field are superimposable over the other field's characters in the display. The attributes implicitly affect the field specified by b0, b1, and b2 (b2 is always handled as if zero, even if not communicated as zero).

Readout Position Mixers

The Readout Position Mixer (U2414, U2415) selects either fixed or cursor-position voltages to mix with the character signals to position them in the display. Selection is done by the MIX0-MIX3 signal levels setup by the Measurement Processor for the particular field of characters being displayed (see Table 3-28).

The 2246 Readout Output Mixer allows three modes of display to present the text and vertical or horizontal cursors.

TEXT OUTPUT MODE. The vertical output displays vertical text information, locked to CRT vertical screen position. The horizontal output displays horizontal text information, locked to CRT horizontal screen position.

HORIZONTAL CURSOR MODE. The vertical output displays vertical text information, whose position is controlled by an analog cursor level control. The horizontal output displays horizontal text information, locked to CRT horizontal screen position.

VERTICAL CURSOR MODE. The vertical output provides a ramp signal, locked to CRT vertical screen

Table 3-28
Field and Mixer Attribute Bit Assignment

MIX3	MIX2	MIX1	MIX0	NC	FLD2	FLD1	FLD0	Value
x	x	x	x	x	b2	b1	b0	Field number (0, 1, or 2)
x	x	0	0	x	x	x	x	Route Horiz DAC to Horiz Ampl
x	x	0	1	x	x	x	x	Route Vert DAC + Cursor0 to Horiz Amplifier
x	x	1	0	x	x	x	x	Route Vert DAC + Cursor1 to Horiz Amplifier
x	x	1	1	x	x	x	x	Unassigned
0	0	x	x	x	x	x	x	Route Vert DAC to Vert Ampl
0	1	x	x	x	x	x	x	Route Vert DAC + Cursor0 to Vert Amplifier
1	0	x	x	x	x	x	x	Route Vert DAC + Cursor1 to Vert Amplifier
1	1	x	x	x	x	x	x	Route Horiz DAC to Vert Ampl

position. The horizontal output matches the voltage of an analog cursor level control.

MIXER OPERATION. The readout system displays text in a pixel-type representation. For example, an underlined letter "A" may be represented as in Figure 3-9. Blackened spaces in the illustration denote a displayed pixel.

For each character, one pixel at a time is displayed by driving the vertical and horizontal outputs to values representing the vertical and horizontal position of a pixel within and character and then unblanking the Z-Axis.

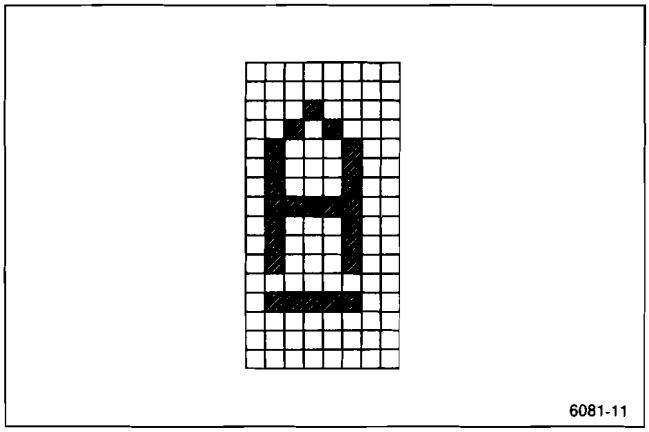

Figure 3-9. Character pixel arrangement.

Multiplexers U2414 and U2415 are ganged electronic switches that mix current and voltage settings. Vertical Readout DAC U2412 (vertical text generator) provides an output current from pin 2 that is proportionate to the vertical position of the pixel being displayed; the minimum output is 0 ma. Horizontal Readout DAC U2413 (horizontal text generator) provides an output current that is proportionate to the horizontal position of the pixel being displayed. Its minimum output is also 0 mA. The REF CURSOR and DELTA CURSOR level are voltages that offset the text output for the type of cursor being displayed (vertical TIME cursors or horizontal VOLTS cursors). When straight text is to be displayed, dc levels for offsetting the vertical and horizontal text display outputs are added. Horizontal and vertical signals to be mixed for a particular readout are selected by the MIX0-3 outputs of latch U2411. The data is latched from the Readout Processor bus when $\overline{\text{MIX STB}}$ clock is generated by the Readout Processor.

Output Buffers

The Output Buffers (U2416B and U2416A—vertical and U2416C and U2416D—horizontal) are voltage follower circuits that mix the signals selected by the Readout Position Multiplexers and buffer them for application to the vertical delay line (RO VERT) and the Horizontal Preamplifier (RO HORIZ).

The voltage at U2416 pin 14 depends on two things: the current from U2414 pin 13, and the voltage at U2414 pin 3. The possible displays are given in Table 3-29.

The voltage at U2416 pin 8 depends on two things: the current from U2415 pin 13, and the voltage at U2415 pin 3. The possible conditions are shown in Table 3-30.

DAC System

The DAC System permits the Measurement Processor to provide analog control voltages to the circuitry under its control and to find out certain analog voltage levels that it must have to do its control and measurement functions.

Input Data Latches

Binary data bytes to be converted to analog voltage are loaded into two latches (U2300 and U2301). Two data bytes are loaded, the MSB (most-significant byte) and the LSB (least-significant byte). Twelve of the bits in the two bytes are the binary value of the analog voltage. The remaining four bits of the LSB in U2301 enable multiplexer U2303 and select the output port that the converted analog will go out on.

Digital to Analog Converter

The D-to-A Converter (U2302) is a 12-bit device that can produce 4096 discrete output signal current levels from 0 to 2 mA. Signal current flows through R2303 to the +2.5 V reference voltage. The resulting voltage drop across the resistor moves the voltage at pin 12 of voltage follower U2304D away from +2.5 V toward 0 V and below. When there is 0 mA output, the voltage at pin 12 is +2.5 V. At maximum output current, the voltage at pin 12 is −2.5 V. Voltage Follower U2304D buffers the voltage and applies it to the input pin of analog multiplexer U2303 where it is directed to the control circuit selected by the Measurement Processor.

A-TO-D CONVERSION. The output from U2304D is also applied to comparator U2306. When analog-to-digital conversion is being done, the Measurement Processor drives the DAC to produce comparison voltage levels in a binary search pattern. The output of U2306 is monitored to determine the smallest DAC input change that will produce an output change from the comparator. That value is then used as the digital representation of the

Table 3-29
Display Possibilities

Readout Type	U2414-3	U2414-13
Stationary Text	0.6 V	U2412 output
Horizontal Ref Cursor	REF CURSOR	U2412 output
Horizontal Delta Cursor	DELTA CURSOR	U2412 output
Vertical Ref Cursor	0.6 V	U2413 output
Vertical Delta Cursor	0.6 V	U2413 output

Table 3-30
Possible Signal Conditions to U2416

Readout Type	U2415-3	U2415-13
Stationary Text	2.0 V	U2413 output
Horizontal Ref Cursor	2.0 V	U2413 output
Horizontal Delta Cursor	2.0 V	U2413 output
Vertical Ref Cursor	REF CURSOR	0 mA
Vertical Delta Cursor	DELTA CURSOR	0 mA

analog voltage applied to the other pin of the comparator on the MAIN BD MUX signal line. Signals found on that multiplexed line are the front panel potentiometers wiper voltages and the probe code levels.

Sample-and-Hold Circuits

The analog voltages from multiplexer U2303 remains stable only for the short period of time that the DAC is at a fixed output level. Control voltages to the analog circuitry must remain constant except for changes to the control settings. Those control voltages are held constant between refreshes by sample-and-hold circuits formed by a capacitor (to hold the voltage) and a voltage follower (to buffer the voltage held by capacitor). The voltage followers circuits are provided by the operational amplifiers of U2304 and U2305. Each of the hold voltages are protected from humidity degradation of the voltage follower's high-impedance input by an active guard shield on the circuit board. Extra noise filtering for two of the control voltages (REF DELAY and DELTA DELAY) is provided by using an RC pi-type filter input circuit to the voltage follower.

SWITCH BOARD AND INTERFACE (diagram 10)

The front-panel LEDs that backlight the switches and panel labels are schematically arranged in a matrix of eight rows and six columns. The front-panel switches are arranged in a matrix of 16 rows and six columns. Each LED and switch is connected to a distinct row/column intersection, with a column of LEDs and a column of switches being common and enabled by the same signal.

At intervals of about 2 ms, a column of LEDs is refreshed (turned on or off) and the status (open or closed) of the connected column of switches is read. All six columns of LEDs and the six columns of switches are completely refreshed and checked every 12 ms. The timing is fast enough to prevent flicker of the LEDs and to catch a push button closure.

LED Refresh

Assume LED column AS0 is being refreshed. First, the LED Cathode Register, U2524, is loaded with a data byte from the Measurement Processor. That byte defines the LEDs that are on for that column, and the outputs of Cathode Driver U2525 for the "on" LEDs are LO. Then, a HI on the D0 bit of the Measurement Processor Data Bus is latched into LED Anode Register U2523 with the $\overline{\text{LED ANODE CLK}}$ signal. That HI turns on the associated Darlington transistor (Q2506 for the AS0 column), and the LEDs in that column that also have their cathodes LO from U2525 are turned on.

Switch Reading

At the same time the AS0 LED column is refreshed, the connected AS0 switch column is pulled HI through CR2006. The switch status (LO for open or HI for closed) for the active switch column is parallel loaded into the Switch Board Shift Registers (U2001 and U2002). This switch status data is then shifted out serially (by 15 $\overline{\text{SW BD SR SHIFT}}$ clocks) to the Measurement Processor on the SW BD DATA return line. The position of a HI in the serial data stream, and knowing the active column, tells the Measurement Processor the switch in column AS0 that is closed (the CH 1 VOLTS/DIV setting). Columns with push-button switches may or may not have a switch closed. A switch closure is interpreted by the Measurement Processor, and any new operating conditions needed (determined from the firmware routines called up to handle a particular switch closure) are set up.

At the next 2 ms interrupt, the Measurement Processor loads new data into Cathode Register U2524 to enable the LED rows, and the column is advanced to enable the A01 column for refresh and switch reading. The process described is continual while the oscilloscope is on.

Part of the Measurement Processor routine stores the new front panel settings in the System RAM each time a change is made. At power on (after being turned off), the stored front-panel settings are recalled from the System RAM to return the oscilloscope to the same operating state that existed at power off (with some exceptions).

Diagnostic

When the Measurement Processor is running the register checks during the DIAGNOSTIC, it can check the condition of registers U2001 and U2002. Serial data is placed on the AS0 line from the D0 bit of the Measurement Processor data bus. That data is serially shifted through the two registers to the SW BD DATA return line. The Measurement Processor compares the returned data stream with what was sent. A difference in the data bits shows an error; a correct comparison passes the test.

POWER SUPPLY (diagram 11)

The Power Supply (diagram 11) provides the various low-voltages needed to operate the 2246 and the high-voltage required by the cathode-ray tube (crt). The supply

circuitry is arranged in the following functional blocks: AC Input, Primary Power Rectifier, Start-Up circuit, Preregulator Control circuit, Preregulator Power Switching circuit, Inverter Control circuit, Inverter Power Switching circuit, Low-Voltage Secondary Supplies, and High-Voltage Supply (see Figure 3-10).

Ac power via the power cord is rectified and filtered by the Primary Power Rectifier to supply the dc voltage to Preregulator circuitry. The output voltage level from the Primary Power Rectifier depends on the ac supply voltage level and may vary between about 125 V and 350 V. This unregulated, filtered, dc voltage is supplied to the Preregulator Start-Up circuit and the Preregulator Switching circuit. The Preregulator Power Switching circuit supplies +44 Vdc output power to drive the Inverter Power Switching circuit.

The +44 V Preregulator output voltage is switched by the Inverter Power Switching circuit to produce an alternating current through the primary of the Inverter power transformer. The current source to the Inverter switching transistors is monitored and regulated by the Inverter Control circuit to maintain a constant output voltage level across the transformer secondaries.

The Low-Voltage Secondary Supplies rectify and filter the low-voltage secondary ac voltages to provide the dc power requirements for the instrument. Two other secondary windings on the Inverter Power Transformer are used in the High-Voltage Supply, a high-voltage winding and a crt filament winding. Voltage from the high-voltage winding is further multiplied and converted to dc voltage for the crt anode, cathode, and intensity-grid voltages.

Both overvoltage and overcurrent protection are provided to protect the oscilloscope circuitry from further damage if a circuit component fails.

AC Input

Applied source voltage is input to the Primary Power Rectifier via surge protection circuitry and noise filtering circuitry. A sealed line filter (FL2201), L2207, L2208, C2214, C2213, C2216, C2215, R2260, R2227, and R2228 form a low-pass filter designed to prevent transmission of high-frequency noise signals either into or out of the instrument. Bleeder resistor R2215 across the input line filter drains off any charge retained by the capacitors in the input circuitry when the power is disconnected. Thermistor RT2201 prevents a sudden rush of input current into the rectifier and filter capacitor, C2202, when the power switch is turned on. The thermistor presents a relatively high resistance when cold, then quickly reduces to a low value when warmed up. Varistor VR2204 acts as a surge limiter to reduce the effects of any power line surges that may damage the input circuit components. The varistor is a voltage-sensitive device that quickly reduces its resistance value when its voltage limits are exceeded. Line fuse F2201 protects the instrument from additional damage in case of a severe short in the power supply.

Primary Power Rectifier

Rectification of the input ac source voltage is done by bridge rectifier CR2233. Simple capacitive filtering of the rectifier output is done by C2202. The filtered output voltage may range between about 80 Vdc and 400 Vdc, depending on the amplitude of the ac input voltage. A line trigger signal is picked off by T2206 for use when the Trigger SOURCE is set to LINE. Bleeder resistor R2256 drains off the charge on C2202 when the instrument is turned off.

Start-Up Circuit

The Start-Up circuit provides the operating supply voltage to the Preregulator. At power on, C2204 in the Start-Up circuit begins charging through R2203 and R2204 from the output of the Primary Power Rectifier. When the voltage across C2204 reached 20 V, the voltage at the base of Q2204 is about 6.8 V. This base voltage level causes Q2204 to conduct (there is a 6.2 V zener diode in the emitter path), and Q2211 also is then biased on. Positive feedback to the base of Q2204 (from the collector of Q2211 through R2220) then keeps both transistors on. The dc voltage to U2201 (Vcc) for start up (and continued running after start up) is provided by the charge on C2204 via Q2211.

With U2201 on and drawing current from C2204, the voltage across C2204 begins to fall. If the Preregulator output rises to +44 V before the voltage across C2204 falls to 10 V, then CR2202 becomes forward biased, and current pulses are supplied by a winding (pins 8 and 9) on T2203 to keep C2204 charged (and U2201 operating).

If the Preregulator output does not rise to +44 V within the time it takes to discharge C2204 below 10 V (about 1/10 of a second), the voltage at the base of Q2204 will drop too low for the feedback voltage to keep it on. That will cause Q2211 to also shut off. The start-up cycle repeats when the voltage across C2204 again reaches 20 V (recharging from the output of the Primary Power Rectifier output via R2203 and R2204). Continued failure of the Preregulator to start up and the repeated attempts to do so is called the "Chirp" mode. Zener diode VR2206 prevents the voltage across C2204 from exceeding about 30 V if no start-up attempt occurs.

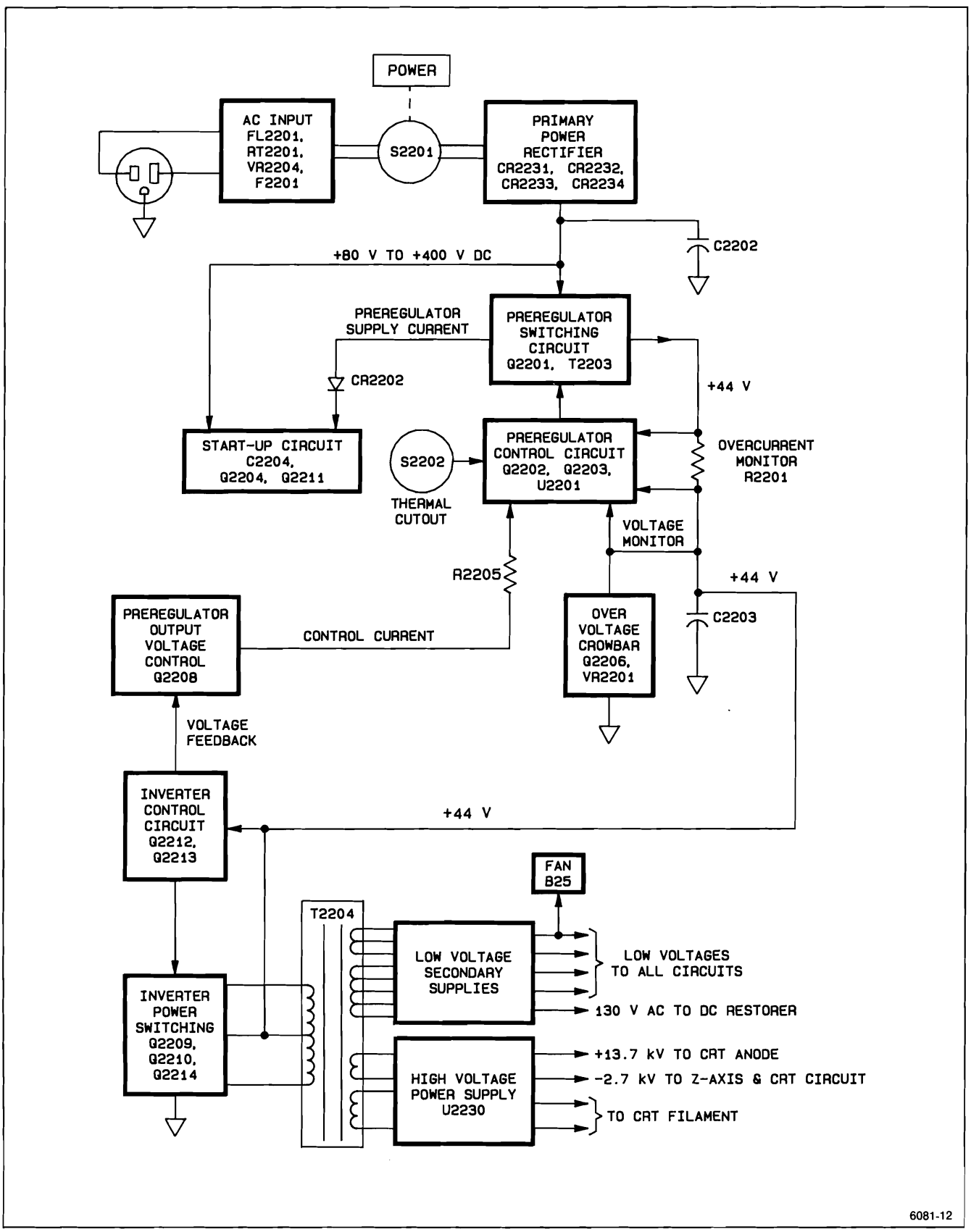

Figure 3-10. Power Supply block diagram.

Preregulator Control Circuit

The Preregulator Control IC, U2201, is a pulse-width modulator used to control the on time of Preregulator Switching FET Q2201. It contains an oscillator, comparators, voltage and current error amplifiers, and logic circuitry that controls its operation. The modulated output pulses drive switching transistor Q2201 through a buffer amplifier composed of Q2202 and Q2203. Pulse width (the time that FET Q2201 is on) is inversely proportional to the control voltage at pin 3 of U2201 (i.e., a lower voltage at pin 3 makes the pulse width wider to keep Q2201 on longer).

Pin 7 of U2201 is the IC ground reference, and it is tied directly to the +44 V output voltage. Therefore, the Preregulator IC and the Start-Up circuitry operating potentials "float" on the regulated output voltage (developed across C2203).

Pin 2 of U2201 is the current-summing node to the voltage-error amplifier. The error amplifier will try to keep the voltage on pin 2 equal to the voltage on pin 1 (the +44 V supply voltage). The error amplifier maintains pin 2 at +44 V by raising (or lowering as necessary) the voltage at pin 3. This raises (or lowers) the voltage across C2203 so that less (or more) current will be drawn out of the current summing node.

The major current injected into the summing node is from the regulated 5 V output, from pin 12 of U2201, via R2212. That current is about 0.6 mA. The current through R2206 adds to the current shunted by the Preregulator Output Voltage Control transistor, Q2208, to produce about 0.6 mA to keep the current into and out of the summing node balanced. The actual current through R2206 is the output voltage (+44 V across C2203) divided by the resistance value of R2206 (100 kΩ) or about 0.4 mA.

SOFT START. At the initial turn-on of the instrument, C2203 is discharged. If no action were taken to prevent it, the initial charging current to that capacitor would exceed safe limits. To avoid such a problem, a "soft start" of the charging path is done.

At turn-on, the +5 V output of U2201 steps to +5 V immediately. A +5 V pulse is coupled to pin 4 of U2201 via C2207. This pin is the "dead time control" input, and when it is HI, the dead time between switching pulses to Q2201 is increased to 100%. Switching transistor Q2201 does not turn on, and no charging of C2203 occurs. Then, as C2207 charges, the voltage on pin 4 begins to decrease toward the ground reference value (on pin 7). This decreases the dead time, allowing increasingly wider conduction pulses to occur.

The on-time gradually increases until the charging current is limited by the internal current limit amplifier of U2201. At that point, the Preregulator is acting as a current source. When the voltage across C2203 reaches +40 V, the voltage error amplifier starts to limit the output, and the Preregulator has reached its operating level and acts as a voltage source.

CURRENT LIMIT. The output current of the Preregulator switching FET, Q2201, is limited to a safe value. If the current exceeds 2.4 amperes, the voltage dropped across R2201 causes pin 14 of U2201 (one input of the current limit amplifier) to exceed the voltage on pin 13 of U2201 (the other input pin of the current limit amplifier). The output of the current limit amplifier then goes HI, raising the voltage on pin 3 of U2201. Increased voltage on pin 3 narrows the width of the turn-on pulses to switching FET Q2201 and limits the output current.

Usually, with a circuit failure, the excess loading remains, and the pulses remain narrow. The Preregulator Control IC then shuts down because the charge on C2204 is not maintained via the Preregulator supply winding on T2203, and the Preregulator goes into the chirp mode (continual shut down and restart attempts).

OVERVOLTAGE CROWBAR. If the output voltage across C2203 exceeds about +51 V, VR2201 in the crowbar circuit conducts. The gate of SCR Q2206 then rises; and, if the rise is enough, the SCR latches on. When on, Q2206 shorts out C2203, and the current limit circuit causes the switching pulses to Q2201 to become very narrow. Preregulator IC U2201 then shuts down (as described in the Current Limit discussion). The Preregulator will attempt a restart after about half a second, but will shut down again if the overvoltage condition continues (this is the "chirp" mode).

PREREGULATOR OUTPUT VOLTAGE CONTROL. The voltage across the Inverter current source transistor, FET Q2214, is monitored by Q2208 (from the collector voltage of either Q2209 or Q2210). That voltage has to be maintained at the proper level to provide enough regulation room for the secondary supply voltages and still not dissipate more power than necessary in Q2214. If the voltage across Q2214 is too high, Q2209 is biased on harder and draws more current from the input summing node (pin 2 of U2201) of the voltage error amplifier in U2201, the Preregulator Control IC. The output of the error amplifier at pin 3 of U2201 then rises, and the width of the switching pulse to the Preregulator Switching circuit narrows to decrease the +44 V output.

The Inverter Control circuit (Q2212 and Q2213) senses the decreased voltage across the primary of the Inverter

power transformer (T2204) and responds by driving Q2214, the Inverter current-source transistor, harder; thereby decreasing the voltage across it.

Control response time in the feedback loop just described is long; but it does not need a fast response time, since the circuit only determines the power dissipation in Q2214. Compensation of the circuit to prevent oscillation is done by a low-pass filter (10 Hz cutoff) formed by C2238, R2205, and R2246.

Preregulator Switching Circuit

The Preregulator Switching circuit provides the energy required to keep C2203 charged up to +44 V. Switching FET Q2201 is driven by the pulse-width modulated output of the Preregulator IC (U2201) via a buffer amplifier circuit. The Preregulator IC controls the on-time to maintain the voltage across C2203 at +44 V.

For the following discussion of the switching circuit, assume that Q2201 is off, C2201 is charged to the rectified line voltage (160 V from the Primary Power Rectifier), and the +44 V supply is up and driving a circuit load.

When the Preregulator IC turns on Q2201, the drain of Q2201 is immediately clamped to 44 V. This forces 116 V (160 V − 44 V) across pins 6 and 7 of T2203. Current begins increasing linearly in that coil as Q2201 supplies current to the +44 V supply. With the one end of C2201 clamped to +44 V, and C2201 being charged to +160 V, the other end of C2201 is pushed down with the anode of CR2201 going to −116 V (44 V − 160 V). This places 116 V (0 − 116 V) across pins 1 and 2 of T2203 and current begins increasing linearly in that coil, also flowing through Q2201 to the +44 V supply. After a time determined by Preregulator IC U2201, the drive signal to Q2201 is switched LO, and the switching FET is turned off.

The current flowing in both coils of T2203 must continue as the magnetic field collapses, but it cannot flow through Q2201. The only available path is through CR2201 (previously biased off). The polarity reversal of the voltage across T2203 that occurs forward biases CR2201, and permits the energy in the magnetic field to be released to the +44 V supply.

When CR2201 is forward biased its cathode is clamped to the +44 V supply level. With C2201 still charged to +160 V (the supply voltage), its positive end is pushed up to 204 V (44 V + 160 V). Now there is −44 V (160 V − 204 V) across the coil of T2203 from pin 7 to pin 6 and −44 V (0 − 44 V) from pin 2 to pin 1 (see Figure 3-11).

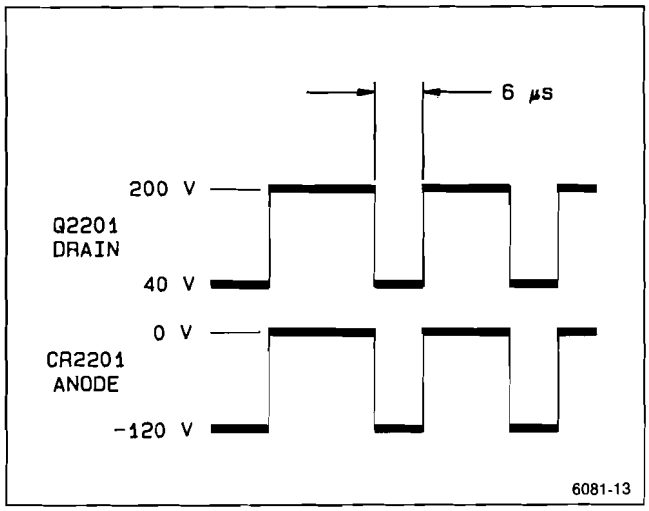

Figure 3-11. Preregulator switching waveforms.

Since C2201 is in parallel with C2202 for dc voltages (coils are shorts to dc), the dc voltage across C2201 can change very little. The capacitance of C2201 is large enough that the charging and discharging currents do not have enough time to change the voltage across C2201 in normal operation.

The two coils of T2203 need not be coupled magnetically for the circuit to operate. Both coils are wound on the same core for convenience. Transformer action is minimal because the waveforms impressed across both coils are nearly identical.

After a time controlled by the Preregulator IC (the dead time), the on-time cycle for Q2201 repeats. On-time depends on the line voltage level; a higher line voltage level means a shorter on time of Q2201 is needed to maintain +40 V across C2203.

Inverter Power Switching Circuit

The Inverter Power Switching circuit is composed of switching transistors Q2209 and Q2210, current source transistor Q2214, inverter power transformer T2204, base-drive transformer T2205, and associated components. Current supplied by the +44 volts output from the Preregulator circuit is alternately switched through each side of the center-tapped primary of T2204 to drive the loads on the secondary windings of the inverter transformer.

INVERTER STARTER. As the Preregulator turns on, the +44 V supply increases from 0 V. The increasing

voltage forward biases CR2236 and charges C2248 through the base-emitter junctions of Q2209 and Q2210. Current is drawn through each side of T2204, from the center tap, as the transistors conduct. One of the two transistors will have a slightly higher gain than the other, and its collector voltage will decrease more than the other. The voltage difference across the primary of T2204 also appears across the primary winding of T2205, and a feedback voltage is induced in the secondary winding of T2204. The polarity of the transformer is such that the conduction of the higher gain transistor is reinforced (positive feedback), and that transistor quickly saturates while the other is cut off. One end of the primary of T2204 is driven toward ground while the other end is opened. After about half a second, C2248 charges up, CR2236 becomes reverse biased, and that path for current through the conducting transistor is blocked.

If the Inverter Power Switching circuit stops, the Inverter Starter circuit will not restart it until C2248 is discharged. Furthermore, C2248 will not discharge until the +44 V supply falls.

INVERTER POWER SWITCHING. Switching is started by one or the other of either Q2209 or Q2210 conducting more that the other, and circuit action biases the other one off. Assume for this discussion that Q2210 is biased on and Q2214 is off. Current flows through current-source FET Q2214, on-transistor Q2210, and half of the primary of T2204 (pins 9 and 11). The voltage drop across current-source transistor Q2214 holds the emitter voltage of Q2209 and Q2210 at 3 V. Voltage across pins 9 and 11 is therefore 40 V (43 V − 3 V).

Through autotransformer action, 40 V is induced in the other half of the primary winding of T2204 from pin 8 to the center-tap pin. That voltage adds to the 40 V from pins 9 to 11 to produce a potential of 80 volts across the primary of switching transformer T2205. Current rapidly ramps up through the primary of T2205 and induces a positive feedback base current in one-half of its center-tapped secondary that keeps Q2210 turned on. Current in the other half of the secondary biases on CR2227 to prevent a high reverse base-to-emitter voltage from being developed across Q2209.

After about 25 μs, the current through the primary of T2205 saturates the magnetic core and the primary impedance of the transformer drops to a low value. When saturation occurs, the impedance presented by L2206 by comparison to that of T2205 is large, and most of the voltage applied from the secondary of T2204 is then dropped across L2206. The secondary voltage of T2205 drops to zero, and with no base-drive current to Q2210, that transistor switches off.

With both Q2209 and Q2210 off, the magnetic energy stored in the primary of T2205 and in L2206 causes current to flow in the primary of T2204, reversing the voltage polarity on this winding. The voltage reversal is not instantaneous because of the parasitic capacitance of the T2204 windings. When the reverse voltage gets high enough, base current flows to Q2204 and that transistor turns on. The inverter current flow cycle through T2204 then repeats but in the opposite direction to induce ac current in the various secondary windings of the inverter power transformer.

INVERTER CONTROL LOOP. Whenever either Q2209 or Q2210 is on, the collector voltage of the on transistor forward biases either CR2205 (if Q2209 is on) or CR2204 (if Q2210 is on). Capacitor C2219 is then charged to nearly the same voltage that is applied to the center tap of the primary winding of Inverter Transformer T2204.

A resistive voltage divider formed by R2239, R2238, and potentiometer R2252 (7.5 V ADJUST) applies a fraction of the voltage across C2219 to the base of Q2213 (one-half of a differential amplifier formed by Q2212 and Q2213). The voltage on the base of Q2213 is compared to a voltage on the base of Q2212 that is referenced back to the +40 V center tap voltage of T2204. If the collector voltage of the conducting inverter switching transistor (Q2009 or Q2210) is not the correct level (about 3 V), the gate voltage of current-source FET Q2214 will be raised or lowered as needed to correct the error.

Low-Voltage Secondary Supplies

The low-voltage power supply circuitry on the pin 12 to pin 22 and pin 13 to pin 15 secondary windings of the Inverter power transformer consist of rectifier and filter components only. All the regulation is done by the Preregulator and Inverter Control circuitry in the primary side of the transformer. Both half-wave and full-wave rectifiers are used, and either simple capacitor or capacitive-input PI filter circuits are used. Rectifier and filter type used for each of the secondary voltages depends on the load requirement. A single 130 Vac output from pin 12 of T2204 supplies the drive to the Z-Axis dc restorer circuitry. Power for the blower fan is supplied by the −15 V power supply line.

The center-tapped secondary winding from pins 13 to 15 of T2204 is used for the +5 V and −5 V supplies. Both are full-wave rectified and filtered using capacitive-input PI filters.

High-Voltage Supply

The high-voltage power supply uses two secondary windings of T2204: one for high-voltage multiplier U2230 and the other for the crt filament. Flying leads from the top of the transformer make the circuit connections into the high-voltage circuitry. The crt filament winding consists of a few turns of insulated wire.

The high-voltage winding attaches directly to the HV Multiplier. Outputs from HV Multiplier U2230 are the 13.7 kV to the crt anode via a high-voltage-insulated connecting lead and the −2.7 kV supplied to the crt cathode, focus grid, and intensity grid. The −2.7 kV supply is filtered by a two-section capacitive input RC filter. A neon lamp across the second section of the filter provides protection against arcing if there is a failure that can cause a large difference of potential to develop between the crt heater and cathode circuits.

MAIN BOARD POWER DISTRIBUTION (diagram 12)

The Main Board Power Distribution diagram schematically displays the distribution paths and decoupling circuits for the low voltages from the Power Supply. The supply and ground connections to the various integrated circuits in the instrument are also shown. Use this diagram to aid circuit tracing when trying to locate a power supply loading problem associated with the Main Board.

PROCESSOR BOARD POWER DISTRIBUTION (diagram 13)

The continuing power distribution from the Main Board to the top board (Processor Board, A16) is depicted in the Processor Board Power Distribution schematic diagram. Use diagram 13 to aid in locating power supply loading problems that are isolated to the Processor Board.

INTERCONNECTION DIAGRAM (diagram 14)

Circuit board interconnections with the plug, jack, pin numbers, and signal names shown are found in schematic diagram 14. The diagram is useful in checking continuity of cable runs and signal paths from board to board through the instrument.

PERFORMANCE CHECK PROCEDURE

INTRODUCTION

The Performance Check Procedure is used to verify the instrument's Performance Requirements as listed in the Specification (Section 1) and to determine the need for readjustment. These checks may also be used as an acceptance test or as a preliminary troubleshooting aid.

Removing the instrument's wrap-around cabinet is not necessary to perform this procedure. All checks are made using the operator-accessible controls and connectors.

TEST EQUIPMENT REQUIRED

The test equipment listed in Table 4-1 is a complete list of the equipment required to accomplish the Performance Check Procedure. Test equipment specifications described in Table 4-1 are the minimum necessary to provide accurate results. Therefore, equipment used must meet or exceed the listed specifications. Detailed operating instructions for test equipment are not given in this procedure. If more operating information is required, refer to the appropriate test equipment instruction manual.

When equipment other than that recommended is used, control settings of the test setup may need to be altered. If the exact item of equipment given as an example in Table 4-1 is not available, check the Minimum Specification column to determine if any other available test equipment might suffice to perform the check or adjustment.

PERFORMANCE CHECK INTERVAL

To ensure instrument accuracy, check its performance after every 2000 hours of operation, or once each year if used infrequently. If the checks made indicate a need for readjustment or repair, refer the instrument to a qualified service person.

PREPARATION

This procedure is structured in subsections to permit checking individual sections of the instrument whenever a complete Performance Check is not required. At the beginning of each subsection there is a list showing only the test equipment required to perform the checks of that subsection. The equipment name in the Equipment Required block at the beginning of each subsection refers to the test equipment listed in Table 4-1.

The initial front-panel control settings required to prepare the instrument for performing Step 1 are given at the beginning of each subsection. Each succeeding step within a subsection should then be performed both in the sequence presented and in its entirety to ensure that control settings will be correct for ensuing steps. The instrument must have had the prescribed 20-minute warmup time to satisfy the conditions required to meet the accuracies stated in the Specification (Section 1). Before beginning the Performance Check Procedures and after warmup, run the SELF CAL MEASUREMENTS routine found under the INTERNAL SETTINGS MENU in the SERVICE MENU choices (see last step in the Adjustment Procedure, Section 5 of this manual).

NOTE

Do not perform the SELF CAL until after the warmup period. When done with a cold instrument, the SELF CAL routine will store calibration constants for that temperature. When the instrument is warmed up, the calibration will then be incorrect and the SELF CAL must then be repeated to restore the correct calibration constants.

Table 4-1

Test Equipment Required

Description	Minimum Specification	Purpose	Example of Suitable Test Equipment
Leveled Sine-Wave Generator	Frequency: 250 kHz to above 70 MHz. Output amplitude: variable from 10 mV to 5 V p-p. Output impedance: 50 Ω. Reference frequency: 50 kHz. Amplitude accuracy: constant within 1.5% of reference frequency to 100 MHz; within 3% above 100 MHz.	Vertical, horizontal, triggering, measurement bandwidth, and Z-Axis checks and adjustments.	TEKTRONIX SG 503 Leveled Sine-Wave Generator.[a]
Calibration Generator	Standard-amplitude signal levels (dc and square wave): 5 mV to 50 V. Accuracy: ±0.25%. High-amplitude signal levels: 1 V to 60 V. Repetition rate: 1 kHz. Fast-rise signal level: 1 V. Repetition rate: 1 MHz. Rise time: 1 ns or less. Flatness: ±0.5%.	Signal source for gain and transient response checks and adjustments.	TEKTRONIX PG 506 Calibration Generator.[a]
Time-Mark Generator	Marker outputs: 5 ns to 0.5 s. Marker accuracy: ±0.1%. Trigger output: 1 ms to 0.1 μs, time-coincident with markers.	Horizontal checks and adjustments. Display adjustment. Time cursor checks.	TEKTRONIX TG 501 Time-Mark Generator.[a]
Function Generator	Range: less than 1 Hz to 1 kHz; sinusoidal output; amplitude variable up to greater than 10 V p-p open circuit with dc offset adjust.	Low-frequency checks.	TEKTRONIX FG 502 Function Generator.[a]
Coaxial Cable (2 required)	Impedance: 50 Ω. Length: 42 in. Connectors: BNC.	Signal interconnection.	Tektronix Part Number 012-0057-01.
Precision Coaxial Cable	Impedance: 50 Ω. Length: 36 in. Connectors: BNC.	Used with PG 506 Calibration Generator and SG 503 Sine Wave Generator.	Tektronix Part Number 012-0482-00.
Termination (2 required)	Impedance: 50 Ω. Connectors: BNC.	Signal termination.	Tektronix Part Number 011-0049-01.
10X Attenuator	Ratio: 10X. Impedance: 50 Ω. Connectors: BNC.	Triggering checks.	Tektronix Part Number 011-0059-02.
2X Attenuator	Ratio: 2X. Impedance: 50 Ω. Connectors: BNC.	Triggering checks.	Tektronix Part Number 011-0069-02.
Adapter	Connectors: BNC male-to-miniature-probe tip.	Signal interconnection.	Tektronix Part Number 013-0084-02.
Alignment Tool	Length: 1-in shaft. Bit size: 3/32 in. Low capacitance; insulated.	Adjust TRACE ROTATION pot. Adjust variable capacitors and resistors.	Tektronix Part Number 003-0675-00.
Test Oscilloscope with 10X Probe	Bandwidth: 20 MHz.	Z-Axis response adjustment.	TEKTRONIX 2246.

[a]**Requires a TM500-Series Power Module.**

Table 4-1 (cont)

Description	Minimum Specification	Purpose	Example of Suitable Test Equipment
Dual-Input Coupler	Connectors BNC female-to-dual-BNC male.	Signal interconnection.	Tektronix Part Number 067-0525-01.
T-Connector	Connectors, BNC.	Signal interconnection.	Tektronix Part Number 103-0030-00.
Precision Normalizer	Input resistance: 1 MΩ. Input capacitance: 20 pF.	Input capacitance adjustments.	Tektronix Part Number 067-1129-00.
TV Signal Generator	Provide Composite TV Video and Line Sync signals.	Check TV Trigger circuit.	TEKTRONIX 067-0601-00. Calibration Fixture with 067-5002-00 (525/60) and 067-5010-00 (1201/60) plug-ins.
Digital Multimeter DMM	Range: 0 to 140 V. Dc voltage accuracy: ±0.15%. 4 1/2 digit display.	Power supply voltage checks and adjustments.	TEKTRONIX DM 501A Digital Multimeter.[a]

[a]Requires a TM500-Series Power Module.

INDEX TO PERFORMANCE CHECK PROCEDURE

DISPLAY

Equipment Required (see Table 4-1):

Time Mark Generator

50 Ω BNC termination

50 Ω BNC coaxial cable

1. Trace Rotation

a. Set:

READOUT (Intensity)	For a viewable readout
A INTEN	For a viewable trace
VERTICAL MODE	CH 1
CH 1 VOLTS/DIV	0.1 V
CH 1 Input COUPLING	AC
A/B SELECT	A Trigger
TRIGGER MODE	AUTO LEVEL
TRIGGER SOURCE	VERT
TRIGGER CPLG	DC
TRIGGER SLOPE	⎍ (positive-going)
TRIGGER HOLDOFF	Min
TRIGGER LEVEL	12 o'clock
Horizontal MODE	A
Horizontal POSITION	12 o'clock
A SEC/DIV	2 μs
Measurements	All off (press CLEAR DISPLAY three times)
FOCUS	For best defined display
BW LIMIT	Off

b. Position trace vertically to the center graticule line.

c. CHECK—Trace rotation control range is adequate to align trace with center graticule line using a small straight-bladed alignment tool.

d. ADJUST—Trace parallel to center horizontal graticule line.

2. Geometry

a. Connect time mark generator (TG 501) to CH 1 via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination.

b. Set generator for 0.2 μs time marks.

c. Position the bottom of the CH 1 signal below the bottom graticule line.

d. CHECK—Deviation of any vertical line within the center eight horizontal divisions does not exceed 0.1 division (half a minor division).

e. Set CH 1 COUPLING to GND.

f. Position trace slowly from the bottom graticule line to the top graticule line while making the following check.

g. CHECK—Bowing or tilt of baseline trace doesn't exceed 0.1 division (half a minor division) within the eight vertical divisions.

h. Disconnect test signal from the 2246.

VERTICAL

Equipment Required (see Table 4-1):

Leveled Sine-Wave Generator	50 Ω Precision BNC coaxial cable
Calibration Generator	50 Ω Termination
Function Generator	Adapter, BNC-male-to-miniature-probe tip
50 Ω BNC coaxial cable	Dual-input Coupler

1. Input COUPLING Functional Check

a. Set:

READOUT (Intensity)	For a viewable readout
A INTEN	For a viewable trace
VERTICAL MODE	CH 1 and CH 2
CH 1 and CH 2 VOLTS/DIV	1 V
CH 1 and CH 2 Input COUPLING	DC
A/B SELECT	A TRIGGER
TRIGGER MODE	AUTO LEVEL
TRIGGER SOURCE	VERT
TRIGGER CPLG	DC
TRIGGER SLOPE	⎍ (positive-going)
TRIGGER LEVEL	12 o'clock
TRIGGER HOLDOFF	Min
Horizontal POSITION	12 o'clock
Horizontal MODE	A
SEC/DIV	0.5 ms
FOCUS	For best defined display
Measurements	All off (press CLEAR DISPLAY three times)
BW LIMIT	Off
CH 2 INVERT	Off

b. CONNECT—Function Generator (FG 502) sine-wave output to the CH 1 input via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination.

c. Set function generator output for 1 kHz sine-wave signal of five divisions peak-to-peak with maximum positive dc offset.

d. Position the bottom of the signal to the center horizontal graticule line.

e. Set CH 1 Input COUPLING to AC.

f. CHECK—Display is centered about the center horizontal graticule line.

g. Move the test signal to the CH 2 input.

h. Set CH 1 VERTICAL MODE to Off.

i. Repeat the procedure for CH 2.

j. Disconnect the test signal from the 2246.

2. CH 1 and CH 2 VOLTS/DIV Trace Shift

a. Set:

CH 1 and CH 2 VERTICAL MODE	On
CH 1 and CH 2 VOLTS/DIV	2 mV
CH 1 and CH 2 Input COUPLING	GND

b. Set VERTICAL MODE to CH 1 (CH 2 off).

c. Position trace to center horizontal graticule line.

d. Switch CH 1 VOLTS/DIV through all positions from 2 mV to 5 V.

e. CHECK—Trace shift does not exceed 0.2 division between steps.

f. Set VERTICAL MODE to CH 2 (CH 1 off).

g. Position CH 2 trace to the center horizontal graticule line.

h. Switch CH 2 VOLTS/DIV through all positions from 2 mV to 5 V.

i. CHECK—Trace shift does not exceed 0.2 division between steps.

3. CH 3 and CH 4 VOLTS/DIV Trace Shift

a. Set VERTICAL MODE to CH 3 (CH 2 off).

b. Position trace to the center horizontal graticule line.

c. Switch CH 3 VOLTS/DIV between 0.1 V and 0.5 V.

d. CHECK—Trace shift does not exceed one division.

e. Set VERTICAL MODE to CH 4 (CH 3 off).

f. Position trace to the center horizontal graticule line.

g. Switch CH 4 VOLTS/DIV between 0.1 V and 0.5 V.

h. CHECK—Trace shift does not exceed one division.

4. CH 1 and CH 2 VAR VOLTS/DIV Trace Shift

a. Set:

VERTICAL MODE	CH 1 (CH 4 off)
CH 1 VOLTS/DIV	2 mV

b. Position trace to center graticule line.

c. Set CH 1 VAR VOLTS/DIV fully CCW.

d. CHECK—Trace shift does not exceed one division.

e. Set:

CH 1 VAR VOLTS/DIV	Detent (calibrated)
VERTICAL MODE	CH 2 (CH 1 off)
CH 2 VOLTS/DIV	2 mV

f. Position trace to center graticule line.

g. Set CH 2 VAR VOLTS/DIV fully CCW.

h. CHECK—Trace shift does not exceed one division.

i. Set CH 2 VAR VOLTS/DIV to detent (calibrated) position.

5. CH 1 and CH 2 Input COUPLING Trace Shift

a. Set CH 2 Input COUPLING to GND.

b. Position trace to center graticule line.

c. Set CH 2 Input COUPLING to DC.

d. CHECK—Trace shift does not exceed 0.25 division.

e. Set:

VERTICAL MODE	CH 1 (CH 2 off)
CH 1 Input COUPLING	GND

f. Position trace to center graticule line.

g. Set CH 1 Input COUPLING to DC.

h. CHECK—Trace shift does not exceed 0.25 division.

6. CH 2 INVERT Trace Shift

a. Set:

VERTICAL MODE	CH 2 (CH 1 off)
CH 2 COUPLING	GND

b. Position trace to center horizontal graticule line.

c. Set CH 2 INVERT On.

d. CHECK—Trace shift does not exceed one division.

e. Set:

CH 2 INVERT	Off
CH 2 COUPLING	DC

7. CH 1 and CH 2 VAR VOLTS/DIV Range

a. Set VERTICAL MODE to CH 1 and CH 2.

b. Position CH 1 and CH 2 traces to the center horizontal graticule line.

c. Connect Calibration Generator (PG 506) Std Ampl output to the CH 1 input via 50 Ω precision BNC coaxial cable. Set generator Std Ampl output to 50 mv.

d. Set:

CH 1 and CH 2 VOLTS/DIV	10 mV
CH 1 VAR VOLTS/DIV	Full CCW

e. CHECK—The signal amplitude is two divisions or less.

f. Set:

CH 1 VAR VOLTS/DIV	Detent (calibrated)
CH 1 VERTICAL MODE	Off

g. Move the test signal to the CH 2 input.

h. Set CH 2 VAR VOLTS/DIV fully CCW.

i. Repeat the CHECK procedure for CH 2.

j. Set CH 2 VAR VOLTS/DIV to detent (calibrated) position.

8. Low Frequency Linearity Check

a. Set:

VERTICAL MODE	CH 1
BW LIMIT	ON

b. Set calibration generator to Std Ampl output, 20 mV.

c. Move the test signal to the CH 1 input.

d. Position top of the signal to top graticule line.

e. CHECK—The signal amplitude is between 1.9 and 2.1 divisions.

f. Set bottom of the signal to bottom graticule line.

g. CHECK—The signal amplitude is between 1.9 and 2.1 divisions.

h. Repeat the procedure for CH 2.

9. CH 1 and CH 2 Vertical Deflection Accuracy

a. Set:

A SEC/DIV	0.5 ms
CH 2 VOLTS/DIV	2 mV

b. Set calibration generator to Std Ampl output, 10 mV.

c. CHECK—All positions of the VOLTS/DIV settings for correct signal-to-graticule accuracy, using the settings in Table 4-2, Signal-to-Graticule Accuracy, for the checks.

d. Set calibration generator to Std Ampl output, 10 mV.

e. Move the test signal to the CH 1 input.

Table 4-2

Signal-to-Graticule Accuracy

VOLTS/DIV Setting	Std Ampl Setting	Deflection Accy. (in divisions)
2 mV	10 mV	4.90 to 5.10
5 mV	20 mV	3.92 to 4.08
10 mV	50 mV	4.90 to 5.10
20 mV	100 mV	4.90 to 5.10
50 mV	200 mV	3.92 to 4.08
0.1 V	500 mV	4.90 to 5.10
0.2 V	1 V	4.90 to 5.10
0.5 V	2 V	3.92 to 4.08
1 V	5 V	4.90 to 5.10
2 V	10 V	4.90 to 5.10
5 V	20 V	3.92 to 4.08

f. Set:

VERTICAL MODE	CH 1 (CH 2 off)
CH 1 VOLTS/DIV	2 mV

g. Repeat CHECK procedure for CH 1.

10. CH 3 and CH 4 Vertical Deflection Accuracy

a. Set:

VERTICAL MODE	CH 3 and CH 4 on; CH 1 off
CH 3 and CH 4 VOLTS/DIV	0.1 V

b. Position CH 3 and CH 4 traces to the second graticule line down from the center horizontal graticule line.

c. Move CH 1 test setup to the CH 3 input.

d. Set Calibration generator to Std Ampl output, 0.5 V.

e. CHECK—The signal amplitude is between 4.90 and 5.10 divisions.

f. Move the test signal to the CH 4 input.

g. Set CH 3 VERTICAL MODE to Off.

h. Repeat CHECK for CH 4.

i. Set CH 3 and CH 4 VOLTS/DIV to 0.5 V.

j. Set calibration generator to Std Ampl output, 2 V.

k. CHECK—The signal amplitude is between 3.92 and 4.08 divisions.

l. Set CH 3 VERTICAL MODE On (CH 4 off).

m. Move the test signal to the CH 3 input.

n. Repeat CHECK procedure for CH 3.

o. Disconnect the test setup from the 2246.

11. ADD Mode and CH 2 INVERT Deflection Accuracy

a. Set:

VERTICAL MODE	ADD (all others OFF)
CH 1 and CH 2 VOLTS/DIV	0.1 V
CH 1 and CH 2 Input COUPLING	DC

b. Connect Calibration Generator Std Ampl output to the CH 1 and CH 2 inputs via 50 Ω precision BNC coaxial cable and a BNC dual-input coupler.

c. Set the calibration generator to Std Ampl output, 0.2 V.

d. Position the ADD signal to the center of the crt graticule with the CH 1 and CH 2 POSITION controls.

e. Set:

CH 1 and CH 2 Input COUPLING	AC
VERTICAL MODE	ADD, CH 1, and CH 2

f. CHECK—The ADD signal amplitude is between 3.92 and 4.08 divisions.

g. Set CH 2 INVERT On.

h. CHECK—The ADD signal amplitude is 0.08 division (less than half a minor graticule division) or less excluding trace width (sweep will free run).

i. Disconnect the test setup from the 2246.

12. Vertical POSITION Range (all channels)

a. Set:

A SEC/DIV	0.1 ms
CH 1 VERTICAL MODE	On (ADD off)
CH 1 VOLTS/DIV	1 V
CH 2 INVERT	Off
BW LIMIT	Off
CH 1 and CH 2 Input COUPLING	AC

b. Connect Leveled Sine-Wave Generator (SG 503) output to the CH 1 and CH 2 inputs via a 50 Ω BNC coaxial cable, a 50 Ω BNC termination, and a BNC dual-input coupler.

c. Position trace to center horizontal graticule line.

d. Set Leveled Sine-Wave Generator output for two-division signal at 50 kHz.

e. Set:

CH 1 VOLTS/DIV	0.1 V
CH 1 POSITION	Full CW

f. CHECK—That the bottom of the waveform is at least one division above the center horizontal graticule line.

g. Set CH 1 POSITION fully CCW.

h. CHECK—That the top of the waveform is at least one division below the center horizontal graticule line.

i. Set:

CH 1 POSITION	12 o'clock
VERTICAL MODE	CH 2 (CH 1 off)
CH 2 POSITION	Full CW

j. CHECK—That the bottom of the waveform is at least one division above the center horizontal graticule line.

k. Set CH 2 POSITION fully CCW.

l. CHECK—That the top of the waveform is at least one division below the center horizontal graticule line.

m. Set CH 2 POSITION to 12 o'clock.

n. Move the BNC dual-input coupler from the CH 1 and CH 2 inputs to the CH 3 and CH 4 inputs.

o. Set:

VERTICAL MODE	CH 3 (CH 2 off)
CH 3 and CH 4 VOLTS/DIV	0.1 V
CH 3 POSITION	Full CW

p. CHECK—That the bottom of the waveform is at least one division above the center graticule line.

q. Set CH 3 POSITION fully CCW.

r. CHECK—That the top of the waveform is at least one division below the center graticule line.

s. Set:

CH 3 POSITION	12 o'clock
VERTICAL MODE	CH 4 (CH 3 off)

t. Repeat the procedure for CH 4.

u. Set CH 4 POSITION to 12 o'clock.

v. Disconnect the test setup from the 2246.

13. CH 1 to CH 2 Signal Delay Match

a. Set:

VERTICAL MODE	CH 1 and CH 2
CH 1 and CH 2 Input COUPLING	DC
CH 1 and CH 2 VOLTS/DIV	0.1 V
SEC/DIV	20 ns
TRIGGER SOURCE	CH 3

b. Superimpose the CH 1 and CH 2 traces at the 100% graticule marking.

c. Connect Calibration Generator (PG 506) FAST RISE, rising-edge signal to the CH 1 and CH 2 inputs via a 50 Ω precision BNC coaxial cable, a 50 Ω BNC termination, and a BNC dual-input coupler.

d. Connect Calibration Generator TRIG OUT signal to the CH 3 input via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination.

e. Set the Calibration Generator output for five divisions of signal amplitude at 1 MHz.

f. Position the rising edges of the superimposed waveforms horizontally to the center vertical graticule line.

g. Set X10 MAG On (for 2 ns/div sweep speed).

h. CHECK—That the leading edges of the two waveforms have less than 0.1 horizontal division separation at the center graticule line excluding trace width.

14. CH 1 to CH 4 Signal Delay Match

a. Set VERTICAL MODE to CH 1 and CH 4 (CH 2 off).

b. Move the CH 2 signal to the CH 4 input connector.

c. Superimpose the CH 4 waveform on the CH 1 waveform.

d. CHECK—That the leading edges of the two waveforms have less than 0.1 horizontal division separation at the center graticule line excluding trace width.

15. CH 3 to CH 4 Signal Delay Match

a. Set:

VERTICAL MODE	CH 3 and CH 4 (CH 1 off)
TRIGGER SOURCE	CH 2

b. Move the CH 1 signal to the CH 3 input and the CH 3 trigger signal to the CH 2 input.

c. Superimpose CH 3 and CH 4 waveforms at the center graticule line.

d. CHECK—That the leading edges of the two waveforms have less than 0.1 horizontal division separation at the center graticule line.

e. Disconnect the test setup.

16. CH 1 and CH 2 Vertical Bandwidth

a. Set:

X10 MAG	Off
VERTICAL MODE	CH 1 (CH 3 and CH 4 off)
SEC/DIV	0.1 ms
CH 1 VOLTS/DIV	2 mV
CH 1 and CH 2 Input COUPLING	DC
TRIGGER SOURCE	VERT
Horizontal POSITION	12 o'clock

b. Connect Leveled Sine-Wave Generator (SG 503) output to the CH 1 input via a 50 Ω precision BNC coaxial cable and a 50 Ω BNC termination.

c. Set the Leveled Sine-Wave Generator output for a six-division signal amplitude at 50 kHz.

d. Set the generator Frequency Range and Frequency Variable controls for a 100 MHz output signal.

e. CHECK the displayed signal amplitude is 4.2 divisions or more.

f. Repeat the frequency setup and CHECK procedure for VOLTS/DIV settings of 5 mV through 1 V.

g. Move the test signal to the CH 2 input.

h. Set:

VERTICAL MODE	CH 2 (CH 1 off)
CH 2 VOLTS/DIV	2 mV

i. Repeat the complete Bandwidth check procedure for Channel 2.

17. CH 3 and CH 4 Vertical Bandwidth

a. Set:

VERTICAL MODE	CH 3 (CH 2 off)
CH 3 and CH 4 VOLTS/DIV	0.1 V

b. Connect Leveled Sine-Wave Generator (SG 503) output to the CH 3 input via a 50 Ω precision BNC coaxial cable and a 50 Ω BNC termination.

c. Set the generator output for a six-division signal display at 50 kHz.

d. Set the generator Frequency Range and Frequency Variable controls for a 100 MHz output frequency.

e. CHECK—That the signal display amplitude is 4.2 divisions or more.

f. Repeat the Procedure for 0.5 VOLTS/DIV setting.

g. Move the test signal to the CH 4 input.

h. Set VERTICAL MODE to CH 4.

i. Repeat the procedure for CH 4.

18. BW LIMIT (Bandwidth Limit) Accuracy

a. Set:

VERTICAL MODE	CH 1 (CH 4 off)
CH 1 VOLTS/DIV	10 mV
BW LIMIT	On

b. Move test signal from the CH 4 input to the CH 1 input.

c. Set Leveled Sine-Wave Generator (SG 503) output for a six-division signal amplitude at 50 kHz.

d. Set the Leveled Sine-Wave generator Frequency Range and Frequency Variable controls to produce a signal display amplitude of 4.2 divisions.

e. CHECK—That the Sine-Wave generator output frequency is between 17 MHz and 23 MHz.

f. Disconnect the test setup.

19. Common-mode Rejection Ratio

a. Connect Leveled Sine-Wave Generator (SG 503) output to the CH 1 and CH 2 input connectors via a 50 Ω precision BNC coaxial cable, a 50 Ω BNC termination, and a BNC dual-input coupler.

b. Set the Leveled Sine-Wave Generator output for an eight-division signal-display amplitude at 50 kHz.

c. Set:

ADD MODE	On
CH 2 VOLTS/DIV	10 mV
CH 2 INVERT	On
CH 1 VERTICAL MODE	Off
BW LIMIT	Off

d. ADJUST—CH 1 OR CH 2 VAR VOLTS/DIV for smallest signal amplitude (as needed).

e. Set the Leveled Sine-Wave output frequency to 50 MHz.

f. Set:

CH 1 VERTICAL MODE	On
ADD MODE	Off

g. Set the Leveled Sine-Wave output amplitude for an eight-division display.

h. Set:

ADD MODE	On
CH 1	Off

i. CHECK—The signal is less than 0.8 division in amplitude.

j. Disconnect the test setup.

20. Channel Isolation

a. Set:

CH 1 and CH 2 VERTICAL MODE	On (ADD off)
CH 2 INVERT	Off
CH 1, CH 2, CH 3, and CH 4 VOLTS/DIV	0.1 V
TRIGGER SOURCE	CH 1

b. Connect the Leveled Sine-Wave Generator (SG 503) output to the CH 1 input via a 50 Ω precision BNC coaxial cable and a 50 Ω BNC termination.

c. Set the Leveled Sine-Wave Generator (SG 503) output for a five-division signal display amplitude at 100 MHz.

d. Set CH 2, CH 3, and CH 4 VERTICAL MODE On (CH 1 off).

e. CHECK—Display amplitude is 0.1 division or less, excluding trace width, on the CH 2, CH 3, and CH 4 traces.

f. Move Sine-Wave Generator signal to the CH 2 input.

g. Set:

CH 1, CH 3, and CH 4 VERTICAL MODE	On (CH 2 off)
TRIGGER SOURCE	CH 2

h. CHECK—Display amplitude is 0.1 division or less, excluding trace width, on the CH 1, CH 3, and CH 4 traces.

i. Move Sine-Wave Generator signal to the CH 3 input.

j. Set:

CH 1, CH 2, and CH 4 VERTICAL MODE	On (CH 3 off)
TRIGGER SOURCE	CH 3

k. CHECK—Display amplitude is 0.1 division or less, excluding trace width, on the CH 1, CH 2, and CH 4 traces.

l. Move Sine-Wave Generator signal to the CH 4 input.

m. Set:

CH 1, CH 2, and CH 3 VERTICAL MODE	On (CH 4 off)
TRIGGER SOURCE	CH 4

n. CHECK—Display amplitude is 0.1 division or less, excluding trace width, on the CH 1, CH 2, and CH 3 traces.

o. Disconnect the test setup.

21. Check AC Coupled Lower −3 dB Point

a. Set:

A SEC/DIV	10 ms
VERTICAL MODE	CH 1 (all others off)
TRIGGER SOURCE	VERT
TRIGGER MODE	NORM
TRIGGER HOLDOFF	Full CW

b. Connect function generator (FG 502) output to the CH 1 input via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination.

c. Set the function generator output controls to produce a six-division sine-wave display at 10 Hz (with no dc offset).

d. Set CH 1 Input COUPLING to AC.

e. CHECK—Display amplitude is 4.2 division or more.

f. Set VERTICAL MODE to CH 2 (CH 1 off).

g. Repeat the procedure for CH 2.

h. Disconnect the test equipment from the 2246.

22. Vertical ALT and CHOP Modes

a. Set:

VERTICAL MODE	CH 1, CH 2 CH 3, and CH 4 on
CHOP VERTICAL MODE	Off (ALT mode)
CH 1 and CH 2 VOLTS/DIV	10 mV
CH 3 and CH 4 VOLTS/DIV	0.1 V
CH 1 and CH 2 Input COUPLING	DC
Horizontal MODE	A
SEC/DIV	1 ms
TRIGGER MODE	AUTO LEVEL

b. Position all traces for two divisions of separation with the CH 1 trace near the top; then in order down the graticule area with the CH 4 trace near the bottom.

c. Set SEC/DIV to 10 ms.

d. CHECK—That four traces are sweeping across the screen alternately.

e. Set CHOP VERTICAL MODE On.

f. CHECK—That four traces are sweeping across the screen simultaneously.

23. BEAM FIND Functional Check

a. Push BEAM FIND in and hold.

b. CHECK—The signal is visible and compressed fully within the graticule area as the horizontal and vertical position controls are rotated through their ranges.

c. Release the BEAM FIND button.

d. Set all Vertical and Horizontal POSITION controls at the 12 o'clock position.

24. A and B Trace Separation

a. Set:

A SEC/DIV	1 ms
VERTICAL MODE	CH 1 (others off)
Horizontal MODE	ALT
B SEC/DIV	0.5 ms
A/B SELECT	B
B Trigger MODE	RUNS AFTER
TRACE SEP	Full CW

b. Position the CH 1 trace below the center horizontal graticule line to display the separated B trace.

c. CHECK—For at least four divisions of upward trace separation between the B trace and the A trace.

d. Set TRACE SEP Fully CCW.

e. Position the CH 1 trace above the center horizontal graticule line to display the separated B trace.

f. CHECK—For at least four divisions downward trace separation of the B trace from the A trace.

TRIGGERING

Equipment Required (see Table 4-1):

Leveled Sine-Wave Generator	Function Generator
50 Ω Precision BNC Coaxial Cable	10X BNC Attenuator
2X BNC Attenuator	50 Ω BNC Termination
Dual-Input Coupler	TV Signal Generator

1. 500 Hz Trigger Sensitivity

a. Set:

READOUT (Intensity)	For a viewable readout
A INTEN	For a viewable trace
VERTICAL MODE	CH 1
CH 1 and CH 2 Input COUPLING	DC
CH 1 VOLTS/DIV	0.1 V
Horizontal MODE	A
A SEC/DIV	20 ms
A/B SELECT	A Trigger
TRIGGER MODE	AUTO LEVEL
TRIGGER SOURCE	VERT
TRIGGER CPLG	AC
TRIGGER SLOPE	⎍ (positive-going)
TRIGGER HOLDOFF	Min
FOCUS	For best defined display
Measurements	All off (press CLEAR DISPLAY three times)
Horizontal POSITION	12 o'clock

b. Connect Function generator (FG 502) output to the CH 1 input via a 50 Ω BNC coaxial cable, and a 50 Ω BNC termination.

c. Set Function Generator (FG 502) output to produce a 7.0 division sine-wave display at 500 Hz.

d. Add a 10X and a 2X BNC attenuator before the 50 Ω BNC termination (for a 0.35 division display).

NOTE

The TRIGGER LEVEL control may be used to obtain a stable display.

e. CHECK—That the display is stably triggered with DC, HF REJ, and AC Trigger CPLG; and that the display will not trigger on NOISE REJ or LF REJ Trigger CPLG.

f. Set:

Horizontal MODE	B
TRIGGER CPLG	DC
A/B SELECT	B Trigger
TRIGGER MODE	NORM
TRIGGER SOURCE	VERT
TRIGGER CPLG	DC
TRIGGER SLOPE	⎍ (positive-going)
B SEC/DIV	0.5 ms
DELAY Time	?0.000 (minimum delay time)
B INTEN	For viewable display

NOTE

It may be necessary to adjust the TRIGGER LEVEL control to obtain a display.

g. CHECK—That, using the Trigger LEVEL control the display can be stably triggered in DC, HF REJ, and AC Trigger CPLG; and that the display can not be triggered in NOISE REJ or LF REJ Trigger CPLG.

h. Disconnect the test setup from the CH 1 input.

2. 500 kHz Trigger Sensitivity

a. Set:

Horizontal MODE	A
A/B SELECT	A Trigger
A SEC/DIV	2 μs

b. Connect Leveled Sine-Wave Generator (SG 503) output to the CH 1 input via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination.

c. Set Leveled Sine-Wave Generator output to produce a 7.0 division sine-wave display amplitude at 500 kHz.

d. Add a 10X and a 2X BNC attenuator before the 50 Ω BNC termination (for a 0.35 division display amplitude).

e. CHECK—That the display cannot be triggered in either HF REJ of NOISE REJ CPLG.

f. Set:

Horizontal MODE	B
A/B SELECT	B Trigger
B SEC/DIV	1 μs

g. CHECK—That the display cannot triggered in HF REJ or NOISE REJ CPLG by adjusting the Trigger LEVEL control.

3. 25 MHz Trigger Sensitivity

a. Set:

Horizontal MODE	A
A/B SELECT	A Trigger
TRIGGER CPLG	DC
A SEC/DIV	50 ns

b. Remove the 10X and 2X BNC attenuators from the signal path.

c. Set Leveled Sine-Wave Generator output to produce a 7.0 division display amplitude at 50 MHz.

d. Add a 10X and a 2X BNC attenuator before the 50 Ω BNC termination.

e. CHECK—That the display is stably triggered in DC, LF REJ, and AC Trigger CPLG; the display is not triggered in NOISE REJ and HF REJ Trigger CPLG settings.

f. Set:

TRIGGER CPLG	AC
Horizontal MODE	B
A/B SELECT	B Trigger
B SEC/DIV	20 ns

g. CHECK—That, using the Trigger LEVEL control the display can be stably triggered in DC, LF REJ, and AC Trigger CPLG; the display cannot be triggered in NOISE REJ and HF REJ Trigger CPLG settings.

h. Set Leveled Sine-Wave Generator (SG 503) to produce a 1.4 division display at 50 MHz.

i. CHECK—That the display can be stably triggered with NOISE REJ Trigger CPLG but does not trigger with HF REJ CPLG.

j. Set:

Horizontal MODE	A
A/B SELECT	A Trigger

k. CHECK—That the display is stably triggered with NOISE REJ Trigger CPLG but does not trigger with HF REJ CPLG. (The Trigger LEVEL control may be adjusted to improve display stability in NOISE REJ CPLG.)

4. 150 MHz Trigger Sensitivity

a. Set TRIGGER CPLG to DC.

b. Set Leveled Sine-Wave Generator to produce a 1.0 division display at 150 MHz.

c. CHECK—That the display is stably triggered in DC, LF REJ, and AC Trigger CPLG; the display is not triggered in NOISE REJ and HF REJ Trigger CPLG.

d. Set:

Horizontal MODE	B
A/B SELECT	B Trigger

e. CHECK—That, using the Trigger LEVEL control the display can be stably triggered in DC, LF REJ, and AC Trigger CPLG; the display cannot be triggered in NOISE REJ and HF REJ Trigger CPLG.

f. Set:

Horizontal MODE	A
VERTICAL MODE	CH 2 (CH 1 off)
CH 2, CH 3, and CH 4	
VOLTS/DIV	0.1 V
A/B SELECT	A Trigger
TRIGGER CPLG	DC

g. Move test signal from CH 1 to the CH 2 input.

h. Set leveled Sine-Wave Generator output to produce a 1.0 division display amplitude at 150 MHz.

i. CHECK—that a stable display can be obtained. (The Trigger LEVEL control may be adjusted to improve the display stability.)

j. Repeat procedure for the CH 3 and CH 4 (turn on the appropriate VERTICAL MODE and move the test signal as required).

k. Move test signal to the CH 1 input.

l. Set VERTICAL MODE to CH 1 (others off).

m. Remove the 2X BNC attenuator from the test signal path.

n. Set Leveled Sine-Wave Generator output for a 2.2 division display amplitude at 100 MHz.

o. CHECK that the display is stably triggered with NOISE REJ Trigger CPLG but is not triggered with HF REJ Trigger CPLG.

p. Set:

TRIGGER CPLG	DC
Horizontal MODE	B
A/B SELECT	B Trigger

q. Repeat 100 MHz HF REJ Trigger CPLG procedure for the B Trigger.

5. Single Sweep Mode

a. Set:

Horizontal MODE	A
A SEC/DIV	10 μs
A/B SELECT	A Trigger

b. Remove the 10X BNC attenuator from the test signal path.

c. Set Leveled Sine Wave Generator output to produce a 7.0 division display amplitude at 50 kHz.

d. Add a 10X and a 2X BNC attenuator before the 50 Ω BNC termination. (Display should stably trigger with AUTO LEVEL finding the correct trigger level setting.)

e. Set:

A TRIGGER MODE	NORM
CH 1 Input COUPLING	GND
TRIGGER MODE	SGL SEQ

f. CHECK—That the Trigger READY LED turns on and remains on.

g. Set:

A INTEN	3/4 full CS
CH 1 Input COUPLING	DC (see CHECK below)

h. CHECK—That the TRIG'D LED flashes, and the READY LED turns off after a single sweep and readout display occurs when the Input COUPLING switches to DC.

6. Trigger LEVEL Control Range

a. Set:

TRIGGER MODE	AUTO (not AUTO LEVEL)
TRIGGER LEVEL	Full CCW
A INTEN	For a good viewing intensity

b. Remove 10X and 2X BNC attenuators from the test signal path.

c. Reduce Leveled Sine-Wave Generator output level until a stably triggered display is just obtainable.

d. Set TRIGGER LEVEL Fully CW.

e. Set Leveled Sine-Wave Generator output for a stable display (if necessary).

f. Set CH 1 VOLTS/DIV to 1 V.

g. CHECK—That the CH 1 signal display amplitude is four divisions or more (peak-to-peak).

h. Disconnect the test setup from the 2246.

7. TV Field Trigger Sensitivity

a. Set:

VERTICAL MODE	CH 2 (CH 1 off)
CH 2 VOLTS/DIV	2 V
SEC/DIV	0.2 ms
TRIGGER SLOPE	⎺_ (negative-going)
TRIGGER MODE	TV FIELD

b. Connect TV SIGNAL GENERATOR negative-going sync pulse output to the CH 1 input via a 50 Ω BNC cable.

c. Set CH 2 VAR VOLTS/DIV control for a 0.5 division composite sync signal.

d. CHECK—That a stable display is obtained.

e. Set:

CH 2 INVERT	On
TRIGGER SLOPE	_/⎺ (positive-going)

f. CHECK—That a stable display is obtained.

8. TV Line Trigger Sensitivity

a. Set:

SEC/DIV	20 μs
TRIGGER MODE	TV LINE
TRIGGER HOLDOFF	For a single triggered display

b. CHECK—That a stable display is obtained.

c. Set:

CH 2 INVERT	Off
TRIGGER SLOPE	⎺_ (negative-going)

d. CHECK—That a stable display is obtained.

e. Set CH 2 VAR VOLTS/DIV to Detent Position (calibrated).

f. Disconnect the TV signal generator from the 2246.

9. Line Trigger

a. Set:

CH 2 VOLTS/DIV	0.1 V (without a 10X probe attached)
CH 2 Input COUPLING	DC
A SEC/DIV	5 ms
TRIGGER MODE	AUTO LEVEL
TRIGGER SOURCE	LINE
TRIGGER CPLG	DC

b. Connect a 10X probe to the CH 2 input connector.

c. CHECK—That the display can be triggered in both _/⎺ (positive-going) and ⎺_ (negative-going) slopes.

d. Disconnect the test setup.

HORIZONTAL

Equipment Required (see Table 4-1):

Time Mark Generator

50 Ω BNC Coaxial Cable

50 Ω BNC Termination

1. A and B Sweep Length

a. Set:

READOUT (Intensity)	For a viewable readout
A INTEN	For a viewable trace
VERTICAL MODE	CH 1
CH 1 and CH 2 Input COUPLING	DC
CH 1 VOLTS/DIV	0.5 V
Horizontal MODE	A
A SEC/DIV	2 ms
A/B SELECT	A Trigger
TRIGGER MODE	AUTO LEVEL
TRIGGER SOURCE	VERT
TRIGGER CPLG	AC
TRIGGER SLOPE	⎍ (positive-going)
TRIGGER HOLDOFF	Min
TRIGGER LEVEL	12 o'clock
Measurements	All off (press CLEAR DISPLAY three times)
FOCUS	For best defined display
Horizontal POSITION	12 o'clock

b. Connect time Mark Generator (TG 501) to the CH 1 input via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination.

c. Set generator for 2 ms time marks.

d. CHECK—Sweep length of the A trace is greater than 10 divisions.

e. Set:

Horizontal MODE	B
B SEC/DIV	1 ms
A/B SELECT	B Trigger
TRIGGER MODE	RUNS AFTER
⊢ or DELAY Control	Full CCW (?0.000)
B INTEN	For a visible display

f. CHECK—The Delay Time readout is ?0.000 ms, and the B Sweep length is greater than 10 divisions.

2. Horizontal Position Range

a. Set:

Horizontal MODE	A
Horizontal POSITION	Full CW

b. CHECK—That the start of trace positions past the center vertical graticule line.

c. Set Horizontal POSITION fully CCW.

d. CHECK—That the eleventh time marker is positioned to the left of the center vertical graticule line.

3. VAR SEC/DIV Range

a. Set:

SEC/DIV	1 ms
SEC/DIV VAR	Full CCW
Horizontal POSITION	12 o'clock

b. Set time mark generator for 5 ms time marks.

c. CHECK—the time-mark spacing is equal to or less than two divisions.

d. Set SEC/DIV VAR fully CW (calibrated detent).

4. Magnifier Registration

a. Set X10 MAG On.

b. Position a time marker to the center vertical graticule line.

c. Set X10 MAG Off.

d. CHECK—For less than 0.5 division horizontal trace shift.

5. A and B Timing Accuracy and Linearity

a. Set A SEC/DIV to 20 ns.

b. Set time-mark generator for 20 ns time marks.

c. Position the time marker peaks vertically to the center horizontal graticule line (allows use of the minor division graticule markings as an aid in making the accuracy checks).

d. Position the second time marker to the second vertical graticule line.

e. Repeat the procedure for all other SEC/DIV settings. Use Table 4-3, Settings for Timing Accuracy Checks, for the SEC/DIV and Time Mark Generator settings.

f. Set SEC/DIV to 20 ns.

g. Set time-mark generator for 20 ns time marks.

h. Set:

Horizontal MODE	B
B INTEN	For a viewable display

i. Repeat the CHECK procedure for all the B SEC/DIV settings.

Table 4-3

Settings for Timing Accuracy Checks

SEC/DIV Setting		Time-Mark Setting	
Normal	**X10 MAG**	**Normal**	**X10 MAG**
20 ns	2 ns	20 ns	5 ns
50 ns	5 ns	50 ns	5 ns
0.1 μs	10 ns	0.1 ns	10 ns
0.2 μs	20 ns	0.2 μs	20 ns
0.5 μs	50 ns	0.5 μs	50 ns
1 μs	0.1 μs	1 μs	0.1 μs
2 μs	0.2 μs	2 μs	0.2 μs
5 μs	0.5 μs	5 μs	0.5 μs
10 μs	1 μs	10 μs	1 μs
20 μs	2 μs	20 μs	2 μs
50 μs	5 μs	50 μs	5 μs
0.1 ms	10 μs	0.1 ms	10 μs
0.2 ms	20 μs	0.2 ms	20 μs
0.5 ms	50 μs	0.5 ms	50 μs
1 ms	0.1 ms	1 ms	0.1 ms
2 ms	0.2 ms	2 ms	0.2 ms
5 ms	0.5 ms	5 ms	0.5 ms
A Sweep only			
10 ms	1 ms	10 ms	1 ms
20 ms	2 ms	20 ms	2 ms
50 ms	5 ms	50 ms	5 ms
0.1 s	10 ms	0.1 s	10 ms
0.2 s	20 ms	0.2 s	20 ms
0.5 s	50 ms	0.5 s	50 ms

6. A and B Magnified Timing Accuracy and Linearity

a. Set time-mark generator for 5 ns time marks.

b. Set:

Horizontal MODE	A
A SEC/DIV	20 ns
Horizontal MODE	B
B SEC/DIV	20 ns
X10 MAG	On (for 2 ns/div sweep speed)
CH 1 VOLTS/DIV	0.5 V (use 0.2 V for the 5 ns time markers if necessary)

NOTE

In the following checks, for magnified SEC/DIV settings between 2 ns and 20 ns, set the first time marker that is 25 ns after the start of the sweep to the second vertical graticule line. For the SEC/DIV settings between 50 ns and 50 ms (0.5 ms for B Sweep), position the leading edge of the second time marker to the second graticule line.

c. Align the rising edge of the first time marker past 25 ns from the start of the sweep with the second vertical graticule line (center the display vertically).

d. CHECK—That the rising edge of the fourth displayed time marker crosses the center horizontal graticule line at between 8.27 divisions to 8.73 divisions.

e. CHECK—The linearity is within 0.1 division over any 2.5 divisions of the center eight divisions. Exclude any portion of the sweep past the 100th magnified division.

f. Set SEC/DIV to 5 ns.

g. Align the correct time marker to the second vertical graticule line (see NOTE above).

h. CHECK—That the tenth displayed time marker is within 0.24 division (left or right) of the tenth graticule line.

i. CHECK—That the linearity accuracy is 0.1 division over any two of the center eight divisions. (Excluding any portion of the sweep past the 100th magnified division for SEC/DIV settings of 5 ns through 20 ns.)

j. Repeat the timing and linearity checks for all SEC/DIV settings between 10 ns and 0.5 s. Use the SEC/DIV and Time Mark Generator X10 MAG settings given in Table 4-3.

k. Set:

Horizontal MODE	A
SEC/DIV	2 ns (with X10 MAG on)

l. Set time-mark generator for 5 ns time marks.

m. Repeat the magnified accuracy and linearity for the A Sweep at all SEC/DIV settings.

7. Delay Time Jitter

a. Set:

X10 MAG	Off
A SEC/DIV	1 ms
Horizontal MODE	ALT
SEC/DIV	0.5 μs

b. Position the intensified dot to the leading edge of the 10th time marker to display the rising edge on the B Trace (using the I← or DELAY control).

c. Set time-mark generator for 1 ms time marks.

d. Set:

Horizontal MODE	B
B INTEN	Full CW (maximum intensity)

e. CHECK—That the jitter on the leading edge does not exceed one division over a two-second interval. Disregard slow drift.

8. Delay Time Accuracy

a. Set:

Horizontal MODE	ALT
B SEC/DIV	10 μs
TRACE SEP	Full CCW (maximum downward position)
CH 1 VERTICAL POSITION	To display both the ALT and the B Delayed Traces

b. Position the first time marker on the ALT trace to first vertical graticule line (left-most edge).

c. Position the intensified dot to full left position (counterclockwise rotation of the I← or DELAY control).

d. CHECK—That the readout is ?0.000 ms.

e. Position the intensified zone to the second time marker and align the leading edge of the time marker displayed on the B Trace to the left-most (first) graticule line. Using the Readout Accuracy Limits given in Table 4-4, check the delay time accuracy.

f. Repeat the procedure for the third through 10th time markers.

Table 4-4

Delay Time Accuracy

Time Marker	Readout Accuracy Limits
1st	? 0.000 ms
2nd	0.975 ms to 1.025 ms
3rd	1.970 ms to 2.030 ms
4th	2.965 ms to 3.035 ms
5th	3.960 ms to 4.040 ms
6th	4.955 ms to 5.045 ms
7th	5.950 ms to 6.050 ms
8th	6.945 ms to 7.055 ms
9th	7.940 ms to 8.060 ms
10th	8.935 ms to 9.065 ms

9. Delay Time Position Range

a. Set time-mark generator for 0.1 ms.

b. Set:

A SEC/DIV	1 ms
B SEC/DIV	5 μs
I← or DELAY Control	Full CCW

c. CHECK—That the intensified dot is positioned at or before the second time mark.

d. Set I← or DELAY control Fully CW.

e. CHECK—That the intensified dot is positioned at or after the 99th time marker (located at a Delay Time of 9.9 ms).

f. Disconnect the Time Mark Generator from the 2246.

10. X-Axis Gain Accuracy

a. Set:

Horizontal MODE	X-Y
VERTICAL MODE	CH 2 (CH 1 off)
CH 1 and CH 2 VOLTS/DIV	10 mV
CH 1 Input COUPLING	DC
CH 2 Input COUPLING	GND

b. Connect Calibration Generator Std Ampl output to the CH 1 and CH 2 inputs via a 50 Ω precision BNC coaxial cable and a BNC dual-input coupler.

c. Set calibration generator for Std Ampl output, 50 mV.

d. CHECK—X-Axis amplitude is between 4.85 and 5.15 horizontal divisions.

11. X-Y Phase Difference

a. Set:

Horizontal MODE	A
VERTICAL MODE	CH 1 (CH 2 off)
CH 1 Input COUPLING	DC

b. Connect Leveled Sine-Wave Generator output to the CH 1 input via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination.

c. Set Leveled Sine-Wave Generator output for six divisions of signal display amplitude at 50 kHz.

d. Set:

Horizontal MODE	X-Y
CH 1 Input COUPLING	GND

e. Position dot to graticule center.

f. Set CH 1 Input COUPLING to DC.

g. CHECK—Ellipse opening at the center is 0.3 division or less, measured horizontally.

12. X-Axis Bandwidth

a. Set VERTICAL MODE to CH 2 (CH 1 off).

b. Set leveled sine-wave output to 3 MHz.

c. CHECK—X-Axis display is 4.2 horizontal divisions or more.

d. Disconnect the test equipment from the 2246.

CURSORS

Equipment Required	
Time Mark Generator	50 Ω BNC coaxial cable
Calibration Generator	50 Ω BNC termination

1. I← SEC →I and I← 1/SEC →I Cursor Accuracy

a. Set:

READOUT (Intensity)	For a viewable readout
A INTEN	For a viewable trace
VERTICAL MODE	CH 1
CH 1 VOLTS/DIV	0.5 V
CH 1 and CH 2	
Input COUPLING	DC
Horizontal MODE	A
A SEC/DIV	1 ms
A/B SELECT	A Trigger
TRIGGER MODE	AUTO LEVEL
TRIGGER CPLG	DC
TRIGGER SOURCE	VERT
TRIGGER SLOPE	⎍ (positive-going)
TRIGGER HOLDOFF	Min
MEASUREMENTS	
CURSORS Menu	On
I← SEC →I CURSORS	On
CH 2 INVERT	Off
BW LIMIT	Off
FOCUS	For best defined display

b. Connect time-mark generator (TG 501) output via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination to the CH 1 input.

c. Set time-mark generator for 1 ms time marks.

d. Position first time marker horizontally to the first vertical graticule line (left-most edge of the graticule).

e. Position the reference cursor to the first time marker and the delta cursor to the second time marker.

f. CHECK—That the readout is 0.975 ms ±1.025 ms.

g. Set MEASUREMENTS CURSORS Menu on.

h. Set I← 1/SEC →I on.

i. CHECK—That the readout is 0.975 kHz ±1.025 kHz.

j. Position delta cursor to align with the 11th time mark.

k. CHECK—That the readout is 99.7 Hz to 100.7 Hz.

l. Set I← SEC →I on.

m. CHECK—That the readout is between 9.930 ms and 10.070 ms.

n. Disconnect Time Mark Generator.

2. I← VOLTS →I Cursor Accuracy

a. Set:

CH 1 VOLTS/DIV	0.1 V
SEC/DIV	0.5 ms
MEASUREMENTS	
CURSORS Menu	On
I← VOLTS →I CURSORS	On

b. Connect calibration generator (PG 506) output to the CH 1 input via a 50 Ω precision BNC coaxial cable.

c. Set calibration generator to Std Ampl 0.5 V.

d. Position bottom of the signal to the second horizontal graticule line from the bottom.

e. Position the Reference cursor to the bottom of the signal and the Delta (Δ) cursor to the top of the signal (both cursors move with the I← OR DELAY control).

f. CHECK—That the readout is between 0.495 V to 0.505 V.

3. ⫛ VOLTS →I Cursor Accuracy

a. Set MEASUREMENTS CURSORS menu, then select ⫛ VOLTS →I CURSORS.

b. Position I← OR DELAY control either clockwise or counter-clockwise.

c. CHECK—That the readout is between 0.495 V and 0.505 V, and none of the cursors move when the I← OR DELAY control is rotated.

4. I← PHASE →I Cursor Accuracy

a. Set CH 1 VOLTS/DIV to 0.5 V.

b. Connect time-mark generator (TG 501) output to the CH 1 input via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination.

c. Set generator for 0.5 ms time marks.

d. Set CURSORS on.

e. Press I← PHASE →I menu selection to display the I← PHASE →I and I← SET 360° →I menu choices.

f. Set I← SET 360° →I on.

g. Position the first time marker to first graticule line. Then position the Reference cursor to the leading edge of the third time marker and the Delta (Δ) cursor to the leading edge of the ninth time-marker.

h. SET I← PHASE →I on.

i. Position delta cursor to the leading edge of the sixth time marker.

j. CHECK—That the readout is between 177.9 degrees and 182.1 degrees.

k. Disconnect Time Mark Generator.

5. Tracking Cursors Position Accuracy

a. Press CLEAR DISPLAY (press twice).

b. Set:

CH 1 VOLTS/DIV	0.1 V
MEASUREMENTS CURSORS Menu	On
AUTO TRACKING MENU	On
TRACK TRIG LVL	On
TRACK ⫛	On
MENU	Off
TRIGGER MODE	AUTO (not AUTO LEVEL)

c. Connect calibration generator Std Ampl output via a 50 Ω BNC cable to the CH 1 input.

d. Set calibration generator for Std Ampl output of 0.5 V.

e. Adjust TRIGGER LEVEL control to align trigger level cursor with the bottom of the signal.

f. CHECK—The readout is 0.000 V ± 0.005 V, and the GND cursor is aligned with the bottom of the signal.

g. Set trigger level cursor to align with the top of the signal.

h. CHECK—The readout is between 0.475 V and 0.525 V.

i. Press CLEAR DISPLAY.

j. Disconnect test equipment if ending here.

CH1/CH2 VOLTMETER

Equipment Required (see Table 4-1)

Calibration Generator	50 Ω precision BNC coaxial cable
Leveled Sine Wave Generator	50 Ω BNC termination
Function Generator	

1. DC Volts Accuracy

a. Set:

READOUT (Intensity)	For a viewable readout
A INTEN	For a viewable trace
VERTICAL MODE	CH 1
CH 1 VOLTS/DIV	50 mV
CH 2 INVERT	Off
BW LIMIT	Off
CH 1 Input COUPLING	GND
Horizontal MODE	A
A SEC/DIV	1 ms
A/B SELECT	A Trigger
TRIGGER MODE	AUTO LEVEL
TRIGGER CPLG	DC
TRIGGER SOURCE	VERT
TRIGGER SLOPE	⎍ (positive-going)
TRIGGER HOLDOFF	Min
CH1/CH2 VOLTMETER	DC
FOCUS	For best defined display
Horizontal POSITION	12 o'clock

b. CHECK—Ground readout is 0.0 mV ±1.2 mV.

c. Set calibration generator (PG 506) internal Square Wave/DC switch to DC.

NOTE

The PG 506 must be removed from the TM power supply to make the change to dc output from the generator. Turn the power off before removing or inserting any plug-in from the TM power supply

d. Connect the calibration generator Std Ampl output to the CH 1 input via a 50 Ω precision BNC coaxial cable.

e. Set calibration generator for Std Ampl output of 50 mV dc.

f. Set:

CH 1 VOLTS/DIV	10 mV
CH 1 Input COUPLING	DC

g. CHECK—The readout is between 49.0 mV and 51.0 mV.

h. Set CH 1 VOLTS/DIV to 0.1 V.

i. Set calibration generator for Std Ampl output 0.5 V.

j. CHECK—The readout is between 0.495 V and 0.505 V.

k. Set CH 1 VOLTS/DIV to 1 V.

l. Set calibration generator for Std Ampl output of 5 V.

m. CHECK—The readout is between 4.95 V and 5.05 V.

n. Disconnect Std Ampl signal from the CH 1 input.

2. DC Volts Normal Mode Rejection Ratio

a. Set SEC/DIV to 5 ms.

b. Connect function generator (FG 502) output to the CH 1 input via a 50 Ω BNC coaxial cable.

c. Set function generator for a six-division sine-wave display amplitude at 50 Hz (with CH 1 VOLTS/DIV at 1 V).

d. Set CH 1 VOLTS/DIV to 0.2 V.

e. CHECK—That the readout is less than ±0.019 V.

f. Disconnect the function generator signal from the 2246.

3. +Peak, −Peak, Peak-to-Peak Voltage Accuracy

a. Set:

VERTICAL MODE	CH 2 (CH 1 off)
CH 1 VOLTS/DIV	10 mV
CH1/CH2 VOLTMETER	+PEAK

b. Set the calibration generator (PG 506) internal Square Wave/DC Switch for a square-wave output signal.

NOTE

It is necessary to remove the PG 506 from the TM power supply module to set the internal Square Wave/DC switch to square-wave output.

c. Connect calibration generator Std Ampl output to the CH 2 input via a 50 Ω precision BNC coaxial cable.

d. Set calibration generator for Std Ampl output of 50 mV dc.

e. CHECK—That the readout is between 47.0 mV and 53.0 mV.

f. Set BW LIMIT on.

g. CHECK—The readout is between 47.7 mV and 52.3 mV.

h. Set:

CH 2 INVERT	On
CH1/CH2 VOLTMETER	−PEAK.

i. CHECK—The readout is between −47.7 mV and −52.3 mV.

j. Set BW LIMIT Off

k. CHECK—The readout is between −47.0 mV and −53.0 mV.

l. Set

CH1/CH2 VOLTMETER	PK-PK.
CH 2 INVERT	Off

m. CHECK—The readout is between 46.5 mV and 53.5 mV.

n. Disconnect calibration generator.

4. 25 MHz +Peak, −Peak, and Peak-to-Peak Volts Accuracy

a. Connect leveled sine-wave generator (SG 503) output to the CH 2 input via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination.

b. Set CH 2 VOLTS/DIV to 20 mV.

c. Set leveled sine-wave generator output for a readout of 100.0 mV ±0.5 mV at 50 kHz.

d. Set leveled sine-wave generator output for 25 MHz.

e. CHECK—The readout is between 95.0 mV and 105.0 mV.

f. Set CH1/CH2 VOLTMETER to −PEAK.

g. CHECK—The readout is between −46.0 mV and −54.0 mV.

h. Set CH1/CH2 VOLTMETER to +PEAK.

i. CHECK—The readout is between 46.0 mV and 54.0 mV.

5. 100 MHz +Peak, −Peak, and Peak-to-Peak Volts Accuracy

a. Set leveled sine wave generator (SG 503) output frequency to 100 MHz.

b. CHECK—The readout is between 34.4 mV and 54.0 mV.

c. Set CH1/CH2 VOLTMETER to −PEAK.

d. CHECK—The readout is between −34.4 mV and −54.0 mV.

e. Set CH1/CH2 VOLTMETER to PK-PK.

f. CHECK—The readout is between 69.7 mV and 107.0 mV.

g. Disconnect the Leveled Sine-Wave signal from the 2246.

6. Gated Volts Accuracy

a. Set:

A SEC/DIV	0.5 ms
CH 2 VOLTS/DIV	10 mV

b. Set CH1/CH2 VOLTMETER to GATED +PEAK.

c. Connect calibration generator (PG 506) Std Ampl output to the CH 2 input via a 50 Ω precision BNC coaxial cable. Set the generator to Std Ampl output, 50 mV.

d. Set Delta (Δ) TIME POSITION to minimum intensified zone width.

e. CHECK—That the width of the dot is less than 0.2 division.

f. Set the intensified dot to a positive peak of the displayed waveform.

g. CHECK—The readout is between 47.0 mV and 53.0 mV.

h. Set the intensified dot to a negative peak of the displayed waveform.

i. CHECK—The readout is 0.0 mV ±0.5 mV.

j. Disconnect the test signal from the 2246.

EXTERNAL Z-AXIS AND CALIBRATOR

Equipment Required

Test Oscilloscope with a 10X probe	BNC T-Connector
Calibration Generator	Two 50 Ω BNC coaxial cables

1. Check External Z-Axis Input

a. Set:

READOUT (Intensity)	For a viewable readout
A INTEN	For a viewable trace
VERTICAL MODE	CH 1
CH 1 VOLTS/DIV	1 V
CH 2 INVERT	Off
BW LIMIT	Off
CH 1 Input COUPLING	DC
Horizontal MODE	A
A SEC/DIV	0.5 ms
A/B SELECT	A Trigger
TRIGGER MODE	AUTO LEVEL
TRIGGER CPLG	DC
TRIGGER SOURCE	VERT
TRIGGER SLOPE	⎍ (positive-going)
TRIGGER HOLDOFF	Min
FOCUS	For best defined display
Horizontal POSITION	12 o'clock

b. Connect calibration generator (PG 506) Std Ampl output to the CH 1 and the EXT Z-AXIS inputs via a 50 Ω precision BNC coaxial cable, a BNC T-connector, and two 50 Ω BNC coaxial cables. Set generator to Std Ampl output, 5 V.

c. Set A INTEN to maximum intensity.

d. CHECK—Waveform display intensity is decreased or blanked at 1.8 V or less; above 3.8 V, the waveform display is completely blanked out.

e. Set A INTEN to midrange.

f. Disconnect the test equipment from the 2246.

2. CALIBRATOR Output

a. Set:

CH 1 VERTICAL MODE	10 mV
SEC/DIV	0.2 ms

b. Connect a 10X probe to the CH 1 input connector and connect the probe tip to the 2246 CALIBRATOR output.

c. CHECK—For a 5-division vertical display of CALIBRATOR square-wave signal (square-wave period is typically 1 ms, within 25%).

d. Disconnect the 10X probe.

THIS COMPLETES THE PERFORMANCE CHECK PROCEDURE.

ADJUSTMENT PROCEDURE

INTRODUCTION

IMPORTANT—PLEASE READ BEFORE USING THIS PROCEDURE

PURPOSE

This Adjustment Procedure is used to return the instrument to conformance with the Performance Requirements as listed in the Specification Tables in Section 1. Adjustments should be done only after the checks in the Performance Check Procedure (Section 4) have indicated a need for a readjustment of the instrument.

TEST EQUIPMENT REQUIRED

The test equipment listed in Table 4-1 is all the equipment required to complete the Adjustment Procedure in this section and the Performance Check Procedure in Section 4. Test equipment specifications described in Table 4-1 are the minimum necessary to provide accurate results. Therefore, equipment used must meet or exceed the listed specifications. Detailed operating instructions for test equipment are not given in this procedure; if more operating information is required, refer to the appropriate test equipment instruction manual.

When equipment other than that recommended is used, control settings of the test setup may need to be altered. If the exact item of equipment given as an example in Table 4-1 is not available, first check the Use column to verify use of this item. Then use the Minimum Specification column to determine whether other available test equipment might work.

LIMITS AND TOLERANCE

The limits and tolerances stated in this procedure are instrument specifications only if they are listed in the Performance Requirements column of the Table 1-1, Electrical Characteristics. Tolerances given are applicable only to the instrument under adjustment and do not include test equipment error. Adjustments must be made at an ambient temperature between +20°C and +30°C, and the instrument must have had a warm-up period of at least 20 minutes.

PARTIAL PROCEDURES

This procedure is divided in subsections to permit adjustment of individual sections of the instrument (except the Power Supply) whenever a complete readjustment is not required. For example, if only the Vertical section fails to meet the Performance Requirements (or has had repairs made or components replaced), it can be readjusted with little or no effect on other sections of the instrument. However, if the Power Supply section has undergone repairs or adjustments that change the absolute value of any of the supply voltages, a complete readjustment of the instrument is required.

At the beginning of each subsection is a list of the initial front-panel control settings required to prepare the instrument for Step 1 in that subsection. Each succeeding step within a subsection should then be done completely and in the sequence presented to ensure that control settings will be correct for steps that follow.

INTERNAL ADJUSTMENTS AND ADJUSTMENT INTERACTION

Do not preset any internal controls, since that may make it necessary to recheck or readjust a major portion of the instrument when only a partial check or adjustment might otherwise have been required. To avoid unnecessary recheck and readjustment, change an internal control setting only when a Performance Characteristic cannot be met with the original setting. When independently changing the setting of any internal control, always check Table 5-1 for possible interacting adjustments that might be required.

Table 5-1
Adjustment Interactions

ADJUSTMENTS OR REPLACEMENTS MADE	ADJUSTMENTS AFFECTED
+7.5 V ADJUST	+7.5 V ADJUST
GRID BIAS	GRID BIAS
ASTIGMATISM	ASTIGMATISM
TRACE ROTATION	TRACE ROTATION
GEOMETRY	GEOMETRY
Z-AXIS RESPONSE	Z-AXIS RESPONSE
READOUT JITTER	READOUT JITTER
VERTICAL OUTPUT GAIN	VERTICAL OUTPUT GAIN
READOUT VERTICAL CENTERING	READOUT VERTICAL CENTERING
CH 1 STEP BALANCE	CH 1 STEP BALANCE
CH 2 STEP BALANCE	CH 2 STEP BALANCE
CH 3 STEP BALANCE	CH 3 STEP BALANCE
CH 4 STEP BALANCE	CH 4 STEP BALANCE
CH 1 MF/LF GAIN & COMP	CH 1 MF/LF GAIN & COMP
CH 1 INPUT CAPACITANCE	CH 1 INPUT CAPACITANCE
CH 1 INPUT COMP X10	CH 1 INPUT COMP X10
CH 1 INPUT COMP X100	CH 1 INPUT COMP X100
CH 1 GAIN	CH 1 GAIN
CH 2 MF/LF GAIN & COMP	CH 2 MF/LF GAIN & COMP
CH 2 INPUT CAPACITANCE	CH 2 INPUT CAPACITANCE
CH 2 INPUT COMP X10	CH 2 INPUT COMP X10
CH 2 INPUT COMP X100	CH 2 INPUT COMP X100
CH 2 GAIN	CH 2 GAIN
CH 3 MF/LF COMP	CH 3 MF/LF COMP
CH 3 GAIN	CH 3 GAIN
CH 4 MF/LF COMP	CH 4 MF/LF COMP
CH 4 GAIN	CH 4 GAIN
DELAY-LINE HF COMP	DELAY-LINE HF COMP
CH 3 HF COMP	CH 3 HF COMP
CH 4 HF COMP	CH 4 HF COMP
HORIZONTAL X1 GAIN (TIMING)	HORIZONTAL X1 GAIN (TIMING)
HORIZONTAL X10 GAIN (TIMING)	HORIZONTAL X10 GAIN (TIMING)
READOUT HORIZONTAL GAIN	READOUT HORIZONTAL GAIN
MAG REGISTRATION	MAG REGISTRATION
A 20ns TIMING	A 20ns TIMING
B 20ns TIMING	B 20ns TIMING
2-5ns TIMING	2-5ns TIMING
X GAIN	X GAIN
VOLTS CAL	VOLTS CAL
B TRIGGER BANDWIDTH	B TRIGGER BANDWIDTH
MID-FREQUENCY FLATNESS	MID-FREQUENCY FLATNESS
CRT REPLACEMENT	

6081-25

The use of Table 5-1 is particularly important if only a partial procedure is done, or if a circuit requires readjustment due to a component replacement. To use this table, first find the adjustment that was made (extreme left column). Then move to the right, across the row, until you come to a darkened square. From the darkened square, move up the table to find the affected adjustment at the heading of that column. Check the accuracy of this adjustment using the Performance Check Procedure in Section 4. Then, if necessary, make a readjustment.

Specific interactions are called out within certain adjustment steps to indicate that the adjustments must be repeated until no further improvement is noted.

PREPARATION FOR ADJUSTMENT

It is necessary to remove the cabinet to do the Adjustment Procedure. See the cabinet removal instructions in the Maintenance section of this manual.

All test equipment items required to do the complete Adjustment Procedure are described in Table 4-1 at the beginning of Section 4, Performance Check Procedure. The specific items of equipment needed to do each subsection in this procedure are listed at the beginning of that subsection.

Connect the test equipment and the 2246 to an appropriate ac-power source and allow 20 minutes warmup before making any adjustments.

FACTORY CONTROL SETTINGS

The 2246 controls can be set up as they were when the instrument left the factory. This makes a good reference point when setting up the initial control settings for each section of the Adjustment Procedure.

Set up factory control settings as follows:

Select SERVICE MENU by simultaneously pressing menu-select buttons 1 and 6.

Press down-arrow button three times to underline INTERNAL SETTINGS MENU, then press SELECT button.

Press the down-arrow button once to underline MAKE FACTORY SETTINGS, then press RUN button.

When the routine is done, press QUIT button to return to normal oscilloscope mode.

INDEX TO ADJUSTMENT PROCEDURE

Power Supply, Display, and Z-Axis

Vertical

Horizontal

Measurement Bandwidth and Self Characterization

POWER SUPPLY, DISPLAY, AND Z-AXIS

Equipment Required (See Table 4-1):

Digital Multimeter (DMM)	50 Ω Coaxial Cable
Leveled Sine-Wave Generator	50 Ω Termination
Test Oscilloscope with 10X Probe	

See **ADJUSTMENT LOCATIONS**

at the back of this manual for test point and adjustment locations.

INITIAL CONTROL SETTINGS

1. Run MAKE FACTORY SETTINGS from the SERVICE MENU. See Factory Control Settings in the Introduction subsection in this section.

2. Set:

VERTICAL POSITION Controls	12 o'clock
A INTEN	10 o'clock
READOUT	12 o'clock
FOCUS	for well defined display
SCALE ILLUM	fully CCW
HOLDOFF	min (CCW)
TRIGGER LEVEL	12 o'clock

PROCEDURE

1. Power Supply DC Levels

a. Connect a Digital Multimeter (DMM) negative lead to chassis ground. Connect positive lead to first test point listed in Table 5-2 (all test points on J1204, Main board).

b. CHECK—Voltage reading is within the range given in Table 5-2.

c. Move DMM positive lead to each of the other supply voltages in Table 5-2 and check that voltage ranges are within limits.

NOTE

If all supply voltages are within the limits given in Table 5-2, it is not necessary to adjust the power supply. If voltages are not within limits, you will have to adjust the +7.5 V supply, recheck the other voltages, and continue with a complete readjustment of the instrument.

d. Connect a Digital Multimeter (DMM) negative lead to chassis ground and positive lead to +7.5 V test point (J2104-8).

Table 5-2
Power Supply Voltage Limits

Nominal Supply Voltage	Test Point (+ lead)	Limits (0°C to 50°C) Min	Max
+7.5 V	J1204-8	+7.42	+7.57
+130 V	J1204-11	+127.17	+135.03
+55 V	J1204-10	+58.36	+59.84
+15 V	J1204-7	+14.65	+15.55
+5.0 V	J1204-1,2	+5.05	+5.25
−5.0 V	J1204-5	−5.14	−5.35
−7.5 V	J1204-9	−7.48	−7.78
−15 V	J1204-6	Approx. −16 V	

e. ADJUST—+7.5 V Adj (R2252) for +7.5 V and check that all supply voltages in Table 5-2 are within limits. The +7.5 V Adjustment is accessible through the right side frame.

f. Disconnect Digital Multimeter.

2. Grid Bias (R2719)

a. Set:

HORIZ MODE	X-Y
VERT MODE	CH 1 (CH 2 off)
CH 1 VOLTS/DIV	5 V
CH 1 COUPLING	GND
BW LIMIT	On
A INTEN	Fully CCW (off)
B INTEN	Fully CCW (off)
READOUT (Intensity)	Fully CCW (off)
SCALE ILLUM	Fully CCW (off)

b. ADJUST—Grid Bias (R2719) for a visible dot.

c. Position dot just off center screen with vertical or horizontal POSITION controls.

d. Set FOCUS control for a well defined dot.

e. ADJUST—Grid Bias (R2719) so that dot is no longer visible.

3. Astigmatism (R2788)

a. Set:

HORIZ MODE	A
A INTEN	10 o'clock
READOUT (Intensity)	12 o'clock
SEC/DIV	5 μs
VAR SEC/DIV	Detent (fully CW)
CH 1 VOLTS/DIV	10 mV
CH 1 COUPLING	DC

b. Connect Leveled Sine-Wave Generator output to the CH 1 input connector via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination. Set for a 5-division display at 50 kHz.

c. ADJUST—Astigmatism (R2788) together with front-panel FOCUS control for best overall resolution of the sine-wave display.

d. Disconnect: Leveled Sine-Wave Generator.

4. Trace Rotation

a. Set CH 1 COUPLING to GND.

b. Position trace to center horizontal graticule line and beginning of trace to first vertical graticule line.

c. ADJUST—TRACE ROTATION (front panel) to align trace parallel with center horizontal graticule line.

5. Geometry (R2784)

a. Set:

CH 1 VOLTS/DIV	0.1 V
CH 1 COUPLING	DC
SEC/DIV	50 μs
READOUT (intensity)	Fully CCW (off)

b. Connect Time Mark Generator to CH 1 via 50 Ω cable and 50 Ω termination. Display 10 μs time marks.

c. Position base trace below bottom graticule line.

d. ADJUST—Geometry (R2784) for minimum bowing of time marks across the full graticule area. Vertical bowing of time mark across screen should be no more than 0.1 division.

e. Disconnect Time Mark Generator.

6. Z-Axis Response (C2704)

a. Set:

READOUT (Intensity)	12 o'clock
SEC/DIV	5 μs
READOUT (Intensity)	Fully CCW (off)

b. Connect test oscilloscope with 10X probe to R2718 (either side).

c. ADJUST—Z-Axis Response (C2704) for flattest response possible of the signal displayed by the test scope.

d. Disconnect test oscilloscope.

7. Readout Jitter (R724)

a. Set:

READOUT (intensity)	12 o'clock
SEC/DIV	10 ms
CH 1 COUPLING	DC
A INTEN	Fully CCW (off)

b. Connect calibration generator to CH 1 input via 50 Ω Precision coaxial cable. Set generator for STD AMPL and 1 volt.

c. ADJUST—Readout Jitter (R724) for the least amount of jitter or sway in the readout.

d. Disconnect calibration generator.

VERTICAL

Equipment Required (See Table 4-1):

- Calibration Generator (PG506)
- Leveled Sine-Wave Generator
- 50 Ω Precision Coaxial Cable
- 50 Ω Termination
- Precision Normalizer (20 pF)

See **ADJUSTMENT LOCATIONS**

at the back of this manual for test point and adjustment locations.

INITIAL CONTROL SETTINGS

1. Run MAKE FACTORY SETTINGS from the SERVICE MENU. See Factory Control Settings in the Introduction subsection in this section.

b. Set:

VERTICAL POSITION	
Controls	12 o'clock
A INTEN	10 o'clock
READOUT	12 o'clock
FOCUS	for well defined display
HOLDOFF	min (CCW)
TRIGGER LEVEL	12 o'clock
TRIGGER SOURCE	VERT

PROCEDURE

1. Vertical Output Gain (R703) and Readout Vertical Centering (R260)

a. Run ADJUST VERTICAL OUTPUT routine.

Select SERVICE MENU. Simultaneously press menu-select buttons 1 and 6. Select INTERNAL SETTINGS MENU. Press down-arrow button three times to underline selection, then press SELECT button. Run ADJUST VERTICAL OUTPUT routine. Press down-arrow button twice to underline selection, then press RUN button.

NOTE

For this adjustment, the 2246 must be placed in the "normal" operating position to avoid incorrect alignment due to the effects of the earth's magnetic field.

b. ADJUST—Vertical Output Gain (R703) and Readout Vertical Centering (R260) alternately until dashed lines produced by the diagnostics are aligned with dotted lines on the graticule.

c. Press END button to end the ADJUST VERTICAL OUTPUT routine. Then press QUIT button to quit the Service Menu.

2. CH 1 Step Balance (R12)

a. Set:

VERTICAL MODE	CH 1 (CH 2 off)
CH 1 COUPLING	GND
BW LIMIT	On

b. Position trace to center of screen.

c. ADJUST—CH 1 Step Balance (R12) so the trace does not move vertically while switching CH 1 VOLTS/DIV switch from 10 mV to 50 mV.

3. CH 2 Step Balance (R22)

a. Set:

VERTICAL MODE	CH 2 (CH 1 off)
CH 2 COUPLING	GND

b. Postion trace to center of graticule.

c. ADJUST—CH 2 Step Balance (R22) so that trace does not move vertically while switching CH 2 VOLTS/DIV switch from 10 mV to 50 mV.

4. CH 3 Step Balance (R141)

a. Set VERTICAL MODE to CH 3 (CH 2 off).

b. Position trace to center of graticule.

c. ADJUST—CH 3 Step Balance (R141) so that trace does not move vertically while switching CH 3 VOLTS/DIV switch from 0.1 V to 0.5 V

5. CH 4 Step Balance (R161)

a. Set VERTICAL MODE to CH 4 (CH 3 off).

b. Position trace to center of graticule.

c. ADJUST—CH 4 Step Balance (R161) so that trace does not move vertically while switching CH 4 VOLTS/DIV switch from 0.1 V to 0.5 V.

6. CH 1 MF/LF Gain (R13) and Compensation (C1)

a. Set:

VERTICAL MODE	CH 1 (CH 4 off)
CH 1 VOLTS/DIV	50 mV
CH 1 COUPLING	DC
SEC/DIV	50 μs

b. Connect calibration generator to CH 1 input via 50 Ω BNC coaxial cable and 50 Ω BNC termination. Set generator for HIGH AMPL. Set Period to 10 kHz and adjust Pulse Amplitude for 5-division display.

c. ADJUST—CH 1 MF/LF Gain (R13) and Compensation (C1) for the flattest response.

7. CH 1 Input Capacitance (C114)

a. Set:

CH 1 VOLTS/DIV	10 mV
SEC/DIV	0.2 ms

b. Add precision normalizer between termination and CH 1 input connector. Set Calibration Generator Period to 1 kHz and adjust Pulse Amplitude for 5-division display.

c. ADJUST—CH 1 Input Capacitance (C114) for best flat top.

d. Remove precision normalizer from the input cable.

8. CH 1 Input Compensation X10 (C11)

a. Set:

CH 1 VOLTS/DIV	0.1 V.
SEC/DIV	50 μs

b. Set calibration generator period to 10 kHz and adjust pulse amplitude for a 5-division display.

c. ADJUST—CH 1 Input Compensation X10 (C11) for flattest response.

9. CH 1 Input Compensation X100 (C10)

a. Set CH 1 VOLTS/DIV to 1 V.

b. Set calibration generator amplitude for a 5-division display.

c. ADJUST—CH 1 Input Compensation X10 (C10) for flattest response.

10. CH 1 Gain (R211)

a. Set calibration generator to STD AMPL and Amplitude to 50 mV. Remove 50 Ω termination from input cable.

b. Set:

CH 1 VOLTS/DIV	10 mV
SEC/DIV	0.2 ms

c. ADJUST—CH 1 Gain (R211) for exactly a 5-division display amplitude.

11. CH 2 MF/LF Gain (R23) and Compensation (C2)

a. Set:

VERTICAL MODE	CH 2 (CH 1 off)
CH 2 VOLTS/DIV	50 mV
CH 2 COUPLING	DC
SEC/DIV	50 μs

b. Move calibration generator signal to CH 2 input. Add 50 Ω termination.

c. Set calibration generator for HIGH AMPL. Set Period to 10 kHz and adjust Pulse Amplitude for 5-division display.

d. ADJUST—CH 2 MF/LF Gain (R23) and Compensation (C2) for flattest response.

12. CH 2 Input Capacitance (C124)

a. Set:

CH 2 VOLTS/DIV	10 mV
SEC/DIV	0.2 ms

b. Add precision normalizer between termination and CH 2 input connector. Set calibration generator Period to 1 kHz and adjust Pulse Amplitude for 5-division display.

c. ADJUST—CH 1 Input Capacitance (C124) for best flat top.

d. Remove precision normalizer from the input cable.

13. CH 2 Input Compensation X10 (C21)

a. Set:

CH 2 VOLTS/DIV	1 V.
SEC/DIV	50 μs

b. Set calibration generator Period to 10 kHz and adjust pulse amplitude for 5-division display.

c. ADJUST—CH 2 Input Compensation X10 (C21) for flattest response.

14. CH 2 Input Compensation X100 (C20)

a. Set CH 2 VOLTS/DIV to 1 V.

b. ADJUST—CH 2 Input Compensation X100 (C20) for flattest response.

15. CH 2 Gain (R221)

a. Set calibration generator to STD AMPL and Amplitude to 50 mV. Remove 50 Ω termination from input cable.

b. Set:

CH 2 VOLTS/DIV	10 mV
SEC/DIV	0.2 ms

c. ADJUST—CH 2 Gain (R221) for exactly a 5-division display amplitude.

16. CH 3 MF/LF Compensation (C134)

a. Set:

VERTICAL MODE	CH 3
CH 3 VOLTS/DIV	0.1 V
SEC/DIV	50 μs

b. Move calibration generator signal to CH 3 input. Add 50 Ω termination.

c. Set calibration generator for HIGH AMPL. Set Period to 10 kHz and adjust Pulse Amplitude for a 5-division display.

d. ADJUST—CH 3 MF/LF Compensation (C134) for flattest response.

17. CH 3 Gain (R231)

a. Set:

CH 3 VOLTS/DIV	0.5 V
SEC/DIV	2 ms

b. Set calibration generator for STD AMPL. Set amplitude to 2 V. Remove 50 Ω termination.

c. ADJUST—CH 3 Gain (R231) for exactly 4 divisions display amplitude.

18. CH 4 MF/LF Compensation (C154)

a. Set:

VERTICAL MODE	CH 4 (CH 3 off)
CH 4 VOLTS/DIV	0.1 V
SEC/DIV	50 μs

b. Move calibration generator signal to CH 4 input. Add 50 Ω termination.

c. Set calibration generator for HIGH AMPL. Set Period to 10 kHz and adjust Pulse Amplitude for a 5-division display.

d. ADJUST—CH 4 MF/LF Compensation (C154) for flattest response.

19. CH 4 Gain (R241)

a. Set:

CH 4 VOLTS/DIV	0.5 V
SEC/DIV	0.2 ms

b. Set calibration generator for STD AMPL. Set amplitude to 2 V. Remove 50 Ω termination.

c. ADJUST—CH 4 Gain (R241) for exactly a 4-division display amplitude.

d. Disconnect calibration generator from CH 4.

20. Delay-line HF Compensation (R272, R273, R275, C274, C273)

a. Set:

VERTICAL MODE	CH 1 (CH 4 off)
CH 1 VOLTS/DIV	50 mV
SEC/DIV	20 ns
BW LIMIT	Off

b. Connect calibration generator positive-going FAST RISE OUTPUT to the CH 1 input via a 50 Ω precision coaxial cable and a 50 Ω termination.

c. Set calibration generator for FAST RISE at 1 MHz and adjust Pulse Amplitude for a 5-division display.

d. Position the top of display to the center horizontal graticule line.

e. ADJUST—Delay-line HF Compensations (R272, R273, R275) for flattest response and C274 and 273 for sharpest front corner with minimum overshoot. Figure 5-1 shows the area of the waveform is affected by each adjustment.

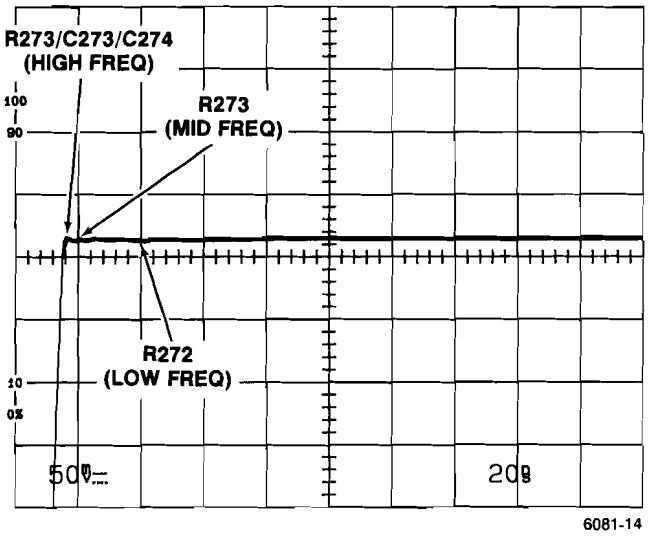

Figure 5-1. Areas of waveform affected by HF compensation adjustments

21. CH 3 HF Compensation (C138)

a. Set:

VERTICAL MODE	CH 3 (CH 1 off)
CH 3 VOLTS/DIV	0.5 V

b. Move calibration generator signal to CH 3. Set Pulse Amplitude to maximum to obtain about a 2.5-division display.

c. ADJUST—CH 3 HF Compensation (C138) for flattest response.

22. CH 4 HF Compensation (C158)

a. Set:

VERTICAL MODE	CH 4 (CH 3 off)
CH 4 VOLTS/DIV	0.5 V

b. Move calibration generator signal to CH 4.

c. ADJUST—CH 4 HF Compensation (C158) for flattest response.

d. Disconnect calibration generator.

23. CH 1 and CH 2 Bandwidth Check

a. Set:

VERTICAL MODE	CH 1 (CH 4 off)
CH 1 VOLTS/DIV	2 mV
SEC/DIV	0.1 ms

b. Connect leveled sine-wave generator output to the CH 1 input via a 50 Ω precision coaxial cable and a 50 Ω BNC termination.

c. Set leveled sine-wave generator output for a six-division signal amplitude at 50 kHz.

d. Set the generator Frequency Range and Frequency Variable controls for a 100 MHz output signal.

e. CHECK—the displayed signal amplitude is 4.2 divisions or more.

f. Repeat the frequency setup and CHECK procedure for VOLTS/DIV settings of 5 mV through 1 V.

NOTE

When checking bandwidth at a VOLTS/DIV setting of 1 V, use 5 divisions at 50 kHz and check for 3.5 divisions or more at 100 MHz.

g. Move the test signal to the CH 2 input.

h. Set:

VERTICAL MODE	CH 2 (CH 1 off)
CH 2 VOLTS/DIV	2 mV

i. Repeat the complete bandwidth check procedure for Channel 2.

24. CH 3 and CH 4 Bandwidth Check

a. Set:

VERTICAL MODE	CH 3 (CH 2 off)
CH 3 VOLTS/DIV	0.1 V

b. Move the leveled sine-wave generator signal to the CH 3 input.

c. Set the generator output for a six-division signal display at 50 kHz.

d. Set the generator Frequency Range and Frequency Variable controls for a 100 MHz output frequency.

e. CHECK—signal display amplitude is 4.2 divisions or more.

f. Repeat the procedure for 0.5 VOLTS/DIV setting.

g. Move the test signal to the CH 4 input.

h. Set:

VERTICAL MODE	CH 4 (CH 3 off)
CH 4 VOLTS/DIV	0.1 V

i. Repeat the procedure for CH 4.

j. Disconnect leveled sine-wave generator.

HORIZONTAL

Equipment Required (See Table 4-1):

Time Mark Generator	50 Ω Coaxial Cable
Calibration Generator	50 Ω Termination

See **ADJUSTMENT LOCATIONS**

at the back of this manual for test point and adjustment locations.

INITIAL CONTROL SETTINGS

1. Run MAKE FACTORY SETTINGS from the SERVICE MENU. See Factory Control Settings in the Introduction subsection in this section.

2. Set:

A INTEN	10 o'clock
READOUT	12 o'clock
FOCUS	for well defined display
SCALE ILLUM	fully CCW
HOLDOFF	min (CCW)
TRIGGER SOURCE	VERT
TRIGGER LEVEL	12 o'clock
VERTICAL POSITION Controls	12 o'clock

PROCEDURE

1. Horizontal X1 Gain (Timing) (R826)

a. Set:

VERTICAL MODE	CH 1 (CH 2 off)
CH 1 VOLTS/DIV	0.5 V

b. Connect time mark generator to CH 1 input via 50 Ω BNC coaxial cable and 50 Ω BNC termination. Set generator for 0.1 ms time marks.

c. Position display to center of screen.

d. ADJUST—Horizontal 1X Gain (R826) for one time mark per division over the center 8 divisions.

2. Horizontal X10 Gain (Timing) (R825)

a. Set X10 MAG to ON.

b. Set time mark generator for 10 μs time marks.

c. Position display about center screen.

d. ADJUST—Horizontal X10 Gain (R825) for one time mark per division over the center 8 divisions.

3. Readout Horizontal Gain (R823) and MAG Registration (R809)

a. Set:

X10 MAG	Off
SEC/DIV	1 ms
A INTEN	CCW (off)

b. Select Time CURSORS. Press the CURSORS button and select SEC from the menu.

c. Rotate the |← or DELAY control counterclockwise and the →| or Δ control clockwise until cursors stop moving.

d. ADJUST—MAG Registration (R809) and Horizontal Readout Gain (R823) alternately until the reference cursor lines up exactly with the left graticule line and the delta cursor lines up exactly with the right graticule line.

e. Remove CURSORS from screen. Press CLEAR DISPLAY button.

f. Set:

SEC/DIV	20 μs
A INTEN	10 o'clock

g. Set time mark generator for 0.1 ms time marks.

h. Position rising edge of middle time mark to the center vertical graticule line.

i. Set X10 MAG to On.

j. INTERACTION—between MAG Registration and horizontal positioning of the time cursors. Check For less than 0.5 division shift of time mark rising edge between MAG off and MAG on. If not within 0.5 division, recheck the accuracy of R809 and R823 adjustments; readjust if necessary.

4. A 20ns Timing (C314)

a. Set:

X10 MAG	Off
SEC/DIV	20 ns

b. Set time mark generator for 20 ns time marks.

c. ADJUST—A 20ns Timing (C314) for one time mark per division over the center 8 divisions.

5. B 20ns TIMING (C329)

a. Set:

HORIZONTAL MODE	B
SEC/DIV (B)	20 ns

b. Set time mark generator for 20 ns Time Marks.

c. ADJUST—B 20ns TIMING (C329) for one time mark per division over the center 8 divisions.

6. 2-5ns Timing (C807, C814)

a. Set:

HORIZONTAL MODE	A
X10 MAG	On
CH 1	50 mV
CH 1 COUPLING	AC

b. Set time mark generator for 5 ns time marks.

c. ADJUST—2-5ns Timing (C807, C814) for 1 cycle for each 2.5 divisions over the center 8 divisions. See Figure 5-2. Use the vertical transition of the sine wave instead of the peaks for better accuracy.

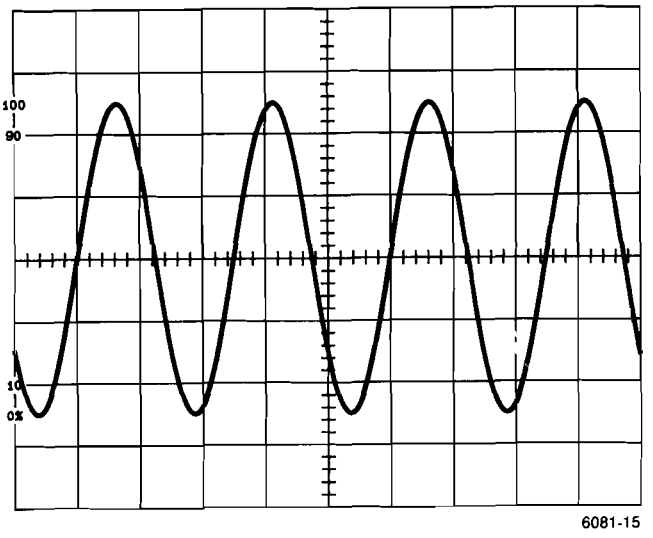

Figure 5-2. 2-5ns Timing.

d. INTERACTION—between C807 and C814. Readjust as necessary to make the timing at 2.5, 5, and 7.5 divisions within ±0.2 division (1 minor division).

e. Disconnect time mark generator.

7. X Gain (R827)

a. Set:

X10 MAG	Off
Horizontal MODE	X-Y
VERTICAL MODE	CH 2
CH 1 VOLTS/DIV	10 mV

b. Connect calibration generator to CH 1 input via 50 Ω coaxial cable. Set generator for STD AMPL. Set amplitude to 50 mV.

c. ADJUST—X Gain (R827) for 5 divisions of horizontal signal.

d. Disconnect calibration generator.

MEASUREMENT BANDWIDTH AND SELF CHARACTERIZATION

Equipment Required (See Table 4-1):

Digital Multimeter (DMM)

Leveled Sine-Wave Generator

50 Ω Coaxial Cable

INITIAL CONTROL SETTINGS

1. Run MAKE FACTORY SETTINGS from the SERVICE MENU. See Factory Control Settings in the Introduction subsection in this section.

2. Set:

A INTEN	10 o'clock
READOUT	12 o'clock
FOCUS	for well defined display
SCALE ILLUM	fully CCW
HOLDOFF	min (CCW)
TRIGGER SOURCE	VERT
TRIGGER LEVEL	12 o'clock
VERTICAL POSITION Controls	12 o'clock

PROCEDURE

1. Volts Cal (R920)

a. Connect digital multimeter (DMM) LO lead to chassis ground and the HI lead to R921 pin 6.

b. ADJUST—Volts Cal (R920) so the DMM reads 0.250V.

2. B Trigger Bandwidth (R455) and Mid-Frequency Flatness (R469)

a. Set:

VERTICAL MODE	CH 2 (CH 1 off)
CH 2 VOLTS/DIV	20 mV
SEC/DIV	50 μs

b. Preset potentiometers R455 and R469 to midrange.

c. Run the SELF CAL routine. Press CH 1/CH 2 VOLTMETER button and select SELF CAL.

d. Connect leveled sine-wave generator output to the CH 2 input connector via a 50 Ω BNC precision coaxial cable and a 50 Ω BNC termination. Set generator for a 5-division display at 50 kHz.

e. Set CH1/CH2 VOLTMETER for PK-PK voltage measurement. Set output of Leveled Sine-Wave Generator for a peak-to-peak readout display of 100 mV ±0.5 mV. Then set generator to 115 MHz.

f. ADJUST— Trigger Bandwidth (R455) for a peak-to-peak readout of 70.7 mV ±0.5 mV.

g. Set leveled sine-wave generator to 12 MHz.

h. ADJUST—Mid-Frequency Flatness (R469) for the minimum peak-to-peak readout.

i. Set leveled sine-wave generator to the frequency between 8 and 20 MHz that produces the lowest peak-to-peak readout.

j. ADJUST—Mid-Frequency Flatness (R469) for a peak-to-peak readout of 99.5 mV.

k. CHECK—the peak-to-peak readout remains between 98 mV and 102 mV when the generator frequency is varied from 8 MHz to 20 MHz. If the readout

goes out of range, readjust R469 (at that frequency) for a slightly higher or lower value as necessary, and recheck from 8 MHz to 20 MHz.

l. INTERACTION—between B Trigger Bandwidth and Mid-Frequency Flatness adjustments. Recheck the B trigger bandwidth. If necessary, readjust R455 and repeat the complete procedure (except presetting the controls) until the readout remains within 98 to 102 mV in the frequency range of 8 MHz to 20 MHz.

m. Disconnect test equipment.

3. Self Characterization

a. Run the SELF CAL MEASUREMENTS routine. Press menu-select buttons 1 and 6. Select INTERNAL SETTINGS MENU, then SELF CAL MEASUREMENTS. Press RUN to start the routine.

b. Run MAKE FACTORY SETTINGS routine. Press up-arrow to select MAKE FACTORY SETTINGS. Press RUN to start the routine. When done, press QUIT to return to normal oscilloscope mode.

MAINTENANCE

This section of the manual contains information for conducting preventive maintenance, troubleshooting, and corrective maintenance on the 2246 Oscilloscope. General information regarding the care and handling of the semiconductor devices that can be damaged by static discharges is provided in "Static-Sensitive Components."

Routine cleaning instructions and visual inspection for defects are covered in "Preventive Maintenance". Internal testing capabilities and diagnostic test routines are included in the "Troubleshooting" part of this section. Circuit board removal procedures are included in the "Corrective Maintenance" part of this section.

STATIC-SENSITIVE COMPONENTS

The following precautions are applicable when performing any maintenance involving internal access to the instrument.

CAUTION

Static discharge can damage any semiconductor component in this instrument.

This instrument contains electrical components that are susceptible to damage from static discharge. Table 6-1 lists the relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

When performing maintenance, observe the following precautions to avoid component damage:

1. Minimize handling of static-sensitive components.

2. Transport and store static-sensitive components or assemblies in their original containers or on a metal rail. Label any package that contains static-sensitive components or assemblies.

3. Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these

Table 6-1

Relative Susceptibility to Static-Discharge Damage

Semiconductor Classes	Relative Susceptibility Levels[a]
MOS or CMOS microcircuits or discretes, or linear microcircuits with MOS inputs (Most Sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFET	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (Least Sensitive)	9

[a]Voltage equivalent for levels (voltage discharged from a 100 pF capacitor through a resistance of 100 ohms):

1 = 100 to 500 V
2 = 200 to 500 V
3 = 250 V
4 = 500 V
5 = 400 to 600 V
6 = 600 to 800 V
7 = 400 to 1000 V (est)
8 = 900 V
9 = 1200 V

components. Servicing static-sensitive components or assemblies should be performed only at a static-free work station by qualified service personnel.

4. Keep anything capable of generating or holding a static charge off the work station surface.

5. Keep the component leads shorted together whenever possible.

6. Pick up components by their bodies, never by their leads.

7. Do not slide the components over any surface.

8. Avoid handling components in areas that have a floor or work-surface covering capable of generating a static charge.

9. Use a soldering iron that is connected to earth ground.

10. Use only approved antistatic, vacuum-type desoldering tools for component removal.

PREVENTIVE MAINTENANCE

INTRODUCTION

Preventive maintenance consists of cleaning, visual inspection, and checking instrument performance. Preventive maintenance on a regular basis may prevent instrument malfunction and improve instrument reliability. The required frequency of maintenance depends on the severity of the environment in which the instrument is used. An appropriate time to do preventive maintenance is just before instrument adjustment.

INSPECTION AND CLEANING

Visually inspect and clean the 2246 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, preventing efficient heat dissipation. It also provides an electrical conduction path that could result in instrument failure, especially under high-humidity conditions

CAUTION

Do not use chemical cleaning agents which might damage the plastics used in this instrument. Use a nonresidue-type cleaner, preferably isopropyl alcohol or a solution of 1% mild detergent with 99% water. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

Exterior

INSPECTION. Inspect the external portions of the instrument for damage, wear, and missing parts; use Table 6-2 as a guide. Instruments that appear to have been dropped or otherwise abused should be checked thoroughly to verify correct operation and performance. Deficiencies that could cause personal injury or could lead to further instrument damage should be repaired immediately.

CAUTION

Do not allow moisture to get inside the instrument during external cleaning. Use only enough liquid to dampen the cloth or applicator.

CLEANING. Loose dust on the outside of the instrument can be removed with a soft cloth or small soft-bristle brush. The brush is particularly useful on and around the controls and connectors. Remove remaining dirt with a soft cloth dampened in a mild detergent-and-water solution. Do not use abrasive cleaners.

Clean the light filters and the crt face with a soft lint-free cloth dampened with either isopropyl alcohol or a mild detergent-and-water solution.

Table 6-2

External Inspection Check List

Item	Inspect For	Repair Action
Cabinet, Front Panel, and Cover	Cracks, scratches, deformations, damaged hardware or gaskets.	Touch up paint scratches and replace defective components.
Front-panel Controls	Missing, damaged, or loose knobs, buttons, and controls.	Repair or replace missing or defective items.
Connectors	Broken shells, cracked insulation, and deformed contacts. Dirt in connectors.	Replace defective parts. Clean or wash out dirt.
Carrying Handle	Correct operation.	Replace defective parts.
Accessories	Missing items or parts of items, bent pins, broken or frayed cables, and damaged connectors.	Replace damaged or missing items, frayed cables, and defective parts.

Interior

To access internal portions of the instrument for inspection and cleaning, refer to the Removal and Replacement Instructions in the Corrective Maintenance part of this section.

INSPECTION. Inspect the internal portions of the 2246 for damage and wear, using Table 6-3 as a guide. Repair deficiencies immediately. The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Since overheating usually indicates other trouble in the instrument, it is important that the cause of overheating be corrected to prevent further damage.

If any electrical component is replaced, conduct a Performance Check for the affected circuit and for other closely related circuits (see Section 4 for the Performance Check). If repair or replacement work is done on any of the power supplies, conduct a complete Performance Check and, if so indicated, an instrument readjustment (see Section 5 for Adjustment Procedure).

CAUTION

To prevent damage from electrical arcing, ensure that circuit boards and components are dry before applying power to the instrument.

CLEANING. To clean the interior, blow off dust with dry, low-pressure air (approximately 9 psi). Remove any remaining dust with a soft brush or a cloth dampened with a solution of mild detergent and water. A cotton-tipped applicator is useful for cleaning in narrow spaces and on circuit boards. If these methods do not remove all the dust or dirt, the instrument may be spray washed using a solution of 5% mild detergent and 95% water as follows:

CAUTION

The front panel potentiometer and switchboard assembly must not be washed. Remove it before washing the rest of the instrument.

1. Remove covers and shields to reach parts to be cleaned (see Removal and Replacement Instructions).

2. Spray wash dirty parts with the detergent-and-water solution; then use clean water to THOROUGHLY rinse them. No detergent may remain in the attenuator or the high voltage areas of the circuitry.

3. Dry all parts with low-pressure air.

4. Dry all components and assemblies in an oven or drying compartment using low-temperature (125°F to 150°F) circulating air.

SWITCH CONTACTS. Switch contacts are permanently treated when assembled. Neither cleaning nor other preventive maintenance is necessary, unless the switch board is replaced or the switch assembly has remained disassembled for a long period of time.

Table 6-3

Internal Inspection Checklist

Item	Inspect For	Repair Action
Circuit Boards	Loose, broken, or corroded solder connections. Burned circuit boards. Burned, broken, or cracked circuit-run plating.	Clean solder corrosion with an eraser and flush with isopropyl alcohol. Resolder defective connections. Determine cause of burned items and repair. Repair defective circuit runs.
Resistors	Burned, cracked, broken, blistered.	Replace defective resistors. Check for cause of burned component and repair as necessary.
Solder Connections	Cold solder or rosin joints.	Resolder joint and clean with isopropyl alcohol.
Capacitors	Damaged or leaking cases. Corroded solder on leads or terminals.	Replace defective capacitors. Clean solder connections and flush with isopropyl alcohol.
Semiconductors	Loosely inserted in sockets. Distorted pins.	Firmly seat loose semiconductors. Remove devices having distorted pins. Carefully straighten pins (as required to fit the socket), using long-nose pliers, and reinsert firmly. Ensure that straightening action does not crack pins, causing them to break off.
Wiring and Cables	Loose plugs or connectors. Burned, broken, or frayed wiring.	Firmly seat connectors. Repair or replace defective wires or cables.
Chassis	Dents, deformations, and damaged hardware.	Straighten, repair, or replace defective hardware.

LUBRICATION

A regular periodic lubrication program for the instrument is not necessary. Most of the potentiometers used in this instrument are permanently sealed and generally do not require periodic lubrication. The backs of the front-panel knob guides have been lubricated when assembled and will require lubrication again only when the front panel assembly is replaced. Rotary switches are installed with proper lubrication when assembled and will require lubrication only when the rotor is replaced.

SEMICONDUCTOR CHECKS

Periodic checks of the transistors and other semiconductors in the oscilloscope are not recommended. The best check of semiconductor performance is actual operation in the instrument.

PERIODIC READJUSTMENT

To ensure accurate measurements, check the performance of this instrument every 2000 hours of operation, or if used infrequently, once each year. If you replace any components, it may be necessary to readjust the affected circuits.

Complete Performance Check instructions are given in Section 4 of this manual; adjustment instructions are given in Section 5. The Performance Check Procedure can be helpful in localizing certain troubles in the instrument. In some cases, minor problems may be revealed or corrected by readjustment. If only a partial adjustment is performed, see Table 5-1 (the interaction chart) for possible adjustment interaction with other circuits.

TROUBLESHOOTING

INTRODUCTION

Preventive maintenance performed on a regular basis should reveal most potential problems before an instrument malfunctions. However, should troubleshooting be required, the following information is provided to aid in locating a fault. In addition, the material presented in the "Theory of Operation" and "Diagrams" sections of this manual may be helpful while troubleshooting.

TROUBLESHOOTING AIDS

Diagnostic Firmware

This instrument contains built-in diagnostic routines that can aid in localizing failures. An automatic power-up self test checks the system RAM and ROM, readout interface, readout RAM and ROM, and interrupt circuitry. If a failure is detected, this information is presented in either of two ways: a flashing code display on the Trigger LEDs or, if the instrument is capable of presenting a readout, error messages in the crt display. In addition to the power-on testing, various diagnostic routines can be run from the Service mode using the SERVICE MENU. (See Internal Testing Capabilities in this subsection for the details.)

Schematic Diagrams

Complete schematic diagrams are located on tabbed foldout pages in the Diagrams section. Portions of circuitry mounted on each circuit board are enclosed by heavy black lines. The assembly number and name of the circuit are shown near the top or the bottom edge of the diagram.

Functional blocks on schematic diagrams are outlined with a wide grey line. Components within the outlined area perform the function designated by the block label. The Theory of Operation uses these functional block names when describing circuit operation as an aid in cross-referencing between the circuit description and the schematic diagrams.

Component numbers and electrical values of components in this instrument are shown on the schematic diagrams. Refer to the first page of the Diagrams section for the reference designators and symbols used to identify components. Important voltages and waveform reference numbers (enclosed in hexagonal-shaped boxes) are also shown on each diagram. Waveform illustrations are located adjacent to their respective schematic diagram.

Circuit Board Illustrations

Circuit board illustrations showing the physical location of each component are provided for use in conjunction with each schematic diagram. Each board illustration is found in the Diagrams section on the back of a foldout page, preceding the first related schematic diagram(s).

The locations of waveform test points are marked on the circuit board illustrations with hexagonal outlined numbers corresponding to the waveform numbers on both the schematic diagram and the waveform illustrations.

Circuit Board Locations

The placement in the instrument of each circuit board is shown in a board locator illustration. This illustration is located on the foldout page along with the circuit board illustration.

Circuit Board Interconnections

A circuit board interconnection diagram (schematic diagram 14) is provided in the Diagrams section to aid in tracing a signal path or power source between boards. All wire, plug, and jack numbers are shown along with their associated wire or pin numbers and signal names.

Power Distribution

Two Power Distribution diagrams (schematic diagrams 12 and 13) are provided to aid in troubleshooting power supply problems. These diagrams show the components that the various voltages are applied to and the jumper connections and decoupling components used to apply the power to those circuits. Excessive loading on a power supply by a circuit fault may be isolated by disconnecting the appropriate jumpers.

Grid Coordinate System

Each schematic diagram and circuit board illustration has a grid border along its left and top edges. A table

located next to each schematic diagram lists the grid coordinates of each component shown in that diagram. To aid in physically locating components on the circuit board, the table also lists the grid coordinates of each component in the circuit board illustration.

Near each circuit board illustration is an alphanumeric listing of all components mounted on that board. The second column in each listing identifies the schematic diagram in which each component can be found. These component-locator tables are especially useful when more than one schematic diagram is associated with a particular circuit board.

Component Color Coding

Information regarding color codes and markings of resistors is located in the color-coding illustration (Figure 9-1) at the beginning of the Diagrams section.

RESISTOR COLOR CODE. Resistors used in this instrument are carbon-film, composition, or precision metal-film types. They are usually color coded with the EIA color code; however, some metal-film type resistors may have the value printed on the body. The color code is interpreted starting with the stripe nearest to one end of the resistor. Composition resistors have four stripes; these represent two significant digits, a multiplier, and a tolerance value. Metal-film resistors have five stripes representing three significant digits, a multiplier, and a tolerance value.

CAPACITOR MARKINGS. Capacitance values of common plastic capacitors and small electrolytics are marked on the side of the capacitor body. Small, machine-insertable capacitors are numerically coded in picofarads. The first two numbers are the significant digits and the third number (if a three-number code) is the number of zeros following the digits. When there are two numbers separated by the letter "R," the two numbers are the significant digits; the letter marks the radix (decimal point). Some examples of this type of capacitor coding are as follows:

475 = 47 00000 pF = 4.7 uF
472 = 47 00 pF = .0047 uF
471 = 47 0 pF
470 = 47 pF
4R7 = 4.7 pF

The code numbers are difficult to locate and read on installed parts. Capacitor values may be found by referencing the circuit designation number in the "Replaceable Electrical Parts" list.

DIODE COLOR CODE. The cathode end of each glass-encased diode is indicated by either a stripe, a series of stripes or a dot. For most diodes marked with a series of stripes, the color combination of the stripes identifies three digits of the Tektronix Part Number, using the resistor color-code system. The cathode and anode ends of a metal-encased diode may be identified by the diode symbol marked on its body.

Semiconductor Lead Configurations

Figure 9-2 in the Diagrams section shows the lead configurations for semiconductor devices used in the instrument. These lead configurations and case styles are typical of those used at completion of the instrument design. Vendor changes and performance improvement changes may result in changes of case styles or lead configurations. If the device in question does not appear to match the configuration shown in Figure 9-2, examine the associated circuitry or consult a manufacturer's data sheet.

Multipin Connections

This instrument uses two types of cable connectors. The main type is an etched-circuit ribbon cable with pin connectors crimped directly to the end of the cable. The number one pin is indicated by a mark on the ribbon cable. The other type of connector is a plastic holder containing connectors crimped to the ends of individual wires. Orientation, where important, is indicated by a triangle (arrow).

TROUBLESHOOTING EQUIPMENT

The equipment listed in Table 4-1 of this manual, or equivalent equipment, may be useful when troubleshooting this instrument.

TROUBLESHOOTING TECHNIQUES

The following procedure is arranged in an order that enables checking simple trouble possibilities before requiring more extensive troubleshooting. The first two steps use diagnostic routines built into the operating system of the instrument.

The next four procedures are check steps that ensure proper control settings, connections, operation, and adjustment. If the trouble is not located by these checks, the remaining steps will aid in locating the defective component. When the defective component is located, replace it using the appropriate replacement procedure given under Corrective Maintenance in this section.

CAUTION

Before using any test equipment to make measurements on static-sensitive, current-sensitive, or voltage-sensitive components or assemblies, ensure that any voltage or current supplied by the test equipment does not exceed the limits of the component to be tested.

1. Power-up Tests

When the instrument power is applied, self tests are automatically run to verify proper operation of the system RAM and ROM, the readout interface and the interrupt circuitry. If the power-up test fails, failure codes appear in the Trigger Mode LEDs to identify the general location of the fault. (See Power-Up Testing later in this section for failure-code information.)

2. Diagnostic Routines

Various diagnostic routines can be run from the SERVICE MENU. The routines can be run at any time by displaying the SERVICE MENU and selecting the desired item from the menu using front panel pushbuttons.

Entry into the Service Menu and its uses are explained in the Diagnostic Routines discussion later in this section.

3. Check Control Settings

Incorrect control settings can give a false indication of instrument malfunction. If there is any question about the correct function or operation of any control, refer to the Operating Information in the 2246 Operators Manual.

4. Check Associated Equipment

Before proceeding, ensure that any equipment used with the 2246 is operating correctly. Verify that input signals are properly connected and that the interconnecting cables are not defective. Check that the ac-power-source voltage to all equipment is correct.

5. Visual Check

WARNING

To avoid electrical shock, disconnect the instrument from the ac power source before making a visual inspection of the internal circuitry.

Perform a visual inspection. This check may reveal broken connections or wires, damaged components, semiconductors not firmly mounted, damaged circuit boards, or other clues to the cause of an instrument malfunction.

6. Check Instrument Performance and Adjustment

Check the performance of either those circuits where trouble appears to exist or the entire instrument. An apparent trouble may be the result of misadjustment. The complete performance check is given in Section 4 of this manual and adjustment instructions are given in Section 5.

7. Isolate Trouble to a Circuit

To isolate problems, use any symptoms noticed when checking the instrument's operation to help localize the trouble to a particular circuit. For example, if the vertical deflection is incorrect on all channels, the problem is most likely from the delay line driver to the vertical output; if deflection is bad only on one channel, the problem is from the attenuator of that channel to the input of the delay line driver. The detailed block diagram shown in the foldout section may be used as an aid in determining signal flow and control line dependency for correct circuit operation. Refer to the troubleshooting hints given in Table 6-6 for diagnostic routine failures. Troubleshooting hints by diagram are given immediately following Table 6-6, and Table 6-9 may be used to aid in locating a problem in the measurement system.

8. Check Power Supplies

WARNING

For safety reasons, an isolation transformer must be used between the ac power main and the instrument's ac power input whenever troubleshooting is done with the cabinet removed. This is especially important when working in the Preregulator and Inverter Power Supply sections of the instrument.

When trouble symptoms appear in more than one circuit, first check the power supplies; then check the affected circuits by taking voltage and waveform readings. Check first for the correct output voltage of each individual supply. These voltages are measured between J1204 (interface connector between power supply and main board) and ground (J1204 pin 4 or 8). See the associated circuit board illustration and Table 6-4.

Voltages levels may be measured either with a DMM or with an oscilloscope. Voltage ripple amplitudes must be measured using an oscilloscope. Use a 1X probe with as short a ground lead as possible to minimize stray pickup.

NOTE

Use 20 MHz bandwidth limiting on the test oscilloscope. A higher bandwidth may produce higher observed ripple levels.

Table 6-4

Power Supply Voltage and Ripple Limits

Nominal Supply Voltage	Test Point (+ lead)	Limits (0°C to 50°C)		P-P Ripple[a]	
		Min	Max	60-150 Hz	20-40 kHz
+130	J1204-11	+127	+135	70 mV	70 mV
+58	J1204-10	+56	+60	40 mV	120 mV
+15	J1204-7	+14.6	+15.6	8 mV	4 mV
+7.5	J1204-8	+7.4	+7.6	8 mV	4 mV
+5.0	J1204-1,2	+5	+5.3	30 mV	20 mV
−5.0	J1204-5	−5.1	−5.4	4 mV	4 mV
−7.5	J1204-9	−7.4	−7.8	4 mV	4 mV
−15 unreg	J1204-6	Approx −16 V		10 mV	100 mV

[a]At rated load.

If the power-supply voltages and ripple are within the listed ranges in Table 6-4, the supply can be assumed to be working correctly. If they are outside the range, the supply may be either misadjusted, operating incorrectly, or excessively loaded. The power supply adjustment procedure is given in the Power Supply, Display, and Z-Axis subsection of Section 5 (the Adjustment Procedure).

A defective component elsewhere in the instrument can create the appearance of a power-supply problem and may also affect the operation of other circuits. Use the power distribution distribution diagrams (schematic diagrams 12 and 13 in the foldouts) to aid in localizing a loading problem to a particular circuit.

9. Check Circuit board Interconnections

After the trouble has been isolated to a particular circuit, again check for loose or broken connections, improperly seated semiconductors, and heat-damaged components.

10. Check Voltages and Waveforms

Often the defective component can be located by checking circuit voltages or waveforms. Typical voltages are listed on the schematic diagrams. Waveforms indicated on the schematic diagrams by hexagonal-outlined numbers are shown adjacent to the diagrams. Waveform test points are shown in the circuit board illustrations.

NOTE

Voltages and waveforms indicated on the schematic diagrams are not absolute and may vary slightly between instruments. To establish operating conditions similar to those used to obtain these readings, see the Voltage and Waveform Setup Conditions preceding the waveform illustrations in the Diagrams section.

Note the recommended test equipment, front-panel control settings, voltage and waveform conditions, and cable-connection instructions. Any special control settings required to obtain a given waveform are noted under the waveform illustration. Volts/Div and Sec/Div settings of the test oscilloscope for a waveform are indicated in the waveform illustration.

11. Check Individual Components

WARNING

To avoid electric shock, always disconnect the instrument from the ac power source before removing or replacing components.

The following procedures describe methods of checking individual components. Two-lead components that are soldered in place are most accurately checked by first disconnecting one end from the circuit board. This isolates the

measurement from the effects of the surrounding circuitry. See Figure 9-1 for component value identification and Figure 9-2 for semiconductor lead configurations.

CAUTION

When checking semiconductors, observe the static-sensitivity precautions given at the beginning of this section.

TRANSISTORS. A good check of a transistor is actual performance under operating conditions. A transistor can most effectively be checked by substituting a known-good component. 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-type transistor checker for testing. Static-type transistor checkers are not recommended, since they do not check operation under simulated operating conditions.

When troubleshooting transistors in the circuit with a voltmeter, measure both the emitter-to-base and emitter-to-collector voltages to determine whether they are consistent with normal circuit voltages. Voltages across a transistor may vary with the type of device and its circuit function.

Some of these voltages are predictable. The emitter-to-base voltage for a conducting silicon transistor will normally range from 0.6 V to 0.8 V. The emitter-to-collector voltage for a saturated transistor is about 0.2 V. Because these values are small, the best way to check them is by connecting a sensitive voltmeter across the junction rather that comparing two voltages taken with respect to ground. If the former method is used, both leads of the voltmeter must be isolated from ground.

If voltage values measured are less that those just given, either the device is shorted or no current is flowing in the external circuit. If values exceed the emitter-to-base values given, either the junction is reverse biased or the device is defective. Voltages exceeding those given for typical emitter-to-collector values could indicate either a nonsaturated device operating normally or a defective (open-circuited) transistor. If the device is conducting, voltage will be developed across the resistors in series with it; if open, no voltage will be developed across the resistors unless current is being supplied by a parallel path.

CAUTION

When checking emitter-to-base junctions, do not use an ohmmeter range that has a high internal current. High current may damage the transistor. Reverse biasing the emitter-to-base junction with a high current may degrade the current-transfer ratio (Beta) of the transistor.

A transistor emitter-to-base junction also can be checked for an open or shorted condition by measuring the resistance between terminals with an ohmmeter set to a range having a low internal source current, such as the R X 1 kΩ range. The junction resistance should be very high in one direction and much lower when the meter leads are reversed.

When troubleshooting a field-effect transistor (FET), the voltage across its elements can be checked in the same manner as previously described for other transistors. However, remember that in the normal depletion mode of operation, the gate-to-source junction is reverse biased; in the enhanced mode, the junction is forward biased.

INTEGRATED CIRCUITS. An integrated circuit (IC) can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of circuit operation is essential when troubleshooting a circuit having IC components. Use care when checking voltages and waveforms around the IC so that adjacent leads are not shorted together. An IC test clip provides a convenient means of clipping a test probe to an IC.

CAUTION

When checking a diode, do not use an ohmmeter scale that has a high internal current. High current may damage a diode. Checks on diodes can be performed in much the same manner as those on transistor emitter-to-base junctions.

DIODES. A diode can be checked for either an open or a shorted condition by measuring the resistance between terminals with an ohmmeter set to a range having a low internal source current, such as the R X 1 kΩ range. The diode resistance should be very high in one direction and much lower when the meter leads are reversed.

Silicon diodes should have 0.6 V to 0.8 V across their junctions when conducting; Schottky diodes about 0.2 V to 0.4 V. Higher readings indicate that they are either reverse biased or defective, depending on polarity.

RESISTORS. Check resistors with an ohmmeter. Refer to the Replaceable Electrical Parts list for the tolerances of resistors used in this instrument. A resistor normally does not require replacement unless its measured value varies widely from its specified value and tolerance.

INDUCTORS. Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit.

CAPACITORS. A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter set to one of the highest ranges. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after the capacitor is charged to the output voltage of the ohmmeter. An open capacitor can be detected with a capacitance meter or by checking whether the capacitor passes ac signals.

12. Repair and Adjust the Circuit

If any defective parts are located, follow the replacement procedures given under Corrective Maintenance in this section. After any electrical component has been replaced, the performance of that circuit and any other closely related circuit should be checked. Since the power supplies affect all circuits, performance of the entire instrument should be checked if work has been done on the power supplies. Readjustment of the affected circuitry may be necessary. Refer to the Performance Check Procedure and the Adjustment Procedure, (sections 4 and 5) and to Table 5-1 (Adjustment Interactions).

INTERNAL TESTING CAPABILITIES

The diagnostics built into the 2246 permit the technician to test much of the digital circuitry and the digital-to-analog interface. The following text describes the testing capabilities of the Measurement Processor and the firmware controlled circuitry.

Power-Up Testing

The systems shown in Figure 6-1 are tested at power-on. Failure codes appear in the Trigger MODE LEDs, with ON being shown as "x" and OFF as "o" in the figure. In the event of a display failure where error message cannot be displayed on the crt, the codes indicate a failure area to begin troubleshooting.

NOTE

In the following text (MB) means that Main board (bottom board) must be attached to do the testing, and (SB) means that Switch board (front panel board) must be attached. See the SERVICE Menu description for access to the diagnostic testing routines.

Measurement Processor System Testing Capabilities

1. ROM Headers. Compares expected System ROM checksum against calculated checksum.

2. RAM Testing. Exceptions are the low end of upper System RAM addresses that provide the system operating instruction stack and the power-down data storage space.

3. "MOV A 0505" Looping. Tests the Measurement Processor and checks for stuck bits on the Measurement Processor AD bus.

4. Interrupt Generation. Checks that the interrupt circuit functions.

5. VOLTS CAL Test. Checks for presence or absence of VOLTS CAL signal (vertical characterization test voltages) (MB).

6. D-to-A and A-to-D system. The A-to-D check covers the 0 V crossover (MB).

	Failure Code (seen on the Trigger LEDS)					
Tests Run	AUTO LEVEL	AUTO	NORM	TV LINE	TV FIELD	SGL SEQ
System RAM	X	o	o	o	o	o
System ROM1	o	X	o	o	o	o
System ROM2	X	X	o	o	o	o
Readout Interface	o	o	X	o	o	o
Interrupt Hardware	X	o	X	o	o	o

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Figure 6-1. Power-on test failure codes.

Readout System Testing Capabilities (MB)

1. Testing of communication buffer. Checks that data can be written to the Readout Processor from the Measurement Processor and that the same data can be read back.

2. Character RAM testing. Checks Readout Character RAM for write and read-back capability.

3. Testing of readout FREEZE capability.

Measurement Processor Interface Hardware Testing Capabilities (MB)

1. Reads back from the Processor Interface Shift Register.

Main board Hardware (MB)

1. Read back from Shift Register 0 (Attenuator and Preamplifier gain settings).

2. Read back from Shift Register 1 (Sweep, Volts Cal, and Auxiliary Shift Register).

3. Offset and gain error testing on preamplifiers for vertical characterization (Channels 1 and 2 only).

4. Offset and gain error testing on Delay Line Driver and Vertical Output Preamplifier for vertical characterization.

5. Test triggering of A and B Triggers with TB Cal signal from Processor board.

6. Test Sweep System and Delay Comparators with TB CAL signal from Processor board for horizontal characterization.

7. Test Display Logic IC U600 (SLIC) internal RAM.

8. Test Display Logic U600 (SLIC) internal control register.

9. Test Trigger Logic IC U602 (FLIC) internal control register.

SERVICE MODE MENU

The service mode driver menu is accessed by pressing the top and bottom menu-item buttons at the same time. Two menus are presented; the menu to the left is the service menu selections, and the menu to the right (next to the selection buttons) is the modifier menu selections.

Each service menu has a title and a number of items in the menu. The title appears in the top line of the CRT display, and the contained items appear under the title, indented (see Figure 6-2). Menu choices that are names of sub-menus have a following slash (/), and when one is underlined, the word "SELECT" appears in the modifier menu list. When a choice with sub-menus is selected, the sub-menu choices are displayed on the left side of the screen with the name of the selected sub-menu displayed in the top line.

A menu choice that has no following slash is an executable service routine. The routine may be run by underlining it and pressing the menu button next to the RUN label that appears in the modifier menu list. Executable servicing selections are: diagnostics that return either a pass message or a fail message along with service data; one-shot exercisers that carry out some service and immediately return to the menu; or regular exercisers that carry out a service while continuously displaying service data.

An underlined Service Menu choice is either available for selection or currently running. To select a menu item, use the buttons next to the up-arrow and down-arrow

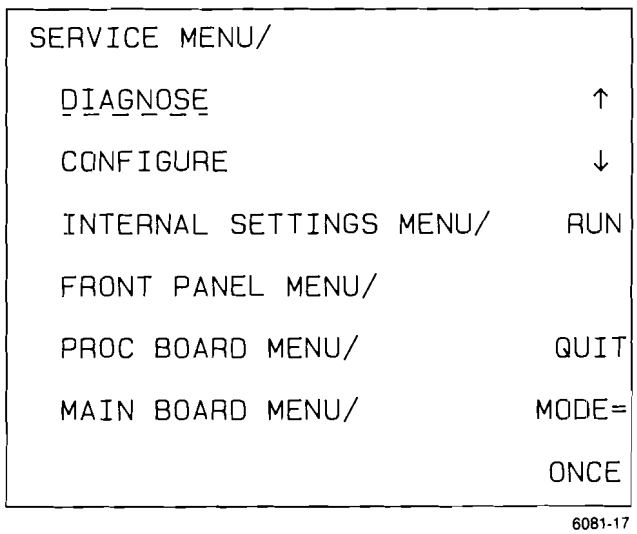


Figure 6-2. Service Menu with DIAGNOSE choice selected.

symbols in the modifier menu to move the underline up or down in the service menu. When the underline is beneath the service menu title, pressing the menu button next to up-arrow MENU label returns to the preceding menu containing that sub-menu (an up-menu operation).

Pressing QUIT at any time the choice is displayed will cause the scope to return to normal oscilloscope mode. If a service routine is operating that has an END menu selection displayed, pressing the button next to END exits the routine and returns to the selection menu (where QUIT is displayed). Routines that run once, return to the selection menu when finished.

The diagnostic tests in the service menu may be run with a conditional setting that determines how many times the routine is done. The conditional MODE setting menu choice appears in the modifier menu when the DIAGNOSE choice in the SERVICE menu is underlined (see Figure 6-2). One of the following mode types will be displayed:

ONCE, CONTINUOUS, UNTIL PASS, or UNTIL FAIL.

Change the mode type displayed in the bottom line by pressing the MODE button. When ONCE is the mode, the diagnostic is run once, and the result is displayed. When CONTINUOUS is the mode, the diagnostics are run continuously. When UNTIL PASS is the mode, the diagnostics are run until they pass. When UNTIL FAIL is the mode, the diagnostics are run until they fail. In order to stop a diagnostic that is looping in the CONTINUOUS, UNTIL PASS, or UNTIL FAIL mode, press the HALT button. The diagnostic will stop and display the current status. When the status is displayed, press END to return to the SERVICE MENU choices.

Service Routines

Descriptions of the available service routines are given in Table 6-5. The complete SERVICE MENU has this structure:

```
SERVICE/
   DIAGNOSE
   CONFIGURE
   INTERNAL SETTINGS MENU/
      MAKE FACTORY SETTINGS
      ADJUST VERTICAL OUTPUT
      SELF CAL MEASUREMENTS
   FRONT PANEL MENU/
      EXERCISE POTS
      EXERCISE LEDS
      EXERCISE SWITCHES
   PROC BOARD MENU/
      A TO D MENU/
         EXERCISE DACS
         EXERCISE PORTS
      READOUT MENU/
         SHOW READOUT ROM HEADER
         EXERCISE RO INTERFACE
      SHOW SYSTEM ROM HEADER
      EXERCISE TIME REF
      SHOW AUTO RESTARTS
   MAIN BOARD MENU/
      SHIFT REGISTER MENU/
         EXERCISE SR 0
         EXERCISE SR 1
         EXERCISE SR 2
      EXERCISE VOLTS REF
```

Table 6-5

Service Menu Selections

Menu Item	Action
DIAGNOSE	Runs all diagnostics in sequence, stopping at the first failed diagnostic. (See Table 6-6 for the diagnostic testing routines that are run.)
CONFIGURE	Configures the scope-mode operation of the instrument according to the users wishes. Configuration is done by answering yes/no questions. KEEP MENU ON WHEN ITEM SELECTED? The menu remains displayed after a measurement function from that menu has been selected. KEEP READOUT ON IN SGL SEQ MODE? The factory setting is to flash the readout on for a brief period after the signal display sequence has finished.
MAKE FACTORY SETTINGS	Resets the front panel settings to those shipped with the instrument. Used to produce a known setup condition. The following is a partial list of setups made: VERT MODE — CH1 and CH2 INPUT COUPLING — DC VOLTS/DIV — 0.1 V HORIZONTAL MODE — A SEC/DIV — 0.1 ms SLOPE — ⎍ A/B TRIG — A TRIGGER MODE — AUTO LVL TRIGGER SOURCE — CH1 TRIGGER COUPLING — DC MEASUREMENTS — OFF
ADJUST VERTICAL OUTPUT	Used to adjust the vertical output gain and centering (see Adjustment Procedure in Section 5).
SELF CAL MEASUREMENTS	Self characterizes the gain and offset errors in the vertical system and time base so that they may be compensated for in the measurements. This should be run only after instrument is warmed up properly, although if desired, it can be used to compensate for an unusual operating temperature.
EXERCISE POTS	Shows the name of the latest digitized potentiometer moved, along with its hexadecimal value (from FF to 00).
EXERCISE LEDS	Uses the delay control to select a single LED to be turned on. The exerciser is used to check for adjacent-row or adjacent-column shorts in the front panel board and for inoperative LEDs.
EXERCISE SWITCHES	Shows the name of the latest momentary-contact button pressed, or the name and position of the latest rotary switch turned. Pressing END exits the exerciser.
EXERCISE DACS	Attaches the DAC (U2302, diagram 9) to a single sample-and-hold channel (through U2303), and outputs a sawtooth waveform to that channel. Select the channel by pressing STEP. This exerciser may be used to trace a sample-hold value through the system, with the DAC system operating in a non-multiplexed mode.

Table 6-5 (cont)

Menu Item	Action
EXERCISE PORTS	Continuously does analog-to-digital conversion on a single A-to-D port. Select the port by pressing STEP. The exerciser may be used to trace a single potentiometer wiper value or probe code value through the system by operating the A-to-D converter in a non-multiplexed mode.
SHOW READOUT ROM HEADER	Shows the Readout ROM part number (U2408, diagram 9) and its expected and actual checksum.
EXERCISE RO INTERFACE	Continuously echos a marching-bit value across the readout interface. This exerciser may be used to check the integrity of the Measurement-Processor-to-Readout-Processor communication system.
EXERCISE TIME REF	Steps through the timing frequencies used to characterize the horizontal timing accuracy. Calibration periods are shown in the following table.

Time	Test Period
5 μs	32 μs
10 μs	64 μs
20 μs	128 μs
50 μs	256 μs
0.1 ms	512 μs
0.2 ms	1.024 ms
0.5 ms	2.048 ms
1 ms	4.096 ms
2 ms	8.192 ms
5 ms	32.768 ms

SHOW AUTO RESTARTS	Shows the address being executed if a software error occurs that causes execution out of normal memory space. This is for factory use only and is of no use in field servicing of the instrument. If an AUTO RESTART is ever seen, record the address displayed and report it to a service center; the error address is cleared from memory when SHOW AUTO RESTARTS is exited.
SHOW SYSTEM ROM HEADER	Shows the System ROM part numbers (U2519 and U2520, diagram 8) and checksums of the installed firmware version.
EXERCISE SR 0	Shifts alternate 0s and 1s through Shift Register 0 (U171, U172, and U173, diagram 1). This shift register sets Attenuator and Input Coupling relay positions and Vertical Preamplifier gain settings.
EXERCISE SR 1	Shifts alternate 0s and 1s through Shift Register 1 (U302 and U303, diagram 5; U1103, diagram 3). This shift register sets sweep speeds and auxiliary trigger settings (TV Trigger, Bandwidth Limit, X10 magnification, and X-Y Mode).
EXERCISE SR 2	Shift alternate 0s and 1s through Shift Register 2 (U502, diagram 4). This shift register sets the port selection for the A-to-D converter.
EXERCISE VOLT REF	Steps through all settings of the Voltage Reference Generator (U931, diagram 7) that are used to calibrate the Volts Measurement system. For each setting, Channels 1 and 2 are placed into the gain configuration (2 mV through 50 mV) that uses that setting. The voltage select lines (VOLTS CAL 2-0) may be checked for activity, and the generated VOLTS CAL SIGNAL may be measured to check its values.

DIAGNOSE Tests

The complete DIAGNOSE routine may be called up by the service technician as needed to aid in troubleshooting the instrument. Testing routines and troubleshooting information for use in the event of a failed test are given in Table 6-6.

Table 6-6

DIAGNOSE ROUTINES

Test Name	Path, Devices Tested, and Troubleshooting Actions
SR0	Attenuator and Preamplifier data path check.
	Devices tested: U171, U172, and U173 on diagram 1.
	NOTE
	U171 and U172 have +15 V clocks and data; U173 has +5 V clocks and data.
	Troubleshooting checks:
	Check pin 3 of each device for correct clock.
	Check pin 9 of each device for marching bit pattern.
	Attenuator relay latches are driven and a clacking sound is heard.
SR1	Sweeps and Auxiliary Trigger data path check.
	Devices tested:
	U302 and U303 on diagram 3; U1103 on diagram 3. Clock and data levels for U302 and U303 are +15 V; they are +5 V for U1103.
	Troubleshooting checks:
	Check pin 3 of each device for the correct clock.
	Check pin 9 of each device for a marching bit pattern.
SR2	Front Panel Potentiometer Multiplexer data path check.
	Device tested: U502, diagram 7.
	Troubleshooting checks:
	Check pin 11 for correct clock.
	Check pin 2 for data.
	Check pin 12 for multiplexer output.
SR3	Switch board data path check.
	NOTE
	There is no exerciser for SR3, but it is included in "DIAGNOSE."
	Devices tested: U2001 and U2002, diagram 10.
	Troubleshooting checks:
	Check pin 10 for serial data in.
	Check pin 9 for serial data out.
	Check pin 2 for clock.

Table 6-6 (cont)

Test Name	Path, Devices Tested, and Troubleshooting Actions
DAC ERROR 0	The A-to-D system, diagram 9, is not working correctly. Ground level was digitized out of the specified error limits. Devices to troubleshoot: U2515, diagram 8; U2306, U2304, U2302, U2300, U2301, diagram 9; and U2517 and U2518, diagram 8.
INTERFACE ERROR	Measurement Processor to Readout Processor Communications. WROTE (hex number that was written). READ (hex number that was read). This test rotates a 1 through the byte on the bus lines. The difference between WROTE and READ indicates which bit is stuck. Devices to troubleshoot: U2401, U2402, U2417C and D, and bus lines between Measurement Processor and Readout Processor. Check U2516 for enabling signal to U2402, and U2400 pin 22 for clock.
READOUT ROM	PART NUMBER (Tektronix Part Number). **NOTE** *Readout ROM is internal to the Readout Processor, U2400; a failure of this test may be a bad Readout Processor.*
READOUT RAM TEST	Writes and reads test bytes from the Readout RAM. RAM ERROR ADDRESS (hex address of error location). WROTE (hex data written). READ (hex data read). The difference between WROTE and READ data indicates a stuck bit. **NOTE** *Readout RAM is internal to the Readout Processor, U2400; a failure of this test may mean a bad Readout Processor.*
SR Failure	See exercisers for devices tested. The Fast Logic IC (U602, diagram 4) register is also checked, but there is no exerciser. SR (0 through 3) REG SR (0 through 3) or FLIC SR WROTE (hex write data) READ (hex data read)

Table 6-6 (cont)

Test Name	Path, Devices Tested, and Troubleshooting Actions
TRIGGER	The trigger diagnostic partially checks the Trigger SOURCE, Trigger CPLG, Trigger SLOPE, and TV signal Peak Detector circuitry.
	Error Messages:
	AT A TRIGGER A Trigger circuitry failed timing test.
	AT B TRIGGER B Trigger circuitry failed timing test.
	TIME SIGNAL TOO SMALL Trigger gate never occurred.
	Check A and B Ramp Generators, diagram 5.
	SLIC (Display Logic IC, U600) and FLIC (Trigger Logic IC, U602) gate outputs and level shifters, diagram 4.

TROUBLESHOOTING HINTS BY DIAGRAM

Vertical SELF CAL—Checks Cursor and Preamplifier Outputs

Vertical SELF CAL needs the below listed circuitry to be operational to work. Troubleshoot these circuits if the voltage measurements or the tracking cursors are not correct.

1. DAC system (U2300, U2301, U2302, U2304, U2305 and U2306, diagram 9).

2. Trigger Level Comparators (U431 and U421, diagram 5).

3. VERT COMP feedback (U702, diagram 2).

4. ECL to CMOS translators between U600 and U602 (diagram 4).

5. Data to Measurement Processor (data bus and bus transceivers, diagram 8).

6. VOLTS CAL signal (U931, U932, and U901, diagram 7).

Horizontal SELF CAL— Checks Sweep Timing

1. Put the oscilloscope into Self Cal and check the CH 5 Trigger at U421A pin 4 (diagram 3) for changing width calibration signals.

2. Run "EXERCISE TIME REF" exerciser and check for correct TB CAL SIG at U421A pin 4, diagram 3 (see Table 6-5).

Schematic Diagram 1—VERTICAL INPUTS

1. Run DIAGNOSE to check for shift register failure.

2. Run the shift register exerciser for Shift Register 0. Check for clock, data, and strobe signals. Check the shift register outputs.

NOTE

The outputs of U171 and U172 are at 15 V; the outputs from U173 are at 5 V.

3. Check the relay driver transistor array outputs. Normal output voltage is about 14 V when active.

4. Go to a known setup and check the outputs for correct levels (see Circuit Description in Section 3). The FACTORY SETTINGS choice available under INTERNAL SETTINGS of the Service Menu provides a known control state.

5. Check relay contacts.

6. Follow the signal path and check for correct signal and gains. Put in a known signal for each each attenuator setting and check at the Vertical Preamplifier inputs to

determine if the signal path is ok. The front panel boards and the attenuator shield have to be removed to gain access to the solder side of the board.

7. Check the channel signal buffer output if the vertical deflection of either channel 1 or channel 2 is defective.

8. Check gains and offsets of the CH 3 and CH 4 input buffers.

Schematic Diagram 2—PREAMPLIFIERS, DELAY LINE DRIVERS and VERTICAL OUTPUT

Perform the following troubleshooting checks with no signal input.

1. Check both inputs of the delay line. If offset on either side, troubleshoot the offsetting side. Inputs to the bases of Q250 and Q251 should be at +7.5 V.

2. Differential voltage across the delay line should be 0 V ±0.5 V.

3. Check signal gain through the Preamplifier IC.

4. Check INVERT operation.

5. Check the operation of U260 if the inputs to delay line driver are not at 7.5 V. This operational amplifier is the bias stabilization circuit that compares the average dc level to +7.5 and moves the emitters (and therefore the bases) of Q250 and Q251 to return the inputs to 7.5 V.

WARNING

Vertical output transistors Q701 and Q702 run extremely hot (in excess of 100°C). Use care when probing in those areas to not touch the heat sinks or cases with bare fingers.

WARNING

The vertical preamplifier runs hot. DO NOT touch it with bare fingers.

CAUTION

The metal tab on top of the vertical preamplifier IC (U701) is NOT ground. Do not connect a ground lead to it. Doing so may cause the IC to fail and usually causes R733 to the −5 V supply to open.

6. Check the leads of resistor pack R708. If the resistor pack is moved excessively, the leads will break. The resistor pack will then have to be replaced.

NOTE

The heat sinks on Q701 and Q702 may be removed for short periods of time to permit access for a test probe around the close-in circuitry. DO NOT leave them off for extended periods. Check that they are on all the way when replaced.

7. If the heat sinks on the output transistors shake loose, the plastic grommet inserted in the top of the heat sink prevents the sink from touching the metal cabinet. If the grommet is left out, then the metal cabinet may come in contact with the heat sink; and the transistor, the vertical preamplifier IC, and R723 may possibly fail. If the heat sinks are removed during maintenance, they must fit tightly when replaced and the grommet must be checked.

NOTE

The cases of Q701 and Q702 are the base leads of the transistors, not the collector as usually seen for a TO5 case. Also, the tab marks the collector lead, not the emitter.

8. The vertical outputs to the crt may be momentarily shorted together to check for offsets in the crt. (This should center the vertical trace.)

9. Pins 6 and 7 of U701 may be shorted together to check for offsets in the Vertical Amplifier. (This should bring the trace to within ±0.5 division of center.)

10. Pins 18 and 19 of U701 may be shorted together to check for offsets from the delay line. (This should bring the trace to within ±1.5 divisions of center.)

11. Shorting the bases of Q701 and Q702 together usually causes the vertical output circuit to oscillate.

12. Check the center lead of R708 for a voltage of about +60 V, and a common-mode voltage difference (between the two deflection plates) of about 0 V (when pins 6 and 7 of U701 are shorted together).

13. Check the operation of Vertical Comparator U702 at self characterization if the track measurement cursors are off screen when called up. (The Vertical Comparator circuit is enabled only during a vertical Self Cal.)

Schematic Diagram 4—DISPLAY AND TRIGGER LOGIC AND PROCESSOR INTERFACE

1. Put oscilloscope in A Horizontal Display Mode with CH 1 and CH 2 Vertical Modes on.

2. Check U600 vertical enables (CH 1 EN pin 39, and CH 2 EN pin 38)

3. Probe U600 ATRIG selects (ATS 1, ATS 2, ATS 0, and A SLOPE) and B TRIG selects (same as A) pins 26 through 33 while making trigger source and slope changes on the front panel. (Probe A lines for A trigger changes and B lines for B trigger changes.)

4. Check the 10 MHz clock at U600 pin 1 and U600 power sources. Check the 1 kHz clock at pin 2.

5. Check communication lines ($\overline{\text{SLIC RD}}$, $\overline{\text{SLIC WR}}$, ADDR0 through ADDR3, and MB DATA) for activity while making front panel trigger mode changes.

6. Check THO line. Signal should go HI then LO again for every new hardware setup condition (changing trigger mode, vertical mode, etc.)

7. Check TD1 for CMOS level switching signal.

8. Check TD0 for ECL level switching signal.

9. Check ATRIG at U602 pin 7.

10. Check A GATE at U602 pin 14. Vary the Holdoff control to see if spacing between A GATES changes.

11. Check Holdoff oscillator output at U600 pin 15. Vary holdoff control to see if the width of the oscillator pulses varies.

Schematic Diagram 5—A AND B SWEEPS AND DELAY COMPARATORS

1. Check that the baseline voltage (level that is present during holdoff after retrace) of the A and B ramp signals is −2 V. (The baseline level is referenced to the output of U309B and controlled by Q302, Q303, and Q304).

2. Check the Sweep End Comparators for correct output. The sweep should end at a maximum of 2.5 V. Check output of U316 (pin 15 for the A Sweep and pin 2 for the B Sweep) for about 3.8 V (the middle of ECL transitions).

3. Place the oscilloscope in delay and delta delay and check the Delay Time Comparators for correct outputs (DLY END 1 and DLY END 0).

NOTE

For firmware versions that permit an A INTEN Mode with no B Sweep (knobs locks at the same A and B Sweep speed), the intensified dot is produced by the action of the Delay and Delta Delay Comparators.

4. Check U301 for correct switching and delay level transfer. Vary the Delay Time and the Delta Delay time and check for smooth signal change at pins 13 and 2 of U301. If not correct, troubleshoot DAC system or front panel controls.

5. Run diagnostics to check for Shift Register 1 failure.

6. Exercise SR1 and check switching of U308, U307, U311, and U310.

Schematic Diagram 6—HORIZONTAL OUTPUT AMPLIFIER

1. Turn off the READOUT and check the ramps for equal (but opposite) waveforms on each plate. (Set up FACTORY SETTINGS using the Service Menu.)

CAUTION

DO NOT short the horizontal output leads together or to ground. This will cause the output amplifier FETs to fail.

2. The MOSFET output transistors (Q801 and Q802 left plate—Q805 and Q806 right plate) run hot. If either side is cold, it is defective.

3. If output is railed to one side or the other, check U801A and the common-mode feedback. This circuit is suppose to keep the outputs at about 70 V average to ground.

NOTE

Pins 12 and 13 of U802 may be shorted together to determine if the unbalance is before or after the horizontal preamplifier (U802). DO NOT short to ground.

4. Check the A and B RAMP input signals (A Horizontal Mode for A RAMP and B Horizontal Mode for B RAMP). They start at −2 V and ramp up to about 2.5 V.

5. Check the RO HORIZ input for correct waveform.

6. Check for an X-Axis input signal on pin 7 of U802 in X-Y mode (a signal must be applied to the CH 1 input).

7. Check at the junction of R855 and R854 (the common-mode bias point of Q810 and Q809) for 9.7 V.

8. Check at the junction of R846 and R852 (the common-mode source voltage of Q802 and Q805) for 15 V.

9. Check at the junction of R845 and R847 (the common-mode collector voltage of emitter followers Q803 and Q807) for 24 V.

10. Check the HD0 and HD1 signals to U802 (see Table 6-7 for display states).

11. The horizontal preamplifier, U802, runs warm to the touch, but not hot.

Table 6-7

Horizontal Display State Logic

HD0	HD1	Display
0	0	Readout
0	1	A Sweep
1	0	B Sweep
1	1	X-Y

Schematic Diagram 7—Z-AXIS, CRT, CALIBRATOR, AND CONTROL MUX

1. Turn off the Readout (READOUT control fully CCW) and test the node between CR2703 and C2713 for correct Z-Axis waveform. Vary A INTEN to check operation. (Readout signals add confusion to the waveforms.)

2. Check for correct auto-focus operation at the junction of CR2715 and C2712. Circuit action is exactly opposite of the Z-Axis to obtain focus tracking.

3. Parts replaced in the CRT High Voltage circuit and Z-Axis are safety controlled parts. Replacements need to be exact.

Schematic Diagram 8—MEASUREMENT PROCESSOR

1. Check U2501 for a RESET condition. Processor will be in permanent reset condition if RESET is HI. Check that RESET goes HI then LO again at power on.

2. Check $\overline{\text{SYS RESET}}$ at U2504E pin 10.

3. Check that $\overline{\text{U2521}}$ is LO when RESET is HI. (This signal prevents random RAM writes on power up and power down when the processor is being reset.)

4. Check the CLK input at U2501 pin 19. The Measurement Processor clock is 8 MHz. Check output of ceramic resonator Y2501 at U2504B pin 4 (24 MHz). Troubleshoot divider U2505A and U2505B if no 8 MHz present. The CLK is a CMOS level signal.

5. Check the INTR line for correct operation. The duty cycle of the signal is about 50% if the processor is not working correctly (not responding to INTR or interrupt counter U2508A not being reset correctly). Duty cycle of HI pulse is short when INTR is working correctly.

6. Check for $\overline{\text{INTA}}$ (interrupt acknowledge) at U2501 pin 24 and U2510 pins 1 and 19. There is only one interrupt vector, and it is hard wired on the input pins of U2510. If the interrupt is not being read, and the $\overline{\text{INTA}}$ signal is correct, suspect U2510.

7. Use the KERNEL test. Lift W2501 (from the pin 24 side) and ground the $\overline{\text{INTA}}$ signal line to force a 05(hex) code on the data bus. This causes a binary count on the

AD0 through A15 address lines. Check the address lines for decreasing binary count frequency from AD0 up. A stuck address line may be the result of a bus fault or a shorted device on the bus. Suspect that U2501 is bad if improper addressing occurs and the CLK signal and supply power are ok.

8. Check address decoding. Using a data analyzer or word recognizer probe, set up to recognize the address that produces a selected enabling strobe from the address decoding circuitry. Observe that the strobe is produced when the correct address is output by the Measurement Processor. The easiest way to generate most addresses during normal operation is to change a front-panel setting. See Table 6-8 for the addresses.

Schematic Diagram 9—READOUT AND DAC SYSTEM

1. Run the EXERCISE POTS exerciser and check the digitized front panel pots for proper operation. The name of the exercised pot is displayed in the readout along with its current hexadecimal value. The range of values is from 00 to FF and the displayed value should change smoothly as the pot is rotated.

2. Run the EXERCISE DACS exerciser and probe the demultiplexed outputs of U2303 and each of the sample-and-hold circuits for proper operation.

3. Run the EXERCISE PORTS exerciser and trace the signal path of of any problems with the A-to-D Converter.

4. Check Readout Request pulse ($\overline{\text{RO REQ}}$, U2410 pin 14).

5. Check Readout Blanking signal ($\overline{\text{RO BLANK}}$, U2410 pin 16).

6. Check activity of Readout Processor (U2400).

7. Check outputs of Vertical and Horizontal Readout DACs (U2412 and U2411).

8. Check outputs of Readout Mixers (U2416A and U2416D) and multiplexers (U2414 and U2415).

Schematic Diagram 10—SWITCHBOARD AND INTERFACE

1. Run the EXERCISE SWITCHES exerciser and check each of the front panel switches for correct operation. The circuit number of the latest switch pressed is displayed in the readout.

2. Run the EXERCISE LEDS exerciser and check that each of the front panel LEDS may be turned on. The circuit number of the lighted LED is displayed in the readout.

Schematic Diagram 11—POWER SUPPLY

1. Check +DC for a voltage of approximately (Vac_{RMS} X 1.414).

2. If power supply is in the chirp mode (continually restarting and shutting down) excessive loading of the +40 V supply is probable.

a. With the power off, short across VR2207 to shut off the Inverter. If the +40 V comes up (actually +43 V) when the power is turned on, then the preregulator is ok and Q2214 is not shorted.

NOTE

If your version of the power supply board has a jumper (W2201) in the drain lead of the current source FET (Q2214), use the following procedure to turn off the Inverter:

Turn off the power and unplug the ac power cord. Unsolder one lead of the jumper and pull it from the circuit board.

b. Short from pin 1 to pin 3 of T2205 (secondary base drive to the switching transistors). If the +40 V comes up then Q2209 and Q2210 are not shorted.

3. A possible failure is a short of Q2210, Q2209, or Q2214 immediately followed by the shorting of the remaining switching transistors in the inverter.

4. A dc power supply capable of supplying +45 V at 2 amperes may be used to drive the inverter circuit. If that operates correctly, then the problem in or before the preregulator circuit.

5. A +20 V supply may be used to supply charging voltage to Q2204. If the supply to U2201 pin 10 comes up, then Q2204 and Q2211 are ok.

Table 6-8

Measurement Processor I/O Memory Map

Address Bits (A19-A0)[a]	Signal Decoded	Signal Source
000x xxxx xxxx xxxx xxxx (00000-000ff)	Enable for interrupt vectors in U2519	U2516 pin 15 (diagram 8)
001x xxxx xxxx xxxx xxxx (20000-21fff)	Enable for RAM U2521	U2516 pin 14 (diagram 8)
011x xxxx xxxx xxxx x000 (60000)	$\overline{\text{LED CATH CLK}}$—Latches cathode data to Front Panel LEDs	U2517 pin 15 (diagram 8)
011x xxxx xxxx xxxx x001 (60001)	$\overline{\text{LED ANODE CLK}}$—Latches anode data to Front Panel LEDs	U2517 pin 14 (diagram 8)
011x xxxx xxxx xxxx x010 (60002)	$\overline{\text{RO BUF WR}}$—Latches bus 1 data to Readout Processor	U2517 pin 13 (diagram 8)
011x xxxx xxxx xxxx x011 (60003)	$\overline{\text{FREQ SEL CLK}}$, selects the frequency for time base measurement calibration	U2517 pin 12 (diagram 8)
011x xxxx xxxx xxxx x100 (60004)	$\overline{\text{DAC LSB CLK}}$—Latches the least significant byte of data and control for sample/hold channel to the D-to-A Converter	U2517 pin 11 (diagram 8)
011x xxxx xxxx xxxx x101 (60005)	DAC MSB CLK—Latches the most significant byte of data to the D-to-A Converter	U2517 pin 10 (diagram 8)
100x xxxx xxxx xxxx x000 (80000-9e000)	MB CNTL CLK—Enables Main board circuits	U2518 pin 15 (diagram 8)
1000 000x xxxx xxxx x000 (80000)	Asserts BEAM FIND	U503 pin 7 (diagram 4)
100x xxxx xxxx xxxx x001 (80001)	SW BD SR LOAD—Loads column data into Switch board Registers	U2518 pin 14 (diagram 8)
100x xxxx xxxx xxxx x010 (80002)	SW BD SR SHIFT—Shifts data in switch board registers to the SW BD DATA signal line	U2518 pin 13 (diagram 8)
100x xxxx xxxx xxxx x011 (80003)	$\overline{\text{SLIC WR}}$—Write to SLIC (U600 diagram 4)	U2518 pin 12 (diagram 8)
100x xxxx xxxx xxxx x100 (80004)	$\overline{\text{TIMER RESET}}$—Resets the Measurement Processor Interrupt Latch	U2518 pin 11 (diagram 8)
100x xxxx xxxx xxxx x110 (80006)	$\overline{\text{FLIC WR}}$—Write to FLIC (U602 diagram 4)	U2518 pin 9 (diagram 8)
1000 001x xxxx xxxx x000 (82000)	SR0 CLK—Clock Shift Register 0	U606F pin 12 (diagram 4)
1000 010x xxxx xxxx x000 (84000)	SR1 CLK—Clock shift Register 1	U606B pin 4 (diagram 4)
1000 011x xxxx xxxx x000 (86000)	Set MP DLY SEL LO (for delta or long delay)	U503 pin 13 (diagram 4)

[a]An x is a "don't care" bit. The possible bit range that addresses a function is given in binary notation; the most used range in software is given as a hexadecimal number(s) in parentheses.

Table 6-8 (cont)

Address Bits (A19-A0)[a]	Signal Decoded	Signal Source
1000 100x xxxx xxxx x000 (88000)	Set MP DLY SEL HI (for reference or short delay)	U503 pin 13 (diagram 4)
1000 100x xxxx xxxx x000 (8a000)	Set SR DATA bit LO	U606C pin 6 (diagram 4)
1000 110x xxxx xxxx x000 (8c000)	Set SR DATA bit HI	U606C pin 6 (diagram 4)
1000 111x xxxx xxxx x000 (8e000)	Shift Register 2 shift (U502 diagram 4)	ADDR3 (A16) U2512 pin 5 (diagram 8)
1001 111x xxxx xxxx x000 (9e000)	Shift Register 2 load (U502 diagram 4)	ADDR3 (A16) U2512 pin 5 (diagram 8)
1001 1xxx xxxx xxxx x011 (9e003)	$\overline{\text{TRIG CLK}}$—Loads coupling data to triggers	U600 pin 19 (diagram 4)
101x xxxx xxxx xxxx xxxx (a0000)	$\overline{\text{RO BUF RD}}$—Enable Readout Processor data onto bus 1 (used for diagnostics only)	U2516 pin 10 (diagram 8)
110x xxxx xxxx xxxx xxxx (c0000-c7fff)	Enable for ROM U2520	U2516 pin 9 (diagram 8)
111x xxxx xxxx xxxx xxxx (f0000-fffff)	Enable for ROM U2519	U2516 pin 7 (diagram 8)

[a]An x is a "don't care" bit. The possible bit range that addresses a function is given in binary notation; the most used range in software is given as a hexadecimal number(s) in parentheses.

TROUBLESHOOTING MEASUREMENT ERRORS

When certain measurement malfunctions occur, the symptoms usually indicate the circuit components that may be causing the problems. Read the following text to become familiar with the terms used in describing a measurement failure problem and the setup conditions needed to determine the symptoms. Then use Table 6-9 to check for measurement malfunction symptoms and probable causes.

Verify all the following conditions and read the definitions before attempting to use Table 6-9 for locating the source of measurement-error problems.

Conditions

All vertical channels can be successfully displayed and positioned independently.

The A and B sweeps both free-run and trigger successfully.

Normal-appearing readout text and cursors can be displayed.

Definition of Terms

Type 1 volts measurements are:

|← VOLTS →|

⏚ VOLTS →|

Type 2 volts measurements are:

DC

Type 3 volts measurements are:

+PEAK

−PEAK

PK-PK

Type 4 volts measurements are:

GATED +PEAK

GATED −PEAK

GATED PK-PK

Measurement value accuracy is the accuracy of number displayed in top line of readout on the crt.

Measurement cursor accuracy is the accuracy of the match between cursor position and the measurement value.

Trigger value accuracy is the accuracy of the number displayed on the trigger level cursor.

Trigger cursor accuracy is the accuracy of the match between cursor position the value displayed on the cursor.

A TL is the A trigger level measurement system.

B TL is the B trigger level measurement system.

Table 6-9

Measurement Error Troubleshooting Hints

Circuit Problem	Symptoms
	VERTICAL INPUTS (schematic diagram 1)
Ground relay stuck in signal position	Gross value problems for Types 1-4 volts measurements.
	Gross value problems A TL and B TL.
	Test: Use "EXERCISE VOLT REF." Check that the ground relay is in ground position.
x10, x100, x1, x2, x5 Relays and Attenuators	Gross value problems for affected channel for Types 1-4 volts measurements.
	Gross value problems in A TL and B TL.
	Test: Check channel accuracy at all VOLTS/DIV settings.
ZERO HYST Stuck LO (U173-13)	In Type 4 measurements, minor value problems for +PK cursors when gating interval is at negative end of waveform, and for −PK cursors when gating interval is at positive end of waveform.
	Test: Turn off all measurements; use the A Horizontal Mode. U431 pin 28 should be −3.0 volts.
	Switch to ALT Horizontal Mode. U431 pin 28 should be −0.7 volts.
$\overline{\text{RO FREEZE}}$ Stuck HI (U173-11)	Gross cursor problems for Types 1, 2, 3, and 4 measurements.
	Gross cursor problems for A TL and B TL.
	Test: Monitor during CH1/CH2 VOLTMETER menu SELF CAL. Signal line should reach TTL LO.
	VERTICAL PREAMP AND OUTPUT AMPLIFIER (diagram 2)
Preamp Trig Outputs Bad	Gross value problems for Types 2, 3, and 4 measurements for affected channel.
	Test: Check B triggering on the affected channel.
Preamp Vert Outputs or Enable Bad	Gross cursor problems for Types 2, 3, and 4 measurements for affected channel.
	Gross value accuracy problems for Type 1 measurements for affected channel.
	Test: With only the affected channel selected for display, check that channel is shown and check gain accuracy.
VERT COMP (U702-7)	Gross value problems with Type 1 measurements.
	Gross cursor problems with Types 2, 3, and 4 measurements.
	Gross cursor problems with A TL and B TL.
	Test: Lift W1101 and ground the base of Q703. VERT COMP should be toggling between TTL HI and TTL LO with readout on, or with 2 channels on (one at screen top, one at screen bottom).

Table 6-9 (cont)

Circuit Problem	Symptoms
	A AND B TRIGGER SYSTEM (schematic diagram 3)
A Trig Source Multiplexer (U421A)	"SEARCH FAILED AT 5 μs" for "SELF CAL" on time measurements (unless stuck in LINE).
	Minor to gross value problems (depending on which source is stuck) with the A TL measurement.
	Test: Set A Trigger SOURCE to VERT.
	For each channel, display only that channel and check that the signal applied to the displayed channel appears at pin 25 of U421.
A Trig Cplg Multiplexer (U421B)	May get "SEARCH FAILED at . . ." for "SELF CAL" on time measurements if coupling is stuck in HF REJ coupling.
	Minor to gross value problems with the A TL if coupling is stuck in any position except DC.
	Test: Switch to all coupling settings with 10 kHz square wave (all negative-going) connected to CH 1 input; use CH 1 for the A Trigger SOURCE.
	Check signal at U421 pin 25 (square edge for DC or NOISE REJ; rounded corner for HF REJ; spiked corner for LF REJ; signal center shifts to ground for AC).
A TRIG Stuck HI or LO (U421C-10)	"SEARCH FAILED AT 5 μs" for "SELF CAL" on time measurements. Gross value problems with A TL.
	Test: Set the A Trigger mode to NORM. Check that the sweep can be triggered on the Channel 1 signal.
A Trig Source Multiplexer (U431A)	Minor to gross value problems (depending on which bit is stuck) with Types 2, 3, and 4 measurements.
	Minor to gross value problems with B TL. "SEARCH RETURNED BAD VALUE AT . . ." on time measurements (unless stuck in LINE).
	Test: Set B trig source to VERT. For each channel, display only that channel and check that the signal applied to the displayed channel appears at U431 pin 25.
B Trig Cplg Multiplexer (U431B)	Minor to gross value problems with Types 3 and 4 measurements (depending on which coupling bit is stuck).
	Gross value problems with Type 2 measurements (unless stuck in measurement mode input).
	Minor to gross value problems with B TL.
B Trig BW Limiter	Minor value problems with Type 3 and 4 measurements if stuck in limited BW position.
	Minor value problems with Type 2 measurements if stuck in full BW position.
BW FULL B (U1103-14)	See notes on "B Trig BW limiter."
	Test: Should be CMOS LO when BW LIMIT button is lit.
	Should be CMOS HI when BW LIMIT button is not lit; use ALT Horizontal Mode with B CPLG set to DC.
B TRIG (U431C)	Gross value problems with Types 2, 3, and 4 measurements.
	Gross value problems with B TL.
	"SEARCH RETURNED BAD VALUE AT . . ." on time measurements.

Table 6-9 (cont)

Circuit Problem	Symptoms
B TV TRIG EN Stuck HI (U1103-4)	Gross value problems with Type 2 measurements.
	Test: Run CH1/CH2 VOLTMETER DC measurement and check that the B TV TRIG EN signal is at TTL LO.
$\overline{\text{VERT COMP EN}}$ (U1103-7)	See notes on "VERT COMP" (schematic diagram 2).
	Test: $\overline{\text{VERT COMP EN}}$ should be at a CMOS HI in normal use. Run "SELF CAL" from the CH1/CH2 VOLTMETER menu and check that $\overline{\text{VERT COMP EN}}$ goes to a CMOS LO.
Line/Time Base Cal Signal Mux Stuck in LINE Position (U1106A)	"RETURNED BAD SEARCH VALUE AT . . ." from "SELF CAL" for time measurements.
	Test: Run "EXERCISE TIME REF" diagnostic and check the output of U1106A (pin 1) for changing signal.
DC Average Circuit (U1101B)	Gross value problems for Type 2 measurements (minor value problems with LO frequencies if RC values in the filter are incorrect).
	Test: Display only CH1, run DC measurement. Apply a 50 Hz sine-wave signal with a DC offset to the CH 1 input. Check that only the dc value appears at output of the DC Average circuit.
DISPLAY AND TRIGGER LOGIC AND PROCESSOR INTERFACE (schematic diagram 4)	
MB RETURN (U502-12)	See notes on VERT COMP (schematic diagram 2).
MP DLY SEL (U503-13) or MP DLY SEL Interface (U602)	"SEARCH RETURNED BAD VALUE AT 5 μs" on time measurements.
	Test: Turn all measurements off. Use the A Horizontal Mode. The MP DLY SEL signal should be at a TTL HI.
SR DATA (U606C-6)	Effects are the same as those caused by malfunctions in SR0 and SR1.
	Test: The A Sweep rate changes when SEC/DIV knob rotated in the A Horizontal Display Mode.
SR0 CLK (U606F-12)	Effects are the same as those caused by malfunctions in SR0.
	Test: Channel 1 sensitivity changes when CH 1 VOLTS/DIV knob rotated.
SR1 CLK (U606B-4)	Effects same as those caused by malfunctions in SR1.
	Test: Check that the A Sweep rate changes when SEC/DIV knob is rotated in the A Horizontal Display Mode.
SR1 CLK TTL (U501-13)	Effects same as those caused by malfunctions in auxiliary section of SR1 (U1103, diagram 3).
	Test: HF noise in trace reduces when BW LIMIT button is lit and increases when not lit.
Processor-to-Display-Sequencer Interface (U600)	Gross effects on all voltage and time measurements.
	Test: Set A Trigger mode to NORM; check that the ATS 0-2 signal lines change when the A trigger SOURCE is changed. Check that no "LOW REP RATE" warning occurs with Type 4 measurements.

Table 6-9 (cont)

Circuit Problem	Symptoms
TDO Level Shifter (U603, Q603, Q602)	Same as Processor-to-Display-Sequencer Interface problem.
	Test: Using NORM mode for both triggers, VERT source for both triggers, CH1 only displayed; apply a four-division, square-wave signal to the CH 1 input. In the A Horizontal Mode, check that the Trig'd LED light goes off and the sweep stops running with the TRIGGER LEVEL control at full CW rotation. Check that the Trig'd LED can be lit and the sweep can be triggered when the Trigger Level is set to within the signal limits. Change to AUTO mode for A trigger; check that sweep free runs with the TRIGGER LEVEL control at full CW rotation. Check that the Trig'd LED can be lit and the sweep can be triggered when the Trigger Level is set to within the signal limits. Keep the A Sweep triggered for the next check. In B Horiz Mode, check that the Trig'd LED goes off, and the sweep stops running with the TRIGGER LEVEL control set at full CW rotation. Check that the Trig'd LED can be lit and the sweep made to trigger when Trigger Level is set to within the signal limits. Change to RUNS AFTER Mode for the B Trigger. Check that the B Sweep free runs.
DLY SEL Stuck LO (U602-32)	"SEARCH RETURNED BAD VALUE AT 5 μs" for "SELF CAL" on time measurements.
	Test: Run the |← TIME →| measurement in ALT Horizontal Mode with the A SEC/DIV at 1 ms/div and the B SEC/DIV at 0.1 ms/div. Check that first delay zone can be positioned over length of sweep with the |← control.
DLY SEL Stuck HI (U602-32)	"SEARCH RETURNED BAD VALUE AT 0.1 ms" for "SELF CAL" on time measurements.
	Test: Use settings given in previous test. Set the first delay zone to the start of the sweep with |← control. Check that the second delay zone can be positioned over the entire sweep length with the →| control.
ATS 0-2 (U600) and A Trig Source Multiplexer	See notes on "A Trig Source Multiplexer" (schematic diagram 4).
BTS 0-2 (Y600) and B Trig Source Multiplexer	See notes on "B Trig Source Multiplexer" (schematic diagram 3).
B SLOPE Stuck HI (U600-26)	Gross problems with +PEAK value, Types 2, 3, and 4 measurements. Gross value problems with the B TL measurement.
TRIG CLK (U600-19)	See notes on "A Trig Cplg Multiplexer" and "B Trig Cplg Multiplexer" (U421 and U431, diagram 3).

Table 6-9 (cont)

Circuit Problem	Symptoms
	A AND B SWEEP AND DELAY COMPARATORS (schematic diagram 5)
DLY END 0 Stuck LO or HI (U315-2)	"SEARCH RETURNED BAD VALUE AT 5 μs" for "SELF CAL" on time measurements.
	Test: Run the ⊢ TIME ⊣ measurement in ALT Horizontal Mode with the A SEC/DIV at 1 ms/div and the B SEC/DIV at 0.1 ms/div. Check that the first delay zone can be positioned over the length of sweep using the ⊢ control.
Ref/Delta Delay Mux Stuck (U301)	See notes on DLY SEL (schematic diagram 4).
SR1 A Sweep Controls (U302.U303)	"SEARCH RETURNED BAD VALUE AT affected SEC/DIV setting" for "SELF CAL" on time measurements.
	Test: Check SEC/DIV accuracy for the A Sweep at all SEC/DIV settings.
VOLT CAL 0-2 (U303)	Gross value problems for Types 1, 2, 3, and 4 measurements for most VOLTS/DIV settings on all channels.
	Test: Use "EXERCISE VOLT REF" diagnostic.
	Z-AXIS, CRT, CALIBRATOR, AND CONTROL MUX (schematic diagram 7)
VOLT CAL SIG (U931-3)	Gross value problems with Types 1, 2, 3, and 4 measurements. Gross value and cursor problems with A TL and B TL.
	Test: Use "EXERCISE VOLT REF" diagnostic.
	MEASUREMENT PROCESSOR (schematic diagram 8)
$\overline{\text{TB CAL SIG}}$ (U2509-10)	"SEARCH FAILED AT SWEEP SPEED . . ." in "SELF CAL" on time measurements.
	Test: Use "EXERCISE TIME REF" diagnostic. Check that $\overline{\text{TB CAL SIG}}$ is correct and signal path is intact to U421A pin 4 (diagram 3).
$\overline{\text{SLIC WR}}$ (U2518-12)	See notes on "Processor-to-Display-Sequencer Interface" (schematic diagram 4).
$\overline{\text{SLIC RD}}$ (U2503B-6)	See notes on "Processor-to-Display-Sequencer Interface" (schematic diagram 4).
$\overline{\text{FLIC WR}}$ (U2518-9)	See notes and tests on "TDO Level Shifter" (schematic diagram 4).
MB DATA (U2515-20)	See notes on "Processor-to-SLIC Interface" (schematic diagram 4).
	READOUT AND DAC SYSTEM (schematic diagram 9)
A TRIG LVL (U2304B-7)	See notes for "A TRIG" (schematic diagram 3).
	Test: Select A trigger, set A Trig Mode to NORM. Check that A TRIG LVL can be set to any value from −2.5 to +2.5 volts using the Trigger LEVEL control.

Table 6-9 (cont)

Circuit Problem	Symptoms
B REF TRIG LVL (U2304C-8)	See notes for "B TRIG" (hints for schematic diagram 3).
	Test: Select B trigger, set B Trig Mode to NORM, and select B Horizontal Mode.
	Check that B REF TRIG LVL can be set to any value from −2.5 to +2.5 volts with trigger level pot.
REF DELAY (U2305A-1)	"RETURNED BAD SEARCH VALUE AT . . ." for "SELF CAL" on time measurements.
	Test: Run I⊢ TIME ⊣I measurement in ALT Horizontal Mode; A at 1 ms/div, B at 0.1 ms/div.
	Check that first delay zone can be positioned over length of sweep with the I⊢ control.
DELTA DELAY (U2305D-14)	"RETURNED BAD SEARCH VALUE AT . . ." for "SELF CAL" on time measurements.
	Test: Use the preceding REF DELAY settings, and set first delay zone to start of sweep with I⊢ control.
	Check that second delay zone chan be positioned over length of sweep with ⊣I control.
REF CURSOR (U2305C-8)	Gross value problems with Type 1 measurements.
	Gross cursor problems with Types 2, 3, and 4 measurements.
	Gross cursor problems with A TL and B TL.
	Test: Run I⊢ VOLTS ⊣I CURSOR Measurement Mode.
	Check that I⊢ cursor can be positioned ±15 divisions around the trace ground level.
DELTA CURSOR (U2305B-7)	Gross value problems with Type 1 measurements.
	Gross cursor problems with Types 2, 3, and 4 measurements.
	Gross cursor problems with A TL and B TL.
	Test: Run I⊢ VOLTS ⊣I CURSOR Measurement Mode.
	Check that ⊣I cursor can be positioned ±15 divisions around the trace ground level.
Output Mixer, Mixer Attribute Latch Stuck (U2411, U2414, U2415)	Gross cursor problems with Types 1, 2, 3, and 4 measurements. Gross cursor problems with A TL and B TL.
	Test: Run I⊢ VOLTS ⊣I CURSOR Measurement Mode with only CH1 displayed.
	Check that cursors move with CH1 position control.
	Check that I⊢ cursor moves with ⊣I control, and ⊣I cursor moves with ⊣I control.
	Check that top and bottom line of readout do not move with any position control.

CORRECTIVE MAINTENANCE

INTRODUCTION

Corrective maintenance consists of component replacement and instrument repair. This part of the manual describes special techniques and procedures that are needed to replace components in this instrument. If it is necessary to ship your instrument to a Tektronix Service Center for repair or service, refer to the Repackaging for Shipment information in this section.

MAINTENANCE PRECAUTIONS

To reduce the possibility of personal injury or instrument damage, observe the following precautions.

1. Disconnect the instrument from the ac-power source before removing or installing components.

2. Verify that the line-rectifier filter capacitors are discharged prior to performing any servicing.

3. Use care not to interconnect instrument grounds which may be at different potentials (cross grounding).

4. When soldering on circuit boards or small insulated wires, use only a 15-watt, pencil-type soldering iron.

CAUTION

Do not exceed 9 in-lbs of torque when tightening the 6-32 screws.

5. Use care not to overtighten screws into chassis. Threads that have been formed directly into aluminum components can be stripped out. If this occurs, use a 6-32 nut to secure the screw.

WARNING

Portions of the power supply are floating at the ac line voltage level and pose a shock hazard if not isolated from ground.

6. Use an isolation transformer to supply power to the 2246 if you troubleshoot in power supply with power applied to the instrument.

OBTAINING REPLACEMENT PARTS

Electrical and mechanical replacement parts can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components may usually be obtained from a local commercial source. Before purchasing or ordering a part from a source other than Tektronix, Inc., please check the Replaceable Electrical Parts list for the proper value, rating, tolerance, and description.

NOTE

The physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance. Parts in the crt high-voltage and Z-Axis circuits are safety-controlled—USE EXACT REPLACEMENTS in these circuits.

Special Parts

In addition to the standard electronic components, some special parts are used in the 2246. These components are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. The various manufacturers can be identified by referring to the Cross Index-Manufacturer's Code number to Manufacturer at the beginning of the Replaceable Electrical Parts list (Section 8). Most of the mechanical parts in this instrument are manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., be sure to include all of the following information:

1. Instrument type (include modification or option numbers).

2. Instrument serial number.

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

4. Tektronix part number.

REPACKAGING FOR SHIPMENT

It is recommended that the original carton and packing material be saved in the event it is necessary for the instrument to be reshipped using a commercial transport carrier. If the original materials are unfit or not available, then repackage the instrument using the following procedure.

1. Use a corrugated cardboard shipping carton having a test strength of at least 275 pounds and with an inside dimension at least six inches greater than the instrument dimensions.

2. If instrument is being shipped to a Tektronix Service Center, enclose the following information: show the owner's address, name and phone number of a contact person, type and serial number of the instrument, reason for returning, and a complete description of the service required.

3. Completely wrap the instrument with polyethylene sheeting or equivalent to protect the outside finish and prevent entry of foreign materials into the instrument.

4. Cushion the instrument on all sides using three inches of padding material or urethane foam, tightly packed between the carton and the instrument.

5. Seal the shipping carton with an industrial stapler or strapping tape.

6. Mark the address of the Tektronix Service Center and also your own return address on the shipping carton.

MAINTENANCE AIDS

The maintenance aids listed in Table 6-10 include items required for performing most of the maintenance procedures in this instrument. Equivalent products may be substituted for the examples given, provided their characteristics are similar.

INTERCONNECTIONS

Several types of mating connectors are used for the interconnecting cable pins. The following information provides the replacement procedures for the various type connectors.

End-Lead Pin Connectors

Pin connectors used to connect the wires to the interconnect pins are factory assembled. They consist of machine-inserted pin connectors mounted in plastic holders. If the connectors are faulty, the entire wire assembly should be replaced.

Ribbon-Cable Connectors

The etch-ribbon cables have the connector pins crimped onto the wire runs. If the connectors are defective, the entire ribbon cable assembly must be replaced.

LITHIUM BATTERY (B2501)

The lithium battery used to supply backup power to the System RAM should last for at least 3 years. However, when it becomes necessary to replace the battery, be sure to observe the following general warning about disposal of lithium batteries.

WARNING

To avoid personal injury, observe proper procedures for handling and disposal of lithium batteries. Improper handling may cause fire, explosion, or severe burns. Do not recharge, crush, disassemble, heat the battery above 212°F (100°C), incinerate, or expose contents of the battery to water. Dispose of battery in accordance with local, state, and national regulations.

Typically, small quantities (less than 20) can be safely disposed of with ordinary garbage in a sanitary landfill. Larger quantities must be sent by surface transport to a hazardous waste disposal facility. The batteries should be individually packaged to prevent shorting and packed in a sturdy container that is clearly labeled "Lithium Batteries—DO NOT OPEN."

TRANSISTORS AND INTEGRATED CIRCUITS

Transistors and integrated circuits should not be replaced unless they are actually defective. If one is removed from its socket or unsoldered from the circuit board during routine maintenance, return it to its original board location. Unnecessary replacement or transposing of semiconductor devices may affect the adjustment of the instrument. When a semiconductor is replaced, check the performance of any circuit that may be affected.

Table 6-10

Maintenance Aids

Description	Specification	Usage	Example
Soldering Iron	15 to 25 W.	General soldering and unsoldering.	Antex Precision Model C.
Flat-bit Screwdriver	3-inch shaft, 3/32-inch bit.	Unplugging ribbon cable connections.	Xcelite Model 3323.
Torx Screwdriver	Torx tip #15.	Assembly and disassembly.	Tektronix Part Number 003-0966-00.
Open-end Wrench	1/2 inch. 9/16 inch.	Channel Input and Ext Z-Axis Input BNC Connectors.	1/2 003-0822-00. 9/16 003-0502-00.
Hex Wrenches	1/16 inch.	VAR knob removal and replacement.	Allen Wrenches.
Long-nose Pliers		Component removal and replacement.	Diamalloy Model LN55-3.
Diagonal Cutters		Component removal and replacement.	Diamalloy Model M554-3.
Vacuum Solder Extractor	No static charge retention.	Unsoldering static sensitive devices and components on multilayer boards.	Pace Model PC-10.
Contact Cleaner and Lubricant	No-Noise	Switch and pot cleaning and lubrication.	Tektronix Part Number 006-0442-02.
Lubricant	Versilube (silicone grease).	Switch and knob shaft lubricant.	Tektronix Part Number 006-0442-02.
IC-removal Tool		Removing DIP IC packages.	Augat T114-1.
Isopropyl Alcohol	Reagent grade.	Cleaning attenuator and front-panel assemblies.	2-Isopropanol.
Isolation Transformer		Isolate the instrument from the ac power source for safety.	Tektronix Part Number 006-5953-00.

CAUTION

After replacing a power transistor, check that the collector is not shorted to the chassis before applying power to the instrument.

Any replacement component should be of the original type or a direct replacement. Bend component leads to fit their circuit board holes, and cut the leads to the same length as the original component. See Figure 9-2 in the Diagrams section for the semiconductor lead-configurations.

To remove socketed dual-in-line packaged (DIP) integrated circuits, pull slowly and evenly on both ends of the device. Avoid disengaging one end of the integrated circuit from the socket before the other, since this may damage the pins.

To remove a soldered DIP IC when it is going to be replaced, clip all the leads of the device and remove the leads from the circuit board one at a time. If the device must be removed intact for possible reinstallation, do not heat adjacent conductors consecutively. Apply heat to pins at alternate sides and ends of the IC as solder is removed. Allow a moment for the circuit board to cool before proceeding to the next pin.

SOLDERING TECHNIQUES

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used to remove or replace parts. General soldering techniques that apply to maintenance of any precision electronic equipment should be used when working on this instrument.

WARNING

To avoid an electric-shock hazard, observe the following precautions before attempting any soldering: turn the instrument off, disconnect it from the ac power source, and wait at least three minutes for the line-rectifier filter capacitors to discharge.

Use rosin-core wire solder containing 63% tin and 37% lead. Contact your local Tektronix Field Office or representative to obtain the names of approved solder types.

When soldering on circuits boards or small insulated wires, use only a 15-watt, pencil-type soldering iron. A higher wattage soldering iron may cause etched circuit conductors to separate from the board base material and melt the insulation on small wires. Always keep the soldering-iron tip properly tinned to ensure the best heat transfer from the tip to the solder joint. Apply only enough solder to make a firm joint. After soldering, clean the area around the solder connection with an approved flux-removing solvent (such as isopropyl alcohol) and allow it to air dry.

CAUTION

Only an experienced maintenance person, proficient in the use of vacuum-type desoldering equipment should attempt repair of any circuit board in this instrument. Many integrated circuits are static sensitive and may be damaged by solder extractors that generate static charges. Perform work involving static-sensitive devices only at a static-free work station while wearing a grounded antistatic wrist strap. Use only an antistatic vacuum-type solder extractor approved by a Tektronix Service Center.

CAUTION

Attempts to unsolder, remove, and resolder leads from the component side of a circuit board may cause damage to the reverse side of the circuit board. The following techniques should be used to replace a component on a circuit board:

1. Touch the vacuum desoldering tool tip to the lead at the solder connection. Never place the tip directly on the board; doing so may damage the board.

NOTE

Some components are difficult to remove from the circuit board due to a bend placed in the component leads during machine insertion. To make removal of machine-inserted components easier, straighten the component leads on the reverse side of the circuit board.

2. For multipin components, especially ICs, do not heat adjacent pins consecutively. Apply heat to the pins at alternate sides and ends as solder is removed. Allow the circuit board to cool before proceeding to the next pin. If an IC is going to be replaced, clip the pins at the board level, then desolder and remove the pins one at a time.

CAUTION

Excessive heat can cause the etched circuit conductors to separate from the circuit board. Never allow the solder extractor tip to remain at one place on the board for more than three seconds. Damage caused by poor soldering techniques can void the instrument warranty.

3. Bend the leads of the replacement component to fit the holes in the circuit board. If the component is replaced while the board is installed in the instrument, cut the leads so they protrude only a small amount through the reverse side of the circuit board. Excess lead length may cause shorting to other conductive parts.

4. Insert the leads into the holes of the board so that the replacement component is positioned the same as the original component. Most components should be firmly seated against the circuit board.

5. Touch the soldering iron tip to the connection and apply enough solder to make a firm solder joint. Do not move the component while the solder hardens.

6. Cut off any excess lead protruding through the circuit board (if not clipped to the correct length in step 3).

7. Clean the area around the solder connection with an approved flux-removing solvent. Be careful not to remove any of the printed information from the circuit board.

REMOVAL AND REPLACEMENT INSTRUCTIONS

WARNING

To avoid electric shock, disconnect the instrument from the power input source before removing or replacing any component or assembly.

The exploded view drawings in Replaceable Mechanical Parts list may be helpful during removal and reinstallation of individual components or subassemblies. Circuit board and component locations are shown in Diagrams section.

Read these instructions before attempting to remove or install any components.

Cabinet

To Remove the Cabinet:

1. Unplug the power cord from its rear-panel connector.

2. Place the instrument face down on a clean, flat surface.

3. Remove the plastic rear cover, held with four Torx-head screws.

4. Remove the Torx-head screw from the right side near the rear of the cabinet.

5. Slide the cabinet housing up and off the instrument.

WARNING

Potentially dangerous voltages exist at several points throughout this instrument. If it is operated with the cabinet removed, do not touch exposed connections or components. Before replacing parts or cleaning, disconnect the ac-power source from the instrument and check that the line-rectifier filter capacitors have discharged. Also, check the low voltages at the power-supply/main-board interface connector (J1024). If any of the supply-voltage or line-voltage filter capacitors remain charged for more that 20 seconds, discharge them to ground through a 1 kΩ 5- or 6-watt resistor.

To Install the Cabinet:

6. Carefully slide the cabinet housing over the rear of the instrument. Be careful not to snag any of the folded ribbon cables. Make sure the cabinet housing slides between the plastic front-panel housing and the instrument chassis.

7. Install the rear-panel. Secure it with four 5/8 in. Torx-head screws.

8. Install a Torx-head screw in the right side of the cabinet.

Crt Removal and Replacement

WARNING

Use care when handling a crt. Breaking the crt can cause high-velocity scattering of glass fragments. Protective clothing and safety glasses or safety face shield should be worn. Avoid striking the crt on any object which might cause it to crack or implode. When storing a crt, either place it in a protective carton or set it face down on a smooth surface in a protected location with a soft mat under faceplate.

To Remove the Crt:

WARNING

To avoid electrical shock, carefully discharge the crt anode lead directly to the metal chassis. To avoid static-discharge damage to electronic components, do not allow the anode lead to discharge into the adjacent circuitry.

1. Disconnect the high-voltage anode lead. Pull the anode-lead coupler apart slowly and carefully. DO NOT touch the exposed connector pin as it is withdrawn from coupler socket. Discharge the exposed anode pin to the metal chassis only. A hole is provided in the left side of the power supply chassis for the purpose of holding the end of the lead to prevent a recharge while it is disconnected.

2. Unplug the trace rotation cable (P27) from the Main board.

3. Unplug the two vertical and the two horizontal deflection leads from the crt neck. Grasp each lead connector with long-nosed pliers and pull it straight away from the crt neck pins. Be careful not to bend the neck pins.

4. Remove the crt implosion shield and bezel frame (held with two screws at the lower side).

5. Place your left hand on crt neck shield and your right hand over crt face. Move the crt assembly forward to unplug the crt from its socket and carefully withdraw it from the instrument while ensuring that the crt anode lead clears all obstructions. DO NOT hold the crt assembly by the shield only.

6. If it is necessary remove the metal shield from crt. Carefully slide the shield to rear of the crt. Be careful not to damage the neck pins.

To Install the Crt:

7. Install the metal shield over the neck of the crt. Make sure that the plastic grommet is in place over the front of the shield. Align the neck pins with the shield holes.

8. Check that the graticule scale-illumination light pipe is in place at bottom front of crt opening. Also make sure that the four crt corner cushions are in place in the crt opening of the subpanel.

9. Carefully guide the crt, anode lead, and trace rotation cable into the instrument. Line up the crt base pins with base socket. Make sure that the ground clip above the rear of the crt shield goes outside of the shield. Hold in on the rear of the base socket with one hand and push on the face of the crt with the other hand to completely seat the crt base pins. If the crt will not go in all the way, check for bent pins. DO NOT FORCE this connection!

10. Connect the trace rotation cable (P27) to the Main board.

11. Connect the vertical and horizontal deflection leads to the crt neck pins. The horizontal deflection leads (going to bottom pins) should be crossed.

12. Connect the high-voltage anode lead.

13. Install the crt implosion shield and frame using two 7/8 in. Torx-head screws.

14. Check that the graticule illumination light bulbs are in place in the light pipe at the bottom of the crt.

BNC Connectors (Vertical Inputs)

To Replace BNC Connectors:

1. Remove the Main board (see Main board removal procedure).

NOTE

Do not disconnect the ends of the delay line from the main board to replace the input BNC connectors.

2. Unsolder the input lead from the defective BNC connectors.

3. Using a 9/16 open-end wrench, remove and replace the defective BNC connector(s).

4. Resolder the input lead(s).

5. Replace the Main board (see Main board installation procedure).

A16 Processor Board

CAUTION

On instruments with serial numbers below B040909, examine the circuitry near A10U802 (the Horizontal Preamplifier IC, shown on diagram 6) to determine if a diode (CR801) has been connected between C816 and W804. The anode of the diode connects to the end of C816 nearest pin 9 (−5 Vcc) of U802, and the cathode connects to to the end of W804 toward the rear of the instrument (the horizontal RO input—pin 1 of U802). For static discharge protection, the diode must be in place or added (and left) to the circuit before disconnecting the ribbon cable to J2302 on the Processor board.

To remove the Processor board:

1. Unplug the two ribbon cables to J2301 and J2502 from the Processor board. To aid the release of the ribbon-cable pins from connector, slide a thin-shafted, flat-bladed screwdriver between the ribbon cable (near the connector) and the etched-circuit board and pry gently.

2. Remove the six Torx-head attaching screws (one at each corner and two in the middle).

3. Unplug the ribbon cable to J2503 and lift the board away from the instrument.

To install the Processor board:

4. Set the Processor board in place on the chassis and plug in the ribbon cable to J2503. Position the connector pins into the socket holes and press them firmly into place.

CAUTION

Do not exceed 9 in-lbs of torque when tightening the 6-32 screws that hold the circuit board to the chassis. Damage to the circuit board and/or screw threads may result if the screws are overtightened.

5. Position the board to align the screw holes and install the six Torx-head attaching screws (two, 5/8 in. screws in the center and one, 7/16 in. screw at each corner).

6. Plug in the two ribbon cables to J2301 and J2502. Press the ribbon cable pins firmly into the connector holes.

A18 Power Supply board

To remove the Power Supply board:

1. Remove the Processor board (see Processor board removal procedure).

WARNING

To avoid electrical shock, carefully discharge the crt anode lead directly to the metal chassis. To avoid static-discharge damage to electronic components, do not allow the anode lead to discharge into the adjacent circuitry.

2. Disconnect the high-voltage anode lead. Pull the anode-lead coupler apart slowly and carefully. DO NOT touch the exposed connector pin as it is withdrawn from coupler socket. Discharge the exposed anode pin to the metal chassis only. A hole is provided in the left side of the power supply chassis for the purpose of holding the end of the lead to prevent a recharge while it is disconnected.

3. Remove the eight screws holding the power supply housing shield and remove the shield.

4. Disconnect the connectors from J2208 and J2225 and the two wires from ac-line filter. (Note the color stripes on the wires to the line filter for reinstallation.)

5. Pull the HV connector through the grommet in the power supply housing.

6. Set the POWER switch in the OFF (out) position.

CAUTION

The POWER switch must be in the OFF position to safely remove the shaft from the shaft of the switch in the following step. Pulling the shaft off with the POWER switch on may damage the switch.

7. Remove the power-switch extension shaft. Snap the extension shaft off the transitional pivot assembly, then pull the shaft off the switch.

8. Remove the six screws that hold down the Power Supply board.

9. Unplug the Power Supply board from the Main board interface connector. Grasp the two heat sinks near the center of the board, one with each hand, and pull up to disconnect the interface connection.

10. Lift the front of Power Supply board and withdraw the board from the power-supply housing.

To Install the Power Supply board:

11. Place the Power Supply board into power-supply housing. First, guide the fuse holder into the rear panel, then lower the front end of the board until the board interface pins touch the interface connector.

12. Plug the interface pins into the interface connector. With the Power Supply board against the rear panel, pull up on the large electrolytic capacitor (near the center of the board) with one hand and push down on HV multiplier module (at front of board) with the other hand. This action tends to align the pins with the connector. At the same

time you will have to move the board around slightly so that the pins will easily slide into the connector holes. DO NOT FORCE this connection, otherwise you may bend the pins.

CAUTION

Do not exceed 9 in-lbs of torque when tightening the 6-32 screws that hold the circuit board to the chassis. Damage to the circuit board or screw threads may result if the screws are overtightened.

13. Secure the circuit board with six screws.

14. Install the power-switch-extension shaft. Snap the shaft onto the switch, then onto the transitional pivot assembly.

15. Insert the high-voltage lead through the power-supply housing grommet and snap the connector shell into the clamp at the front of the power-supply housing.

16. Connect the leads to J2208, J2225, and the ac-line filter (observe the color coding noted when the filter leads were disconnected).

17. Install the power-supply-housing shield with eight screws.

18. Connect the crt anode lead to the HV connector.

19. Install the Processor board (see Processor board installation instructions).

Potentiometer/Switch board Assembly

To remove the Potentiometer/Switch board assembly:

1. Unplug ribbon-cable connector P2501 from the Processor board and unplug ribbon-cable connector P2105 from the Potentiometer board.

2. Remove the CH 1 and CH 2 VOLTS/DIV VAR knobs and the SEC/DIV VAR knob. (A 1/16 in. hexagonal wrench is needed for the set screws).

3. Pull out all the remaining front-panel knobs to the right of the crt. Grasp the knobs firmly and pull straight out from the front panel.

4. Pull out on the four captive plastic snap fasteners on the back of the switch board that hold the Switch board assembly to the front panel (not those that hold the Potentiometer board to the Switch board). Use long-nose pliers as necessary to reach the fasteners.

5. Unclip the high-voltage connector from the front of the power-supply housing. Remove the plastic retaining clip from the housing (it is pressed in). Move the high-voltage connector to the top of the power-supply housing to make room for removing the Potentiometer/Switch board.

6. Move the Potentiometer/Switch board assembly back away from the front panel and lift it out of the instrument.

To separate the A12 Potentiometer board from the A14 Switch board:

7. Pull out on the three snap fasteners that hold the Potentiometer board to the Switch board.

8. Separate the Potentiometer board from the Switch board.

9. If necessary, unplug the VAR control shafts from their potentiometers.

To install the Potentiometer board:

10. Set the three snap fasteners on the board in the released (out) position.

11. Plug the three VAR control shafts onto the VAR potentiometers.

12. Set the Potentiometer board in place over the Switch board and press in on the snap fasteners.

To install the Potentiometer/Switch board assembly:

13. Set the four snap fasteners (on the Switch board) in the released (out) position.

14. Guide the Potentiometer/Switch board assembly into place behind the front panel and press in on the snap fasteners.

15. Install the control knobs. Push knobs in while rotating slightly until they align with the shaft and snap in place. The two knobs without a position-indicator rib go on the DELTA and DELAY control shafts.

16. Install the three VAR control knobs, using 1/16 in. Allen wrench. Make sure that VAR controls are in the detent (fully CW) position, then rotate the knobs so that the VAR label is horizontal before tightening the set screws.

17. Install the high-voltage connector clip to the front side of the power-supply housing and snap the connector shell into it.

18. Connect ribbon cable J2105 to the Potentiometer board and P2501 to the Processor board. Position the connector pins in the socket holes and push them fully into place.

A10 Main Board

NOTE

This procedure is intended for the complete replacement of the Main board. All repairs and component replacements (except BNC connectors) can be done without completely removing the Main board. When replacing BNC connectors, use the BNC Connector replacement procedure previously given in this section.

To Remove the Main board:

1. Remove the crt (see crt removal procedure).

2. Pull out and remove the five crt-display control knobs.

3. Remove the Processor board (see Processor board removal procedure).

4. Remove the shield from the power-supply housing (held with eight screws).

5. Unplug the three-wire cable from J2208 on the Power Supply board. Pull the cable and connector through the plastic grommet.

6. Release the crt socket from its holder on the rear panel. First pull off clear plastic socket retainer, then push the socket out the rear enough to turn it sideways and push it through to the inside of the instrument.

7. Remove the Potentiometer/Switch board assembly (see Potentiometer/Switch board assembly removal procedure).

8. Remove the top and bottom attenuator shields. The bottom shield is held with 5 screws and the top shield is held with one remaining screw. See Figure 6-3.

NOTE

If the Main board is being removed to replace or repair a component (such as a BNC connector), it is not necessary to disconnect the delay line from the board as indicated in the following step.

9. Unsolder the main delay-line wires from both sides of board (see Figures 6-3 and 6-4).

10. Unclip the delay line from both sides of the board and from the two clips at the lower side of the rear panel. Remove the two clips from the rear panel.

11. Remove the ten screws that hold the Main board to the chassis. Back out the three screws going through the rear panel enough to allow removal of Main board. See Figure 6-3.

12. Pull the three ribbon cables through to the bottom of the instrument.

13. Lift the back of main board enough to disconnect interface connection between Main board and Power Supply board.

14. Slide the Main board back away from front panel to completely remove the board from the instrument.

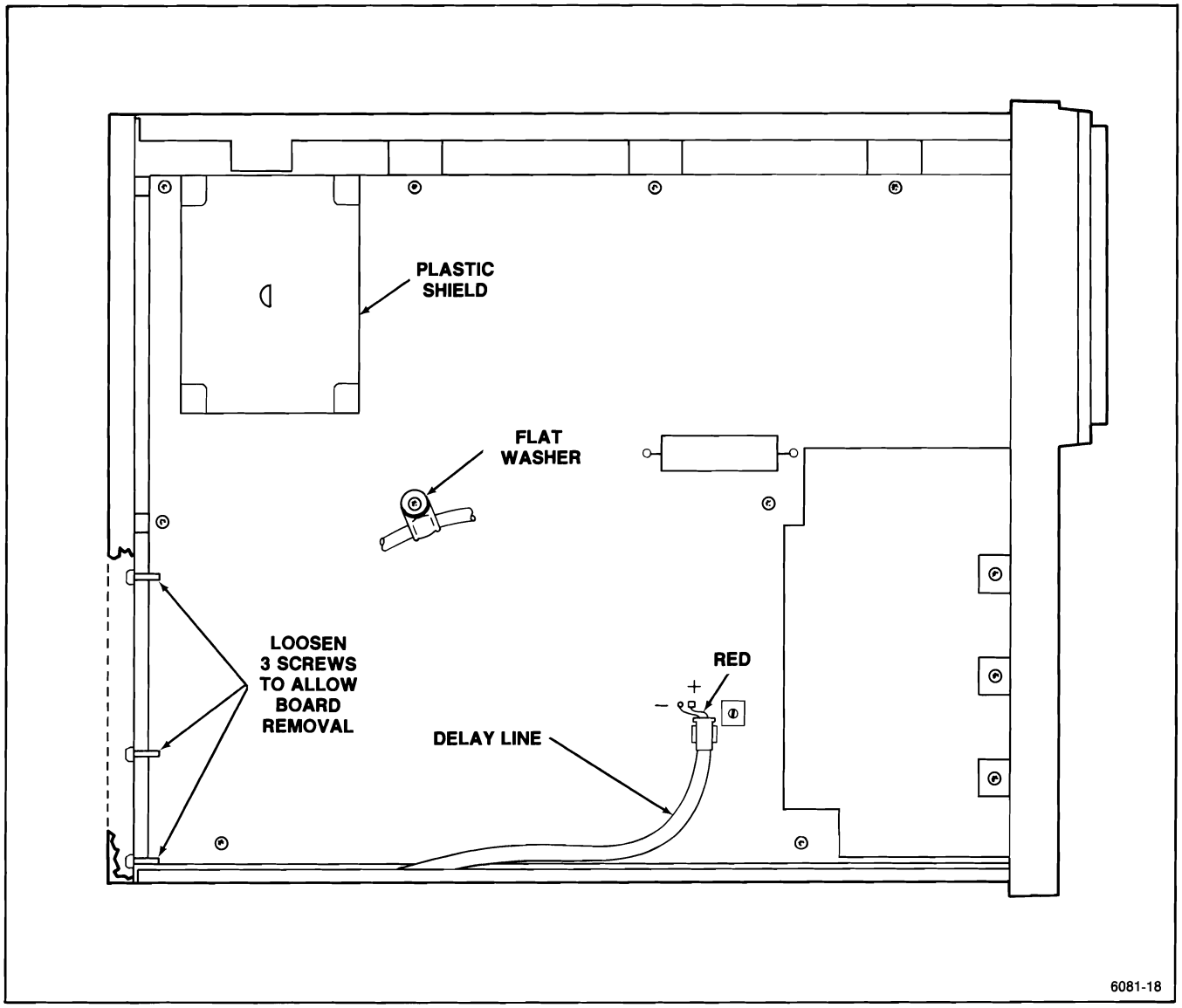


Figure 6-3. Main board removal.

To install the Main board:

15. Guide the BNC connectors at front of the Main board into the holes in the front panel. Make sure that you guide the CALIBRATOR terminal into the front panel as well as the BNC connectors.

16. Lower the rear of Main board while guiding the interface connector onto the power supply interface pins. DO NOT FORCE this connection; the pins may bend. Make sure that the grommet holding the crt and power supply wires is in place between the board and the rear panel.

CAUTION

Do not exceed 9 in-lbs of torque when tightening the 6-32 screws that hold the circuit board to the chassis. Damage to the circuit board or screw threads may result if the screws are overtightened.

17. Secure the Main board with ten screws. See Figure 6-3.

18. Solder both ends of delay line to Main board. Be sure to observe the polarity of the leads. See Figures 6-3 and 6-4. Press the ends of delay line into the clips on board.

19. Snap the two plastic clips into the lower edge of the rear panel and snap the delay line into them.

20. Connect the three-wire cable from the crt-socket cable assembly to J2208 on the Power Supply board.

21. Install the shield on the power-supply housing (eight screws).

22. Install the inside attenuator shield (secure with one screw). Then install the outside attenuator shield (secure with five screws).

23. Install the Potentiometer/Switch board assembly (see Potentiometer/Switch board assembly installation procedure).

24. Install the Processor board.

25. Dress the two ribbon cables to the top of the instrument. Connect them to the Processor and Potentiometer boards.

26. Install the crt socket. Turn the socket sideways and push it through the crt-socket holder in the rear panel.

27. Install the crt (see crt installation procedure).

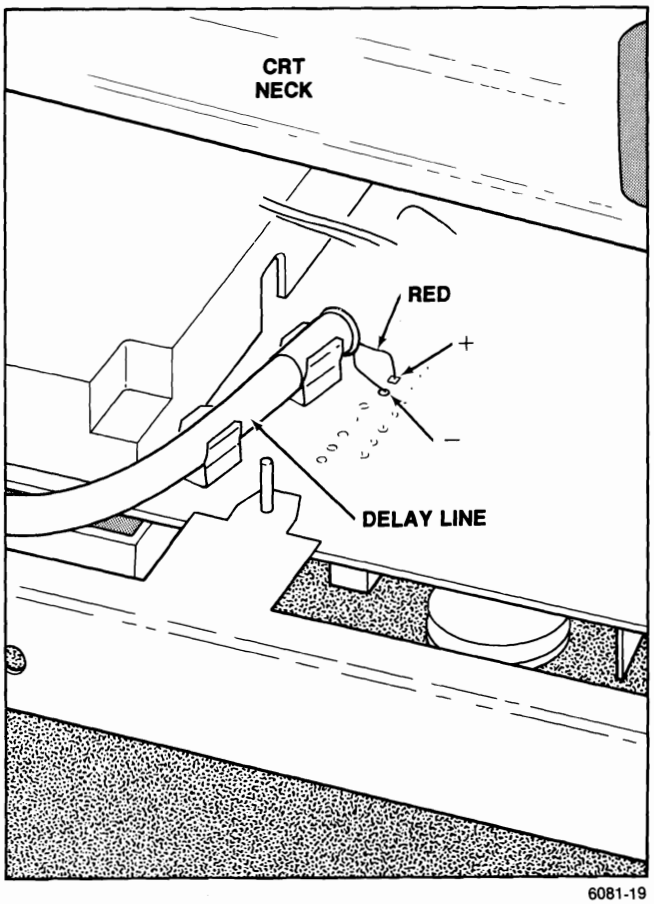


Figure 6-4. Delay-line connections to top of Main board.

OPTIONS AND ACCESSORIES

INTRODUCTION

The section contains a general description of instrument options and accessories available at the time of publication of this manual. Additional information about instrument options and other accessories can be obtained either by consulting the current Tektronix Product Catalog or by contacting your local Tektronix Field Office or representative.

OPTIONS A0-A5 INTERNATIONAL POWER CORDS

Instruments are shipped with the detachable power-cord option ordered by the customer. Descriptive information about the international power-cord options is provided in Section 2, "Preparation for Use." The following list identifies the Tektronix part numbers for the available power cords.

Option A0	(North American, 120 V) Power cord (74 inches)	161-0230-00
Option A1	(Universal Euro) Power cord (2.5 m)	161-0104-06
Option A2	(UK) Power cord (2.5 m)	161-0104-07
Option A3	(Australian) Power cord (2.5 m)	161-0104-05
Option A4	(North American, 240 V) Power cord (2.5 m)	161-0104-08
Option A5	(Switzerland) Power cord (2.5 m)	161-0167-00

OPTION 1R RACKMOUNTED INSTRUMENT

When the 2246 Portable Oscilloscope is ordered with Option 1R, it is shipped in a configuration that permits easy installation into a 19-inch-wide equipment rack. Also, an optional rackmounting kit may be ordered to convert the standard 2246 to a rackmounted instrument. Installation instructions for rackmounting are provided in the documentation supplied with the rackmounting kit and the 1R Option.

STANDARD ACCESSORIES

The following standard accessories are provided with each instrument:

		Part Number
2	Probes, 10X, 1.5 meter with accessories	P6109 Option 01
1	Operators Manual	070-6083-00
1	Operators Guide	070-6082-00
1	Crt implosion shield, blue plastic (installed)	337-2775-00
1	Accessory bag, ziploc	016-0537-00
1	Fuse, 2 A, 250 V, slow-blow	159-0023-00

OPTIONAL ACCESSORIES

The following optional accessories are recommended for use with the 2246 Oscilloscope:

Instrument Enhancements	Part Number
Protective Front-Panel Cover	200-3232-00
Attaching Accessories Pouch	016-0857-00
Protective Waterproof Vinyl Cover	016-0848-00
Clear Implosion Shield	337-2275-01
Rackmounting Kit	2240F1R
DC Inverter Power Supply	1105

Transportation Aids	Part Number
Carrying Strap	346-0199-00
Portable Instrument Cart	K212
Instrument Shuttle	K117

Cameras

Low-Cost Scope Camera	C5 Option 02
Motorized Camera	C7 Options 03 and 30
High-Performance Camera	C30B Option 01

Probes

Active Probe	P6202A
Power Supply for Active Probe	1101A
Current Probes	P6021 (1.52 m); P6022 (1.52 m); A6302/AM503; A6303/AM503
Environmental Probe	P6008 (1.83 m)
High Voltage Probe	P6009 (2.74 m)
Subminiature 10X Probe	P6130 (2 m)
Ground Isolation Monitor	A6901
Isolator (for floating measurements)	A6902B

Viewing Hoods

Collapsible Viewing Hood	016-0592-00
Binocular Viewing Hood	016-0566-00
Polarized Collapsible Viewing Hood	016-0180-00

Manual

Service Manual	070-6081-00

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.

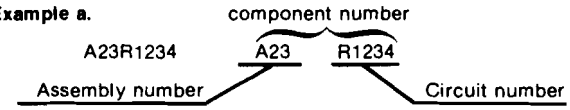
ABBREVIATIONS

Abbreviations conform to American National Standard Y1.1.

COMPONENT NUMBER (column one of the Electrical Parts List)

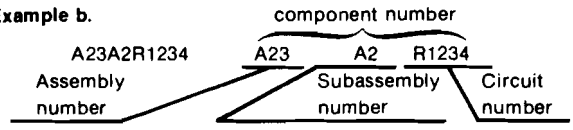
A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:

Example a.



Read: Resistor 1234 of Assembly 23

Example b.



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
00779	AMP INC	P O BOX 3608	HARRISBURG PA 17105
01121	ALLEN-BRADLEY CO	1201 SOUTH 2ND ST	MILWAUKEE WI 53204
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPRESSWAY P O BOX 225012 M/S 49	DALLAS TX 75265
02735	RCA CORP SOLID STATE DIVISION	ROUTE 202	SOMERVILLE NJ 08876
03508	GENERAL ELECTRIC CO SEMI-CONDUCTOR PRODUCTS DEPT	W GENESEE ST	AUBURN NY 13021
04099	CAPCO INC	FORESIGHT INDUSTRIAL PARK P O BOX 2164	GRAND JUNCTION CO 81501
04272	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR GROUP	5005 E MCDOWELL RD	PHOENIX AZ 85008
05245	CORCOM INC	2635 N KILDARE AVE	CHICAGO IL 60639
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
06665	PRECISION MONOLITHICS INC SUB OF BOURNS INC	1500 SPACE PARK DR	SANTA CLARA CA 95050
07263	FAIRCHILD CAMERA AND INSTRUMENT CORP SEMICONDUCTOR DIV	464 ELLIS ST	MOUNTAIN VIEW CA 94042
08806	GENERAL ELECTRIC CO MINIATURE LAMP PRODUCTS DEPT	NELA PK	CLEVELAND OH 44112
09922	BURNDY CORP	RICHARDS AVE	NORWALK CT 06852
11236	CTS OF BERNE INC	406 PARR ROAD	BERNE IN 46711
12954	MICROSEMI CORP	8700 E THOMAS RD P O BOX 1390	SCOTTSDALE AZ 85252
13511	AMPHENOL CADRE DIV BUNKER RAMO CORP		LOS GATOS CA
14433	ITT SEMICONDUCTORS DIV		WEST PALM BEACH FL
14552	MICRO/SEMICONDUCTOR CORP	2830 S FAIRVIEW ST	SANTA ANA CA 92704
15238	ITT SEMICONDUCTORS A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORP	500 BROADWAY P O BOX 168	LAWRENCE MA 01841
15454	AMETEK INC RODAN DIV	2905 BLUE STAR ST	ANAHEIM CA 92806
18324	SIGNETICS CORP	811 E ARQUES	SUNNYVALE CA 94086
19701	MEPCO/ELECTRA INC A NORTH AMERICAN PHILIPS CO	P O BOX 760	MINERAL WELLS TX 76067
20932	KYOCERA INC	11620 SORRENTO VALLEY RD	SAN DIEGO CA 92121
24546	CORNING GLASS WORKS	550 HIGH ST	BRADFORD PA 16701
24931	SPECIALTY CONNECTOR CO INC	2620 ENDRESS PLACE P O BOX 0	GREENWOOD IN 46142
27014	NATIONAL SEMICONDUCTOR CORP	2900 SEMICONDUCTOR DR	SANTA CLARA CA 95051
31918	ITT SCHADOW INC	8081 WALLACE RD	EDEN PRAIRIE MN 55343
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507
34649	INTEL CORP	3065 BOWERS AVE	SANTA CLARA CA 95051
50434	HEWLETT-PACKARD CO OPTOELECTRONICS DIV	640 PAGE MILL RD	PALO ALTO CA 94304
51406	MURATA ERIE NORTH AMERICA INC GEORGIA OPERATIONS	1148 FRANKLIN RD SE	MARIETTA GA 30067
51642	CENTRE ENGINEERING INC	2820 E COLLEGE AVE	STATE COLLEGE PA 16801
52769	SPRAGUE-GOODMAN ELECTRONICS INC	134 FULTON AVE	GARDEN CITY PARK NY 11040
54473	MATSUSHITA ELECTRIC CORP OF AMERICA	ONE PANASONIC WAY	SECAUCUS NJ 07094
54583	TOK ELECTRONICS CORP	755 EASTGATE BLVD	GARDEN CITY NY 11530
54937	DE YOUNG MANUFACTURING INC	12920 NE 125TH WAY	KIRKLAND, WA 98034-7716
55112	WESTLAKE CAPACITORS INC	5334 STERLING CENTER DRIVE	WESTLAKE VILLAGE CA 91361
55680	NICHICON /AMERICA/ CORP	927 E STATE PKY	SCHAUMBURG IL 60195
56289	SPRAGUE ELECTRIC CO	87 MARSHALL ST	NORTH ADAMS MA 01247
57668	ROHM CORP	16931 MILLIKEN AVE	IRVINE CA 92713
59660	TUSONIX INC	2155 N FORBES BLVD	TUCSON, ARIZONA 85705
61529	AROMAT CORP	250 SHEFFIELD ST	MOUNTAINSIDE NJ 07092
61964	OMRON ELECTRONICS INC		
71400	BUSSMANN MFG CO MCGRAW EDISION CO	114 OLD STATE RD PO BOX 14460	ST LOUIS MO 63178

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
71590	GLOBE-UNION INC CENTRALAB ELECTRONICS DIV	HWY 20 W P O BOX 858	FORT DODGE IA 50501
75042	TRW INC TRW ELECTRONIC COMPONENTS IRC FIXED RESISTORS PHILADELPHIA DIV	401 N BROAD ST	PHILADELPHIA PA 19108
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
91637	DALE ELECTRONICS INC	P O BOX 609	COLUMBUS NE 68601
96733	SAN FERNANDO ELECTRIC MFG CO	1501 FIRST ST	SAN FERNANDO CA 91341
05243	ROEDERSTEIN E SPEZIALFABRIK FUER KONDENSATOREN GMBH	LUDWILLASTRASSE 23-25	8300 LANDSHUT GERMANY
TK0213	TOPTRON CORP	TOKYO	JAPAN
TK0273	MITEL SEMICONDUCTOR	18 AIRPORT BLVD	BROMONT QUEBEC J0E1L0
TK0510	PANASONIC COMPANY DIV OF MATSUSHITA ELECTRIC CORP	ONE PANASONIC WAY	SECAUCUS NJ 07094
TK0515	RIFA WORLD PRODUCTS INC	19678 8TH STREET EAST P O BOX 517	SONOMA CA 95476
TK0961	NEC ELECTRONICS USA INC	401 ELLIS ST	MOUNTAIN VIEW CA 94043
TK1015	MUSASHI WORKS OF HITACHI LTD	1450 JOSUIHON-CHO KODAIRA-SHI	TOKYO JAPAN
TK1016	TOSHIBA AMERICA INC ELECTRONIC COMPONENTS DIV BUSINESS SECTOR	2692 DOW AVE	TUSTIN CA 92680
TK1424	MARCON AMERICA CORP	700 LANDWEHR RD	NORTHBROOK IL 60062
TK1441	GFS MANUFACTURING INC	6 PROGRESS DR BOX 517	DOVER NH 03820
TK1450	TOKYO COSMOS ELECTRIC CO LTD	2-268 SOBUDAI ZAMA	KANAGAWA 228 JAPAN
TK1573	WILHELM WESTERMAN	PO BOX 2345 AUGUSTA-ANLAGE 56	6800 MANNHEIM 1 WEST GERMANY
TK1689	AROMAT CORP	10400 N TANTAU AVE	CUPERTINO CA 95014
TK2042	ZWAN & ASSOCIATES	7633 SO. 180TH	KENT, WA 98032

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A8	670-9783-00	B010100	B040804	CIRCUIT BD ASSY:CRT CONTROL	80009	670-9783-00
A8	670-9783-01	B040805		CIRCUIT BD ASSY:CRT CONTROL	80009	670-9783-01
A10	670-9400-00	B010100	B040984	CIRCUIT BD ASSY:MAIN	80009	670-9400-00
A10	670-9400-01	B040985		CIRCUIT BD ASSY:MAIN	80009	670-9400-01
A12	670-9402-00	B010100	B040804	CIRCUIT BD ASSY:POTENTIOMETER	80009	670-9402-00
A12	670-9402-01	B040805		CIRCUIT BD ASSY:POTENTIOMETER	80009	670-9402-01
A14	670-9399-00	B010100	B040984	CIRCUIT BD ASSY:SWITCH	80009	670-9399-00
A14	670-9399-01	B040985		CIRCUIT BD ASSY:SWITCH	80009	670-9399-01
A16	670-9401-00	B010100	B040918	CIRCUIT BD ASSY:PROCESSOR	80009	670-9401-00
A16	670-9401-01	B040919		CIRCUIT BD ASSY:PROCESSOR	80009	670-9401-01
A18	670-9398-00	B010100	B040818	CIRCUIT BD ASSY:LV PWR SPLY	80009	670-9398-00
A18	670-9398-01	B040819		CIRCUIT BD ASSY:LV PWR SPLY	80009	670-9398-01

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A8	670-9783-00	B010100	B040804	CIRCUIT BD ASSY:CRT CONTROL	80009	670-9783-00
A8	670-9783-01	B040805		CIRCUIT BD ASSY:CRT CONTROL	80009	670-9783-01
A8J8	131-4038-00			CONN,RCPT,ELEC:HDR,1 X 8,RTANG,0.1 SPACING	00779	640453-8
A8P8	131-4038-00			CONN,RCPT,ELEC:HDR,1 X 8,RTANG,0.1 SPACING	00779	640453-8
A8R901	311-2344-00			RES,VAR,NONWW:CKT BD,4.7K OHM,20%,1.25W	71590	BA17140001
A8R902	311-2344-00			RES,VAR,NONWW:CKT BD,4.7K OHM,20%,1.25W	71590	BA17140001
A8R903	311-2344-00			RES,VAR,NONWW:CKT BD,4.7K OHM,20%,1.25W	71590	BA17140001
A8R905	311-2344-00			RES,VAR,NONWW:CKT BD,4.7K OHM,20%,1.25W	71590	BA17140001

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10	670-9400-00	B010100	B040984	CIRCUIT BD ASSY:MAIN	80009	670-9400-00
A10	670-9400-01	B040985		CIRCUIT BD ASSY:MAIN	80009	670-9400-01
A10AT117	307-2135-00			RES NTWK,FXD,FI:ATTENUATOR DIP PKG	80009	307-2135-00
A10AT127	307-2135-00			RES NTWK,FXD,FI:ATTENUATOR DIP PKG	80009	307-2135-00
A10C101	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C102	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C103	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C104	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C105	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C106	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C107	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C108	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C111	281-0909-00	B010100	B020099	CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C111	281-0909-00	B020145		CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C112	283-0414-00			CAP,FXD,CER DI:0.022UF,20%,500V	51642	300-500X7R223M
A10C113	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C114	281-0064-00			CAP,VAR,PLASTIC:0.25-1.5PF,600V	52769	ER-530-013
A10C121	281-0909-00	B010100	B020099	CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C121	281-0909-00	B020145		CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C122	283-0414-00			CAP,FXD,CER DI:0.022UF,20%,500V	51642	300-500X7R223M
A10C123	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C124	281-0064-00			CAP,VAR,PLASTIC:0.25-1.5PF,600V	52769	ER-530-013
A10C125	281-0770-00	B020145		CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A10C126	281-0770-00	B020145		CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A10C131	281-0909-00	B010100	B020099	CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C131	281-0909-00	B020145		CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C132	281-0938-00			CAP,FXD,CER DI:20PF,2%,500V	96733	R3900
A10C133	281-0799-00			CAP,FXD,CER DI:62PF,2%,100V	04222	MA101A620GAA
A10C134	281-0282-00			CAP,VAR,PLASTIC:2.5 - 20PF,100V	52769	GZL20000
A10C135	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C136	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C137	281-0940-00			CAP,FXD,CER DI:1.5PF,+/-0.25PF,100V	96733	T-NP12BY1R5CM
A10C138	281-0282-00			CAP,VAR,PLASTIC:2.5 - 20PF,100V	52769	GZL20000
A10C139	281-0797-00			CAP,FXD,CER DI:15PF,10%,100V	04222	MA106A150KAA
A10C140	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C151	281-0909-00	B010100	B020099	CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C151	281-0909-00	B020145		CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C152	281-0938-00			CAP,FXD,CER DI:20PF,2%,500V	96733	R3900
A10C153	281-0799-00			CAP,FXD,CER DI:62PF,2%,100V	04222	MA101A620GAA
A10C154	281-0282-00			CAP,VAR,PLASTIC:2.5 - 20PF,100V	52769	GZL20000
A10C155	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C156	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C157	281-0940-00			CAP,FXD,CER DI:1.5PF,+/-0.25PF,100V	96733	T-NP12BY1R5CM
A10C158	281-0282-00			CAP,VAR,PLASTIC:2.5 - 20PF,100V	52769	GZL20000
A10C159	281-0797-00			CAP,FXD,CER DI:15PF,10%,100V	04222	MA106A150KAA
A10C171	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C172	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C173	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C180	290-0944-01			CAP,FXD,ELCTLT:220UF,20%,10V	55680	ULB1A221MA1TD
A10C181	290-0944-01			CAP,FXD,ELCTLT:220UF,20%,10V	55680	ULB1A221MA1TD
A10C201	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C202	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C203	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C204	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C205	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C206	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C210	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C211	281-0759-00	B030100		CAP,FXD,CER DI:22PF,10%,100V	04222	MA101A220KAA
A10C212	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10C213	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C214	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C215	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C216	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C218	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C219	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C220	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C221	281-0759-00	B030100		CAP,FXD,CER DI:22PF,10%,100V	04222	MA101A220KAA
A10C222	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C223	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C224	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C225	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C228	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C229	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C232	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C233	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C234	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C235	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C238	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C239	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C242	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C243	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C244	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C245	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C248	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C249	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C258	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C265	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C268	281-0770-00			CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A10C272	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V	04222	GC105A330J
A10C273	281-0123-00			CAP,VAR,CER DI:5-25PF,100V	59660	518-000A5-25
A10C274	281-0218-00			CAP,VAR,CER DI:1-5PF,+2 -2.5%,100V	59660	513-011A1-5
A10C275	281-0872-00			CAP,FXD,CER DI:91PF,5%,100V	04222	MC101A910J
A10C282	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C283	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C297	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C298	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C301	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C302	281-0909-00	B010100	B020144	CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C302	281-0770-00	B020145		CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A10C303	290-0183-00			CAP,FXD,ELCTLT:1UF,10%,35V	05397	T3228105K035AS
A10C304	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C305	290-0183-00			CAP,FXD,ELCTLT:1UF,10%,35V	05397	T3228105K035AS
A10C306	290-0183-00			CAP,FXD,ELCTLT:1UF,10%,35V	05397	T3228105K035AS
A10C307	295-0198-00			CAP SET,MATCHED:(1),10.0UF,1.5%,25V (1)0.1UF,1.5%,35V,(1)0.0099UF,1.5%,50V	80009	295-0198-00
A10C308	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C309	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C310	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C311	281-0798-00			CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A10C312	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C313	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C314	281-0123-00			CAP,VAR,CER DI:5-25PF,100V	59660	518-000A5-25
A10C315	281-0798-00			CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A10C316	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C317	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C318	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C319	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C320	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10C321	281-0798-00			CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A10C322	281-0763-00			CAP,FXD,CER DI:47PF,10%,100V	04222	MA101A470KAA
A10C326	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C329	281-0123-00			CAP,VAR,CER DI:5-25PF,100V	59660	518-000A5-25
A10C330	281-0799-00			CAP,FXD,CER DI:62PF,2%,100V	04222	MA101A620GAA
A10C337	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C338	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C339	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C351	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C421	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
A10C422	281-0861-00			CAP,FXD,CER DI:270PF,5%,50V	54583	MA12C0G1H271J
A10C423	281-0864-00			CAP,FXD,CER DI:430PF,5%,100V	54583	MA12C0G2A431J
A10C424	290-0183-00			CAP,FXD,ELCTLT:1UF,10%,35V	05397	T3228105K035AS
A10C425	281-0820-00			CAP,FXD,CER DI:680 PF,10%,50V	04222	MA1D5C651KAA
A10C426	281-0820-00	B010100	B040618	CAP,FXD,CER DI:680 PF,10%,50V	04222	MA105C651KAA
A10C426	281-0864-00	B040619		CAP,FXD,CER DI:430PF,5%,100V	54583	MA12C0G2A431J
A10C432	281-0767-00			CAP,FXD,CER DI:330PF,20%,100V	04222	MA106C331MAA
A10C444	281-0765-00			CAP,FXD,CER DI:100PF,5%,100V	04222	MA101A101JAA
A10C445	281-0183-00			CAP,VAR,CER DI:0.5-3PF	80009	281-0183-00
A10C447	281-0770-00			CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A10C451	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
A10C452	281-0861-00			CAP,FXD,CER DI:270PF,5%,50V	54583	MA12C0G1H271J
A10C453	281-0864-00			CAP,FXD,CER DI:430PF,5%,100V	54583	MA12C0G2A431J
A10C454	290-0183-00			CAP,FXD,ELCTLT:1UF,10%,35V	05397	T3228105K035AS
A10C455	281-0820-00			CAP,FXD,CER DI:680 PF,10%,50V	04222	MA105C651KAA
A10C462	281-0861-00			CAP,FXD,CER DI:270PF,5%,50V	54583	MA12C0G1H271J
A10C463	281-0813-00			CAP,FXD,CER DI:0.047UF,20%,50V	05397	C412C473M5V2CA
A10C464	281-0928-00	B010100	B040099	CAP,FXD,CER DI:150PF,5%,TUBULAR,AXIAL MI	04222	MA101A151JAA
A10C464	281-0809-00	B040100		CAP,FXD,CER DI:200 PF,5%,100V	04222	MA101A201JAA
A10C465	281-0158-00	B010100	B040099	CAP,VAR,CER DI:7-45PF,25V	59660	518-006 G 7-45
A10C474	281-0928-00			CAP,FXD,CER DI:150PF,5%,TUBULAR,AXIAL MI	04222	MA101A151JAA
A10C475	281-0183-00			CAP,VAR,CER DI:0.5-3PF	80009	281-0183-00
A10C477	281-0770-00			CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A10C481	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C482	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C483	281-0770-00	B010100	B030099	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A10C483	281-0820-00	B030100		CAP,FXD,CER DI:680 PF,10%,50V	04222	MA105C651KAA
A10C484	281-0765-00			CAP,FXD,CER DI:100PF,5%,100V	04222	MA101A101JAA
A10C485	281-0765-00			CAP,FXD,CER DI:100PF,5%,100V	04222	MA101A101JAA
A10C486	281-0765-00			CAP,FXD,CER DI:100PF,5%,100V	04222	MA101A101JAA
A10C488	281-0765-00			CAP,FXD,CER DI:100PF,5%,100V	04222	MA101A101JAA
A10C491	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V	04222	GC105A330J
A10C492	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V	04222	GC105A330J
A10C493	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V	04222	GC105A330J
A10C494	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V	04222	GC105A330J
A10C501	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C502	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C503	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C504	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C505	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C506	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C600	281-0861-00			CAP,FXD,CER DI:270PF,5%,50V	54583	MA12C0G1H271J
A10C601	281-0861-00			CAP,FXD,CER DI:270PF,5%,50V	54583	MA12C0G1H271J
A10C602	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V	04222	GC105A330J
A10C603	281-0819-00			CAP,FXD,CER DI:33 PF,5%,50V	04222	GC105A330J
A10C604	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C605	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C606	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C607	281-0765-00			CAP,FXD,CER DI:100PF,5%,100V	04222	MA101A101JAA

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A10C608	281-0765-00			CAP,FXD,CER DI:100PF,5%,100V	04222	MA101A101JAA
A10C609	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C610	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C611	281-0909-00	B010100	B020099	CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C611	281-0903-00	B020100	B030099	CAP,FXD,CER DI:3.9PF,100V	04222	MA101A3R9DAA
A10C611	281-0810-00	B030100		CAP,FXD,CER DI:5.6PF,+/-0.5PF,100V	04222	MA101A5R6DAA
A10C612	281-0909-00	B010100	B020099	CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C612	281-0903-00	B020100	B030099	CAP,FXD,CER DI:3.9PF,100V	04222	MA101A3R9DAA
A10C612	281-0810-00	B030100		CAP,FXD,CER DI:5.6PF,+/-0.5PF,100V	04222	MA101A5R6DAA
A10C613	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C701	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C702	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C703	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C704	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C705	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
A10C706	281-0893-00			CAP,FXD,CER DI:4.7PF,+/-0.5PF,100V	04222	MA101A4R7DAA
A10C707	281-0798-00			CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A10C708	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C711	283-0201-00	B010100	B040099	CAP,FXD,CER DI:27PF,10%,200V	05397	C312C270K2G5CA
A10C711	283-0201-02	B040100		CAP,FXD,CER DI:27PF,10%,50V	80009	283-0201-02
A10C712	283-0201-00	B010100	B040099	CAP,FXD,CER DI:27PF,10%,200V	05397	C312C270K2G5CA
A10C712	283-0201-02	B040100		CAP,FXD,CER DI:27PF,10%,50V	80009	283-0201-02
A10C723	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C801	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
A10C802	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
A10C803	281-0707-00			CAP,FXD,CER DI:15000PF,20%,200V	20932	402EM200AD153K
A10C804	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C805	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C806	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C807	281-0064-00			CAP,VAR,PLASTIC:0.25-1.5PF,600V	52769	ER-530-013
A10C809	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
A10C810	281-0707-00			CAP,FXD,CER DI:15000PF,20%,200V	20932	402EM200AD153K
A10C811	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C814	281-0064-00			CAP,VAR,PLASTIC:0.25-1.5PF,600V	52769	ER-530-013
A10C815	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C816	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C817	290-0770-00			CAP,FXD,ELCTLT:100UF,+50-10%,25VDC	54473	ECE-A25V100L
A10C818	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
A10C819	281-0765-00	B020100		CAP,FXD,CER DI:100PF,5%,100V	04222	MA101A101JAA
A10C901	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C902	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C903	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C904	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C910	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C935	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C1001	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C1002	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C1003	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C1004	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C1005	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C1006	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C1101	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C1102	281-0909-00	B010100	B020099	CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C1102	290-0183-00	B020100		CAP,FXD,ELCTLT:1UF,10%,35V	05397	T3228105K035AS
A10C1103	290-0974-00	B010100	B030099	CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C1103	290-0183-00	B030100		CAP,FXD,ELCTLT:1UF,10%,35V	05397	T3228105K035AS
A10C1104	281-0819-00	B010100	B040976	CAP,FXD,CER DI:33 PF,5%,50V	04222	GC105A330J
A10C1105	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C1106	281-0820-00			CAP,FXD,CER DI:680 PF,10%,50V	04222	MA105C651KAA

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A10C1107	281-0765-00			CAP,FXD,CER DI:100PF,5%,100V	04222	MA101A101JAA
A10C1111	281-0765-00			CAP,FXD,CER DI:100PF,5%,100V	04222	MA101A101JAA
A10C1114	290-0974-00			CAP,FXD,ELCTLT:10UF,20%,50VDC	55680	ULB1H100MEA
A10C1121	281-0765-00			CAP,FXD,CER DI:100PF,5%,100V	04222	MA101A101JAA
A10C1130	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C1154	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C1155	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C1158	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C1159	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C2701	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C2702	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C2703	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C2704	281-0064-00			CAP,VAR,PLASTIC:0.25-1.5PF,600V	52769	ER-53D-013
A10C2705	281-0771-00			CAP,FXD,CER DI:2200PF,20%,200V	04222	MA106E222MAA
A10C2706	281-0893-00			CAP,FXD,CER DI:4.7PF,+/-0.5PF,100V	04222	MA101A4R7DAA
A10C2707	281-0893-00			CAP,FXD,CER DI:4.7PF,+/-0.5PF,100V	04222	MA101A4R7DAA
A10C2708	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
A10C2709	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
A10C2710	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
A10C2711	285-1184-01	B010100	B040099	CAP,FXD,MTLZD:0.01UF,20%,4KV	56289	430P103X040
A10C2711	285-1184-02	B040100		CAP,FXD,MTLZD:0.01UF,20%,4KV	80009	285-1184-02
A10C2712	285-1040-00			CAP,FXD,PLASTIC:1200PF,10%,4000V	04099	TEK-17A
A10C2713	281-0771-00			CAP,FXD,CER DI:2200PF,20%,200V	04222	MA106E222MAA
A10C2715	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C2716	281-0771-00			CAP,FXD,CER DI:2200PF,20%,200V	04222	MA106E222MAA
A10C2717	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
A10C2719	285-1184-01	B010100	B040099	CAP,FXD,MTLZD:0.01UF,20%,4KV	56289	430P103X040
A10C2719	285-1184-02	B04D1DD		CAP,FXD,MTLZD:D.01UF,20%,4KV	80009	285-1184-02
A10C2720	285-1040-00			CAP,FXD,PLASTIC:1200PF,10%,4000V	04099	TEK-17A
A10C2721	281-0771-00			CAP,FXD,CER DI:2200PF,20%,200V	04222	MA106E222MAA
A10C2723	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C2724	285-1184-01	B01D100	B040099	CAP,FXD,MTLZD:0.01UF,20%,4KV	56289	430P103X040
A10C2724	285-1184-02	B040100		CAP,FXD,MTLZD:0.01UF,20%,4KV	80009	285-1184-02
A10C2758	285-1184-01	B010100	B040099	CAP,FXD,MTLZD:0.01UF,20%,4KV	56289	430P1D3X040
A10C2758	285-1184-02	BD40100		CAP,FXD,MTLZD:0.01UF,20%,4KV	80009	285-1184-02
A10C2783	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
A10C2784	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A10C2785	283-0057-00			CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
A10CR131	152-0246-00			SEMICOND DVC,DI:SM,SI,40V,200MA,DO-7	14433	MG1537TK
A10CR151	152-0246-00			SEMICOND DVC,DI:SM,SI,40V,200MA,DO-7	14433	MG1537TK
A10CR171	152-0141-00			SEMICOND DVC,DI:SM,SI,30V,150MA,3DV,DO-7	80009	152-0141-00
A10CR201	152-0141-02	B040281		SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR202	152-0141-02	B040281		SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR260	152-0066-00			SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
A10CR261	152-0066-00			SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
A10CR301	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR432	152-0246-00			SEMICOND DVC,DI:SM,SI,40V,200MA,DO-7	14433	MG1537TK
A10CR462	152-0246-00			SEMICOND DVC,DI:SM,SI,40V,200MA,DO-7	14433	MG1537TK
A10CR603	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR801	152-0141-02	B040932		SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR935	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR936	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR1001	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR1002	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR1003	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR1004	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR1005	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR2701	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
A10CR2702	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10CR2703	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
A10CR2704	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
A10CR2705	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR2707	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR2713	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR2714	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
A10CR2715	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
A10CR2716	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
A10CR2717	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
A10CR2718	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
A10DL22	119-2119-00			DELAY LINE,ELEC:	80009	119-2119-00
A10DS901	150-0146-00			LAMP,INCAND:14V,80MA,73E,WEDGE BASE	08806	73E
A10DS902	150-0146-00			LAMP,INCAND:14V,80MA,73E,WEDGE BASE	08806	73E
A10DS903	150-0146-00			LAMP,INCAND:14V,80MA,73E,WEDGE BASE	08806	73E
A10DS2701	150-0035-00			LAMP,GLOW:90V MAX,0.3MA,AID-T,WIRE LD	TK0213	JH005/3011JA
A10DS2702	150-0035-00			LAMP,GLOW:90V MAX,0.3MA,AID-T,WIRE LD	TK0213	JH005/3011JA
A10DS2703	150-0035-00			LAMP,GLOW:90V MAX,0.3MA,AID-T,WIRE LD	TK0213	JH005/3011JA
A10DS2704	150-0035-00			LAMP,GLOW:90V MAX,0.3MA,AID-T,WIRE LD	TK0213	JH005/3011JA
A10J11	131-0679-01	B010100	B020099	CONN,RCPT,ELEC:BNC,MALE,3 CONTACT	24931	28JR168-2
A10J11	131-3731-00	B020100		CONN,RCPT,ELEC:BNC,MALE	24931	28JR377-1
A10J12	131-0679-01	B010100	B020099	CONN,RCPT,ELEC:BNC,MALE,3 CONTACT	24931	28JR168-2
A10J12	131-3731-00	B020100		CONN,RCPT,ELEC:BNC,MALE	24931	28JR377-1
A10J13	131-0679-01	B010100	B020099	CONN,RCPT,ELEC:BNC,MALE,3 CONTACT	24931	28JR168-2
A10J13	131-3731-00	B020100		CONN,RCPT,ELEC:BNC,MALE	24931	28JR377-1
A10J14	131-0679-01	B010100	B020099	CONN,RCPT,ELEC:BNC,MALE,3 CONTACT	24931	28JR168-2
A10J14	131-3731-00	B020100		CONN,RCPT,ELEC:BNC,MALE	24931	28JR377-1
A10J15	131-3464-00			CONTACT,ELEC:BRASS	80009	131-3464-00
A10J927	131-3486-00			CONN,RCPT,ELEC:HDR,RTANG,2 POS,0.1 SP	00779	640452-2
A10J1204	131-3638-00			CONN,RCPT,ELEC:HDR,13 CKT,0.156 SP	80009	131-3638-00
A10K100	148-0174-00			RELAY,ARMATURE:1 FORM C,12VDC	TK1689	DS1EM-DC 12V
A10K101	148-0174-00			RELAY,ARMATURE:1 FORM C,12VDC	TK1689	DS1EM-DC 12V
A10K102	148-0173-00			RELAY,ARMATURE:12 VDC	61964	G5Y 154 DC12
A10K103	148-0173-00			RELAY,ARMATURE:12 VDC	61964	G5Y 154 DC12
A10K104	148-0174-00			RELAY,ARMATURE:1 FORM C,12VDC	TK1689	DS1EM-DC 12V
A10K105	148-0174-00			RELAY,ARMATURE:1 FORM C,12VDC	TK1689	DS1EM-DC 12V
A10K107	148-0174-00			RELAY,ARMATURE:1 FORM C,12VDC	TK1689	DS1EM-DC 12V
A10K108	148-0174-00			RELAY,ARMATURE:1 FORM C,12VDC	TK1689	DS1EM-DC 12V
A10K109	148-0173-00			RELAY,ARMATURE:12 VDC	61964	G5Y 154 DC12
A10K110	148-0173-00			RELAY,ARMATURE:12 VDC	61964	G5Y 154 DC12
A10K111	148-0174-00			RELAY,ARMATURE:1 FORM C,12VDC	TK1689	DS1EM-DC 12V
A10K112	148-0174-00			RELAY,ARMATURE:1 FORM C,12VDC	TK1689	DS1EM-DC 12V
A10L101	108-1319-00			INDUCTOR,FIXED:33UH,10%,1.8A	54583	TSL1110-330K 1R8
A10L102	108-1319-00			INDUCTOR,FIXED:33UH,10%,1.8A	54583	TSL1110-330K 1R8
A10L201	108-1319-00			INDUCTOR,FIXED:33UH,10%,1.8A	54583	TSL1110-330K 1R8
A10L426	108-0509-00	B010100	B020099	COIL,RF:FIXED,2.45UH	TK2042	ORDER BY DESCR
A10L426	108-1281-00	B020100		COIL,RF:FXD,2.2UH,10%	54583	SP0305-2R2K
A10L432	108-1341-00			COIL,RF:FXD,180NH,10%,0.1 OHM,	80009	108-1341-00
A10L445	108-1339-00			COIL,RF:FXD,330NH	80009	108-1339-00
A10L462	108-1341-00			COIL,RF:FXD,180NH,10%,0.1 OHM,	80009	108-1341-00
A10L464	108-0262-00			COIL,RF:FIXED,510NH	80009	108-0262-00
A10L475	108-1339-00			COIL,RF:FXD,330NH	80009	108-1339-00
A10L701	108-1339-00			COIL,RF:FXD,330NH	80009	108-1339-00
A10L702	108-1339-00			COIL,RF:FXD,330NH	80009	108-1339-00
A10L703	120-1688-00			TRANSFORMER,RF:TAPPED INDUCTOR	80009	120-1688-00
A10L704	120-1688-00			TRANSFORMER,RF:TAPPED INDUCTOR	80009	120-1688-00
A10Q131	151-1042-00			SEMICOND DVC SE:FET,SI,TO-92	04713	SPF627M2
A10Q151	151-1042-00			SEMICOND DVC SE:FET,SI,TO-92	04713	SPF627M2
A10Q171	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A10Q250	151-0712-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8223

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A100251	151-0712-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8223
A100252	151-0271-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8236
A100253	151-0271-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8236
A100284	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
A100285	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
A100301	151-0254-00			TRANSISTOR:DARLINGTON,NPN,SI	03508	X38L3118
A100302	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100303	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100304	151-0830-00			TRANSISTOR:NPN,SI,AMPLIFIER,625,TO-92	80009	151-0830-00
A100305	151-0830-00			TRANSISTOR:NPN,SI,AMPLIFIER,625,TO-92	80009	151-0830-00
A100306	151-0830-00			TRANSISTOR:NPN,SI,AMPLIFIER,625,TO-92	80009	151-0830-00
A100307	151-0829-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0829-00
A100308	151-0830-00			TRANSISTOR:NPN,SI,AMPLIFIER,625,TO-92	80009	151-0830-00
A100309	151-0830-00			TRANSISTOR:NPN,SI,AMPLIFIER,625,TO-92	80009	151-0830-00
A100310	151-1042-00			SEMICOND DVC SE:FET,SI,TO-92	04713	SPF627M2
A100311	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100312	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100313	151-0736-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0736-00
A100315	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100316	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100317	151-0830-00			TRANSISTOR:NPN,SI,AMPLIFIER,625,TO-92	80009	151-0830-00
A100318	151-0830-00			TRANSISTOR:NPN,SI,AMPLIFIER,625,TO-92	80009	151-0830-00
A100320	151-0829-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0829-00
A100321	151-0830-00			TRANSISTOR:NPN,SI,AMPLIFIER,625,TO-92	80009	151-0830-00
A100322	151-0830-00			TRANSISTOR:NPN,SI,AMPLIFIER,625,TO-92	80009	151-0830-00
A100323	151-1042-00			SEMICOND DVC SE:FET,SI,TO-92	04713	SPF627M2
A100325	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100326	151-0736-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0736-00
A100328	151-0829-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0829-00
A100329	151-0829-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0829-00
A100330	151-0829-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0829-00
A100331	151-0829-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0829-00
A100332	151-0736-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0736-00
A100333	151-0736-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0736-00
A100440	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100444	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A100470	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100474	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A100480	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100501	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A100600	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100601	151-0424-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8246
A100602	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100603	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100604	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100605	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100606	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100607	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A100608	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A100701	151-0846-00			TRANSISTOR:NPN,SI,5W,TO-39	80009	151-0846-00
A100702	151-0846-00			TRANSISTOR:NPN,SI,5W,TO-39	80009	151-0846-00
A100703	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A100704	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A100801	151-1212-00			TRANSISTOR:MOSFET,VDMOS,P-CHAN,TO-39	80009	151-1212-00
A100802	151-1211-00			TRANSISTOR:MOSFET,VDMOS,N-CHAN,TO-39	80009	151-1211-00
A100803	151-0736-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0736-00
A100804	151-0712-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8223
A100805	151-1211-00			TRANSISTOR:MOSFET,VDMOS,N-CHAN,TO-39	80009	151-1211-00
A100806	151-1212-00			TRANSISTOR:MOSFET,VDMOS,P-CHAN,TO-39	80009	151-1212-00

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10Q807	151-0164-00			TRANSISTOR:PNP,SI,TO-92	04713	2N2907A
A10Q808	151-0711-00			TRANSISTOR:NPN,SI,TO-92B	80009	151-0711-00
A10Q809	151-0711-00			TRANSISTOR:NPN,SI,TO-92B	80009	151-0711-00
A10Q810	151-0711-00			TRANSISTOR:NPN,SI,TO-92B	80009	151-0711-00
A10Q905	151-0622-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8956(MPSM51A)
A10Q907	151-0622-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8956(MPSM51A)
A10Q908	151-0622-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8956(MPSM51A)
A10Q1001	151-0424-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8246
A10Q1002	151-0424-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8246
A10Q1003	151-0424-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8246
A10Q1004	151-0424-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8246
A10Q1005	151-0216-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8803
A10Q1101	151-0216-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8803
A10Q1102	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
A10Q1103	151-0216-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8803
A10Q1104	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
A10Q1105	151-0216-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8803
A10Q1106	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
A10Q2701	151-0164-00			TRANSISTOR:PNP,SI,TO-92	04713	2N2907A
A10Q2702	151-0164-00			TRANSISTOR:PNP,SI,TO-92	04713	2N2907A
A10Q2703	151-0736-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0736-00
A10Q2704	151-0736-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0736-00
A10Q2705	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
A10Q2706	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A10Q2707	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A10Q2708	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A10Q2709	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A10Q2711	151-0199-00			TRANSISTOR:PNP,SI,TO-92	27014	ST65057
A10Q2712	151-0347-02			TRANSISTOR:NPN,SI,TO-92	56289	CT7916
A10Q2713	151-0350-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS6700
A10Q2715	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A10R101	313-1822-00			RES,FXD,FILM:8.2K,OHM,5%,0.2W	57668	TR20JE 08K2
A10R102	313-1822-00			RES,FXD,FILM:8.2K,OHM,5%,0.2W	57668	TR20JE 08K2
A10R103	313-1822-00			RES,FXD,FILM:8.2K,OHM,5%,0.2W	57668	TR20JE 08K2
A10R104	313-1822-00			RES,FXD,FILM:8.2K,OHM,5%,0.2W	57668	TR20JE 08K2
A10R105	313-1102-00	B010100	B020144	RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R105	313-1103-00	B020145		RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R106	313-1102-00	B010100	B020144	RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R106	313-1103-00	B020145		RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R107	313-1102-00	B010100	B020145	RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R107	313-1103-00	B020145		RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R108	313-1102-00	B010100	B020144	RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R108	313-1103-00	B020145		RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R111	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
A10R113	313-1200-00			RES,FXD,FILM:20 OHM,5%,0.2W	57668	TR20JE20E
A10R114	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R115	322-3085-00			RES,FXD,FILM:75 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 75E0
A10R121	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
A10R123	313-1200-00			RES,FXD,FILM:20 OHM,5%,0.2W	57668	TR20JE20E
A10R124	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R125	322-3085-00			RES,FXD,FILM:75 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 75E0
A10R131	315-0390-00			RES,FXD,FILM:39 OHM,5%,0.25W	57668	NTR25J-E39E0
A10R132	322-3443-00			RES,FXD,FILM:402K OHM,1%,0.2W,TC=T0	91637	CCF50G40202F
A10R133	322-3443-00			RES,FXD,FILM:402K OHM,1%,0.2W,TC=T0	91637	CCF50G40202F
A10R134	322-3414-00			RES,FXD,FILM:200K OHM,1%,0.2W,TC=T0	91637	CCF50G20002F
A10R135	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R136	322-3284-00			RES,FXD,FILM:8.87K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 8K87
A10R137	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R138	322-3189-00			RES,FXD,FILM:909 OHM,1%,0.2W,TC=T0	57668	CRB 20 FXE 909E

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10R139	322-3085-00			RES,FXD,FILM:75 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 75E0
A10R140	322-3085-00			RES,FXD,FILM:75 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 75E0
A10R141	311-2224-00			RES,VAR,NONWW:TRMR,20 OHM,20%,0.5W LINEAR	TK1450	GF06UT
A10R142	313-1240-00			RES,FXD,FILM:24 OHM,5%,0.2W	57668	TR20JT6824E0
A10R151	315-0390-00			RES,FXD,FILM:39 OHM,5%,0.25W	57668	NTR25J-E39E0
A10R152	322-3443-00			RES,FXD,FILM:402K OHM,1%,0.2W,TC=T0	91637	CCF50G40202F
A10R153	322-3443-00			RES,FXD,FILM:402K OHM,1%,0.2W,TC=T0	91637	CCF50G40202F
A10R154	322-3414-00			RES,FXD,FILM:200K OHM,1%,0.2W,TC=T0	91637	CCF50G20002F
A10R155	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R156	322-3284-00			RES,FXD,FILM:8.87K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 8K87
A10R157	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R158	322-3189-00			RES,FXD,FILM:909 OHM,1%,0.2W,TC=T0	57668	CRB 20 FXE 909E
A10R159	322-3085-00			RES,FXD,FILM:75 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 75E0
A10R160	322-3085-00			RES,FXD,FILM:75 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 75E0
A10R161	311-2224-00			RES,VAR,NONWW:TRMR,20 OHM,20%,0.5W LINEAR	TK1450	GF06UT
A10R162	313-1240-00			RES,FXD,FILM:24 OHM,5%,0.2W	57668	TR20JT6824E0
A10R171	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R175	313-1204-00			RES,FXD,FILM:200K,5%,0.2W	57668	TR20JE 200K
A10R176	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R177	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A10R178	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A10R179	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R180	313-1241-00	B010100	B020099	RES,FXD,FILM:240 OHM,5%,0.2W	57668	TR20JE 240E
A10R180	313-1101-00	B020100		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R181	313-1241-00	B010100	B020099	RES,FXD,FILM:240 OHM,5%,0.2W	57668	TR20JE 240E
A10R181	313-1101-00	B020100		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R182	308-0058-00			RES,FXD,MM:1.5 OHM,10%,1W	75042	BW-20-1R500K
A10R201	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R202	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R203	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R204	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R205	322-3150-00			RES,FXD,FILM:357 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 357E
A10R206	322-3236-00			RES,FXD,FILM:2.8K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 2K80
A10R207	322-3150-00			RES,FXD,FILM:357 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 357E
A10R208	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R209	313-1512-00	B010100	B020119	RES,FXD,CMPSN:5.1K OHM,5%,0.2W	57668	TR20JE 5K1
A10R209	313-1102-00	B020120	B040099	RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R209	313-1511-00	B040100		RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R210	313-1331-00			RES,FXD,FILM:330 OHM,5%,0.2W	57668	TR20JE 330E
A10R211	311-2329-00			RES,VAR,NONWW:TRIMMER,5K OHM,10%	32997	3386R-EA5-502
A10R212	313-1102-00	B010100	B040099	RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R212	313-1511-00	B040100		RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R213	313-1243-00			RES,FXD,FILM:24K OHM,5%,0.2W	80009	313-1243-00
A10R214	322-3285-00			RES,FXD,FILM:9.09K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 9K09
A10R216	313-1100-00	B010100	B030099	RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R216	313-1101-00	B030100		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R217	313-1100-00	B010100	B030099	RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R217	313-1101-00	B030100		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R218	322-3237-00			RES,FXD,FILM:2.87K OHM,1%,0.2W,TC=T0	80009	322-3237-00
A10R219	313-1104-00	B040619		RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A10R220	313-1331-00			RES,FXD,FILM:330 OHM,5%,0.2W	57668	TR20JE 330E
A10R221	311-2329-00			RES,VAR,NONWW:TRIMMER,5K OHM,10%	32997	3386R-EA5-502
A10R222	313-1102-00	B010100	B040099	RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R222	313-1511-00	B040100		RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R223	313-1243-00			RES,FXD,FILM:24K OHM,5%,0.2W	80009	313-1243-00
A10R224	322-3285-00			RES,FXD,FILM:9.09K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 9K09
A10R226	313-1027-00			RES,FXD,FILM:2.7 OHM,5%,0.2W	57668	TR20JE 02E7
A10R228	322-3237-00			RES,FXD,FILM:2.87K OHM,1%,0.2W,TC=T0	80009	322-3237-00
A10R229	313-1104-00	B040619		RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K

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A10R230	313-1331-00			RES,FXD,FILM:330 OHM,5%,0.2W	57668	TR20JE 330E
A10R231	311-2329-00			RES,VAR,NONWW:TRIMMER,5K OHM,10%	32997	3386R-EA5-502
A10R232	313-1102-00	B010100	B040099	RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R232	313-1511-00	B040100		RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R233	313-1243-00			RES,FXD,FILM:24K OHM,5%,0.2W	80009	313-1243-00
A10R234	322-3285-00			RES,FXD,FILM:9.09K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 9K09
A10R235	322-3237-00			RES,FXD,FILM:2.87K OHM,1%,0.2W,TC=T0	80009	322-3237-00
A10R238	313-1242-00			RES,FXD,FILM:2.4K OHM,5%,0.2W	57668	TR20JE 02K4
A10R239	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2W	57668	TR20JE 5K1
A10R240	313-1331-00			RES,FXD,FILM:330 OHM,5%,0.2W	57668	TR20JE 330E
A10R241	311-2329-00			RES,VAR,NONWW:TRIMMER,5K OHM,10%	32997	3386R-EA5-502
A10R242	313-1102-00	B010100	B040099	RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R242	313-1511-00	B040100		RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R243	313-1243-00			RES,FXD,FILM:24K OHM,5%,0.2W	80009	313-1243-00
A10R244	322-3285-00			RES,FXD,FILM:9.09K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 9K09
A10R245	313-1027-00			RES,FXD,FILM:2.7 OHM,5%,0.2W	57668	TR20JE 02E7
A10R248	322-3237-00			RES,FXD,FILM:2.87K OHM,1%,0.2W,TC=T0	80009	322-3237-00
A10R250	307-0792-00			RES NTWK,FXD,FI:7,82 OHM,2%,0.15W EACH	11236	750-81-R82
A10R251	307-0792-00			RES NTWK,FXD,FI:7,82 OHM,2%,0.15W EACH	11236	750-81-R82
A10R254	322-3318-00			RES,FXD,FILM:20K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 20K0
A10R255	322-3318-00			RES,FXD,FILM:20K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 20K0
A10R256	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R260	311-2234-00			RES,VAR,NONWW:TRMR,5K OHM,20%,0.5W	TK1450	GF06UT 5K
A10R261	313-1243-00			RES,FXD,FILM:24K OHM,5%,0.2W	80009	313-1243-00
A10R262	322-3083-00			RES,FXD,FILM:71.5 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 71E5
A10R263	322-3083-00			RES,FXD,FILM:71.5 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 71E5
A10R264	322-3083-00			RES,FXD,FILM:71.5 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 71E5
A10R265	322-3083-00			RES,FXD,FILM:71.5 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 71E5
A10R266	313-1302-00			RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR20JE 03K0
A10R267	322-3164-00			RES,FXD,FILM:499 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 499E
A10R268	322-3158-00			RES,FXD,FILM:432 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 432
A10R269	322-3158-00			RES,FXD,FILM:432 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 432
A10R270	313-1751-00			RES,FXD,FILM:750 OHM,5%,0.2W	57668	TR20JE 750E
A10R271	313-1912-00			RES,FXD,FILM:9.1K OHM,5%,0.2W	57668	TR20 FXE 9.1K
A10R272	311-2232-00			RES,VAR,NONWW:TRMR,2K OHM,20%,0.5W LINEAR	TK1450	GF06UT 2K
A10R273	311-2230-00			RES,VAR,NONWW:TRMR,500 OHM,20%,0.50 LINEAR	TK1450	GF06UT 500
A10R274	313-1100-00	B040100		RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R275	311-2227-00			RES,VAR,NONWW:TRMR,100 OHM,20%,0.5W LINEAR	TK1450	GF06UT 100
A10R276	322-3213-00			RES,FXD,FILM:1.62K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K62
A10R277	322-3213-00			RES,FXD,FILM:1.62K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K62
A10R278	322-3141-00			RES,FXD,FILM:287 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 287E
A10R279	322-3141-00			RES,FXD,FILM:287 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 287E
A10R280	322-3098-00			RES,FXD,FILM:102 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 102E
A10R281	322-3098-00			RES,FXD,FILM:102 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 102E
A10R282	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R283	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R284	313-1393-00			RES,FXD,FILM:39K OHM,5%,0.2W	57668	TR20JE 39K
A10R285	313-1393-00			RES,FXD,FILM:39K OHM,5%,0.2W	57668	TR20JE 39K
A10R286	322-3097-00			RES,FXD,FILM:100 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 100E
A10R287	322-3097-00			RES,FXD,FILM:100 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 100E
A10R288	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R289	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R290	322-3123-00			RES,FXD,FILM:187 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 187E
A10R291	322-3123-00			RES,FXD,FILM:187 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 187E
A10R292	313-1752-00			RES,FXD,FILM:7.5K OHM,5%,0.2W	57668	TR20JE 07K5
A10R293	313-1752-00			RES,FXD,FILM:7.5K OHM,5%,0.2W	57668	TR20JE 07K5
A10R294	313-1202-00			RES,FXD,FILM:2K OHM,5%,0.2W	57668	TR20JE02K0
A10R295	313-1302-00			RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR20JE 03K0
A10R296	322-3117-00			RES,FXD,FILM:162 OHM,1%,0.2W,TC=T0	57668	CRB 20 FXE 162E

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A10R297	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R298	313-1027-00			RES,FXD,FILM:2.7 OHM,5%,0.2W	57668	TR20JE 02E7
A10R301	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R302	313-1027-00			RES,FXD,FILM:2.7 OHM,5%,0.2W	57668	TR20JE 02E7
A10R303	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R304	313-1470-00			RES,FXD,FILM:47 OHM,5%,0.2W	57668	TR20JE 47E
A10R305	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R306	313-1051-00			RES,FXD,FILM:5.1 OHM,5%,0.2W	57668	TR20JT68 05E1
A10R307	322-3328-02			RES,FXD,FILM:25.5K OHM,0.5%,0.2W,TC=T2	57668	CRB20 DYE 25K5
A10R308	322-3319-02			RES,FXD,FILM:20.5K OHM,0.5%,0.2W,TC=T2	57668	CRB20 DYE 20K5
A10R309	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 10K0
A10R310	313-1473-00			RES,FXD,FILM:47K OHM,5%,0.2W	57668	TR20JE 47K
A10R311	322-3269-02			RES,FXD,FILM:6.19K OHM,0.2W,5%	57668	CRB DYE 6K19
A10R312	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R313	307-2132-00			RES NTWK,FXD,FI:REF VOLTAGE DIVIDER	80009	307-2132-00
A10R314	322-3333-02			RES,FXD,FILM:28.7K OHM,0.2W,5%	57668	CRB20 DYE 28K7
A10R315	313-1470-00			RES,FXD,FILM:47 OHM,5%,0.2W	57668	TR20JE 47E
A10R316	313-1270-00			RES,FXD,FILM:27 OHM 5%,0.2W	57668	TR20JT68 27E
A10R317	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R318	313-1822-00	B010100	B040099	RES,FXD,FILM:8.2K,OHM,5%,0.2W	57668	TR20JE 08K2
A10R318	313-1681-00	B040100		RES,FXD,FILM:680 OHM,5%,0.2W	57668	TR20JE 680E
A10R319	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6
A10R320	313-1470-00			RES,FXD,FILM:47 OHM,5%,0.2W	57668	TR20JE 47E
A10R321	307-2133-00			RES NTWK,FXD,FI:RESISTOR NETWORK	80009	307-2133-00
A10R322	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2W	57668	TR20JE 5K1
A10R323	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2W	57668	TR20JE 5K1
A10R325	313-1132-00			RES,FXD,FILM:1.3K OHM,5%,0.2W	57668	TR20JE01K3
A10R326	313-1132-00			RES,FXD,FILM:1.3K OHM,5%,0.2W	57668	TR20JE01K3
A10R327	313-1470-00			RES,FXD,FILM:47 OHM,5%,0.2W	57668	TR20JE 47E
A10R328	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R329	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R330	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R331	313-1392-00			RES,FXD,FILMN:3.9K OHM,5%,0.2W	57668	TR20JE 03K9
A10R332	313-1820-00			RES,FXD,FILM:82 OHM,5%,0.2W	57668	TR20JE 82E
A10R333	313-1120-00			RES,FXD,FILM:12 OHM,5%,0.2W	57668	TR20JE12E0
A10R334	313-1161-00			RES,FXD,FILM:160 OHM,5%,0.2W	57668	TR20JE160E
A10R335	313-1162-00			RES,FXD,FILM:1.6K OHM,5%,0.2W	57668	TR20JT681K6
A10R336	313-1162-00			RES,FXD,FILM:1.6K OHM,5%,0.2W	57668	TR20JT681K6
A10R337	313-1151-00			RES,FXD,FILM:150 OHM,5%,0.2W	57668	TR20JE150E
A10R338	313-1132-00			RES,FXD,FILM:1.3K OHM,5%,0.2W	57668	TR20JE01K3
A10R339	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R340	313-1820-00			RES,FXD,FILM:82 OHM,5%,0.2W	57668	TR20JE 82E
A10R341	313-1162-00			RES,FXD,FILM:1.6K OHM,5%,0.2W	57668	TR20JT681K6
A10R342	313-1132-00			RES,FXD,FILM:1.3K OHM,5%,0.2W	57668	TR20JE01K3
A10R343	313-1162-00			RES,FXD,FILM:1.6K OHM,5%,0.2W	57668	TR20JT681K6
A10R344	313-1332-00			RES,FXD,FILM:3.3K OHM,5%,0.2W	57668	TR20JE 03K3
A10R345	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R346	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R347	313-1202-00			RES,FXD,FILM:2K OHM,5%,0.2W	57668	TR20JE02K0
A10R348	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R349	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R350	307-0540-00			RES NTWK,FXD,FI:(5)1K OHM,10%,0.7W	11236	750-61-R1K0HM
A10R351	313-1473-00			RES,FXD,FILM:47K OHM,5%,0.2W	57668	TR20JE 47K
A10R352	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R353	313-1152-00			RES,FXD,FILM:1.5K OHM,5%,0.2W	57668	TR20JE01K5
A10R354	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R355	313-1822-00	B010100	B040099	RES,FXD,FILM:8.2K,OHM,5%,0.2W	57668	TR20JE 08K2
A10R355	313-1681-00	B040100		RES,FXD,FILM:680 OHM,5%,0.2W	57668	TR20JE 680E
A10R356	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6

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A10R357	307-0540-00			RES NTWK,FXD,FI:(5)1K OHM,10%,0.7W	11236	750-61-R1KOHM
A10R358	313-1561-00			RES,FXD,FILM:560 OHM,5%,0.2W	57668	TR20JE 560E
A10R359	313-1162-00			RES,FXD,FILM:1.6K OHM,5%,0.2W	57668	TR20JT681K6
A10R360	313-1162-00			RES,FXD,FILM:1.6K OHM,5%,0.2W	57668	TR20JT681K6
A10R361	313-1200-00			RES,FXD,FILM:20 OHM,5%,0.2W	57668	TR20JE20E
A10R362	313-1562-00	B010100	B020144	RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6
A10R362	313-1362-00	B020145		RES,FXD,FILM:3.6K OHM,5%,0.2W	57668	TR20JE 03K6
A10R363	313-1562-00	B010100	B020144	RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6
A10R363	313-1362-00	B020145		RES,FXD,FILM:3.6K OHM,5%,0.2W	57668	TR20JE 03K6
A10R364	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R365	313-1132-00			RES,FXD,FILM:1.3K OHM,5%,0.2W	57668	TR20JE01K3
A10R366	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R367	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R369	313-1331-00			RES,FXD,FILM:330 OHM,5%,0.2W	57668	TR20JE 330E
A10R370	313-1820-00			RES,FXD,FILM:82 OHM,5%,0.2W	57668	TR20JE 82E
A10R371	313-1120-00			RES,FXD,FILM:12 OHM,5%,0.2W	57668	TR20JE12E0
A10R372	313-1200-00			RES,FXD,FILM:20 OHM,5%,0.2W	57668	TR20JE20E
A10R373	313-1820-00			RES,FXD,FILM:82 OHM,5%,0.2W	57668	TR20JE 82E
A10R374	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R375	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R376	313-1332-00			RES,FXD,FILM:3.3K OHM,5%,0.2W	57668	TR20JE 03K3
A10R377	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 1K00
A10R378	313-1820-00			RES,FXD,FILM:82 OHM,5%,0.2W	57668	TR20JE 82E
A10R379	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 1K00
A10R380	313-1820-00			RES,FXD,FILM:82 OHM,5%,0.2W	57668	TR20JE 82E
A10R381	313-1270-00			RES,FXD,FILM:27 OHM 5%,0.2W	57668	TR20JT68 27E
A10R382	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 1K00
A10R383	313-1161-00			RES,FXD,FILM:160 OHM,5%,0.2W	57668	TR20JE160E
A10R384	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R385	313-1162-00			RES,FXD,FILM:1.6K OHM,5%,0.2W	57668	TR20JT681K6
A10R386	313-1162-00			RES,FXD,FILM:1.6K OHM,5%,0.2W	57668	TR20JT681K6
A10R387	313-1820-00			RES,FXD,FILM:82 OHM,5%,0.2W	57668	TR20JE 82E
A10R388	313-1820-00			RES,FXD,FILM:82 OHM,5%,0.2W	57668	TR20JE 82E
A10R390	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R391	313-1203-00			RES,FXD,FILM:20K OHM,5%,0.2W	57668	TR20JE20K
A10R392	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R393	313-1471-00			RES,FXD,FILM:470 OHM,5%,0.2W	57668	TR20JE 470E
A10R394	313-1471-00			RES,FXD,FILM:470 OHM,5%,0.2W	57668	TR20JE 470E
A10R395	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R396	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R397	313-1120-00	B010100	B020144	RES,FXD,FILM:12 OHM,5%,0.2W	57668	TR20JE12E0
A10R410	313-1391-00	B020100	B030099	RES,FXD,FILM:390 OHM,5%,0.2W	57668	TR20JE 390E
A10R410	313-1511-00	B030100		RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R411	313-1101-00	B020100	B030099	RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R411	313-1300-00	B030100	B040099	RES,FXD,FILM:30 OHM,5%,0.2W	57668	TR20JE 30E
A10R411	313-1101-00	B040100		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R412	313-1391-00	B020100	B030099	RES,FXD,FILM:390 OHM,5%,0.2W	57668	TR20JE 390E
A10R412	313-1300-00	B030100	B040099	RES,FXD,FILM:30 OHM,5%,0.2W	57668	TR20JE 30E
A10R412	313-1101-00	B040100		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R413	313-1391-00	B020100	B030099	RES,FXD,FILM:390 OHM,5%,0.2W	57668	TR20JE 390E
A10R413	313-1511-00	B030100		RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R414	313-1391-00	B020100	B030099	RES,FXD,FILM:390 OHM,5%,0.2W	57668	TR20JE 390E
A10R414	313-1511-00	B030100		RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R415	313-1101-00	B020100	B030099	RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R415	313-1300-00	B030100	B040099	RES,FXD,FILM:30 OHM,5%,0.2W	57668	TR20JE 30E
A10R415	313-1101-00	B040100		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R416	313-1101-00	B020100	B030099	RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R416	313-1300-00	B030100	B040099	RES,FXD,FILM:30 OHM,5%,0.2W	57668	TR20JE 30E
A10R416	313-1101-00	B040100		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10R417	313-1391-00	B020100	B030099	RES,FXD,FILM:390 OHM,5%,0.2W	57668	TR20JE 390E
A10R417	313-1511-00	B030100		RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R420	313-1271-00			RES,FXD,FILM:270 OHM,5%,0.2W	57668	TR20JE 270E
A10R421	322-3279-00			RES,FXD,FILM:7.87K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 7K87
A10R422	322-3279-00			RES,FXD,FILM:7.87K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 7K87
A10R423	322-3279-00			RES,FXD,FILM:7.87K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 7K87
A10R424	322-3279-00			RES,FXD,FILM:7.87K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 7K87
A10R425	313-1620-00	B010100	B020099	RES,FXD,FILM:62 OHM,5%,0.2W	57668	TR20JT6862E0
A10R425	313-1151-00	B020100		RES,FXD,FILM:150 OHM,5%,0.2W	57668	TR20JE150E
A10R426	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R430	313-1271-00			RES,FXD,FILM:270 OHM,5%,0.2W	57668	TR20JE 270E
A10R431	313-1151-00			RES,FXD,FILM:150 OHM,5%,0.2W	57668	TR20JE150E
A10R432	322-3074-00			RES,FXD,FILM:57.6 OHM,1%,0.2W,TC=T0	80009	322-3074-00
A10R440	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A10R441	313-1621-00			RES,FXD,FILM:620 OHM,5%,0.2W	57668	TR20JE 620E
A10R442	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6
A10R443	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6
A10R444	313-1561-00			RES,FXD,FILM:560 OHM,5%,0.2W	57668	TR20JE 560E
A10R446	313-1751-00	B030100		RES,FXD,FILM:750 OHM,5%,0.2W	57668	TR20JE 750E
A10R447	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 1K00
A10R448	322-3251-00			RES,FXD,FILM:4.02K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 4K02
A10R449	313-1392-00	B030100		RES,FXD,FILMN:3.9K OHM,5%,0.2W	57668	TR20JE 03K9
A10R450	313-1271-00			RES,FXD,FILM:270 OHM,5%,0.2W	57668	TR20JE 270E
A10R451	322-3279-00			RES,FXD,FILM:7.87K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 7K87
A10R452	322-3279-00			RES,FXD,FILM:7.87K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 7K87
A10R453	322-3279-00			RES,FXD,FILM:7.87K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 7K87
A10R454	322-3279-00			RES,FXD,FILM:7.87K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 7K87
A10R456	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R460	313-1271-00			RES,FXD,FILM:270 OHM,5%,0.2W	57668	TR20JE 270E
A10R462	322-3074-00			RES,FXD,FILM:57.6 OHM,1%,0.2W,TC=T0	80009	322-3074-00
A10R463	313-1120-00			RES,FXD,FILM:12 OHM,5%,0.2W	57668	TR20JE12E0
A10R464	311-2229-00	B010100	B020099	RES,VAR,NONWW:TRMR,250 OHM,20%,0.5W LINEAR	TK1450	GF06UT 250
A10R469	311-2229-00	B020100		RES,VAR,NONWW:TRMR,250 OHM,20%,0.5W LINEAR	TK1450	GF06UT 250
A10R470	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A10R471	313-1621-00			RES,FXD,FILM:620 OHM,5%,0.2W	57668	TR20JE 620E
A10R472	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6
A10R473	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6
A10R474	313-1561-00			RES,FXD,FILM:560 OHM,5%,0.2W	57668	TR20JE 560E
A10R475	322-3119-00			RES,FXD,FILM:169 OHM,1%,0.2W,TC=T0	91637	CCF-50 1690F
A10R476	313-1202-00	B010100	B030099	RES,FXD,FILM:2K OHM,5%,0.2W	57668	TR20JE02K0
A10R476	313-1392-00	B030100		RES,FXD,FILMN:3.9K OHM,5%,0.2W	57668	TR20JE 03K9
A10R477	322-3119-00			RES,FXD,FILM:169 OHM,1%,0.2W,TC=T0	91637	CCF-50 1690F
A10R478	322-3237-00			RES,FXD,FILM:2.87K OHM,1%,0.2W,TC=T0	80009	322-3237-00
A10R481	313-1051-00			RES,FXD,FILM:5.1 OHM,5%,0.2W	57668	TR20JT68 05E1
A10R482	313-1051-00			RES,FXD,FILM:5.1 OHM,5%,0.2W	57668	TR20JT68 05E1
A10R483	313-1680-00	B010100	B030099	RES,FXD,FILM:68 OHM,0.2W,5%	57668	TR20JT68 68E
A10R483	313-1151-00	B030100		RES,FXD,FILM:150 OHM,5%,0.2W	57668	TR20JE150E
A10R484	313-1202-00			RES,FXD,FILM:2K OHM,5%,0.2W	57668	TR20JE02K0
A10R485	313-1392-00			RES,FXD,FILMN:3.9K OHM,5%,0.2W	57668	TR20JE 03K9
A10R486	313-1302-00	B010100	B030099	RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR20JE 03K0
A10R486	313-1512-00	B030100		RES,FXD,CMPSN:5.1K OHM,5%,0.2W	57668	TR20JE 5K1
A10R487	313-1751-00	B030100		RES,FXD,FILM:750 OHM,5%,0.2W	57668	TR20JE 750E
A10R490	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R491	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R492	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R493	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R494	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R495	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R496	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E

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A10R497	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R498	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R501	307-0446-00			RES NTWK,FXD,FI:10K OHM,20%,(9)RES	11236	750-101-R10K
A10R502	307-0446-00			RES NTWK,FXD,FI:10K OHM,20%,(9)RES	11236	750-101-R10K
A10R503	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R504	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R505	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A10R506	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A10R507	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A10R508	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A10R509	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R510	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R511	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R512	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R513	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R514	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R515	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R516	313-1152-00			RES,FXD,FILM:1.5K OHM,5%,0.2W	57668	TR20JE01K5
A10R517	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A10R601	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R602	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R603	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R604	322-3231-00			RES,FXD,FILM:2.49K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 2K49
A10R605	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A10R606	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R609	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R610	313-1391-00			RES,FXD,FILM:390 OHM,5%,0.2W	57668	TR20JE 390E
A10R611	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R612	313-1391-00			RES,FXD,FILM:390 OHM,5%,0.2W	57668	TR20JE 390E
A10R613	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R614	313-1391-00			RES,FXD,FILM:390 OHM,5%,0.2W	57668	TR20JE 390E
A10R615	313-1471-00			RES,FXD,FILM:470 OHM,5%,0.2W	57668	TR20JE 470E
A10R616	313-1471-00			RES,FXD,FILM:470 OHM,5%,0.2W	57668	TR20JE 470E
A10R617	313-1471-00			RES,FXD,FILM:470 OHM,5%,0.2W	57668	TR20JE 470E
A10R618	313-1821-00			RES,FXD,FILM:820 OHM,5%,0.2W	57668	TR20JE 820E
A10R619	313-1821-00			RES,FXD,FILM:820 OHM,5%,0.2W	57668	TR20JE 820E
A10R620	313-1821-00			RES,FXD,FILM:820 OHM,5%,0.2W	57668	TR20JE 820E
A10R621	313-1302-00			RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR20JE 03K0
A10R622	313-1302-00			RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR20JE 03K0
A10R623	313-1302-00			RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR20JE 03K0
A10R624	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R625	313-1221-00			RES,FXD,FILM:220 OHM,5%,0.2W	57668	TR20JE220E
A10R626	313-1390-00			RES,FXD,FILM:39 OHM,5%,0.2W	57668	TR20JE 39E
A10R627	313-1390-00			RES,FXD,FILM:39 OHM,5%,0.2W	57668	TR20JE 39E
A10R628	307-0503-00			RES NTWK,FXD,FI:(9) 510 OHM,20%,0.125W	11236	750-101-R510
A10R630	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R631	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R632	313-1820-00	B010100	B020099	RES,FXD,FILM:82 OHM,5%,0.2W	57668	TR20JE 82E
A10R633	313-1750-00	B010100	B020099	RES,FXD,FILM:75 OHM,5%,0.2W	57668	TR20JE 75E
A10R636	313-1273-00			RES,FXD,FILM:27K OHM,5%,0.2W	57668	TR20JE 27K
A10R637	313-1822-00			RES,FXD,FILM:8.2K,OHM,5%,0.2W	57668	TR20JE 08K2
A10R638	313-1753-00			RES,FXD,FILM:75K OHM,5%,0.2W	57668	TR20JE 75K
A10R639	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2W	57668	TR20JE 5K1
A10R640	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2W	57668	TR20JE 5K1
A10R641	313-1821-00			RES,FXD,FILM:820 OHM,5%,0.2W	57668	TR20JE 820E
A10R642	313-1821-00			RES,FXD,FILM:820 OHM,5%,0.2W	57668	TR20JE 820E
A10R643	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6
A10R644	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6
A10R645	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10R646	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6
A10R647	313-1821-00			RES,FXD,FILM:820 OHM,5%,0.2W	57668	TR20JE 820E
A10R648	313-1471-00			RES,FXD,FILM:470 OHM,5%,0.2W	57668	TR20JE 470E
A10R649	313-1302-00			RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR20JE 03K0
A10R650	313-1751-00			RES,FXD,FILM:750 OHM,5%,0.2W	57668	TR20JE 750E
A10R651	313-1331-00			RES,FXD,FILM:330 OHM,5%,0.2W	57668	TR20JE 330E
A10R652	313-1331-00			RES,FXD,FILM:330 OHM,5%,0.2W	57668	TR20JE 330E
A10R653	313-1471-00			RES,FXD,FILM:470 OHM,5%,0.2W	57668	TR20JE 470E
A10R654	313-1302-00			RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR20JE 03K0
A10R655	313-1821-00			RES,FXD,FILM:820 OHM,5%,0.2W	57668	TR20JE 820E
A10R656	313-1621-00			RES,FXD,FILM:620 OHM,5%,0.2W	57668	TR20JE 620E
A10R657	313-1621-00			RES,FXD,FILM:620 OHM,5%,0.2W	57668	TR20JE 620E
A10R658	313-1302-00			RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR20JE 03K0
A10R659	313-1302-00			RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR20JE 03K0
A10R660	313-1820-00	B010100	B020099	RES,FXD,FILM:82 OHM,5%,0.2W	57668	TR20JE 82E
A10R661	313-1750-00	B010100	B020099	RES,FXD,FILM:75 OHM,5%,0.2W	57668	TR20JE 75E
A10R662	313-1393-00			RES,FXD,FILM:39K OHM,5%,0.2W	57668	TR20JE 39K
A10R663	313-1393-00			RES,FXD,FILM:39K OHM,5%,0.2W	57668	TR20JE 39K
A10R664	313-1393-00			RES,FXD,FILM:39K OHM,5%,0.2W	57668	TR20JE 39K
A10R665	313-1393-00			RES,FXD,FILM:39K OHM,5%,0.2W	57668	TR20JE 39K
A10R666	313-1393-00			RES,FXD,FILM:39K OHM,5%,0.2W	57668	TR20JE 39K
A10R667	313-1161-00	B010100	B020099	RES,FXD,FILM:160 OHM,5%,0.2W	57668	TR20JE160E
A10R668	313-1161-00	B010100	B020099	RES,FXD,FILM:160 OHM,5%,0.2W	57668	TR20JE160E
A10R669	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R670	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR20JT68 510E
A10R671	313-1180-00			RES,FXD,FILM:18 OHM,5%,0.2W	80009	313-1180-00
A10R672	313-1333-00			RES,FXD,FILM:33K OHM,5%,0.2W	57668	TR20JE 33K
A10R701	322-3226-00			RES,FXD,FILM:2.21K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 2K21
A10R702	313-1222-00			RES,FXD,FILM:2.2K OHM,5%,0.2W	57668	TR20JE 02K2
A10R703	311-2230-00			RES,VAR,NONWW:TRMR,500 OHM,20%,0.50 LINEAR	TK1450	GF06UT 500
A10R706	322-3085-00			RES,FXD,FILM:75 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 75E0
A10R707	322-3085-00			RES,FXD,FILM:75 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 75E0
A10R708	307-2130-00			RES NTWK,FXD,FI:DUAL LOAD RESISTOR	80009	307-2130-00
A10R709	313-1027-00			RES,FXD,FILM:2.7 OHM,5%,0.2W	57668	TR20JE 02E7
A10R710	313-1134-00			RES,FXD,FILM:130K OHM 5%,0.2W	57668	TR20JT68 130K
A10R711	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R712	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R715	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R716	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R717	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R718	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R719	313-1200-00			RES,FXD,FILM:20 OHM,5%,0.2W	57668	TR20JE20E
A10R720	313-1200-00			RES,FXD,FILM:20 OHM,5%,0.2W	57668	TR20JE20E
A10R721	313-1134-00			RES,FXD,FILM:130K OHM 5%,0.2W	57668	TR20JT68 130K
A10R722	313-1134-00			RES,FXD,FILM:130K OHM 5%,0.2W	57668	TR20JT68 130K
A10R723	313-1027-00			RES,FXD,FILM:2.7 OHM,5%,0.2W	57668	TR20JE 02E7
A10R724	311-2234-00			RES,VAR,NONWW:TRMR,5K OHM,20%,0.5W	TK1450	GF06UT 5K
A10R725	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R726	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R727	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A10R728	313-1824-00			RES,FXD,FILM:820K OHM,0.2W,5%	80009	313-1824-00
A10R729	313-1202-00			RES,FXD,FILM:2K OHM,5%,0.2W	57668	TR20JE02K0
A10R730	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R731	313-1750-00			RES,FXD,FILM:75 OHM,5%,0.2W	57668	TR20JE 75E
A10R732	313-1750-00			RES,FXD,FILM:75 OHM,5%,0.2W	57668	TR20JE 75E
A10R733	313-1027-00			RES,FXD,FILM:2.7 OHM,5%,0.2W	57668	TR20JE 02E7
A10R734	313-1120-00			RES,FXD,FILM:12 OHM,5%,0.2W	57668	TR20JE12E0
A10R801	313-1431-00			RES,FXD,FILM:430 OHM,5%,0.2W	57668	TR20JE 430E
A10R802	313-1750-00			RES,FXD,FILM:75 OHM,5%,0.2W	57668	TR20JE 75E

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10R803	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6
A10R804	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A10R805	313-1182-00			RES,FXD,FILM:1.8K OHM 5%,0.2W	57668	TR20JT681K8
A10R806	323-0210-00			RES,FXD,FILM:1.50K OHM,1%,0.5W,TC=T0	19701	5053R01K500F
A10R808	313-1242-00			RES,FXD,FILM:2.4K OHM,5%,0.2W	57668	TR20JE 02K4
A10R809	311-2234-00			RES,VAR,NONWW:TRMR,5K OHM,20%,0.5W	TK1450	GF06UT 5K
A10R810	313-1242-00			RES,FXD,FILM:2.4K OHM,5%,0.2W	57668	TR20JE 02K4
A10R811	322-3266-00			RES,FXD,FILM:5.76K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 5K76
A10R812	322-3266-00			RES,FXD,FILM:5.76K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 5K76
A10R813	313-1431-00			RES,FXD,FILM:430 OHM,5%,0.2W	57668	TR20JE 430E
A10R814	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR20JE 05K6
A10R815	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A10R816	323-0310-00			RES,FXD,FILM:16.5K OHM,1%,0.5W,TC=T0	75042	CECT0-1652F
A10R819	313-1750-00			RES,FXD,FILM:75 OHM,5%,0.2W	57668	TR20JE 75E
A10R820	322-3402-00			RES,FXD,FILM:150K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 150K
A10R821	322-3402-00			RES,FXD,FILM:150K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 150K
A10R822	322-3265-00			RES,FXD,FILM:5.62K OHM,1%,0.2W,TC=T0	80009	322-3265-00
A10R823	311-2230-00			RES,VAR,NONWW:TRMR,500 OHM,20%,0.50 LINEAR	TK1450	GF06UT 500
A10R825	311-2234-00			RES,VAR,NONWW:TRMR,5K OHM,20%,0.5W	TK1450	GF06UT 5K
A10R826	311-2234-00			RES,VAR,NONWW:TRMR,5K OHM,20%,0.5W	TK1450	GF06UT 5K
A10R827	311-2229-00			RES,VAR,NONWW:TRMR,250 OHM,20%,0.5W LINEAR	TK1450	GF06UT 250
A10R828	301-0203-00			RES,FXD,FILM:20K OHM,5%,0.5W	19701	5053CX20K00J
A10R829	301-0203-00			RES,FXD,FILM:20K OHM,5%,0.5W	19701	5053CX20K00J
A10R836	322-3152-00			RES,FXD,FILM:374 OHM,1%,0.2W,TC=T0	57668	CR820 FXE 374E
A10R837	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R840	313-1470-00			RES,FXD,FILM:47 OHM,5%,0.2W	57668	TR20JE 47E
A10R841	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R842	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R843	301-0751-00			RES,FXD,FILM:750 OHM,5%,0.5W	19701	5053CX750R0J
A10R844	301-0751-00			RES,FXD,FILM:750 OHM,5%,0.5W	19701	5053CX750R0J
A10R845	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R846	322-3058-00			RES,FXD,FILM:39.2 OHM,1%,0.2W,TC=T0	57668	CR820 FXE 39E2
A10R847	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R848	301-0222-00			RES,FXD,FILM:2.2K OHM,5%,0.5W	19701	5053CX2K200J
A10R849	301-0222-00			RES,FXD,FILM:2.2K OHM,5%,0.5W	19701	5053CX2K200J
A10R850	313-1432-00			RES,FXD,FILM:4.3K OHM,5%,0.2W	57668	TR20JE 04K3
A10R851	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R852	322-3073-00			RES,FXD,FILM:56.2 OHM,1%,0.2W,TC=T0	80009	322-3073-00
A10R853	313-1470-00			RES,FXD,FILM:47 OHM,5%,0.2W	57668	TR20JE 47E
A10R854	313-1201-00			RES,FXD,FILM:200 OHM,5%,0.2W	57668	TR20JE200E
A10R855	313-1201-00			RES,FXD,FILM:200 OHM,5%,0.2W	57668	TR20JE200E
A10R856	322-3288-00			RES,FXD,FILM:9.76K OHM,1%,0.2W,TC=T0	80009	322-3288-00
A10R857	322-3264-00			RES,FXD,FILM:5.49K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 5K49
A10R858	322-3143-00			RES,FXD,FILM:301 OHM,1%,0.2W,TC=T0	57668	CR820 FXE 301E
A10R906	313-1120-00			RES,FXD,FILM:12 OHM,5%,0.2W	57668	TR20JE12E0
A10R907	313-1120-00			RES,FXD,FILM:12 OHM,5%,0.2W	57668	TR20JE12E0
A10R908	313-1120-00			RES,FXD,FILM:12 OHM,5%,0.2W	57668	TR20JE12E0
A10R909	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R910	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R911	311-1239-00			RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3386X-T07-252
A10R915	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 10K0
A10R916	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CR820 FXE 10K0
A10R920	311-2228-00			RES,VAR,NONWW:TRMR,200 OHM,20%,0.5W LINEAR	TK1450	GF06UT B200 OHM
A10R921	307-2131-00			RES NTWK,FXD,FI:PRECESION VOLTAGE DIVIDER	80009	307-2131-00
A10R922	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R923	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R924	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R930	313-1751-00			RES,FXD,FILM:750 OHM,5%,0.2W	57668	TR20JE 750E
A10R931	322-3193-02			RES,FXD,FILM:1K OHM,0.5%,0.2W,TC=T2	57668	CR820 DYE 1K00

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10R932	322-3239-03			RES,FXD,FILM:3.01K OHM,0.25%,0.2W,TC=T2	57668	CRB20 CYE 3K01
A10R933	313-1272-00			RES,FXD,FILM:2.7K OHM,5%,0.2W	57668	TR20JE 02K7
A10R934	313-1122-00			RES,FXD,FILM:1.2K OHM,5%,0.2W	57668	TR20JE01K2
A10R935	313-1223-00			RES,FXD,FILM:22K,OHM,5%,0.2W	57668	TR20JE 22K
A10R936	322-3489-02			RES,FXD,FILM:3.52K OHM,0.2W,5%	57668	CRB20 DYE 3K52
A10R937	322-3126-02			RES,FXD,FILM:200 OHM,0.5%,0.2W,TC=T2	80009	322-3126-02
A10R938	313-1752-00			RES,FXD,FILM:7.5K OHM,5%,0.2W	57668	TR20JE 07K5
A10R939	313-1152-00			RES,FXD,FILM:1.5K OHM,5%,0.2W	57668	TR20JE01K5
A10R940	313-1122-00	B020100		RES,FXD,FILM:1.2K OHM,5%,0.2W	57668	TR20JE01K2
A10R1001	322-3232-00			RES,FXD,FILM:2.55K OHM,1%,0.2W,TC=T0	80009	322-3232-00
A10R1002	322-3232-00			RES,FXD,FILM:2.55K OHM,1%,0.2W,TC=T0	80009	322-3232-00
A10R1003	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2W	57668	TR20JE 5K1
A10R1004	322-3232-00			RES,FXD,FILM:2.55K OHM,1%,0.2W,TC=T0	80009	322-3232-00
A10R1005	322-3251-00			RES,FXD,FILM:4.02K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 4K02
A10R1006	322-3184-00			RES,FXD,FILM:806 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 806E
A10R1007	322-3251-00			RES,FXD,FILM:4.02K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 4K02
A10R1008	322-3184-00			RES,FXD,FILM:806 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 806E
A10R1009	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R1010	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R1020	313-1272-00			RES,FXD,FILM:2.7K OHM,5%,0.2W	57668	TR20JE 02K7
A10R1021	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2W	57668	TR20JE 5K1
A10R1022	313-1272-00			RES,FXD,FILM:2.7K OHM,5%,0.2W	57668	TR20JE 02K7
A10R1023	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2W	57668	TR20JE 5K1
A10R1024	313-1272-00			RES,FXD,FILM:2.7K OHM,5%,0.2W	57668	TR20JE 02K7
A10R1025	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2W	57668	TR20JE 5K1
A10R1026	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R1027	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R1028	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R1101	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R1102	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR20JE10E0
A10R1103	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R1104	313-1682-00			RES,FXD,FILM:6.8K OHM,5%,0.2W	57668	TR20JE 06K8
A10R1110	313-1682-00			RES,FXD,FILM:6.8K OHM,5%,0.2W	57668	TR20JE 06K8
A10R1111	313-1303-00			RES,FXD,FILM:30K OHM,5%,0.2W	57668	TR20JE 30K
A10R1112	313-1302-00			RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR20JE 03K0
A10R1113	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R1114	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R1115	313-1682-00			RES,FXD,FILM:6.8K OHM,5%,0.2W	57668	TR20JE 06K8
A10R1116	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R1117	313-1113-00	B010100	B040976	RES,FXD,FILM:11K OHM,5%,0.2W	57668	TR20JE11K0
A10R1117	313-1332-00	B040977		RES,FXD,FILM:3.3K OHM,5%,0.2W	57668	TR20JE 03K3
A10R1118	313-1751-00			RES,FXD,FILM:750 OHM,5%,0.2W	57668	TR20JE 750E
A10R1120	313-1682-00			RES,FXD,FILM:6.8K OHM,5%,0.2W	57668	TR20JE 06K8
A10R1121	313-1303-00			RES,FXD,FILM:30K OHM,5%,0.2W	57668	TR20JE 30K
A10R1122	313-1302-00			RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR20JE 03K0
A10R1123	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A10R1124	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A10R1125	313-1682-00			RES,FXD,FILM:6.8K OHM,5%,0.2W	57668	TR20JE 06K8
A10R1126	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A10R1127	313-1113-00	B010100	B040976	RES,FXD,FILM:11K OHM,5%,0.2W	57668	TR20JE11K0
A10R1127	313-1332-00	B040977		RES,FXD,FILM:3.3K OHM,5%,0.2W	57668	TR20JE 03K3
A10R1128	313-1751-00			RES,FXD,FILM:750 OHM,5%,0.2W	57668	TR20JE 750E
A10R1130	313-1393-00	B010100	B040976	RES,FXD,FILM:39K OHM,5%,0.2W	57668	TR20JE 39K
A10R1131	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A10R1132	313-1183-00			RES,FXD,FILM:18K OHM,5%,0.2W	57668	TR20JT68 18K
A10R1133	313-1124-00			RES,FXD,FILM:120K OHM,5%,0.2W	57668	TR20JE120K
A10R1134	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A10R1135	313-1244-00	B040977		RES,FXD,FILM:240K OHM,5%,0.2W	57668	TR20JE 240K
A10R1136	313-1244-00	B040977		RES,FXD,FILM:240K OHM,5%,0.2W	57668	TR20JE 240K

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10R1142	313-1683-00	B010100	B040976	RES,FXD,FILM:68K OHM,5%,0.2W	57668	TR2OJE 68K
A10R1142	313-1273-00	B040977		RES,FXD,FILM:27K OHM,5%,0.2W	57668	TR2OJE 27K
A10R1143	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR2OJE01K0
A10R1144	313-1683-00			RES,FXD,FILM:68K OHM,5%,0.2W	57668	TR2OJE 68K
A10R1145	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR2OJE01K0
A10R1150	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR2OJE01K0
A10R1154	313-1105-00	B010100	B030099	RES,FXD,FILM:1M OHM,5%,0.2W	57668	TR2OJE1M
A10R1154	315-0205-00	B030100		RES,FXD,FILM:2M OHM,5%,0.25W	01121	CB2055
A10R1155	313-1105-00	B010100	B030099	RES,FXD,FILM:1M OHM,5%,0.2W	57668	TR2OJE1M
A10R1155	315-0205-00	B030100		RES,FXD,FILM:2M OHM,5%,0.25W	01121	CB2055
A10R1158	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR2OJE10E0
A10R1159	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR2OJE10E0
A10R1162	313-1302-00			RES,FXD,FILM:3K OHM,5%,0.2W	57668	TR2OJE 03K0
A10R1163	313-1152-00			RES,FXD,FILM:1.5K OHM,5%,0.2W	57668	TR2OJE01K5
A10R1170	313-1152-00			RES,FXD,FILM:1.5K OHM,5%,0.2W	57668	TR2OJE01K5
A10R2701	322-3112-00			RES,FXD,FILM:143 OHM,1%,0.2W,TC=T0	80009	322-3112-00
A10R2702	313-1393-00			RES,FXD,FILM:39K OHM,5%,0.2W	57668	TR2OJE 39K
A10R2703	322-3282-00			RES,FXD,FILM:8.45K OHM,1%,0.2W,TC=T0	80009	322-3282-00
A10R2704	322-3164-00			RES,FXD,FILM:499 OHM,1%,0.2W,TC=T0	57668	CRB2O FXE 499E
A10R2705	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR2OJE01K0
A10R2706	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR2OJE10K0
A10R2708	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB2O FXE 10K0
A10R2709	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB2O FXE 10K0
A10R2710	313-1361-00			RES,FXD,FILM:360 OHM,5%,0.2W	57668	TR2OJE 360E
A10R2711	313-1333-00			RES,FXD,FILM:33K OHM,5%,0.2W	57668	TR2OJE 33K
A10R2712	313-1333-00			RES,FXD,FILM:33K OHM,5%,0.2W	57668	TR2OJE 33K
A10R2713	313-1333-00			RES,FXD,FILM:33K OHM,5%,0.2W	57668	TR2OJE 33K
A10R2714	313-1333-00			RES,FXD,FILM:33K OHM,5%,0.2W	57668	TR2OJE 33K
A10R2715	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR2OJE100K
A10R2716	313-1333-00			RES,FXD,FILM:33K OHM,5%,0.2W	57668	TR2OJE 33K
A10R2717	313-1562-00			RES,FXD,FILM:5.6K OHM,5%,0.2W	57668	TR2OJE 05K6
A10R2718	313-1750-00			RES,FXD,FILM:75 OHM,5%,0.2W	57668	TR2OJE 75E
A10R2719	311-2236-00			RES,VAR,NONWW:TRMR,20K OHM,20%,0.5W LINEAR	TK1450	GF06UT 20K
A10R2720	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
A10R2721	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR2OJE 04K7
A10R2722	313-1244-00			RES,FXD,FILM:240K OHM,5%,0.2W	57668	TR2OJE 240K
A10R2723	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR2OJT68 510E
A10R2724	315-0625-00			RES,FXD,FILM:6.2M OHM,5%,0.25W	01121	CB6255
A10R2726	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR2OJE100E
A10R2727	322-3213-00			RES,FXD,FILM:1.62K OHM,1%,0.2W,TC=T0	57668	CRB2O FXE 1K62
A10R2728	313-1200-00			RES,FXD,FILM:20 OHM,5%,0.2W	57668	TR2OJE20E
A10R2729	322-3210-00			RES,FXD,FILM:1.5K OHM,1%,0.2W,TC=T0	57668	CRB2O FXE 1K50
A10R2733	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR2OJE01K0
A10R2734	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR2OJE100E
A10R2735	315-0122-00			RES,FXD,FILM:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A10R2736	301-0203-00			RES,FXD,FILM:20K OHM,5%,0.5W	19701	5053CX20K00J
A10R2737	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR2OJE100K
A10R2738	313-1333-00			RES,FXD,FILM:33K OHM,5%,0.2W	57668	TR2OJE 33K
A10R2739	313-1752-00			RES,FXD,FILM:7.5K OHM,5%,0.2W	57668	TR2OJE 07K5
A10R2740	313-1750-00			RES,FXD,FILM:75 OHM,5%,0.2W	57668	TR2OJE 75E
A10R2741	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR2OJE 04K7
A10R2742	313-1244-00			RES,FXD,FILM:240K OHM,5%,0.2W	57668	TR2OJE 240K
A10R2743	313-1122-00			RES,FXD,FILM:1.2K OHM,5%,0.2W	57668	TR2OJE01K2
A10R2745	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR2OJE01K0
A10R2750	313-1511-00			RES,FXD,FILM:510 OHM,5%,0.2W	57668	TR2OJT68 510E
A10R2751	315-0625-00			RES,FXD,FILM:6.2M OHM,5%,0.25W	01121	CB6255
A10R2758	311-1933-00			RES,VAR,NONWW:PNL,5M OHM,10%,0.5W	01121	23W909
A10R2760	307-2173-00			RES NTWK,FXD,FI:HIGH VOLTAGE,FINISHED	80009	307-2173-00
A10R2765	322-3188-00			RES,FXD,FILM:887 OHM,1%,0.2W,TC=T0	57668	CRB2O FXE 887E

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10R2783	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR2OJE100E
A10R2784	311-2239-00			RES,VAR,NONWW:TRMR,100K OHM,20%,0.5W LINEAR	TK1450	GF06UT 100K
A10R2785	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR2OJE01KO
A10R2786	313-1823-00			RES,FXD,FILM:82K OHM,5%,0.2W	57668	TR2OJE 82K
A10R2787	313-1363-00			RES,FXD,FILM:36K OHM,5%,0.2W	57668	TR2OJE 36K
A10R2788	311-2239-00			RES,VAR,NONWW:TRMR,100K OHM,20%,0.5W LINEAR	TK1450	GF06UT 100K
A10R2789	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR2OJE01KO
A10R2795	322-3268-00			RES,FXD,FILM:6.04K OHM.1%,0.2W,TC=TO	57668	CRB2O FXE 6KO4
A10R2796	313-1100-00			RES,FXD,FILM:10 OHM,5%,0.2W	57668	TR2OJE10EO
A10T421	120-0487-00	B010100	B020099	XFMR,TOROID:	80009	120-0487-00
A10T431	120-0487-00	B010100	B020099	XFMR,TOROID:	80009	120-0487-00
A10U112	165-2154-00			MICROCKT,LINEAR:BUFFER AMPLIFIER	80009	165-2154-00
A10U122	165-2154-00			MICROCKT,LINEAR:BUFFER AMPLIFIER	80009	165-2154-00
A10U171	156-0796-01	B010100	B040345	MICROCKT,DGTL:8 STG SHF & STORE BUS RGTR	02735	CD4094BFX
A10U171	156-0796-00	B040346		MICROCKT,DGTL:8 STG SHF & STORE BUS RGTR	02735	CD4094BF
A10U172	156-0796-01	B010100	B040345	MICROCKT,DGTL:8 STG SHF & STORE BUS RGTR	02735	CD4094BFX
A10U172	156-0796-00	B040346		MICROCKT,DGTL:8 STG SHF & STORE BUS RGTR	02735	CD4094BF
A10U173	156-0796-01	B010100	B040345	MICROCKT,DGTL:8 STG SHF & STORE BUS RGTR	02735	CD4094BFX
A10U173	156-0796-00	B040346		MICROCKT,DGTL:8 STG SHF & STORE BUS RGTR	02735	CD4094BF
A10U174	156-1190-00			MICROCKT,LINEAR:7 XSTR	02735	CA3082-98
A10U175	156-1190-00			MICROCKT,LINEAR:7 XSTR	02735	CA3082-98
A10U201	156-2571-00			MICROCKT,DGTL:HCMOS,ANALOG MUX,TRIPLE,2	80009	156-2571-00
A10U202	156-2571-00			MICROCKT,DGTL:HCMOS,ANALOG MUX,TRIPLE,2	80009	156-2571-00
A10U203	156-2667-00			MICROCKT,LINEAR:QUAD LOW PWR,OP AMPL	80009	156-2667-00
A10U210	234-0203-20			QUICK CHIP:SH3 VERSION OF M84	80009	234-0203-20
A10U220	234-0203-20			QUICK CHIP:SH3 VERSION OF M84	80009	234-0203-20
A10U230	234-0203-20			QUICK CHIP:SH3 VERSION OF M84	80009	234-0203-20
A10U240	234-0203-20			QUICK CHIP:SH3 VERSION OF M84	80009	234-0203-20
A10U260	156-0067-01			MICROCKT,LINEAR:OPNL AMPL,CHECKED	04713	MC1741CP1DS
A10U280	156-1349-00			MICROCKT,LINEAR:DUAL INDEP DIFF AMPL	02735	CA3054-98
A10U301	156-2571-00			MICROCKT,DGTL:HCMOS,ANALOG MUX,TRIPLE,2	80009	156-2571-00
A10U302	156-0796-01	B010100	B040345	MICROCKT,DGTL:8 STG SHF & STORE BUS RGTR	02735	CD4094BFX
A10U302	156-0796-00	B040346		MICROCKT,DGTL:8 STG SHF & STORE BUS RGTR	02735	CD4094BF
A10U303	156-0796-01	B010100	B040345	MICROCKT,DGTL:8 STG SHF & STORE BUS RGTR	02735	CD4094BFX
A10U303	156-0796-00	B040346		MICROCKT,DGTL:8 STG SHF & STORE BUS RGTR	02735	CD4094BF
A10U304	156-2873-00			MICROCKT,LINEAR:DUAL BIFET,OP AMPL	80009	156-2873-00
A10U307	156-0514-01	B010100	B040345	MICROCKT,DGTL:DIFF 4-CHANNEL MUX,SEL	80009	156-0514-01
A10U307	156-0514-00	B040346		MICROCKT,DGTL:CMOS,DIFF 4-CHANNEL MUX	02735	CD4052BF-98
A10U308	156-0514-01	B010100	B040345	MICROCKT,DGTL:DIFF 4-CHANNEL MUX,SEL	80009	156-0514-01
A10U308	156-0514-00	B040346		MICROCKT,DGTL:CMOS,DIFF 4-CHANNEL MUX	02735	CD4052BF-98
A10U309	156-0158-07			MICROCKT,LINEAR:DUAL OPNL AMPL,SCREENED	01295	MC1458JG4
A10U310	156-0514-01	B010100	B040345	MICROCKT,DGTL:DIFF 4-CHANNEL MUX,SEL	80009	156-0514-01
A10U310	156-0514-00	B040346		MICROCKT,DGTL:CMOS,DIFF 4-CHANNEL MUX	02735	CD4052BF-98
A10U311	156-0514-01	B01D100	B040345	MICROCKT,DGTL:DIFF 4-CHANNEL MUX,SEL	80009	156-0514-01
A10U311	156-0514-00	B040346		MICROCKT,DGTL:CMOS,DIFF 4-CHANNEL MUX	02735	CD4052BF-98
A10U313	156-1349-00			MICROCKT,LINEAR:DUAL INDEP DIFF AMPL	02735	CA3054-98
A10U315	156-1640-01	B010100	B040345	MICROCKT,DGTL:SCREENED	04713	MC10H116(LDORPD)
A10U315	156-1640-00	B040346		MICROCKT,DGTL:ECL,TPL LINE RCVR	04713	MC10H116(L OR P)
A10U316	156-0308-04	B010100	B040345	MICROCKT,DGTL:QUAD DIFF LINE RCVR,SCREENED	04713	MC10115PD/LD
A10U316	156-0308-00	B040346		MICROCKT,DGTL:ECL,QUAD DIFF LINE RCVR	04713	MC10115L OR P
A10U421	234-0204-20			INTEGRATED CKT:SCHMITT TRIGGER	80009	234-0204-20
A10U431	234-0204-20			INTEGRATED CKT:SCHMITT TRIGGER	80009	234-0204-20
A10U441	156-2027-00			MICROCKT,DGTL:CMOS,HEX INVERTER	27014	MM74HC04N
A10U501	156-0469-02	B01D100	B040345	MICROCKT,DGTL:3/8 LINE DCOR	01295	SN74LS138NP3
A10U501	156-0469-00	B040346		MICROCKT,DGTL:3-LINE TO 8-LINE DECODER	01295	SN74LS138N
A10U502	156-0768-01	B010100	B040345	MICROCKT,DGTL:BIDIRECT UNIV SR,SCREENED	01295	SN74LS194ANP3
A10U502	156-0768-00	B040346		MICROCKT,DGTL:BIDIRECT UNIV SR	01295	SN74LS194AN
A10U503	156-0804-02	B010100	B040345	MICROCKT,DGTL:QUADRUPLE S-R LATCH	01295	SN74LS279NP3/JP4
A10U503	156-0804-00	B040346		MICROCKT,DGTL:QUADRUPLE S-R LATCH	04713	74LS279(N OR J)

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10U505	156-0513-03	B010100	B040345	MICROCKT,LINEAR:CMOS,8 CHAN ANALOG MUX	04713	MC14051BCL
A10U505	156-0513-00	B040346		MICROCKT,DGTL:CMOS,8-CHANNEL MUX	04713	MC14051BCL
A10U506	156-0513-03	B010100	B040345	MICROCKT,LINEAR:CMOS,8 CHAN ANALOG MUX	04713	MC14051BCL
A10U506	156-0513-00	B040346		MICROCKT,DGTL:CMOS,8-CHANNEL MUX	04713	MC14051BCL
A10U600	156-2655-00			MICROCKT,DGTL:SEMI CUSTOM,STD CELL,SLOW	80009	156-2655-00
A10U601	156-1126-00			MICROCKT,LINEAR:VOLTAGE COMPARATOR	01295	LM311P
A10U602	156-2654-00			MICROCKT,DGTL:ECL,SEMI CUSTOM,FAST LOGIC	80009	156-2654-00
A10U603	156-0631-03	B010100	B040345	MICROCKT,DGTL:QUAD 2 INPUT OR/NOR GATE	04713	MC10101 (LD)
A10U603	156-0631-00	B040346		MICROCKT,DGTL:ECL,QUAD 2 INPUT OR/NOR GATE	04713	MC10101(L OR P)
A10U604	156-0860-02	B010100	B040345	MICROCKT,DGTL:TRIPLE LINE RECEIVER	04713	MC10116PD/LD
A10U604	156-0860-00	B040346		MICROCKT,DGTL:ECL,TRIPLE LINE RECEIVER	04713	MC10116L
A10U606	156-0140-02	B010100	B040345	MICROCKT,DGTL:HEX BUFFERS W/OC HV OUT,	18324	N7417(NB OR FB)
A10U606	156-0140-00	B040346		MICROCKT,DGTL:HEX BUFFER W/OC HV OUT,14	01295	SN7417N
A10U701	155-0322-00			MICROCKT,LINEAR:VERTICAL OUTPUT AMPLIFIER	80009	155-0322-00
A10U702	156-1126-00			MICROCKT,LINEAR:VOLTAGE COMPARATOR	01295	LM311P
A10U801	156-0158-07			MICROCKT,LINEAR:DUAL OPNL AMPL,SCREENED	01295	MC1458JG4
A10U802	234-0401-20			QUICK CHIP:GPS HORIZONTAL PREAMP	80009	234-0401-20
A10U901	156-2702-00			MICROCKT,LINEAR:DUAL OP AMP,HIGH OUTPUT CUR	80009	156-2702-00
A10U930	156-0158-07			MICROCKT,LINEAR:DUAL OPNL AMPL,SCREENED	01295	MC1458JG4
A10U931	156-2605-00			MICROCKT,DGTL:HCMOS,ANALOG MUX,8 CHANNEL	80009	156-2605-00
A10U932	156-1173-00			MICROCKT,LINEAR:VOLTAGE REFERENCE	04713	MC1403U0S
A10U1001	156-0495-00			MICROCKT,LINEAR:OPNL AMPL	01295	LM324N
A10U1101	156-2873-00			MICROCKT,LINEAR:DUAL BIFET,OP AMPL	80009	156-2873-00
A10U1102	156-1225-00			MICROCKT,LINEAR:DUAL COMPARATOR	01295	LM393P
A10U1103	156-0796-01	B010100	B040345	MICROCKT,DGTL:8 STG SHF & STORE BUS RGTR	02735	CD4094BFX
A10U1103	156-0796-00	B040346		MICROCKT,DGTL:8 STG SHF & STORE BUS RGTR	02735	CD4094BF
A10U1104	156-0515-02	B010100	B040345	MICROCKT,DGTL:TRIPLE 3-CHAN MUX,SEL	80009	156-0515-02
A10U1104	156-0515-00	B040346		MICROCKT,DGTL:CMOS,TRIPLE 3-CHAN MUX	02735	CD4053BF
A10U1106	156-0515-02	B010100	B040345	MICROCKT,DGTL:TRIPLE 3-CHAN MUX,SEL	80009	156-0515-02
A10U1106	156-0515-00	B040346		MICROCKT,DGTL:CMOS,TRIPLE 3-CHAN MUX	02735	CD4053BF
A10VR301	152-0437-00			SEMICOND DVC,DI:ZEN,SI,8.2V,2%,0.4W,DO-7	04713	SZG14RL
A10VR302	152-0437-00			SEMICOND DVC,DI:ZEN,SI,8.2V,2%,0.4W,DO-7	04713	SZG14RL
A10VR303	152-0437-00			SEMICOND DVC,DI:ZEN,SI,8.2V,2%,0.4W,DO-7	04713	SZG14RL
A10VR304	152-0437-00			SEMICOND DVC,DI:ZEN,SI,8.2V,2%,0.4W,DO-7	04713	SZG14RL
A10VR308	152-0127-00			SEMICOND DVC,DI:ZEN,SI,7.5V,5%,0.4W,DO-7	14433	Z5347 (1N9588)
A10VR309	152-0757-00	B010100	B040618	SEMICOND DVC,DI:ZEN,SI,6.2V,5%,1W,DO-41	04713	1N4735A
A10VR309	152-0166-00	B040619		SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-7	04713	SZ11738RL
A10VR310	152-0757-00	B010100	B040618	SEMICOND DVC,DI:ZEN,SI,6.2V,5%,1W,DO-41	04713	1N4735A
A10VR310	152-0166-00	B040619		SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-7	04713	SZ11738RL
A10VR311	152-0168-00			SEMICOND DVC,DI:ZEN,SI,12V,5%,0.4W,DO-763B	14552	TD331689
A10VR312	152-0168-00			SEMICOND DVC,DI:ZEN,SI,12V,5%,0.4W,DO-763B	14552	TD331689
A10VR801	152-0243-00			SEMICOND DVC,DI:ZEN,SI,15V,5%,0.4W,DO-7	04713	SZ13203 (1N9658)
A10VR802	152-0265-00			SEMICOND DVC,DI:ZEN,SI,24V,5%,0.4W	14552	TD3810986
A10VR2701	152-0306-00			SEMICOND DVC,DI:ZEN,SI,9.1V,5%,0.4W,DO-7	12954	1N960B
A10W2	175-9901-00			CA ASSY,SP,ELEC:15,27 AWG,8.05 L	80009	175-9901-00
A10W3	175-9903-00			CA ASSY,SP,ELEC:25,27 AWG,6.4 L	80009	175-9903-00
A10W5	175-9879-00			CA ASSY,SP,ELEC:17,27 AWG,15.5 L	80009	175-9879-00
A10W9	198-5523-00			WIRE SET,ELEC:SOCKET ASSY CRT	80009	198-5523-00
A10W17	196-3069-00			LEAD,ELECTRICAL:22 AWG,5.0 L,9-W	80009	196-3069-00
A10W18	196-3069-00			LEAD,ELECTRICAL:22 AWG,5.0 L,9-W	80009	196-3069-00
A10W19	196-3069-00			LEAD,ELECTRICAL:22 AWG,5.0 L,9-W	80009	196-3069-00
A10W20	196-3069-00			LEAD,ELECTRICAL:22 AWG,5.0 L,9-W	80009	196-3069-00
A10W100	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OWA 07
A10W101	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OWA 07
A10W102	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OWA 07
A10W103	131-0566-00	B020100		BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OWA 07
A10W200	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OWA 07
A10W201	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OWA 07

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10M202	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M203	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M205	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M206	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M207	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M208	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M209	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M210	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M223	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M231	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M232	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M235	131-0566-00	B020100		BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M301	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M302	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M304	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M305	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M310	131-0566-00	B010100	B020099	BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M401	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M402	131-0566-00	B020100	B040618	BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M403	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M404	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M405	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M406	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M407	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M408	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M410	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M411	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M412	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M413	131-0566-00	B020100		BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M414	131-0566-00	B020100		BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M415	174-0733-00	B040100		CA ASSY,SP,ELEC:4,26 AWG,4.5 L,RIBBON	80009	174-0733-00
A10M416	174-0732-00	B040100		CA ASSY,SP,ELEC:4,26 AWG,3.0 L,RIBBON	80009	174-0732-00
A10M426	131-0566-00	B020100	B040618	BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M502	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M504	131-0566-00	B010100	B020099	BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M505	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M506	131-0566-00	B010100	B020099	BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M507	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M508	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M510	131-0566-00	B020100		BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M603	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M604	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M605	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M606	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M610	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M611	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M612	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M613	131-0566-00	B010100	B020099	BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M614	131-0566-00	B010100	B020099	BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M615	131-0566-00	B010100	B020099	BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M616	131-0566-00	B010100	B020099	BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M802	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M804	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M805	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M806	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M807	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M808	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M810	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10M811	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M815	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M901	131-0566-00	B01D100	B040618	BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M902	131-0566-00	B010100	B040618	BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M906	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1000	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1010	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1101	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1102	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1103	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1104	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1105	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1106	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1107	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1120	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1200	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1201	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1202	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1204	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1205	131-0566-00	B020100		BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1209	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1210	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1216	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1217	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1218	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1219	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1221	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1222	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1223	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1231	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1236	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1237	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1247	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1248	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1249	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1250	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1251	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1252	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1255	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1256	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1257	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1277	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1286	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M1288	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10M2701	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A10X600	119-2051-00	B010100	B020099	RESONATOR,CER:10MHZ	51406	CSA 10:00 MX11
A10Y600	119-2051-00	B020100		RESONATOR,CER:10MHZ	51406	CSA 10:00 MX11

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A12	670-9402-00	B010100	B040804	CIRCUIT BD ASSY:POTENTIOMETER	80009	670-9402-00
A12	670-9402-01	B040805		CIRCUIT BD ASSY:POTENTIOMETER	80009	670-9402-01
A12J2105	131-3626-00			CONN,RCPT,ELEC:SIP STRIP RCPT 17 POSITION	00779	643649-1
A12R2101	311-2343-00			RES,VAR,NONWW:CKT BD,5K OHM,20%,0.5W	32997	91Z1AZ45EA0119
A12R2102	311-2345-00			RES,VAR,NONWW:CKT BD 5K OHM,20%,0.5W	32997	91Z1AZ45EA0117
A12R2103	311-2343-00			RES,VAR,NONWW:CKT BD,5K OHM,20%,0.5W	32997	91Z1AZ45EA0119
A12R2104	311-2345-00			RES,VAR,NONWW:CKT BD 5K OHM,20%,0.5W	32997	91Z1AZ45EA0117
A12R2105	311-2345-00			RES,VAR,NONWW:CKT BD 5K OHM,20%,0.5W	32997	91Z1AZ45EA0117
A12R2106	311-2345-00			RES,VAR,NONWW:CKT BD 5K OHM,20%,0.5W	32997	91Z1AZ45EA0117
A12R2107	311-2343-00			RES,VAR,NONWW:CKT BD,5K OHM,20%,0.5W	32997	91Z1AZ45EA0119
A12R2108	311-2345-00			RES,VAR,NONWW:CKT BD 5K OHM,20%,0.5W	32997	91Z1AZ45EA0117
A12R2109	311-2345-00			RES,VAR,NONWW:CKT BD 5K OHM,20%,0.5W	32997	91Z1AZ45EA0117
A12R2110	311-2345-00			RES,VAR,NONWW:CKT BD 5K OHM,20%,0.5W	32997	91Z1AZ45EA0117
A12R2111	311-2181-00			RES,VAR,NONWW:LINEAR,5K OHM,30%,0.25W	32997	91Z20-Z45-EA0020
A12R2112	311-2345-00			RES,VAR,NONWW:CKT BD 5K OHM,20%,0.5W	32997	91Z1AZ45EA0117
A12R2113	311-2181-00			RES,VAR,NONWW:LINEAR,5K OHM,30%,0.25W	32997	91Z20-Z45-EA0020

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A14	670-9399-00	B010100	B040984	CIRCUIT BD ASSY:SWITCH	80009	670-9399-00
A14	670-9399-01	B040985		CIRCUIT BD ASSY:SWITCH	80009	670-9399-01
A14C2001	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A14CR2001	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A14CR2002	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A14CR2003	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A14CR2004	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A14CR2005	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A14CR2006	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A14DS2001	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2002	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2003	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2004	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2005	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2006	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2007	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2008	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2009	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2010	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2011	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2012	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A14DS2013	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2014	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2015	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2020	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2021	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2022	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A14DS2023	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A14DS2025	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2026	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2027	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2028	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2029	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2030	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2031	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2032	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2033	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2034	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A14DS2035	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2036	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2037	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2038	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2039	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A14DS2041	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2042	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2043	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2044	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A14DS2045	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A14DS2046	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A14DS2047	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14DS2048	150-1160-00			LT EMITTING DIO:GREEN	50434	QLMP 1587
A14R2001	307-0675-00			RES NTWK,FXD,FI:9,1K OHM,2%1.25W	11236	750-101-R1K OHM
A14R2002	307-0675-00			RES NTWK,FXD,FI:9,1K OHM,2%1.25W	11236	750-101-R1K OHM
A14U2001	156-0789-02	B010100	B040345	MICROCKT,DGTL:8 BIT SR,PRL LOAD,SCREENED	04713	SN74LS165JOS
A14U2001	156-0789-00	B040346		MICROCKT,DGTL:8-BIT SR,PRL LOAD	01295	SN74LS165N
A14U2002	156-0789-02	B010100	B040345	MICROCKT,DGTL:8 BIT SR,PRL LOAD,SCREENED	04713	SN74LS165JOS
A14U2002	156-0789-00	B040346		MICROCKT,DGTL:8-BIT SR,PRL LOAD	01295	SN74LS165N
A14W1	175-9902-00			CA ASSY,SP,ELEC:20,27 AWG,8.05 L	80009	175-9902-00

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A16	670-9401-00	B010100	B040918	CIRCUIT BD ASSY:PROCESSOR	80009	670-9401-00
A16	670-9401-01	B040919		CIRCUIT BD ASSY:PROCESSOR	80009	670-9401-01
A16BT2501	146-0055-00			BATTERY,DRY:3.0V,1200 MAH,LITHIUM	TK0510	BR-2/3A-E2P
A16C2300	281-0759-00			CAP,FXD,CER DI:22PF,10%,100V	04222	MA101A220KAA
A16C2301	285-1300-01			CAP,FXD,MTLZD:0.1UF,10%,63V	55112	185/0.1/K/63/ABA
A16C2302	285-1300-01			CAP,FXD,MTLZD:0.1UF,10%,63V	55112	185/0.1/K/63/ABA
A16C2303	285-1300-01			CAP,FXD,MTLZD:0.1UF,10%,63V	55112	185/0.1/K/63/ABA
A16C2305	285-1300-01			CAP,FXD,MTLZD:0.1UF,10%,63V	55112	185/0.1/K/63/ABA
A16C2306	285-1300-01			CAP,FXD,MTLZD:0.1UF,10%,63V	55112	185/0.1/K/63/ABA
A16C2307	285-1301-01			CAP,FXD,MTLZD:0.47UF,10%,50V	55112	1850.47K50ABB
A16C2308	285-1348-00			CAP,FXD,MTLZD:0.22UF,10%,63V	55112	1850.22K63ABB
A16C2309	285-1301-01			CAP,FXD,MTLZD:0.47UF,10%,50V	55112	1850.47K50ABB
A16C2310	285-1348-00			CAP,FXD,MTLZD:0.22UF,10%,63V	55112	1850.22K63ABB
A16C2311	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2312	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2313	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2314	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2315	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2316	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2317	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2318	281-0809-00			CAP,FXD,CER DI:200 PF,5%,100V	04222	MA101A201JAA
A16C2319	281-0809-00	B010100	B040099	CAP,FXD,CER DI:200 PF,5%,100V	04222	MA101A201JAA
A16C2401	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2402	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2403	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2404	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2405	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2406	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2407	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2408	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2409	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2410	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2411	281-0809-00			CAP,FXD,CER DI:200 PF,5%,100V	04222	MA101A201JAA
A16C2412	281-0809-00			CAP,FXD,CER DI:200 PF,5%,100V	04222	MA101A201JAA
A16C2413	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2414	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2415	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2416	281-0798-00	B040100		CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A16C2417	281-0798-00	B040100		CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A16C2418	281-0798-00	B040100		CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A16C2419	281-0798-00	B040100		CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A16C2420	281-0798-00	B040100		CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A16C2501	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2502	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2503	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2504	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2505	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2506	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2507	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2508	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2509	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2510	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2511	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2512	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2513	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2514	281-0759-00			CAP,FXD,CER DI:22PF,10%,100V	04222	MA101A220KAA
A16C2515	281-0759-00			CAP,FXD,CER DI:22PF,10%,100V	04222	MA101A220KAA
A16C2516	285-1301-01			CAP,FXD,MTLZD:0.47UF,10%,50V	55112	1850.47K50ABB
A16C2517	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A16C2518	285-1301-01			CAP,FXD,MTLZD:0.47UF,10%,50V	55112	1850.47K50B0B
A16C2521	281-0770-00	B010100	B020144	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2521	281-0772-00	B020145	B040280	CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2521	281-0770-00	B040281	B040918	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2521	281-0772-00	B040919	B040931	CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2521	281-0770-00	B040932		CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2522	281-0770-00	B010100	B020144	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2522	281-0772-00	B020145	B020280	CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2522	281-0770-00	B040281	B040918	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2522	281-0772-00	B040919	B040931	CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2522	281-0770-00	B040932		CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2523	281-0770-00	B010100	B020144	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2523	281-0772-00	B020145	B040280	CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2523	281-0770-00	B040281	B040918	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2523	281-0772-00	B040919	B040931	CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2523	281-0770-00	B040932		CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2524	281-0770-00	B010100	B020144	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2524	281-0772-00	B020145	B020480	CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2524	281-0770-00	B040281	B040918	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2524	281-0772-00	B040919	B040931	CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2524	281-0770-00	B040932		CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2525	281-0770-00	B010100	B020144	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2525	281-0772-00	B020145	B040280	CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2525	281-0770-00	B040281	B040918	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2525	281-0772-00	B040919	B040931	CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2525	281-0770-00	B040932		CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2526	281-0770-00	B010100	B020144	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2526	281-0772-00	B020145	B040280	CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2526	281-0770-00	B040281	B040918	CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2526	281-0772-00	B040919	B040931	CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2526	281-0770-00	B040932		CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A16C2530	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2531	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2532	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2533	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2534	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2535	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2536	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2537	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2538	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2539	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2540	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2541	290-0748-00			CAP,FXD,ELCTLT:10UF,+50-10%,25V	54473	ECE-B1EV100S
A16C2542	281-0909-00			CAP,FXD,CER DI:0.022UF,20%,50V	54583	MA12X7R1H223M-T
A16C2543	281-0772-00			CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2544	281-0772-00			CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2545	281-0772-00			CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2546	281-0772-00			CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2547	281-0772-00			CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2548	281-0772-00			CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2549	281-0772-00			CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2550	281-0772-00			CAP,FXD,CER DI:4700PF,10%,100V	04222	MA201C472KAA
A16C2551	281-0798-00	B040619		CAP,FXD,CER DI:51PF,1%,100V	04222	MA1D1A510GAA
A16C2552	281-0798-00	B040619		CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A16C2553	281-0798-00	B040619		CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A16C2554	281-0798-00	B040619		CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A16C2555	281-0798-00	B040785		CAP,FXD,CER DI:51PF,1%,100V	04222	MA1D1A510GAA
A16CR2501	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,00-35	03508	DA2527 (1N4152)
A16CR2502	152-0322-00	B010100	B040918	SEMICOND DVC,DI:SCHOTTKY BARRIER,SI,15V	50434	5082-2672
A16CR2502	152-0951-00	B040919		SEMICOND DVC DI:SI,SCHOTTKY,60V,2.2F	50434	IN6263

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A16CR2504	152-0141-02			SEMICOND DVC,DI:SM,SI,30V,150MA,30V,00-35	03508	DA2527 (1N4152)
A16CR2505	152-0322-00	B010100	B040918	SEMICOND DVC,DI:SCHOTTKY BARRIER,SI,15V	50434	5082-2672
A16CR2505	152-0951-00	B040919		SEMICOND DVC DI:SI,SCHOTTKY,60V,2.2F	50434	IN6263
A16DS2501	150-1161-00			LT EMITTING DIO:YELLOW	50434	QLMP 1487
A16J2302	131-3625-00			CONN,RCPT,ELEC:SIP STRIP RCPT 15 POSITION	00779	643647-1
A16J2501	131-3624-00			CONN,RCPT,ELEC:SIP STRIP RCPT 20 POSITION	00779	643652-1
A16J2503	131-3623-00			CONN,RCPT,ELEC:SIP STRIP RCPT 25 POSITION	00779	643657-1
A16Q2501	151-0716-00			TRANSISTOR:DARLINGTON,NPN,SI,TO-92	27014	92 PU45A
A16Q2502	151-0716-00			TRANSISTOR:DARLINGTON,NPN,SI,TO-92	27014	92 PU45A
A16Q2503	151-0716-00			TRANSISTOR:DARLINGTON,NPN,SI,TO-92	27014	92 PU45A
A16Q2504	151-0716-00			TRANSISTOR:DARLINGTON,NPN,SI,TO-92	27014	92 PU45A
A16Q2505	151-0716-00			TRANSISTOR:DARLINGTON,NPN,SI,TO-92	27014	92 PU45A
A16Q2506	151-0716-00			TRANSISTOR:DARLINGTON,NPN,SI,TO-92	27014	92 PU45A
A16Q2507	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A16R2301	322-3260-00			RES,FXD,FILM:4.99K OHM,1%,0.2W,TC=TO	57668	CRB20 FXE 4K99
A16R2302	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A16R2303	322-3231-00			RES,FXD,FILM:2.49K OHM,1%,0.2W,TC=TO	57668	CRB20 FXE 2K49
A16R2304	313-1203-00			RES,FXD,FILM:20K OHM,5%,0.2W	57668	TR20JE20K
A16R2305	313-1203-00			RES,FXD,FILM:20K OHM,5%,0.2W	57668	TR20JE20K
A16R2306	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A16R2307	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A16R2308	313-1621-00			RES,FXD,FILM:620 OHM,5%,0.2W	57668	TR20JE 620E
A16R2309	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2400	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A16R2401	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A16R2402	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A16R2404	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A16R2405	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A16R2406	322-3220-00			RES,FXD,FILM:1.91K OHM,1%,0.2W,TC=TO	80009	322-3220-00
A16R2407	322-3172-00			RES,FXD,FILM:604 OHM,1%,0.2W,TC=TO	57668	CRB20 FXE 604E
A16R2408	322-3172-00			RES,FXD,FILM:604 OHM,1%,0.2W,TC=TO	57668	CRB20 FXE 604E
A16R2409	322-3220-00			RES,FXD,FILM:1.91K OHM,1%,0.2W,TC=TO	80009	322-3220-00
A16R2410	322-3172-00			RES,FXD,FILM:604 OHM,1%,0.2W,TC=TO	57668	CRB20 FXE 604E
A16R2411	322-3220-00			RES,FXD,FILM:1.91K OHM,1%,0.2W,TC=TO	80009	322-3220-00
A16R2412	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2413	322-3202-00			RES,FXD,FILM:1.24K OHM,1%,0.2W,TC=TO	57668	CRB20 FXE 1K24
A16R2414	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2415	322-3202-00			RES,FXD,FILM:1.24K OHM,1%,0.2W,TC=TO	57668	CRB20 FXE 1K24
A16R2416	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2417	322-3202-00			RES,FXD,FILM:1.24K OHM,1%,0.2W,TC=TO	57668	CRB20 FXE 1K24
A16R2418	322-3077-00			RES,FXD,FILM:61.9 OHM,1%,0.2W,TC=TO	80009	322-3077-00
A16R2419	313-1101-00	B020145		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2420	313-1101-00	B020145		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2421	313-1101-00	B020145	B040099	RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2422	313-1101-00	B020145	B040099	RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2423	313-1101-00	B020145	B040099	RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2424	313-1101-00	B020145	B040099	RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2425	313-1101-00	B020145	B040099	RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2501	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A16R2502	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2503	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A16R2504	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A16R2506	313-1621-00			RES,FXD,FILM:620 OHM,5%,0.2W	57668	TR20JE 620E
A16R2507	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2508	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2509	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2510	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2511	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2512	313-1472-00			RES,FXD,FILMN:4.7K OHM,5%,0.2W	57668	TR20JE 04K7

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A16R2513	313-1472-00			RES,FXD,FILM:4.7K OHM,5%,0.2W	57668	TR20JE 04K7
A16R2514	313-1621-00			RES,FXD,FILM:620 OHM,5%,0.2W	57668	TR20JE 620E
A16R2515	313-1621-00			RES,FXD,FILM:620 OHM,5%,0.2W	57668	TR20JE 620E
A16R2516	313-1621-00			RES,FXD,FILM:620 OHM,5%,0.2W	57668	TR20JE 620E
A16R2517	313-1621-00			RES,FXD,FILM:620 OHM,5%,0.2W	57668	TR20JE 620E
A16R2518	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2519	313-1621-00			RES,FXD,FILM:620 OHM,5%,0.2W	57668	TR20JE 620E
A16R2520	307-0446-00			RES NTWK,FXD,FI:10K OHM,20%,(9)RES	11236	750-101-R10K
A16R2521	307-0446-00			RES NTWK,FXD,FI:10K OHM,20%,(9)RES	11236	750-101-R10K
A16R2522	307-0446-00			RES NTWK,FXD,FI:10K OHM,20%,(9)RES	11236	750-101-R10K
A16R2523	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2524	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2531	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2532	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2533	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2534	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2535	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2536	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2537	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2538	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2539	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2540	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2541	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2542	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2546	313-1220-00			RES,FXD,FILM:22 OHM,5%,0.2W	57668	TR20JE22E
A16R2547	313-1220-00			RES,FXD,FILM:22 OHM,5%,0.2W	57668	TR20JE22E
A16R2548	313-1220-00			RES,FXD,FILM:22 OHM,5%,0.2W	57668	TR20JE22E
A16R2549	313-1220-00			RES,FXD,FILM:22 OHM,5%,0.2W	57668	TR20JE22E
A16R2550	313-1220-00			RES,FXD,FILM:22 OHM,5%,0.2W	57668	TR20JE22E
A16R2551	313-1220-00			RES,FXD,FILM:22 OHM,5%,0.2W	57668	TR20JE22E
A16R2552	313-1220-00			RES,FXD,FILM:22 OHM,5%,0.2W	57668	TR20JE22E
A16R2553	313-1220-00			RES,FXD,FILM:22 OHM,5%,0.2W	57668	TR20JE22E
A16R2554	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A16R2555	313-1101-00	B020145		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2560	313-1101-00	B030100		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2561	313-1101-00	B030100		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2562	313-1101-00	B030100		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2563	313-1101-00	B030100		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16R2564	313-1101-00	B040785		RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A16U2300	156-1646-00			MICROCKT,DGTL:OCTAL D-TYPE EDGE TRIG FF	TK0273	MD74HCT374RE
A16U2301	156-1646-00			MICROCKT,DGTL:OCTAL D-TYPE EDGE TRIG FF	TK0273	MD74HCT374RE
A16U2302	156-1589-00			MICROCKT,LINEAR:D/A CNVRTR,12 BIT,HS	06665	DAC312FR
A16U2303	156-0513-03	B010100	B040345	MICROCKT,LINEAR:CMOS,8 CHAN ANALOG MUX	04713	MC14051BCL
A16U2303	156-0513-00	B040346		MICROCKT,DGTL:CMOS,8-CHANNEL MUX	04713	MC14051BCL
A16U2304	156-1200-00			MICROCKT,LINEAR:OPERATIONAL AMP,QUAD BI-FET	01295	TL074CN
A16U2305	156-1200-00			MICROCKT,LINEAR:OPERATIONAL AMP,QUAD BI-FET	01295	TL074CN
A16U2306	156-1126-00			MICROCKT,LINEAR:VOLTAGE COMPARATOR	01295	LM311P
A16U2400	160-3493-00	B010100	B040345	MICROCKT,DGTL:8 BIT MICROCOMPUTER	80009	160-3493-00
A16U2400	160-4512-00	B040346		MICROCKT,DGTL:MICROCOMPUTER 8 BIT	80009	160-4512-00
A16U2401	156-1646-00			MICROCKT,DGTL:OCTAL D-TYPE EDGE TRIG FF	TK0273	MD74HCT374RE
A16U2402	156-1646-00			MICROCKT,DGTL:OCTAL D-TYPE EDGE TRIG FF	TK0273	MD74HCT374RE
A16U2403	156-1646-00			MICROCKT,DGTL:OCTAL D-TYPE EDGE TRIG FF	TK0273	MD74HCT374RE
A16U2404	156-0412-02	B010100	B040345	MICROCKT,DGTL:SYN 4 BIT UP/DOWN CNTR	27014	DM74LS193NA+
A16U2404	156-0412-00	B040346		MICROCKT,DGTL:SYN 4-BIT UP/DN CNTR,DUAL CLK	18324	N74LS193(N OR F)
A16U2405	156-0412-02	B010100	B040345	MICROCKT,DGTL:SYN 4 BIT UP/DOWN CNTR	27014	DM74LS193NA+
A16U2405	156-0412-00	B040346		MICROCKT,DGTL:SYN 4-BIT UP/DN CNTR,DUAL CLK	18324	N74LS193(N OR F)
A16U2406	156-1594-00			MICROCKT,DGTL:NMOS,2048 X 8 SRAM	TK1015	HM6116P-3(DP-24)
A16U2407	156-1172-01	B010100	B040345	MICROCKT,DGTL:DUAL 4 BIT BIN CNTR	01295	SN74LS393NP3
A16U2407	156-1172-00	B040346		MICROCKT,DGTL:DUAL 4 BIT BIN CNTR	01295	SN74LS393N

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A16U2408	160-4084-00			MICROCKT,DGTL:4096 X 8 EPROM M/3 ST OUT	80009	160-4084-00
A16U2409	156-1172-01	B010100	B040345	MICROCKT,DGTL:DUAL 4 BIT BIN CNTR	01295	SN74LS393NP3
A16U2409	156-1172-00	B040346		MICROCKT,DGTL:DUAL 4 BIT BIN CNTR	01295	SN74LS393N
A16U2410	160-4085-00			MICROCKT,DGTL:OCTAL 16 INPUT REG AND/OR	80009	160-4085-00
A16U2411	156-1646-00			MICROCKT,DGTL:OCTAL D-TYPE EDGE TRIG FF	TK0273	MD74HCT374RE
A16U2412	156-1255-00			MICROCKT,LINEAR:D/A CONVERTER	06665	DAC08-157Q
A16U2413	156-1255-00			MICROCKT,LINEAR:D/A CONVERTER	06665	DAC08-157Q
A16U2414	156-0514-01	B010100	B040345	MICROCKT,DGTL:DIFF 4-CHANNEL MUX,SEL	80009	156-0514-01
A16U2414	156-0514-00	B040346		MICROCKT,DGTL:CMOS,DIFF 4-CHANNEL MUX	02735	CD4052BF-98
A16U2415	156-0514-01	B010100	B040345	MICROCKT,DGTL:DIFF 4-CHANNEL MUX,SEL	80009	156-0514-01
A16U2415	156-0514-00	B040346		MICROCKT,DGTL:CMOS,DIFF 4-CHANNEL MUX	02735	CD4052BF-98
A16U2416	156-1200-00			MICROCKT,LINEAR:OPERATIONAL AMP,QUAD BI-FET	01295	TL074CN
A16U2417	156-0382-02	B010100	B040345	MICROCKT,DGTL:QUAD 2 INP NAND GATE BURN	18324	N74LS00NB
A16U2417	156-0382-00	B040346		MICROCKT,DGTL:QUAD 2-INP NAND GATE	01295	SN74LS00(N OR J)
A16U2501	156-1609-01			MICROCKT,DGTL:HMOS,8 BIT MICROPROCESSOR	34649	D8088-2PC
A16U2502	156-2396-00			MICROCKT,DGTL:RESET GENERATOR,5V SUPPLY	01295	TL7705 ACP
A16U2503	156-0479-02	B010100	B040345	MICROCKT,DGTL:QUAD 2-INP OR GATE	01295	SN74LS32NP3
A16U2503	156-0479-00	B040346		MICROCKT,DGTL:QUAD 2-INP OR GATE	01295	SN74LS32(N OR J)
A16U2504	156-2027-00			MICROCKT,DGTL:CMOS,HEX INVERTER	27014	MM74HC04N
A16U2505	156-2851-00			MICROCKT,DGTL:DUAL J-K FLIP FLOP M/CLR	80009	156-2851-00
A16U2506	156-0382-02	B010100	B040345	MICROCKT,DGTL:QUAD 2 INP NAND GATE BURN	18324	N74LS00NB
A16U2506	156-0382-00	B040346		MICROCKT,DGTL:QUAD 2-INP NAND GATE	01295	SN74LS00(N OR J)
A16U2507	156-0545-01	B010100	B040345	MICROCKT,DGTL:12 BIT BINARY CNTR	02735	CD4040BFX
A16U2507	156-0545-00	B040346		MICROCKT,DGTL:12-BIT BINARY CNTR	04713	MC140408CL
A16U2508	156-1172-01	B010100	B040345	MICROCKT,DGTL:DUAL 4 BIT BIN CNTR	01295	SN74LS393NP3
A16U2508	156-1172-00	B040346		MICROCKT,DGTL:DUAL 4 BIT BIN CNTR	01295	SN74LS393N
A16U2509	156-0299-02	B010100	B040345	MICROCKT,DGTL:TTL,16-BIT DATA SELECTOR	18324	N74150(NB OR FB)
A16U2509	156-0299-00	B040346		MICROCKT,DGTL:16-BIT DATA SELECTOR	01295	SN74150N
A16U2510	156-0956-02	B010100	B040345	MICROCKT,DGTL:OCTAL BFR M/3 STATE OUT	01295	SN74LS244NP3
A16U2510	156-0956-00	B040346		MICROCKT,DGTL:OCTAL BFR M/3 STATE OUT	18324	N74LS244(N OR F)
A16U2511	156-1646-00			MICROCKT,DGTL:OCTAL D-TYPE EDGE TRIG FF	TK0273	MD74HCT374RE
A16U2512	156-1065-01	B010100	B040345	MICROCKT,DGTL:OCTAL D TYPE TRANS LATCHES	04713	SN74LS373 ND/JD
A16U2512	156-1065-00	B040346		MICROCKT,DGTL:OCTAL D TYPE TRANS LATCHES	01295	SN74LS373N
A16U2513	156-1065-01	B010100	B040345	MICROCKT,DGTL:OCTAL D TYPE TRANS LATCHES	04713	SN74LS373 ND/JD
A16U2513	156-1065-00	B040346		MICROCKT,DGTL:OCTAL D TYPE TRANS LATCHES	01295	SN74LS373N
A16U2514	156-1111-02	B010100	B040345	MICROCKT,DGTL:OCTAL BUS XCVRS M/3 ST OUT	01295	SN74LS245N3
A16U2514	156-1111-00	B040346		MICROCKT,DGTL:OCTAL BUS TRANSCEIVERS	01295	SN74LS245N
A16U2515	156-1111-02	B010100	B040345	MICROCKT,DGTL:OCTAL BUS XCVRS M/3 ST OUT	01295	SN74LS245N3
A16U2515	156-1111-00	B040346		MICROCKT,DGTL:OCTAL BUS TRANSCEIVERS	01295	SN74LS245N
A16U2516	156-0469-02	B010100	B040345	MICROCKT,DGTL:3/8 LINE DCDR	01295	SN74LS138NP3
A16U2516	156-0469-00	B040346		MICROCKT,DGTL:3-LINE TO 8-LINE DECODER	01295	SN74LS138N
A16U2517	156-0469-02	B010100	B040345	MICROCKT,DGTL:3/8 LINE DCDR	01295	SN74LS138NP3
A16U2517	156-0469-00	B040346		MICROCKT,DGTL:3-LINE TO 8-LINE DECODER	01295	SN74LS138N
A16U2518	156-0469-02	B010100	B040345	MICROCKT,DGTL:3/8 LINE DCDR	01295	SN74LS138NP3
A16U2518	156-0469-00	B040346		MICROCKT,DGTL:3-LINE TO 8-LINE DECODER	01295	SN74LS138N
A16U2519	160-4082-00	B010100	B040099	MICROCKT,DGTL:65536 X 8 EPROMM/3 ST OUT	80009	160-4082-00
A16U2519	160-4082-01	B040100		MICROCKT,DGTL:65536 X 8 EPROM M/3 ST OUT	80009	160-4082-01
A16U2520	160-4083-00	B010100	B040099	MICROCKT,DGTL:256K UV ERASABLE,PROM,PRGM	80009	160-4083-00
A16U2520	160-4083-01	B040100		MICROCKT,DGTL:256K UV ERASEABLE PROM,PRGM	80009	160-4083-01
A16U2521	156-2473-00			MICROCKT,DGTL:8192 X 8,LOW STANDBY PWR	TK0961	uPD4464C-20
A16U2523	156-1646-00			MICROCKT,DGTL:OCTAL D-TYPE EDGE TRIG FF	TK0273	MD74HCT374RE
A16U2524	156-1646-00			MICROCKT,DGTL:OCTAL D-TYPE EDGE TRIG FF	TK0273	MD74HCT374RE
A16U2525	156-1058-01	B010100	B040345	MICROCKT,DGTL:OCTAL ST BUFFER M/3 STATE OUT	01295	SN74S240JP4
A16U2525	156-1058-00	B040346		MICROCKT,DGTL:STTL,OCTAL SCHMITT TRIGR BFR	01295	SN74S240J
A16M2501	131-0566-00			BUS,CNDCT:DUMMY RES,0.094 OD X 0.225 L	24546	OMA 07
A16X2400	136-0755-00			SKT,PL-IN ELEK:MICROCIRCUIT,28 DIP	09922	DILB28P-108
A16X2400	136-0755-00	B020120		SKT,PL-IN ELEK:MICROCIRCUIT,28 DIP	09922	DILB28P-108
A16X2501	136-0757-00	B010100	B040918	SKT,PL-IN ELEK:MICROCIRCUIT,40 DIP	09922	DILB40P-108
A16X2519	136-0755-00			SKT,PL-IN ELEK:MICROCIRCUIT,28 DIP	09922	DILB28P-108

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A16X2520	136-0755-00			SKT,PL-IN ELEK:MICROCIRCUIT,28 DIP	09922	DILB28P-108
A16Y2501	119-2215-00			RESONATOR,CER:24 MHZ,0.3%	51406	CSA 24.00 MX 11

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A18	670-9398-00	B010100	B040818	CIRCUIT BD ASSY:LV PWR SPLY	80009	670-9398-00
A18	670-9398-01	B040819		CIRCUIT BD ASSY:LV PWR SPLY	80009	670-9398-01
A18A17	119-2515-00	B030100	B040221	INDUCTOR ASSY:POWER SUPPLY	80009	119-2515-00
A18C2201	285-1331-00			CAP,FXD,MTLZD:0.47UF,5%,400V	TK1573	MKS4 .47/400/5
A18C2202	290-1118-00			CAP,FXD,ELCTLT:220UF,20%,400V	TK1424	CEFTM2G221B
A18C2203	290-0922-01			CAP,FXD,ELCTLT:1000UF,4100% -10%,50V	56289	6740108H050JJ5A
A18C2204	290-0950-00	B010100	B020144	CAP,FXD,ELCTLT:100UF,+50-10%,50V	55680	ULB1H101TJAANA
A18C2204	290-1151-00	B020145		CAP,FXD,ELCTLT:100UF,20%,63V	55680	UEB1J101M
A18C2206	281-0775-01			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18C2207	281-0775-01			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18C2209	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
A18C2210	290-1144-00			CAP,FXD,ELCTLT:4.7UF,20%,100V	80009	290-1144-00
A18C2211	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
A18C2212	281-0761-00			CAP,FXD,CER DI:27PF,5%,100V	04222	MA101A270JAA
A18C2213	285-1381-00			CAP,FXD,MTLZD:1500PF,10%,250V	TK0515	PME271Y415
A18C2214	285-1381-00			CAP,FXD,MTLZD:1500PF,10%,250V	TK0515	PME271Y415
A18C2215	285-1252-00			CAP,FXD,PLASTIC:0.15UF,10%,250VAC	05243	F1772-415-2000
A18C2216	285-1252-00			CAP,FXD,PLASTIC:0.15UF,10%,250VAC	05243	F1772-415-2000
A18C2218	281-0813-00			CAP,FXD,CER DI:0.047UF,20%,50V	05397	C412C473M5V2CA
A18C2219	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
A18C2221	290-1129-00			CAP,FXD,ELCTLT:1000UF,+100%-10%,12V	56289	ORDER BY DESCR
A18C2222	290-1129-00			CAP,FXD,ELCTLT:1000UF,+100%-10%,12V	56289	ORDER BY DESCR
A18C2223	290-1129-00			CAP,FXD,ELCTLT:1000UF,+100%-10%,12V	56289	ORDER BY DESCR
A18C2224	290-1129-00			CAP,FXD,ELCTLT:1000UF,+100%-10%,12V	56289	ORDER BY DESCR
A18C2225	290-1129-00			CAP,FXD,ELCTLT:1000UF,+100%-10%,12V	56289	ORDER BY DESCR
A18C2226	290-1129-00			CAP,FXD,ELCTLT:1000UF,+100%-10%,12V	56289	ORDER BY DESCR
A18C2227	290-1129-00			CAP,FXD,ELCTLT:1000UF,+100%-10%,12V	56289	ORDER BY DESCR
A18C2228	290-1129-00			CAP,FXD,ELCTLT:1000UF,+100%-10%,12V	56289	ORDER BY DESCR
A18C2229	290-1128-00			CAP,FXD,ELCTLT:470UF,+100%,25V	56289	ORDER BY DESCR
A18C2230	290-1128-00			CAP,FXD,ELCTLT:470UF,+100%,25V	56289	ORDER BY DESCR
A18C2232	290-1130-00			CAP,FXD,ELCTLT:39UF,+100%-10%,150V	56289	ORDER BY DESCR
A18C2233	290-1130-00			CAP,FXD,ELCTLT:39UF,+100%-10%,150V	56289	ORDER BY DESCR
A18C2234	290-1128-00			CAP,FXD,ELCTLT:470UF,+100%,25V	56289	ORDER BY DESCR
A18C2236	290-1128-00			CAP,FXD,ELCTLT:470UF,+100%,25V	56289	ORDER BY DESCR
A18C2238	290-1144-00			CAP,FXD,ELCTLT:4.7UF,20%,100V	80009	290-1144-00
A18C2239	281-0775-01			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18C2243	281-0770-00			CAP,FXD,CER DI:1000PF,20%,100V	04222	MA101C102MAA
A18C2244	285-1184-01			CAP,FXD,MTLZD:0.01UF,20%,4KV	56289	430P103X040
A18C2245	285-1184-01			CAP,FXD,MTLZD:0.01UF,20%,4KV	56289	430P103X040
A18C2248	290-0950-00	B010100	B020144	CAP,FXD,ELCTLT:100UF,+50-10%,50V	55680	ULB1H101TJAANA
A18C2248	290-1151-00	B020145		CAP,FXD,ELCTLT:100UF,20%,63V	55680	UEB1J101M
A18C2249	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
A18CR2201	152-0906-00			SEMICOND DVC,DI:RECT,SI,400V,3 AMP,50 NS	80009	152-0906-00
A18CR2202	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2202	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2204	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2204	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2205	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2205	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2206	152-0582-00			SEMICOND DVC,DI:RECT,SI,20V,3A	80009	152-0582-00
A18CR2207	152-0582-00			SEMICOND DVC,DI:RECT,SI,20V,3A	80009	152-0582-00
A18CR2208	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2208	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2209	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2209	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2210	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2210	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2211	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2211	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A18CR2212	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2212	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2213	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2213	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2214	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2214	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2215	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2215	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2216	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2216	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2218	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2218	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2219	152-0581-00			SEMICOND DVC,DI:RECT,SI,20V,1A,A59	04713	1N5817
A18CR2220	152-0581-00			SEMICOND DVC,DI:RECT,SI,20V,1A,A59	04713	1N5817
A18CR2227	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2227	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2228	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2228	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2231	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
A18CR2232	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
A18CR2233	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
A18CR2234	152-0040-00			SEMICOND DVC,DI:RECT,SI,600V,1A,DO-41	80009	152-0040-00
A18CR2235	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2235	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2236	152-0398-00	B010100	B040221	SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A18CR2236	152-0400-00	B040222		SEMICOND DVC,DI:RECT,SI,400V,1A	04713	SR1977K
A18CR2237	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A18DS2201	150-0035-00			LAMP,GLOW:90V MAX,0.3MA,AID-T,WIRE LD	TK0213	JH005/3011JA
A18J2208	131-3645-00			CONN,RCPT,ELEC:3 POSITION,0.01 SPACING	80009	131-3645-00
A18J2225	131-3486-00			CONN,RCPT,ELEC:HDR,RTANG,2 POS,0.1 SP	00779	640452-2
A18L2201	108-1324-00			COIL,RF:FXD,33UH,POWER	54583	OL1338-330K5R0
A18L2202	108-1319-00			INDUCTOR,FIXED:33UH,10%,1.8A	54583	TSL1110-330K 1R8
A18L2203	108-1319-00			INDUCTOR,FIXED:33UH,10%,1.8A	54583	TSL1110-330K 1R8
A18L2204	108-1319-00			INDUCTOR,FIXED:33UH,10%,1.8A	54583	TSL1110-330K 1R8
A18L2205	108-1319-00			INDUCTOR,FIXED:33UH,10%,1.8A	54583	TSL1110-330K 1R8
A18L2206	108-1348-00			COIL,RF:FIXED,330UH,10%,0.55A DC	80009	108-1348-00
A18L2207	108-1357-00	B010100	B030099	COIL,RF:FXD,POWER	TK1441	86-343-2
A18L2207	108-1357-00	B040222		COIL,RF:FXD,POWER	TK1441	86-343-2
A18L2208	108-1357-00	B010100	B030099	COIL,RF:FXD,POWER	TK1441	86-343-2
A18L2208	108-1357-00	B040222		COIL,RF:FXD,POWER	TK1441	86-343-2
A18P2204	131-3637-00			CONN,RCPT,ELEC:HDR,13 CKT,0.156 SP	80009	131-3637-00
A18Q2201	151-1214-00			TRANSISTOR:MOSFET,SI,TO-220	80009	151-1214-00
A18Q2202	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A18Q2203	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A18Q2204	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A18Q2206	151-0506-01			SCR:SI,GE	80009	151-0506-01
A18Q2208	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A18Q2209	151-0476-03			TRANSISTOR:POWER,W/LEAD FORM,TO-220	80009	151-0476-03
A18Q2210	151-0476-03			TRANSISTOR:POWER,W/LEAD FORM,TO-220	80009	151-0476-03
A18Q2211	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A18Q2212	151-0276-01			TRANSISTOR:PNP,SI,TO-92	TK1016	S1423-TPE2
A18Q2213	151-0276-01			TRANSISTOR:PNP,SI,TO-92	TK1016	S1423-TPE2
A18Q2214	151-1197-00			TRANSISTOR:FET,MOS PWR,N-CHAN,TO-220	04713	IRF533MLEADFORM
A18R2201	308-0678-00			RES,FXD,MM:0.1 OHM,5%,2W	75042	BWH-R1000J
A18R2202	308-0778-00			RES,FXD,MM:3 OHM,5%,5W	91637	CW5-3R00J T/R
A18R2203	301-0184-00			RES,FXD,FILM:180K OHM,5%,0.5W	57668	TR50J-E180K
A18R2204	301-0184-00			RES,FXD,FILM:180K OHM,5%,0.5W	57668	TR50J-E180K
A18R2205	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K
A18R2206	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2W	57668	TR20JE100K

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A18R2207	322-3164-00			RES,FXD,FILM:499 OHM,1%,0.2M,TC=T0	57668	CRB20 FXE 499E
A18R2208	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2M	57668	TR20JE01K0
A18R2209	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2M	57668	TR20JE100K
A18R2210	313-1513-00			RES,FXD,CMPSN:51K OHM,5%,0.2M	57668	TR20JE 51K
A18R2211	313-1332-00			RES,FXD,FILM:3.3K OHM,5%,0.2M	57668	TR20JE 03K3
A18R2212	313-1822-00			RES,FXD,FILM:8.2K,OHM,5%,0.2M	57668	TR20JE 08K2
A18R2215	313-1272-00			RES,FXD,FILM:2.7K OHM,5%,0.2M	57668	TR20JE 02K7
A18R2216	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2M	57668	TR20JE01K0
A18R2219	313-1105-00			RES,FXD,FILM:1M OHM,5%,0.2M	57668	TR20JE1M
A18R2220	313-1105-00			RES,FXD,FILM:1M OHM,5%,0.2M	57668	TR20JE1M
A18R2221	313-1203-00			RES,FXD,FILM:20K OHM,5%,0.2M	57668	TR20JE20K
A18R2222	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2M	57668	TR20JE10K0
A18R2223	313-1105-00			RES,FXD,FILM:1M OHM,5%,0.2M	57668	TR20JE1M
A18R2224	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2M	57668	TR20JE100E
A18R2225	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2M	57668	TR20JE100E
A18R2226	301-0474-00	B010100	B030099	RES,FXD,FILM:470K OHM,5%,0.5M	19701	5053CX470K0J
A18R2226	301-0274-00	B030100		RES,FXD,FILM:270K OHM,5%,0.5M	19701	5053CX270K0J
A18R2227	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2M	57668	TR20JE 5K1
A18R2228	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2M	57668	TR20JE01K0
A18R2229	301-0823-00			RES,FXD,FILM:82K OHM,5%,0.5M	19701	5053CX82K00J
A18R2230	301-0823-00			RES,FXD,FILM:82K OHM,5%,0.5M	19701	5053CX82K00J
A18R2231	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2M	57668	TR20JE100E
A18R2232	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2M	57668	TR20JE01K0
A18R2233	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2M	57668	TR20JE10K0
A18R2236	313-1104-00			RES,FXD,FILM:100K OHM,5%,0.2M	57668	TR20JE100K
A18R2237	313-1105-00			RES,FXD,FILM:1M OHM,5%,0.2M	57668	TR20JE1M
A18R2238	313-1753-00			RES,FXD,FILM:75K OHM,5%,0.2M	57668	TR20JE 75K
A18R2239	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2M	57668	TR20JE10K0
A18R2240	313-1204-00			RES,FXD,FILM:200K,5%,0.2M	57668	TR20JE 200K
A18R2241	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2M	57668	TR20JE10K0
A18R2242	313-1027-00			RES,FXD,FILM:2.7 OHM,5%,0.2M	57668	TR20JE 02E7
A18R2243	313-1027-00			RES,FXD,FILM:2.7 OHM,5%,0.2M	57668	TR20JE 02E7
A18R2245	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2M	57668	TR20JE10K0
A18R2246	313-1513-00			RES,FXD,CMPSN:51K OHM,5%,0.2M	57668	TR20JE 51K
A18R2247	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2M,TC=T0	57668	CRB20 FXE 10K0
A18R2248	313-1513-00			RES,FXD,CMPSN:51K OHM,5%,0.2M	57668	TR20JE 51K
A18R2250	301-0106-00			RES,FXD,FILM:10M OHM,5%,0.50M	01121	EB1065
A18R2252	311-2270-00			RES,VAR,NONWM:TRMR,10K OHM,20%,0.5M	TK1450	GF06VT 10 K OHM
A18R2253	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2M	57668	TR20JE100E
A18R2254	313-1051-00			RES,FXD,FILM:5.1 OHM,5%,0.2M	57668	TR20JT68 05E1
A18R2255	313-1051-00			RES,FXD,FILM:5.1 OHM,5%,0.2M	57668	TR20JT68 05E1
A18R2256	301-0474-00	B010100	B030099	RES,FXD,FILM:470K OHM,5%,0.5M	19701	5053CX470K0J
A18R2256	301-0274-00	B030100		RES,FXD,FILM:270K OHM,5%,0.5M	19701	5053CX270K0J
A18R2257	301-0200-00			RES,FXD,FILM:20 OHM,5%,0.5M	19701	5053CX20R00J
A18R2259	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2M	57668	TR20JE 5K1
A18R2260	301-0560-00			RES,FXD,FILM:56 OHM,5%,0.5M	19701	5053CX56R00J
A18R2265	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2M	57668	TR20JE100E
A18R2266	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2M	57668	TR20JE 5K1
A18R2267	313-1051-00			RES,FXD,FILM:5.1 OHM,5%,0.2M	57668	TR20JT68 05E1
A18R2268	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2M	57668	TR20JE10K0
A18R2270	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2M	57668	TR20JE10K0
A18R2271	313-1512-00			RES,FXD,CMPSN:5.1K OHM,5%,0.2M	57668	TR20JE 5K1
A18R2272	313-1051-00			RES,FXD,FILM:5.1 OHM,5%,0.2M	57668	TR20JT68 05E1
A18R2273	313-1051-00			RES,FXD,FILM:5.1 OHM,5%,0.2M	57668	TR20JT68 05E1
A18R2274	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2M	57668	TR20JE10K0
A18R2275	301-0432-00	B040222		RES,FXD,FILM:4.3K OHM,5%,0.5M	19701	5053CX4K300J
A18R2276	313-1102-00	B040222		RES,FXD,FILM:1K OHM,5%,0.2M	57668	TR20JE01K0
A18RT2201	307-0863-00			RES,THERMAL:10 OHM,10%,NTC	15454	SG-135
A18S2201	260-2309-00			SWITCH,PUSH:DPST,4A,250VAC	31918	NE15CT112A

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A18S2202	260-2318-00			SWITCH,THRMSTC:NC,105/80 DEG C OPEN/CLOSED	80009	260-2318-00
A18T2203	120-1686-00			TRANSFORMER,RF:COUPLED INDUCTOR	80009	120-1686-00
A18T2204	120-1685-00			XFMR,PWR,STU:HIGH VOLTAGE	80009	120-1685-00
A18T2205	120-1347-00			TRANSFORMER,RF:DRIVER SATURATING	54583	BOT-001
A18T2206	120-1401-00			XFMR,TRIGGER:LINE,1:1 TURNS RATIO	54937	DMI 500-2044
A18U2201	156-2395-00			MICROCKT,LINEAR:BIPOLAR,PWM PWR SPLY,CONT	01295	MC34060N
A18U2230	152-0926-00			SEMICOND DVC,DI:	80009	152-0926-00
A18VR2201	152-0255-00			SEMICOND DVC,DI:ZEN,SI,51V,5%,0.4W,DO-7	04713	SZG35009K7
A18VR2202	152-0166-00			SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-7	04713	SZ11738RL
A18VR2203	152-0304-00			SEMICOND DVC,DI:ZEN,SI,20V,5%,0.4W,DO-7	15238	Z5411
A18VR2204	307-0456-00			RES,V SENSITIVE:250VAC,15W,METAL OXIDE	03508	MOV-V250LA15A
A18VR2205	152-0166-00			SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-7	04713	SZ11738RL
A18VR2206	152-0282-00			SEMICOND DVC,DI:ZEN,SI,30V,5%,0.4W,DO-7	04713	SZG35009K13
A18VR2207	152-0304-00			SEMICOND DVC,DI:ZEN,SI,20V,5%,0.4W,DO-7	15238	Z5411
A18W28	196-3093-00			LEAD,ELECTRICAL:18 AWG,3.3 L,8-9	80009	196-3093-00
A18W29	196-3092-00			LEAD,ELECTRICAL:18 AWG,3.3 L,8-0	80009	196-3092-00
A18W31	196-3094-00			LEAD,ELECTRICAL:26 AWG,2.6 L,9-N	80009	196-3094-00
A18W32	196-3094-00			LEAD,ELECTRICAL:26 AWG,2.6 L,9-N	80009	196-3094-00

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
B25	119-2063-00			FAN,TUBEAXIAL:12V,130MA,19.4 CFM	61529	A1F891003
DL21	119-2118-00			DELAY LINE,ELEC:	80009	119-2118-00
F2201	159-0023-00			FUSE,CARTRIDGE:3AG,2A,250V,SLOW BLOW	71400	MDX2
FL2201	119-2055-00			FILTER,RFI:3A,115-230V,48-440HZ	05245	3EF1F
J16	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
V1	154-0905-00			ELECTRON TUBE:CRT	80009	154-0905-00
W30	195-3990-00			LEAD,ELECTRICAL:18 AWG,4.5 L,5-4	80009	195-3990-00

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:

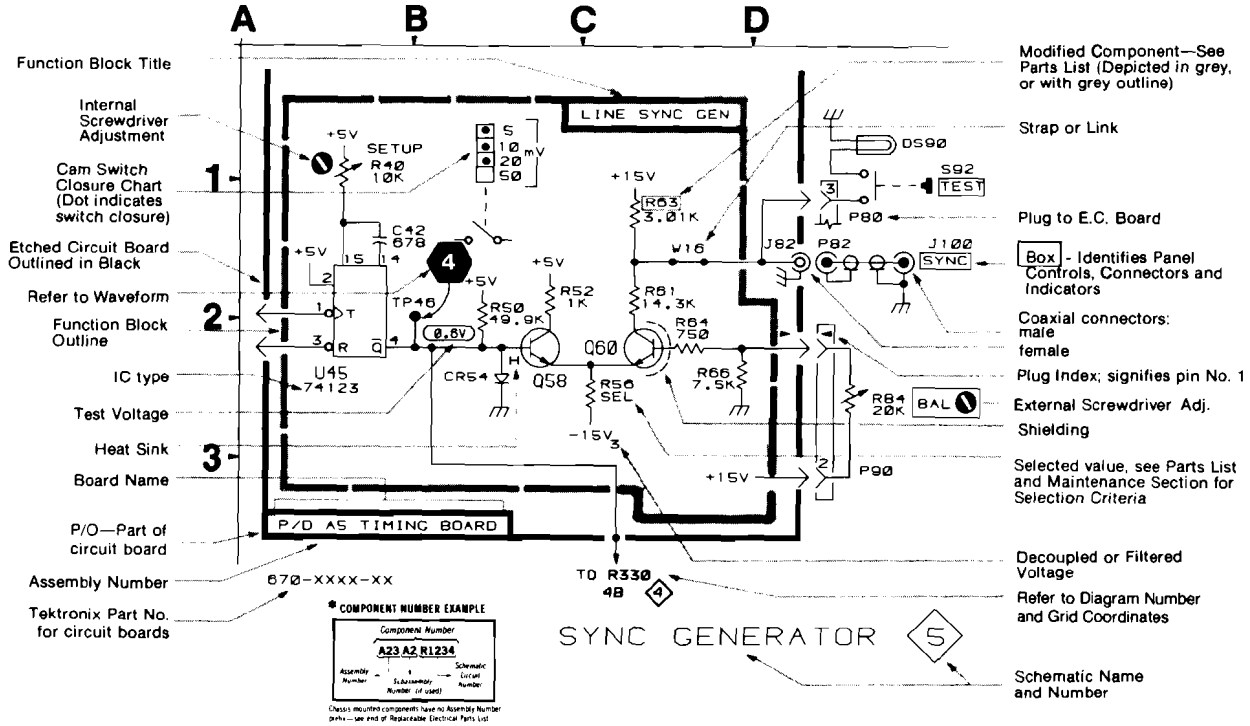
Capacitors = Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).
Resistors = Ohms (Ω).

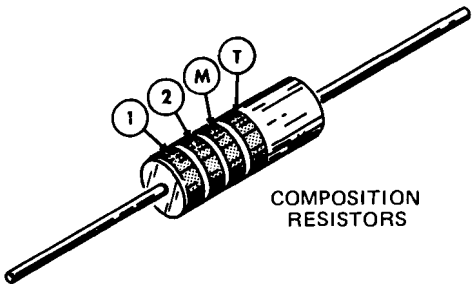
The information and special symbols below may appear in this manual.

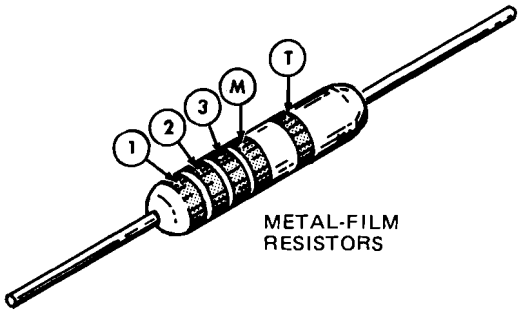
Assembly Numbers and Grid Coordinates

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.







(1)(2) and (3) – 1st, 2nd, and 3rd significant figures

(M) –multiplier (T) –tolerance

(TC) –temperature coefficient

(P) –polarity and voltage rating

COLOR	SIGNIFICANT FIGURES	RESISTORS	
		MULTIPLIER	TOLERANCE
BLACK	0	1	---
BROWN	1	10	±1%
RED	2	10^2 or 100	±2%
ORANGE	3	10^3 or 1 K	±3%
YELLOW	4	10^4 or 10 K	±4%
GREEN	5	10^5 or 100 K	±½%
BLUE	6	10^6 or 1 M	±¼%
VIOLET	7	---	±1/10%
GRAY	8	---	---
WHITE	9	---	---
GOLD	–	10^{-1} or 0.1	±5%
SILVER	–	10^{-2} or 0.01	±10%
NONE	–	---	±20%

(1861-20A)6081-95

Figure 9-1. Color codes for resistors.

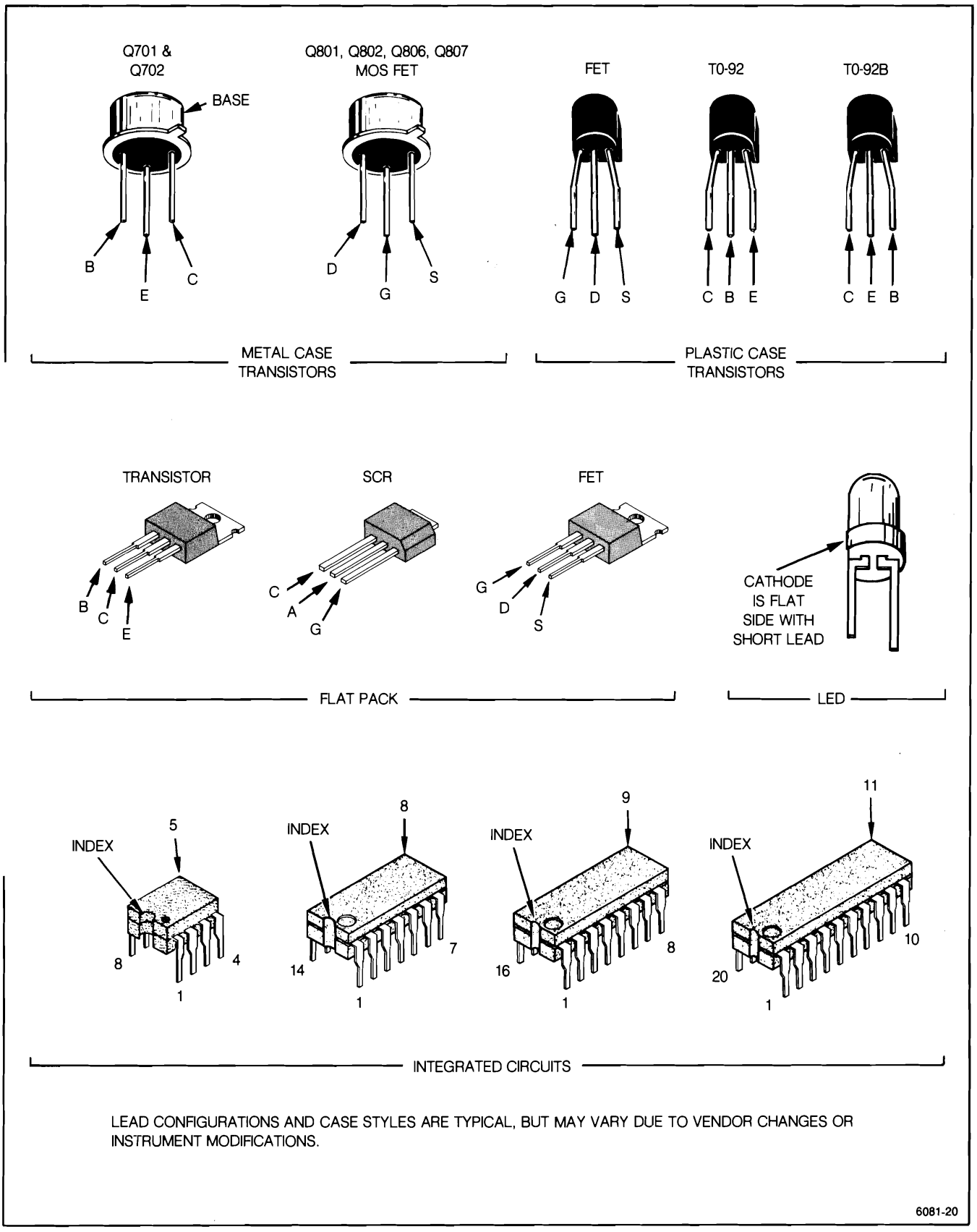


Figure 9-2. Semiconductor lead configurations.

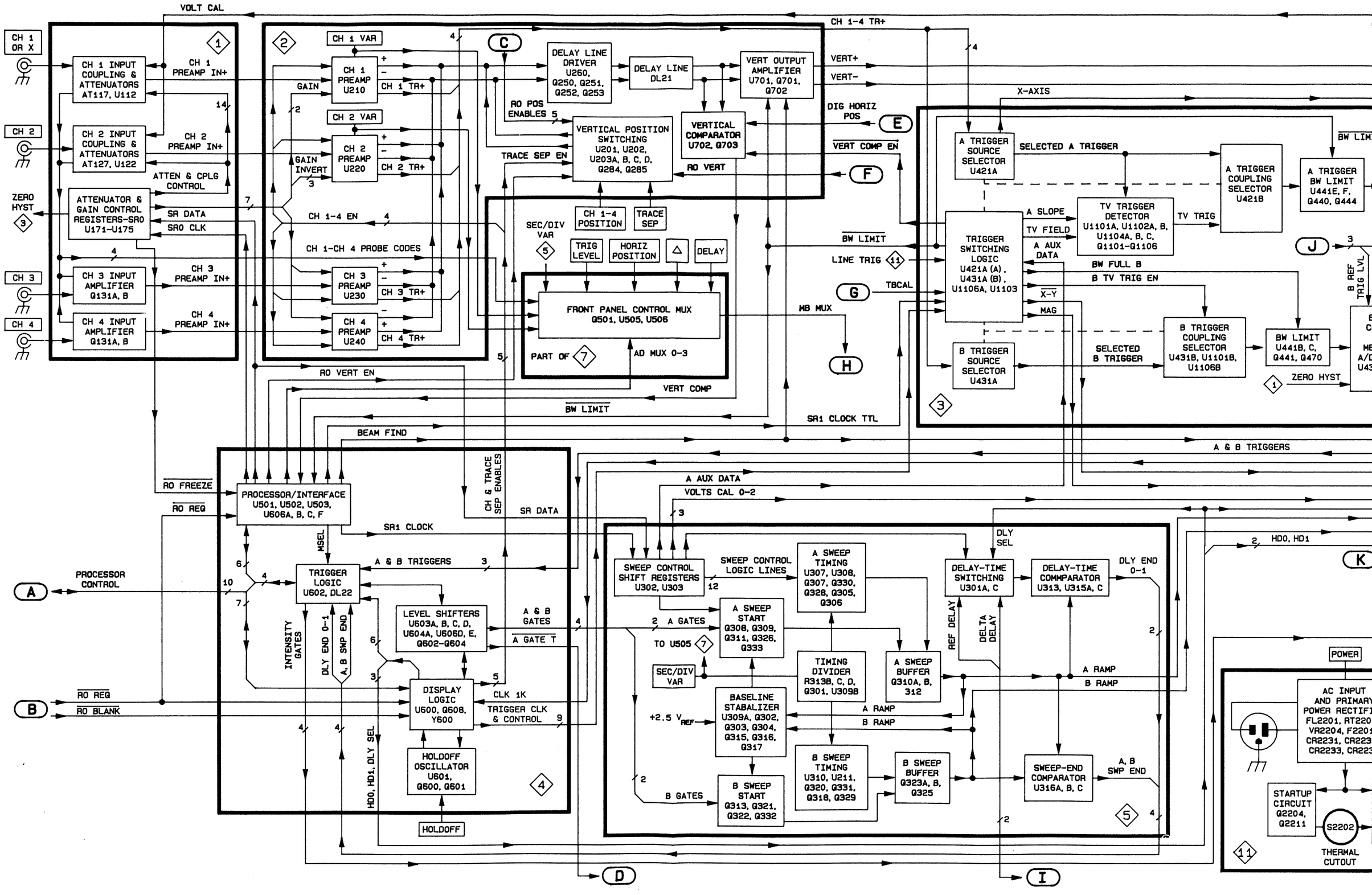


Figure 9-4a. 2246 block diagram—part 1.

CH 1-4 TR+
VERT+
VERT-
DELAY LINE DL21
VERT OUTPUT AMPLIFIER U701, Q701, Q702
DIG HORIZ POS
VERTICAL COMPARATOR U702, Q703
VERT COMP EN
RO VERT
TRACE SEP
HORIZ POSITION
DELAY
PANEL CONTROL MUX 501, U505, U506
AD MUX 0-3
VERT COMP
SR1 CLOCK TTL
MB MUX
BW LIMIT
LINE TRIG
TBCAL
X-AXIS
A TRIGGER SOURCE SELECTOR U421A
SELECTED A TRIGGER
A TRIGGER COUPLING SELECTOR U421B
A TRIGGER BW LIMIT U441E, F, Q440, Q444
A TRIGGER COMPARATOR U421C
TV TRIGGER DETECTOR U1101A, U1102A, B, U1104A, B, C, Q1101-Q1106
TV TRIG
A SLOPE
TV FIELD
A AUX DATA
TRIGGER SWITCHING LOGIC U421A (A), U431A (B), U1106A, U1103
BW FULL B
B TV TRIG EN
X-Y
MAG
A TRIG LVL
B REF TRIG LVL
B DELTA TRIG LVL
B TRIGGER SOURCE SELECTOR U431A
SELECTED B TRIGGER
B TRIGGER COUPLING SELECTOR U431B, U1101B, U1106B
BW LIMIT U441B, C, Q441, Q470
ZERO HYST
B TRIGGER COMPARATOR AND MEASUREMENT A/D CONVERTER U431C, U1106B, Q480
DLY SEL
A & B TRIGGERS
A AUX DATA
VOLTS CAL 0-2
SCALE ILLUM
CALIBRATION
SCALE ILLUMINATION Q905, Q907, Q908
CALIBRATOR U930A, B
CLK 1K
+2.5 V
+2.5 V
VOLT CAL
VOLTS CAL SIGNAL SOURCE U931, R921
VOLT CAL 0-2
PART OF 7
HORIZ +
HORIZ -
BOTTOM
TOP
X-AXIS
BEAM FIND
X-Y
MAG
A RAMP
B RAMP
HD0, HD1
RO HORIZ
DIG HORIZ POS
HORIZONTAL PREAMP U301B, U802
COMMON-MODE STABILIZER U801A
HORIZONTAL OUTPUT AMPLIFIERS Q801, Q802, Q805, Q806
DRIVER AMPLIFIERS Q803, Q804, Q807, Q808, Q809, Q810
SWEEP CONTROL SHIFT REGISTERS U302, U303
SWEEP CONTROL LOGIC LINES
A SWEEP TIMING U307, U308, Q307, Q330, Q328, Q305, Q306
A SWEEP START Q308, Q309, Q311, Q326, Q333
A GATES
TO U505 7
SEC/DIV VAR
TIMING DIVIDER R313B, C, D, Q301, U309B
A SWEEP BUFFER Q310A, B, 312
BASELINE STABALIZER U309A, Q302, Q303, Q304, Q315, Q316, Q317
+2.5 V REF
B SWEEP TIMING U310, U211, Q320, Q331, Q318, Q329
B SWEEP BUFFER Q323A, B, Q325
B SWEEP START Q313, Q321, Q322, Q332
B GATES
DELAY-TIME SWITCHING U301A, C
DELAY-TIME COMPARATOR U313, U315A, C
DLY END 0-1
REF DELAY
DELTA DELAY
SWEEP-END COMPARATOR U316A, B, C
A, B SWP END
DLY SEL
HD0, HD1
BEAM FIND
INTENSITY GATES
EXT Z-AXIS
Z-AXIS/FOCUS DRIVER U1001A, B, C, D, U1001, Q1001, Q1004, Q1008
Z-AXIS/AUTO FOCUS AMPLIFIER Q2701-Q2709, Q2711, Q2712, Q2713, Q2715
AUTO FOCUS
ANODE
INTENSITY
-2.7 KV
A INTEN
B INTEN
READOUT
130 V AC
POWER
AC INPUT AND PRIMARY POWER RECTIFIER FL2201, RT2201, VR2204, F2201, CR2231, CR2232, CR2233, CR2234
LINE TRIG 3
+44 V
STARTUP CIRCUIT Q2204, Q2211
S2202
THERMAL CUTOUT
PREREGULATOR CIRCUITS Q2201, T2203, Q2202, Q2203, U2201, Q2208, Q2206, VR2201
INVERTER CONTROL CIRCUIT Q2212, Q2213
INVERTER POWER SWITCHING Q2209, Q2210, Q2214
T2204
LOW VOLTAGE SECONDARY SUPPLIES
LOW VOLTAGES TO ALL CIRCUITS
HIGH VOLTAGE POWER SUPPLY U2230
+13.7 KV

Figure 9-4a. 2246 block diagram—part 1.

6081-21

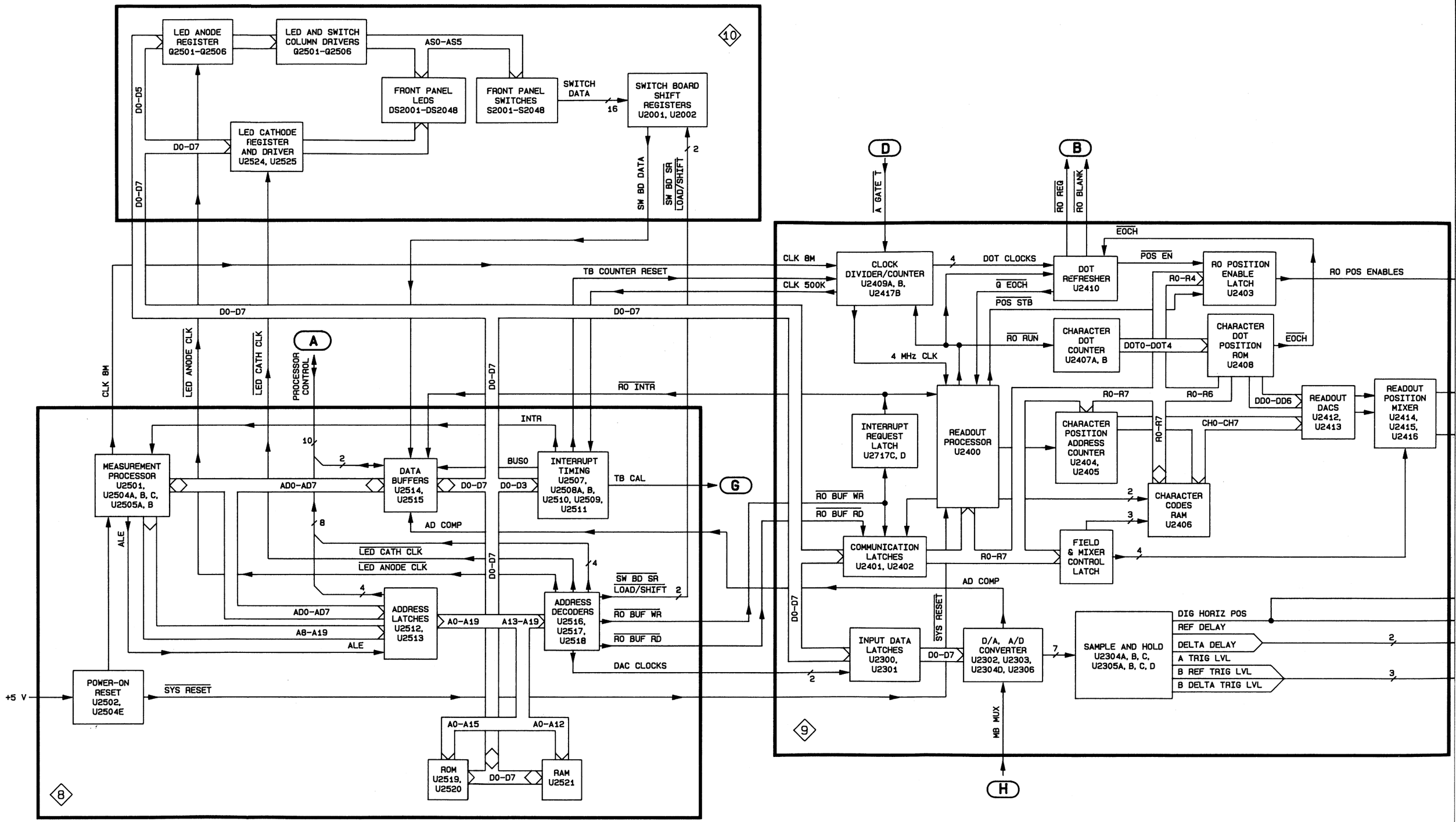


Figure 9-4b. 2246 block diagram—part 2.

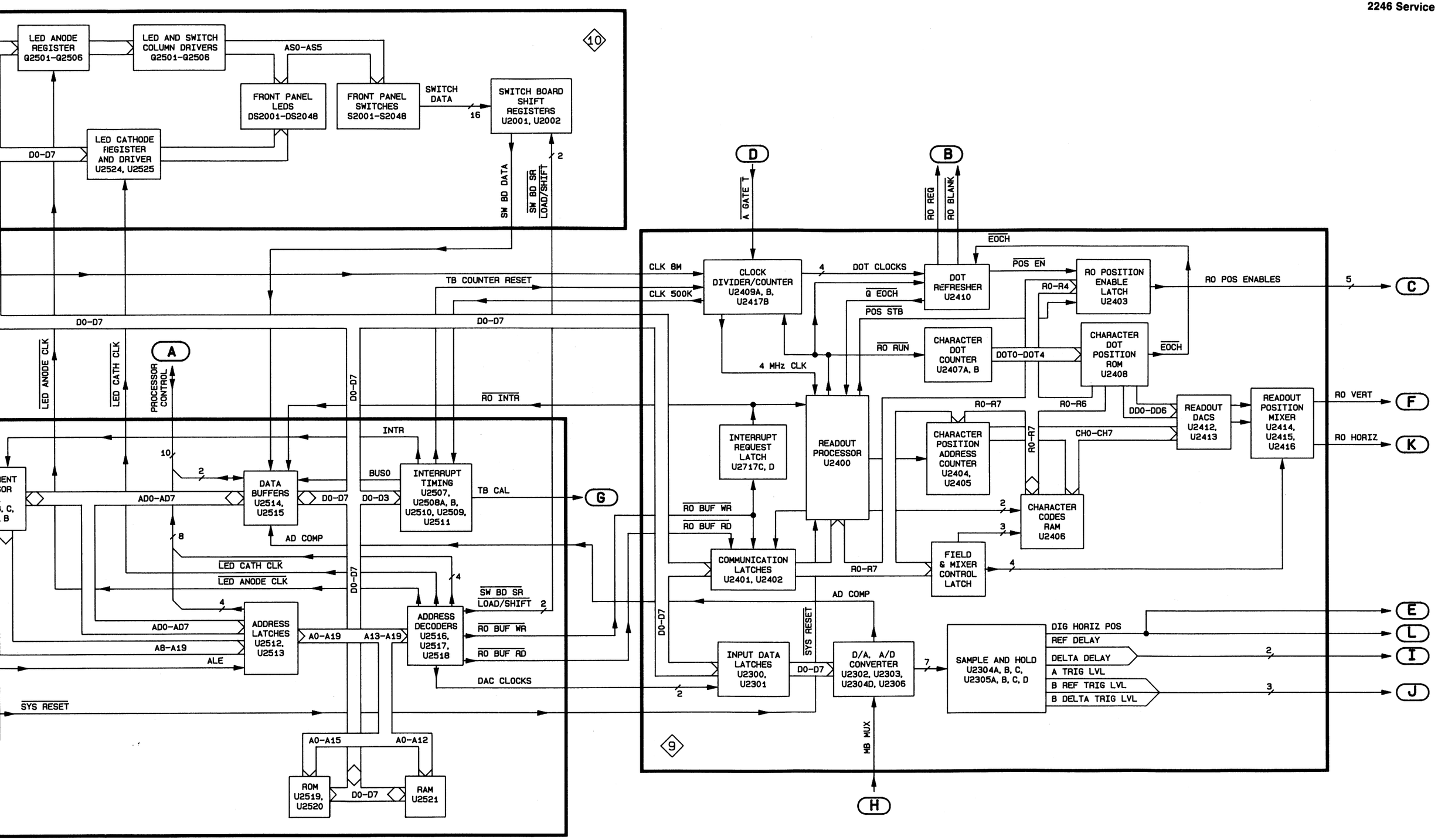


Figure 9-4b. 2246 block diagram—part 2.

6081-22

Table 9-1
SIGNAL LINE LOCATIONS

SIGNAL NAME	ORIGINATES [a] DIAG/CIR#(VIA)	GOES TO DIAG/CIR#(VIA)
A GATE	4/U603-11	5/VR302
A GATE T	4/Q604	9/U2410-9;4/U600-14
A GATE	4/U603-14	5/VR301
A INTEN GATE	4/U602-17	7/Q1001-EMITTER
A RAMP	5/Q312,Q328	6/U802-3
A SLOPE	4/600-30	3/U421-8(R493)
A SWP END	5/U316-15(R378)	4/U602-8
A TRIG	3/U421-10(R411)	4/U602-7
A TRIG LVL	9/U2304-7	3/U421-24(R448)
AD COMP	9/U2306-7	8/U2515-15(R2511)
AD MUX 0	4/U501-12	7/U505-11,U506-11
AD MUX 1	4/U501-13	7/U505-10,U506-10
AD MUX 2	4/U501-14	7/U505-9,U506-9
AD MUX 3	4/U501-15	7/U505-6,U506-6,R517
ADDR0	8/U2512-16	4/U501-1,U602-38(R619),U600-9
ADDR1	8/U2512-19	4/U501-2,U602-39(R618),U600-5
ADDR2	8/U2512-2	4/U501-3,U600-6
ADDR3	8/U2512-5	4/U502-10,U600-7
ATS 0	4/U600-31	3/U421-13(R490)
ATS 1	4/U600-32	3/U421-12(R491)
ATS 2	4/U600-33	3/U421-9(R492)
AUX DATA	5/U303-9	3/U1103-2(R1162)
B DELTA TRIG LVL	9/U2304-8	3/U1106-5
B GATE	4/U603-9	5/VR304
B GATE	4/U603-15	5/VR303
B INTEN GATE	4/U602-18	7/Q1004
B RAMP	5/Q325,Q329	6/U802-5
B REF TRIG LVL	9/U2304-8	3/U1106-3
B SLOPE	4/U600-26	3/U431-8
B SWP END	5/U316-2(R380)	4/U602-37
B TRIG	3/U431-10(R415)	5/U602-34
B TRIG	3/U431-11(R416)	5/DL22
BEAM FIND	4/U503-7	7/Q2706(R2705);2/U701-21;6/U802-14
BTS 0	4/U600-27	3/U431-13
BTS 1	4/U600-28	3/U431-12
BTS 2	4/U600-29	3/U431-9
BW LIMIT	3/U1103-11	4/U502-4;2/U701-22;3/U441-11,13
CH 1 EN	4/U600-39	2/U210-11(R213)
CH 1 PRB	1/R105/C111	7/U506-15
CH 1 PREAMP 0	1/U172-4	2/U210-1
CH 1 PREAMP 1	1/U171-11	2/U210-2
CH 1 PREAMP IN +	1/U112-8	2/U210-7
CH 1 TR +	2/U210-20	3/U421-7,U431-7
CH 1 VAR	2/R210-1	7/U505-14
CH 2 EN	4/U600-38	2/U220-11 (R223)
CH 2 INVERT	1/U173-6	2/U220-12

[a]Signals that begin and end on the same diagram are not listed in this table.

MORE

Table 9-1 (cont)
SIGNAL LINE LOCATIONS

SIGNAL NAME	ORIGINATES DIAG/CIR#(VIA)	GOES TO DIAG/CIR#(VIA)
CH 2 PRB	1/R106,C121	7/U506-12
CH 2 PREAMP 0	1/U173-5	2/U220-1
CH 2 PREAMP 1	1/U173-4	2/U220-2
CH 2 PREAMP IN +	1/U122-8	2/U220-7
CH 2 TR +	2/U220-20	3/U421-5,U431-5
CH 2 VAR	2/R2103	7/U505-13
CH 3 EN	4/U600-37	2/U230-11(R233)
CH 3 PRB	1/R107,C131	7/U506-1
CH 3 PREAMP 1	1/U173-7	2/U230-2
CH 3 PREAMP IN +	1/R139	2/U230-7
CH 3 TR +	2/U230-20	3/U421-3
CH 3 TR +	2/U230-20	3/U421-3
CH 4 EN	4/U600-36	2/U240-11(R243)
CH 4 PRB	1/R108,C151	7/U506-5
CH 4 PREAMP 1	1/U173-14	2/U240-2
CH 4 PREAMP IN +	1/R159	2/U240-7
CH 4 TR +	2/U240-20	3/U421-4,U431-4
CLK 1K	7/R934,R939	4/U600-2
CLK 500K	9/U2409-6	8/U2508-13
CLK 8M	8/U2505-5	9/U2409-1
$\overline{\text{DAC LSB CLK}}$	8/U2517-11	9/U2301-11
$\overline{\text{DAC MSB CLK}}$	8/U2517-10	9/U2300-11
DELTA DELAY	9/U2305-14	5/U301-2,-12(R330)
DIG HORIZ POS	9/U2304-1	6/U301-3(R369);2/U702-3
DLY END 0	5/U315-15(R388)	4/U602-36
DLY END 1	5/U315-2(R387)	4/U602-35
$\overline{\text{DLY SEL}}$	4/U600-25	5/U301-11
$\overline{\text{FLIC WR}}$	8/U2518-9	4/U602(R647)
HD0	4/U600-24	6/U802-8
HD1	4/U600-23	6/U802-11
$\overline{\text{IZ INTEN GATE}}$	4/U602-19	7/Q1003
$\overline{\text{LED ANODE CLK}}$	8/U2517-14	10/U2514-11
$\overline{\text{LED CATH CLK}}$	8/U2517-15	10/U2523-11
LINE TRIG	11/T2202	3/U1106-2
MAG	3/U1103-6i	6/U802-6
MAIN BD MUX	7/U505-3(R503)	9/U2306-2(R2307)
$\overline{\text{MB CNTL WR}}$	8/U2518-15	4/U501-4
MB DATA	4/U600-9,U602-12	8/U2515-14(R2555);4/U502-2
MB RETURN	4/U606A	8/U2515-17(R2509)
REF DELAY	9/U2305-1	5/U301-13(R329)
$\overline{\text{RO BLANK}}$	9/U2410-16(R2419)	4/U600-12
$\overline{\text{RO BUF RD}}$	8/U2516-10	9/U2402-1
$\overline{\text{RO BUF WR}}$	8/U2517-13	9/U2417-9,U2401-11
RO CH 1 POS EN	9/U2403-19	2/U202-10
RO CH 2 POS EN	9/U2403-2	2/U202-11
RO CH 3 POS EN	9/U2403-5	2/U201-9

MORE

Table 9-1 (cont)
SIGNAL LINE LOCATIONS

SIGNAL NAME	ORIGINATES DIAG/CIR#(VIA)	GOES TO DIAG/CIR#(VIA)
RO CH 4 POS EN	9/U2403-6	2/U201-10
RO FREEZE	1/U173-11	4/U502-5,U503-3
RO HORIZ	9/U2416-8	6/U802-1
RO INTEN GATE	4/U602-20	7/Q1002
RO INTR	9/U2417-11	8/U2515-18(R2508),U2400-2
RO REQ	9/U2410-14(R2420)	4/U503-2,U600-11
RO TR SEP EN	9/U2403-9	2/U201-11
RO VERT	9/U2416-14	2/U202-4(R207,R205)
RO VERT EN	4/U503-4	2/U202-9(R215)
SLIC RD	8/U2503-6	4/U600-8
SLIC WR	8/U2518-12	4/U600-3
SR 1 CLK	4/U606-4	5/U302-3,U303-3
SR 1 CLK TTL	4/U501-13	3/U1103-3
SR DATA	4/U606-6	1/Q171B,U171-2;5/U302-2
SR0 CLK	4/U606-12	1/U171-3,U172-3
SR1 CLK TTL	4/U501-13	3/U1103-3
SW BD DATA	10/U2002-9	8/U2515-16(R2510)
SW BD SR LOAD	8/U2518-14	10/U2001-1,U2002-1
SW BD SR SHIFT	8/U2518-13	10/U2001-2,U2002-2
SYS RESET	8/U2504-10	9/U2400-28
TB CAL	8/U2509-10	3/U1106-1(R1170)
TB COUNTER RESET	8/R2516	9/U2509-12
TIME VAR	5/R2107	5/R309;7/U505-15
TRACE SEP EN	4/U600-22	2/U201-11(R209)
TRIG CLK	4/U600-19	3/U421-2(R498)
VERT COMP	2/U702-7	4/U502-6
VERT COMP EN	3/U1103-7	2/Q703
VOLT CAL	7/U931-3	1/R114/R124
VOLT CAL 0	5/U303-11	7/U931-11
VOLT CAL 1	5/U303-12	7/U931-10
VOLT CAL 2	5/U303-13	7/U931-9
X-Y	3/U1103-12	6/U301-9
X-AXIS	3/U421-19(R426,L426)	6/U802-7(R836,R827)
ZERO HYST	1/U173-13	3/Q480(R484)

VOLTAGE/WAVEFORM SETUP CONDITIONS

WAVEFORMS

Test waveforms are shown on a page just before the schematic diagram to which they apply. Normal control settings for the test oscilloscope are given in the readouts shown in each waveform illustration. Unless otherwise indicated near the waveform, setup conditions for the oscilloscope under test are as follows:

1. Set up Factory Control Settings from the SERVICE MENU as described in the Introduction to the Adjustment Procedure, section 5.

2. Turn on BW LIMIT and turn off CH 2.

3. Connect the front panel CALIBRATOR output to the channel 1 input connector.

4. For all waveforms, except those obtained from the Low-Voltage Power Supply, connect the test oscilloscope probe ground wire to the chassis. When obtaining waveforms from the power supply, first connect the power cord of the 2246 under test through an isolation transformer, then connect probe ground wire to ground "P" (rear side of R2256). See Figure 9-10 to locate ground "P".

WARNING

To avoid electric shock and instrument damage, always connect the power cord of the instrument under test through an isolation transformer when viewing waveforms or measuring voltages in the low-voltage power supply.

DC VOLTAGES

Dc voltages shown the schematic diagrams are typical of a normally operating instrument. Voltages are referenced to chassis ground, except in the isolated portion of the Low Voltage Power Supply where they are referenced to ground "P" (at R2256 as shown in Figure 9-7). Make sure that the DMM leads are floating (isolated from chassis ground) when measuring voltages in this section.

TEST EQUIPMENT

The following test equipment is recommended for obtaining waveforms and voltages from the 2246 Oscilloscope. Other similar equipment types can also be used.

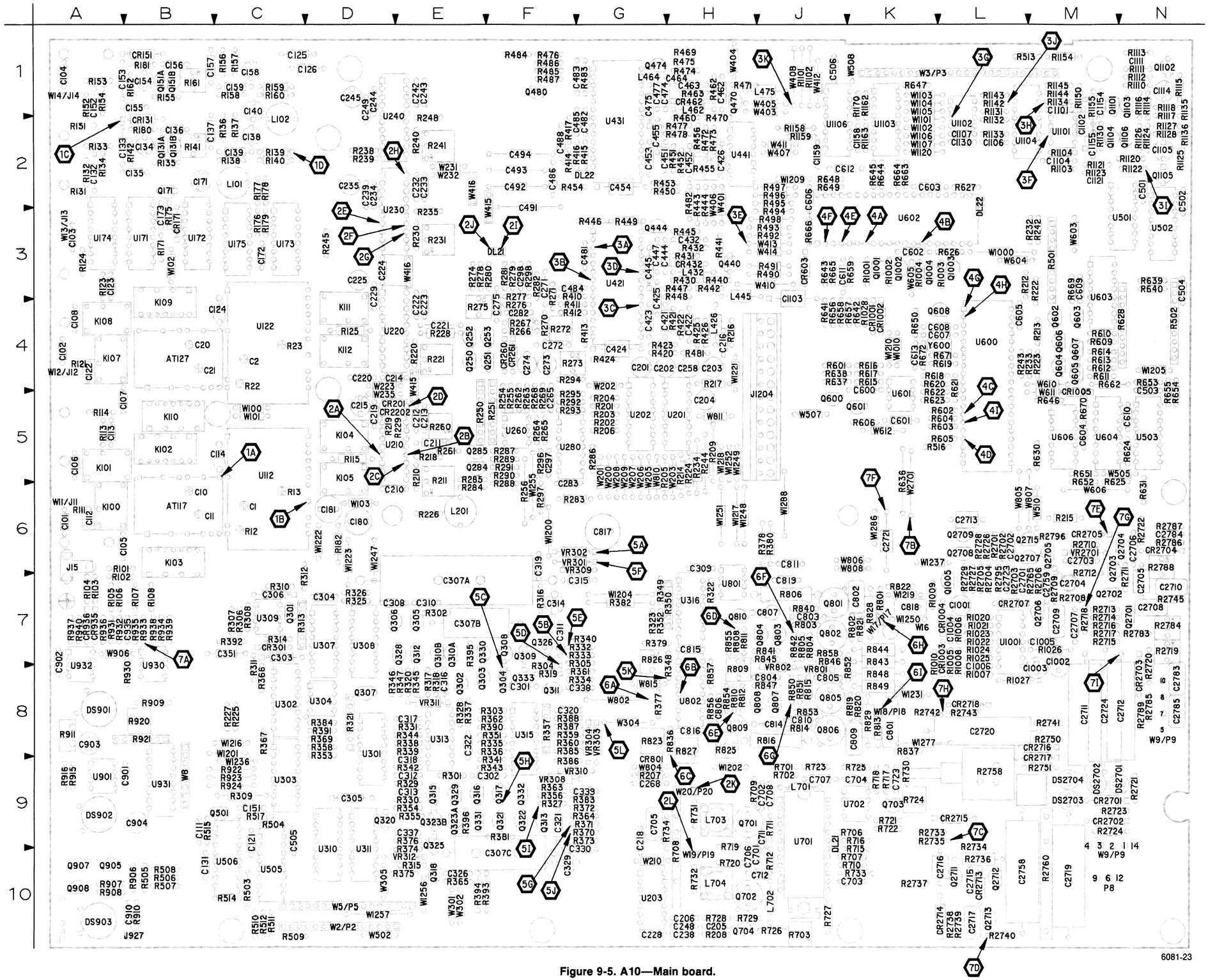
1. Test Oscilloscope with 10X probe(s)—TEKTRONIX 2246.

2. Digital Voltmeter—TEKTRONIX DM501A.

3. Power-Line Isolation Transformer—Tektronix Part No. 006-5953-00.

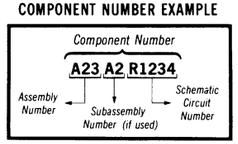
OTHER PARTS

CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION
B25	11	6N	P25	11	6N
			P26	7	1L
DL21	2	3K	P27	7	2L
FL2201	11	2A	S2202	11	3E
J16	7	7A			



Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

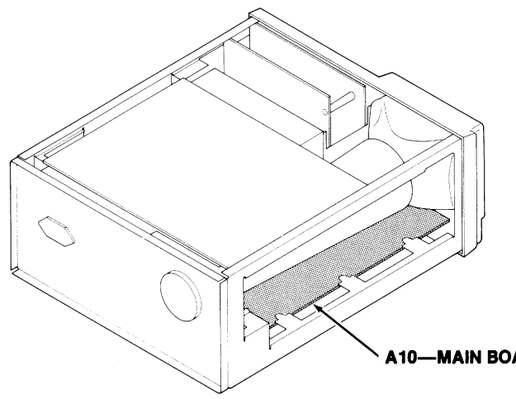


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Figure 9-5. A10—Main board.

A10—MAIN BOARD

CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER
AT117	1	C242	2	C502	12	C2708	7	K110	1	Q603	4
AT127	1	C243	2	C503	12	C2709	12	K111	1	Q604	4
		C244	12	C504	12	C2710	7	K112	1	Q605	4
C1	1	C245	12	C505	12	C2711	7			Q606	4
C2	1	C248	2	C506	12	C2712	7	L101	12	Q607	4
C10	1	C249	12	C600	4	C2713	7	L102	12	Q608	4
C11	1	C258	2	C601	4	C2715	7	L201	12	Q701	2
C20	1	C265	12	C602	4	C2716	7	L426	3	Q702	2
C21	1	C268	2	C603	4	C2717	7	L432	3	Q703	2
C101	1	C271	2	C604	12	C2719	7	L445	12	Q704	2
C102	1	C272	2	C605	12	C2720	7	L462	3	Q801	6
C103	1	C273	2	C606	12	C2721	7	L464	3	Q802	6
C104	1	C274	2	C607	4	C2723	7	L475	12	Q803	6
C105	1	C275	2	C608	4	C2724	7	L701	2	Q804	6
C106	1	C282	12	C609	12	C2758	7	L702	2	Q805	6
C107	1	C283	12	C610	12	C2759	7	L703	2	Q806	6
C108	1	C297	12	C611	3	C2783	7	L704	2	Q807	6
C111	1	C298	12	C612	4	C2784	7			Q808	6
C112	1	C301	5	C613	12	C2785	7	P2	7	Q809	6
C113	1	C302	5	C701	12			P2	12	Q810	6
C114	1	C303	5	C702	12	CR131	1	P3	4	Q905	7
C121	1	C304	12	C703	12	CR151	1	P3	12	Q907	7
C122	1	C305	5	C704	12	CR171	1	P5	4	Q908	7
C123	1	C306	5	C705	12	CR201	2	P5	5	Q1001	7
C124	1	C307	5	C706	2	CR202	2	P5	7	Q1002	7
C125	1	C308	5	C707	2	CR260	2	P5	12	Q1003	7
C126	1	C309	12	C708	12	CR261	2	P8	7	Q1004	7
C131	1	C310	5	C711	2	CR301	5	P9	7	Q1005	7
C132	1	C311	5	C712	2	CR432	3	P17	6	Q1101	3
C133	1	C312	5	C723	2	CR462	3	P18	6	Q1102	3
C134	1	C313	5	C801	12	CR603	4	P19	2	Q1103	3
C135	12	C314	5	C802	6	CR801	6	P20	2	Q1104	3
C136	12	C315	5	C803	6	CR935	7			Q1105	3
C137	1	C316	12	C804	6	CR936	7	Q131	1	Q1106	3
C138	1	C317	12	C805	6	CR1001	7	Q151	1	Q2701	7
C139	2	C318	12	C806	12	CR1002	7	Q171	1	Q2702	7
C140	12	C319	6	C807	6	CR1003	7	Q250	2	Q2703	7
C151	1	C320	12	C809	6	CR1004	7	Q251	2	Q2704	7
C152	1	C321	5	C810	6	CR1005	7	Q252	2	Q2705	7
C153	1	C322	5	C811	2	CR2701	7	Q253	2	Q2706	7
C154	1	C326	5	C814	6	CR2702	7	Q284	2	Q2707	7
C155	12	C329	5	C815	12	CR2703	7	Q285	2	Q2708	7
C156	12	C330	5	C816	12	CR2704	7	Q301	5	Q2709	7
C157	1	C337	12	C817	6	CR2705	7	Q302	5	Q2711	7
C158	1	C338	12	C818	12	CR2707	7	Q303	5	Q2712	7
C159	2	C339	12	C819	6	CR2713	7	Q304	5	Q2713	7
C171	12	C351	12	C901	12	CR2714	7	Q305	5	Q2715	7
C172	12	C421	3	C902	12	CR2715	7	Q306	5		
C173	1	C422	3	C903	12	CR2716	7	Q307	5	R12	1
C180	12	C423	3	C904	12	CR2717	7	Q308	5	R13	1
C181	12	C424	3	C910	7	CR2718	7	Q309	5	R22	1
C201	2	C425	3	C935	7			Q310	5	R23	1
C202	2	C426	3	C1001	7	DL21	2	Q311	5	R101	1
C203	2	C432	3	C1002	7	DL22	4	Q312	5	R102	1
C204	2	C444	3	C1003	7			Q313	5	R103	1
C205	12	C445	12	C1004	7	DS901	7	Q315	5	R104	1
C206	12	C447	3	C1005	12	DS902	7	Q316	5	R105	1
C210	2	C451	3	C1006	12	DS903	7	Q317	5	R106	1
C211	2	C452	3	C1101	12	DS2701	7	Q318	5	R107	1
C212	2	C453	3	C1102	12	DS2702	7	Q320	5	R108	1
C213	2	C454	3	C1103	3	DS2703	7	Q321	5	R111	1
C214	12	C455	3	C1104	3	DS2704	7	Q322	5	R113	1
C215	12	C462	3	C1105	3			Q323	5	R114	1
C216	12	C463	3	C1106	3	J11	1	Q325	5	R115	2
C218	2	C464	3	C1107	3	J12	1	Q326	5	R121	1
C219	12	C474	3	C1111	3	J13	1	Q328	5	R123	1
C220	2	C475	12	C1114	3	J14	1	Q329	5	R124	1
C221	2	C477	3	C1121	3	J15	7	Q330	5	R125	2
C222	2	C481	12	C1130	3	J927	7	Q331	5	R131	1
C223	2	C482	12	C1154	3	J1204	12	Q332	5	R132	1
C224	12	C483	3	C1155	3			Q333	5	R133	1
C225	12	C484	3	C1158	12	K100	1	Q440	3	R134	1
C228	2	C485	3	C1159	12	K101	1	Q444	3	R135	1
C229	12	C486	3	C2701	12	K102	1	Q470	3	R136	1
C232	2	C488	3	C2702	12	K103	1	Q474	3	R137	1
C233	2	C491	2	C2703	7	K104	1	Q480	3	R138	2
C234	12	C492	2	C2704	7	K105	1	Q501	7	R139	1
C235	12	C493	2	C2705	7	K107	1	Q600	4	R140	2
C238	2	C494	2	C2706	7	K108	1	Q601	4	R141	1
C239	12	C501	12	C2707	7	K109	1	Q602	4	R142	1

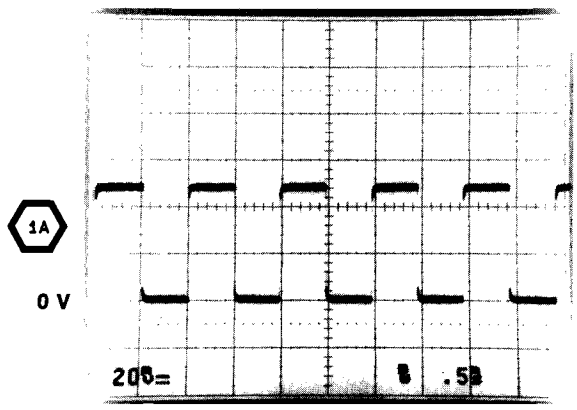
A10—MAIN BOARD (cont)

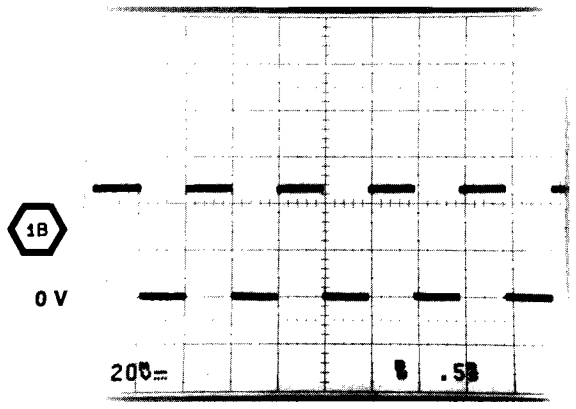
CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER
R151	1	R270	2	R353	6	R469	3	R645	4	R837	12
R152	1	R271	2	R354	5	R470	3	R646	4	R840	6
R153	1	R272	2	R355	5	R471	3	R647	4	R841	6
R154	1	R273	2	R356	5	R472	3	R648	4	R842	6
R155	1	R274	2	R357	5	R473	3	R649	4	R843	6
R156	1	R275	2	R358	6	R474	3	R650	4	R844	6
R157	1	R276	2	R359	5	R475	3	R651	4	R845	6
R158	2	R277	2	R360	5	R476	3	R652	4	R846	6
R159	1	R278	2	R361	5	R477	3	R653	4	R847	6
R160	2	R279	2	R362	5	R478	3	R654	4	R848	6
R161	1	R280	2	R363	5	R481	12	R655	4	R849	6
R162	1	R281	2	R364	5	R482	12	R656	4	R850	6
R171	1	R282	12	R365	5	R483	3	R657	4	R851	6
R175	1	R283	12	R366	5	R484	3	R658	4	R852	6
R176	1	R284	2	R367	5	R485	3	R659	4	R853	6
R177	1	R285	2	R369	6	R486	3	R662	4	R854	6
R178	1	R286	2	R370	5	R487	3	R663	4	R855	6
R179	1	R287	2	R371	5	R490	3	R664	4	R856	6
R180	1	R288	2	R372	5	R491	3	R665	4	R857	6
R181	1	R289	2	R373	5	R492	3	R666	4	R858	6
R182	12	R290	2	R374	12	R493	3	R669	4	R906	7
R201	2	R291	2	R375	5	R494	3	R670	4	R907	7
R202	2	R292	2	R376	5	R495	3	R671	4	R908	7
R203	2	R293	2	R377	5	R496	3	R672	4	R909	7
R204	2	R294	2	R378	5	R497	3	R701	12	R910	7
R205	2	R295	2	R379	5	R498	3	R702	2	R911	7
R206	2	R296	2	R380	5	R501	4	R703	2	R915	12
R207	2	R297	12	R381	5	R502	4	R706	2	R916	12
R208	12	R298	12	R382	5	R503	7	R707	2	R920	7
R209	2	R301	5	R383	5	R504	12	R708	2	R921	7
R210	2	R302	5	R384	5	R505	7	R709	12	R922	7
R211	2	R303	5	R385	5	R506	7	R710	2	R923	7
R212	2	R304	5	R386	5	R507	7	R711	2	R924	7
R213	2	R305	5	R387	5	R508	7	R712	2	R930	7
R214	2	R306	5	R388	5	R509	7	R715	2	R931	7
R215	2	R307	5	R390	12	R510	7	R716	2	R932	7
R216	12	R308	5	R391	5	R511	7	R717	2	R933	7
R217	12	R309	5	R392	12	R512	7	R718	2	R934	7
R218	2	R310	5	R393	5	R513	4	R719	2	R935	7
R219	2	R311	5	R394	5	R514	7	R720	2	R936	7
R220	2	R312	12	R395	5	R515	7	R721	2	R937	7
R221	2	R313	5	R396	5	R516	4	R722	2	R938	7
R222	2	R314	5	R410	3	R517	7	R723	12	R939	7
R223	2	R315	5	R411	3	R601	4	R724	2	R940	7
R224	2	R316	5	R412	3	R602	4	R725	2	R1001	7
R225	2	R317	5	R413	3	R603	4	R726	2	R1002	7
R226	12	R318	5	R414	3	R604	4	R727	2	R1003	7
R227	2	R319	5	R415	3	R605	4	R728	2	R1004	7
R228	2	R320	5	R416	3	R606	4	R729	2	R1005	7
R229	2	R321	5	R417	3	R609	4	R730	2	R1006	7
R230	2	R322	5	R420	3	R610	4	R731	2	R1007	7
R231	2	R323	5	R421	3	R611	4	R732	2	R1008	7
R232	2	R325	5	R422	3	R612	4	R733	12	R1009	7
R233	2	R326	5	R423	3	R613	4	R734	12	R1010	7
R234	2	R327	5	R424	3	R614	4	R801	6	R1020	7
R235	2	R328	5	R425	3	R615	4	R802	6	R1021	7
R238	2	R329	5	R426	3	R616	4	R803	6	R1022	7
R239	2	R330	5	R430	3	R617	4	R804	6	R1023	7
R240	2	R331	5	R431	3	R618	4	R805	6	R1024	7
R241	2	R332	5	R432	3	R619	4	R806	6	R1025	7
R242	2	R333	5	R440	3	R620	4	R808	6	R1026	12
R243	2	R334	5	R441	3	R621	4	R809	6	R1027	12
R244	2	R335	5	R442	3	R622	4	R810	6	R1028	7
R245	12	R336	5	R443	3	R623	4	R811	6	R1101	12
R248	2	R337	5	R444	3	R624	4	R812	6	R1102	12
R250	2	R338	5	R445	3	R625	4	R813	6	R1103	3
R251	2	R339	12	R446	3	R626	4	R814	6	R1104	3
R254	2	R340	5	R447	3	R627	4	R815	6	R1110	3
R255	2	R341	5	R448	3	R628	4	R816	6	R1111	3
R256	2	R342	5	R449	3	R630	4	R819	6	R1112	3
R260	2	R343	5	R450	3	R631	4	R820	6	R1113	3
R261	2	R344	5	R451	3	R636	4	R821	6	R1114	3
R262	2	R345	12	R452	3	R637	4	R822	6	R1115	3
R263	2	R346	5	R453	3	R638	4	R823	6	R1116	3
R264	2	R347	5	R454	3	R639	4	R825	6	R1117	3
R265	2	R348	5	R455	3	R640	4	R826	6	R1118	3
R266	2	R349	5	R456	3	R641	4	R827	6	R1120	3
R267	2	R350	5	R460	3	R642	4	R828	6	R1121	3
R268	2	R351	5	R462	3	R643	4	R829	6	R1122	3
R269	2	R352	5	R463	3	R644	4	R836	6	R1123	3

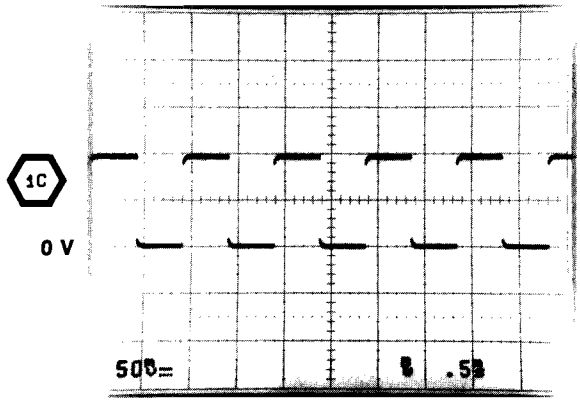
A10—MAIN BOARD (cont)

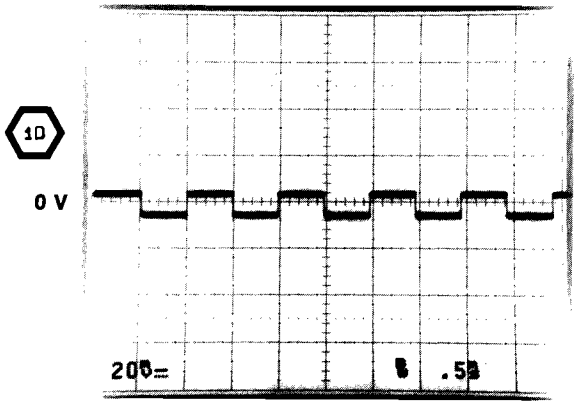
CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER
R1124	3	R2736	7	U301	6	U801	2	W17	6	W805	6
R1125	3	R2737	7	U301	12	U801	6	W18	6	W806	6
R1126	3	R2738	7	U302	5	U801	12	W19	2	W807	6
R1127	3	R2739	7	U302	12	U802	6	W20	2	W808	6
R1128	3	R2740	7	U303	5	U802	12	W100	1	W810	6
R1130	3	R2741	7	U303	12	U901	12	W101	1	W811	6
R1131	3	R2742	7	U304	5	U930	7	W102	1	W815	2
R1132	3	R2743	7	U304	12	U930	12	W103	12	W906	7
R1133	3	R2745	7	U307	5	U931	7	W200	2	W1000	7
R1134	3	R2750	7	U307	12	U931	12	W201	2	W1010	7
R1135	3	R2751	7	U308	5	U932	12	W202	2	W1101	3
R1136	3	R2758	7	U308	12	U1001	7	W203	2	W1102	3
R1142	3	R2760	7	U309	5	U1001	12	W205	2	W1103	12
R1143	3	R2765	7	U309	12	U1101	3	W206	2	W1104	3
R1144	3	R2783	12	U310	5	U1101	7	W207	2	W1105	3
R1145	3	R2784	7	U310	12	U1101	12	W208	2	W1106	3
R1150	3	R2785	7	U311	5	U1102	3	W209	2	W1107	3
R1154	3	R2786	7	U311	12	U1102	12	W210	2	W1120	3
R1155	3	R2787	7	U313	5	U1103	3	W223	2	W1200	12
R1158	12	R2788	7	U315	5	U1103	12	W231	2	W1201	12
R1159	12	R2789	7	U315	12	U1104	3	W232	2	W1202	12
R1162	3	R2795	7	U316	5	U1104	12	W235	12	W1204	12
R1163	3	R2796	7	U421	3	U1106	3	W301	5	W1205	12
R1170	3			U421	12	U1106	12	W302	5	W1209	12
R2701	7	U112	1	U431	3			W304	5	W1210	12
R2702	7	U112	12	U431	12	VR301	5	W305	6	W1216	12
R2703	7	U122	1	U441	3	VR302	5	W401	3	W1217	12
R2704	7	U122	12	U441	12	VR303	5	W403	3	W1218	12
R2705	7	U171	1	U501	4	VR304	5	W404	3	W1219	12
R2706	7	U171	12	U501	12	VR308	5	W405	3	W1221	12
R2708	7	U172	1	U502	4	VR309	5	W406	3	W1222	12
R2709	7	U172	12	U502	12	VR310	5	W407	3	W1223	12
R2710	7	U173	1	U503	4	VR311	5	W408	3	W1231	12
R2711	7	U173	12	U503	12	VR312	5	W410	3	W1236	12
R2712	7	U174	1	U505	7	VR801	6	W411	3	W1237	12
R2713	7	U175	1	U505	12	VR802	6	W412	3	W1247	12
R2714	7	U201	2	U506	7	VR2701	7	W413	3	W1248	12
R2715	7	U201	12	U506	12			W414	3	W1249	12
R2716	7	U202	2	U600	4	W2	7	W415	2	W1250	12
R2717	7	U202	12	U600	12	W2	12	W416	2	W1251	12
R2718	7	U203	2	U601	4	W3	4	W502	7	W1252	12
R2719	7	U203	12	U601	12	W3	12	W505	4	W1255	12
R2720	7	U210	2	U602	4	W5	2	W507	4	W1256	12
R2721	7	U210	12	U602	12	W5	4	W508	4	W1257	12
R2722	7	U220	2	U603	4	W5	5	W510	4	W1277	12
R2723	7	U220	12	U603	12	W5	7	W603	4	W1286	7
R2724	7	U230	2	U604	4	W5	12	W604	4	W1288	7
R2726	7	U230	12	U604	12	W8	12	W605	4	W2701	7
R2727	7	U240	2	U606	4	W9	7	W606	4		
R2728	7	U240	12	U606	12	W11	1	W610	4	Y600	4
R2729	7	U260	2	U701	2	W12	1	W611	4		
R2733	7	U260	12	U701	12	W13	1	W612	4		
R2734	7	U280	2	U702	2	W14	1	W802	6		
R2735	7	U301	5	U702	12	W16	7	W804	6		

WAVEFORMS FOR DIAGRAM 1









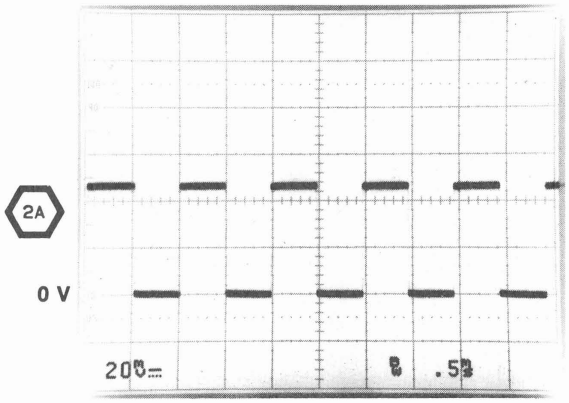
VERTICAL INPUTS DIAGRAM 1

ASSEMBLY A10

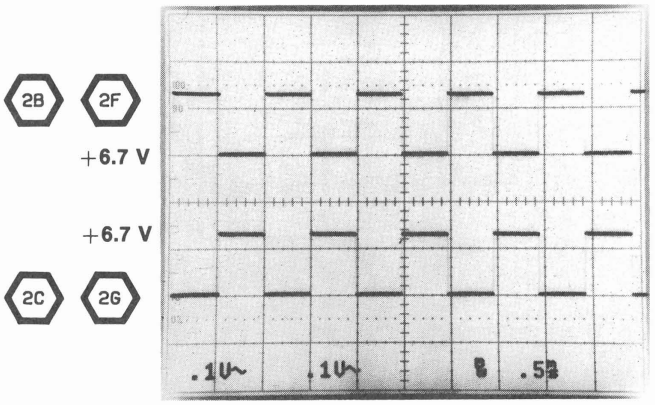
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
AT00117	1J	6B	J11	1A	6A	R132	6H	2A
AT127	3H	5B	J11	1A	6A	R133	6H	2A
			J12	4A	4A	R134	7H	2A
C1	1K	6C	J13	7A	3A	R135	7J	2B
C2	4K	4C	J14	8A	1A	R136	7K	2C
C10	2H	6B				R137	7K	2C
C11	2J	6B	K100	1F	6A	R139	7L	2C
C20	4H	4B	K101	1G	5A	R141	7J	2B
C21	5J	4B	K102	1G	5B	R142	7J	2B
C101	1B	6A	K103	1H	6B	R151	8A	2A
C102	3B	4A	K104	2L	5D	R152	8H	1A
C103	7B	3A	K105	2K	5D	R153	8H	1A
C104	8B	1A	K107	4F	4A	R154	8H	1A
C105	1F	6A	K108	4G	4A	R155	8J	1B
C106	2G	5A	K109	4G	4B	R156	8K	1C
C107	4F	5A	K110	4H	5B	R157	8K	1C
C108	5G	4A	K111	5L	4D	R159	8L	1C
C111	1B	9B	K112	5K	4D	R161	8J	1B
C112	1F	6A				R162	8J	1B
C113	1F	5A	Q131A	7K	2B	R171	5B	3B
C114	2J	5C	Q131B	7J	2B	R175	5B	3B
C121	3B	9C	Q151A	8K	1B	R176	6C	3C
C122	4F	4A	Q151B	8J	1B	R177	6C	2C
C123	4F	3A	Q171	5C	2B	R178	6E	2C
C124	4J	4C				R179	6E	3C
C125	4B	1C	R12	2K	6C	R180	6J	2B
C126	7F	1D	R13	2K	6C	R181	8J	1B
C131	7B	10B	R22	4K	4C			
C132	7H	2A	R23	4K	4C	U112	1L	6C
C133	7J	2A	R101	1B	6A	U122	4L	4C
C134	7J	2B	R102	3B	7A	U171	4C	3B
C137	7K	2B	R103	7B	7A	U172	5D	3B
C138	7K	2C	R104	7B	7A	U173	6E	3C
C151	8B	9C	R105	1B	7A	U174	1E	3A
C152	8H	1A	R106	3B	7A	U175	4E	3C
C153	8J	1A	R107	7B	7B			
C154	8J	1B	R108	8B	7B	W11	1B	6A
C157	8K	1B	R111	1A	6A	W12	3A	4A
C158	8K	1C	R113	1G	5A	W13	7A	3A
C173	5C	3B	R114	1F	5A	W14	7B	1A
			R121	3A	4A	W100	4F	5C
CR131	6H	2B	R123	3G	3A	W101	5G	5C
CR151	8H	1B	R124	3F	3A	W102	5G	3B
CR171	5B	3B	R131	7A	2A			

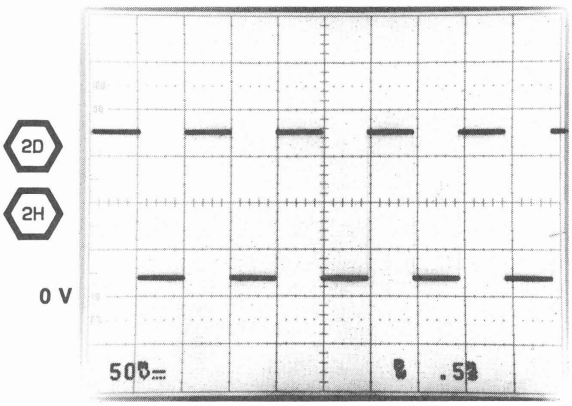
Partial A10 also shown on diagrams 2, 3, 4, 5, 6, 7 and 12.

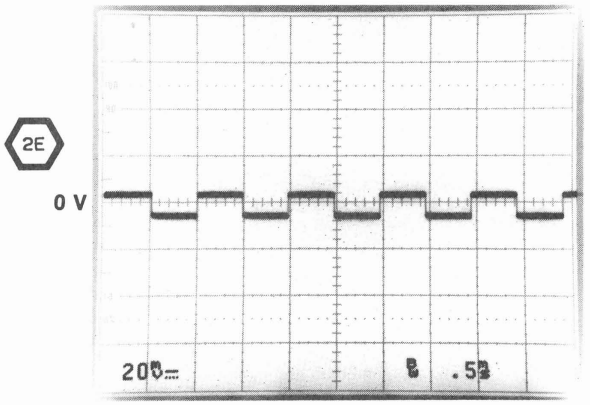
WAVEFORMS FOR DIAGRAM 2



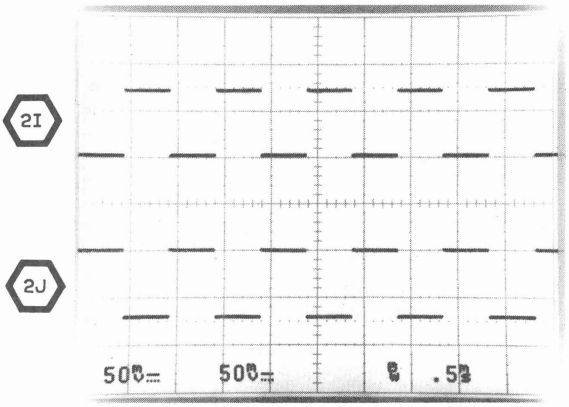
SET READOUT CONTROL CCW (OFF)



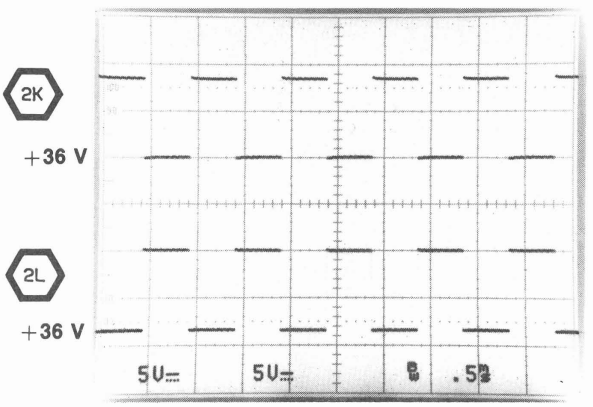




SET READOUT CONTROL CCW (OFF)



SET READOUT CONTROL CCW (OFF)



6081-26

WAVEFORMS

CIRCUIT NUMBER	+15V	+7.5V	+5V	GND	-7.5V
U112		5, 14		1, 3, 6, 15	7, 13
U122		5, 14		1, 3, 6, 15	7, 13
U171	16			8	
U172	16			8	
U173			16	8	

CH1 INPUT BUFFER AMPLIFIER & 1X, 2X, 5X ATTENUATORS

CH1 INPUT COUPLING & 10X, 100X ATTENUATORS

CH2 INPUT BUFFER AMPLIFIER & 1X, 2X, 5X ATTENUATORS

CH2 INPUT COUPLING & 10X, 100X ATTENUATORS

ATTENUATOR & VERTICAL MODE CONTROL REGISTERS

CH3 & CH4 INPUT AMPLIFIERS

COMPONENT NUMBER EXAMPLE

Component Number: A23, A2, R1234 (Assembly Number; Subassembly Number (if used); Schematic Circuit Number)

Chassis-mounted components have no Assembly Number prefix--see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATES ON ANOTHER SCHEMATIC (FOR EXAMPLE: 4E)

FOR INTEGRATED CIRCUIT SUPPLY CONNECTIONS AND POWER SUPPLY DECOUPLING NETWORKS SEE: MAIN BOARD POWER DISTRIBUTION 12

PARTIAL A10 MAIN BOARD

2246

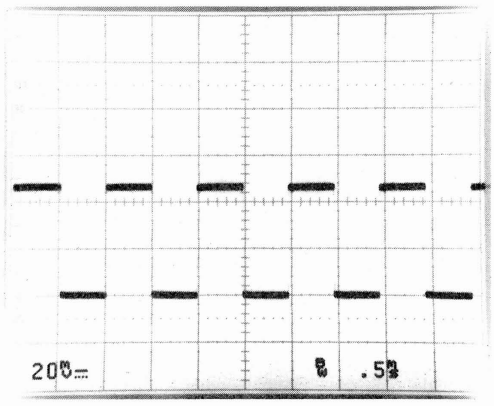
6081-50

VERTICAL INPUTS 1

WAVEFORMS FOR DIAGRAM 2

2A

0 V



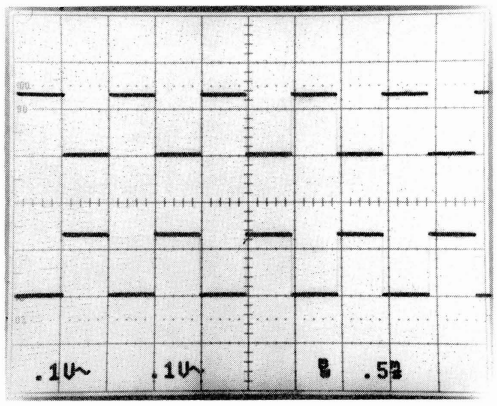
SET READOUT CONTROL CCW (OFF)

2B 2F

+6.7 V

+6.7 V

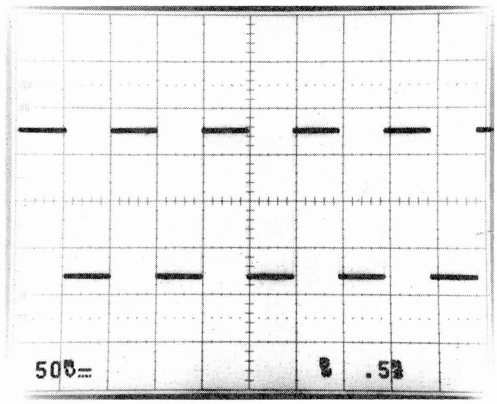
2C 2G



2D

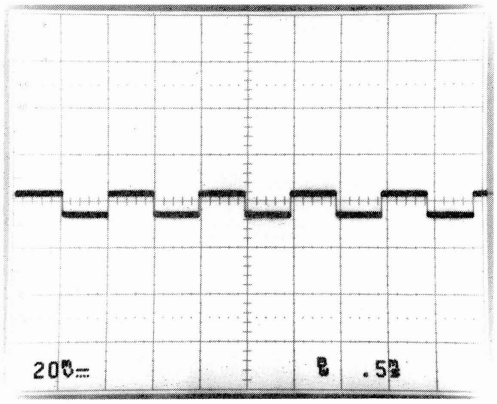
2H

0 V



2E

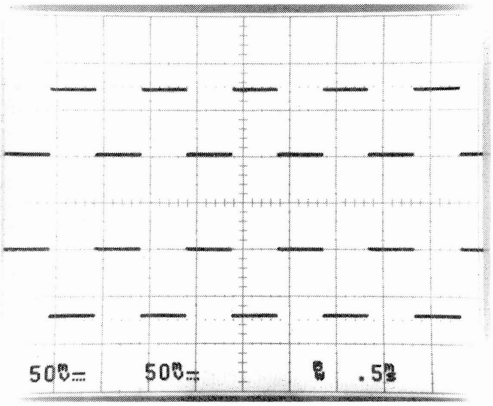
0 V



SET READOUT CONTROL CCW (OFF)

2I

2J



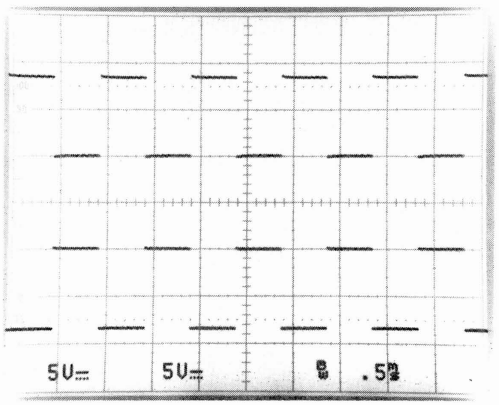
SET READOUT CONTROL CCW (OFF)

2K

+36 V

2L

+36 V



6081-26

VERTICAL PREAMPS AND OUTPUT AMPLIFIER DIAGRAM 2

ASSEMBLY A10

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C139	4C	2C	Q253	4J	4F	R250D	3E	5E	R712	4L	10J
C159	5C	1C	Q284	6F	5E	R250E	5E	5E	R715	1L	10K
C201	7C	4G	Q285	6F	5E	R250F	2H	5E	R716	2L	9K
C202	7C	4G	Q701	3M	9H	R250G	3H	5E	R717	2M	9K
C203	7C	4H	Q702	4M	10H	R251A	5F	5F	R718	1M	9K
C204	8C	5H	Q703	2M	9K	R251B	1E	5F	R719	3M	10H
C210	1C	6D	Q704	6K	10H	R251C	2E	5F	R720	4M	10H
C211	2D	5E				R251D	4E	5F	R721	1L	9K
C212	1E	5E	R115	1D	5D	R251E	5E	5F	R722	2L	9K
C213	2E	5E	R125	2D	4D	R251F	4H	5F	R724	4K	9K
C218	6B	9G	R138	4C	2C	R251G	4H	5F	R725	4K	9K
C220	3C	4D	R140	4D	2C	R254	3G	5F	R726	6K	10J
C221	3D	4E	R158	5C	1C	R255	3G	5F	R727	5K	10J
C222	3E	4E	R160	5D	1C	R256	2G	6F	R728	5K	10H
C223	3E	4E	R201	6E	5G	R260	7G	5E	R729	5K	10H
C228	7B	10G	R202	7E	5G	R261	7G	5E	R730	5K	9K
C232	4E	2E	R203	8E	5G	R262	3F	5F	R731	3M	9H
C233	5E	2E	R204	8E	5G	R263	4F	5F	R732	4M	10H
C238	7B	10H	R205	7D	5G	R264	3F	5F			
C242	5E	1E	R206	8E	5G	R265	4F	5F	U201	8D	5H
C243	6E	1E	R207	7C	9G	R266	2G	4F	U202	7D	5G
C248	8B	10H	R209	7C	5H	R267	2G	4F	U203A	6B	10G
C258	8C	4H	R210	1E	5E	R268	4J	5F	U203B	7B	10G
C268	7D	9G	R211	1E	5E	R269	2J	5F	U203C	7B	10G
C271	3H	3F	R212	2C	3L	R270	3J	4F	U203D	8B	10G
C272	3H	4F	R213	2C	4M	R271	4H	3F	U210	1D	5D
C273	3H	4F	R214	2C	5H	R272	3H	4F	U220	2D	4D
C274	3H	4F	R215	7C	6M	R273	3H	4F	U230	3D	3D
C275	4G	4F	R218	2C	5E	R274	3J	3E	U240	5D	2D
C491	2E	2F	R219	1C	5D	R275	3G	4E	U260	2F	5F
C492	3E	2F	R220	2E	4E	R276	4G	4F	U280	8F	5F
C493	4E	2F	R221	2E	4E	R277	3G	3F	U701	2L	9J
C494	6E	2F	R222	3C	3M	R278	3J	3E	U702	1M	9K
C706	3L	10H	R223	3C	4M	R279	4J	3F	U801B	8B	7H
C707	6L	9J	R224	3C	5H	R280	3J	3F			
C711	3L	9J	R225	1C	8C	R281	4J	3F	W5	8B	10D
C712	4L	10J	R227	2C	8C	R284	6E	6E	W19	4M	10H
C723	4K	9K	R228	3C	4E	R285	6G	5E	W20	3M	9H
C811	8B	6J	R229	1C	5D	R286	7F	5G	W200	3C	5G
			R230	4E	3E	R287	7F	5F	W201	2C	5G
CR201	2C	5D	R231	4E	3E	R288	7G	6F	W202	7E	4G
CR202	1C	5D	R232	5C	3M	R289	6G	5F	W203	7D	5H
CR260	3J	4F	R233	5C	4M	R290	7F	5F	W205	7B	5G
CR261	4J	4F	R234	4C	5H	R291	7F	5F	W206	6C	5G
			R235	5D	3E	R292	8E	5F	W207	7C	5G
L701	5L	9J	R238	4C	2D	R293	8F	5F	W208	8B	5G
L702	6L	10J	R239	4C	2D	R294	8G	4F	W209	8C	5G
L703	3M	9H	R240	5E	2E	R295	8G	5F	W210	8B	10G
L704	4M	10H	R241	5E	2E	R296	7F	5F	W223	3C	4D
			R242	6C	3M	R702	5K	9J	W231	4E	2E
P19	4N	10H	R243	6C	4L	R703	5K	10J	W232	4E	2E
P20	3N	9H	R244	6C	5H	R706	3K	9K	W415	1E	2F
			R248	6D	2E	R707	4K	10K	W415	1E	4E
Q250	3G	4E	R250A	5F	5E	R708	3M	10H	W416	3E	2E
Q251	4G	4F	R250B	1E	5E	R710	1L	10K	W416	3E	3E
Q252	3J	4E	R250C	2E	5E	R711	3L	9J	W815	8B	8G

Partial A10 also shown on diagrams 1, 3, 4, 5, 6, 7 and 12.

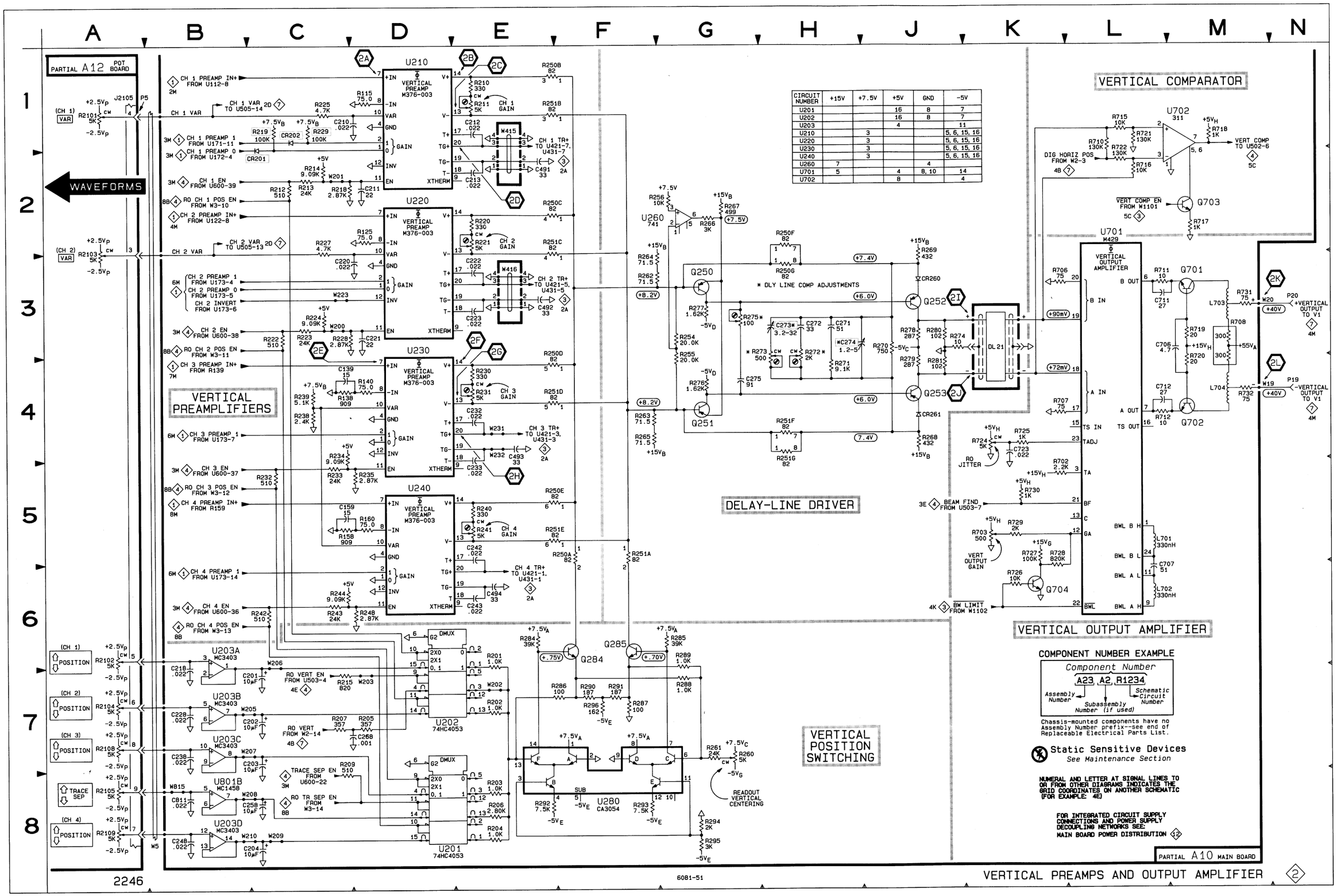
ASSEMBLY A12

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
J2105	1A	1B	R2102	6A	2A	R2105	8A	4C			
			R2103	2A	3B	R2108	7A	4D			
R2101	1A	3A	R2104	7A	2B	R2109	8A	4F			

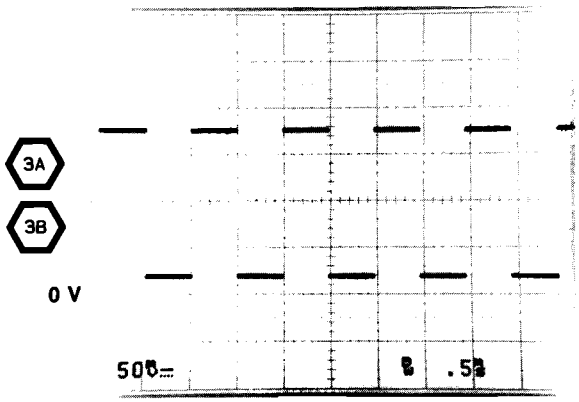
Partial A12 also shown on diagrams 4, 5, 7 and 12.

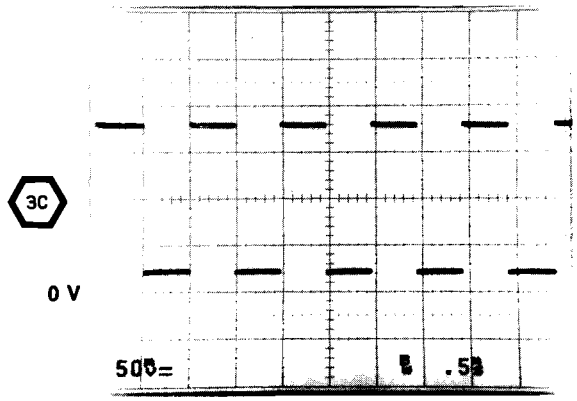
OTHER PARTS

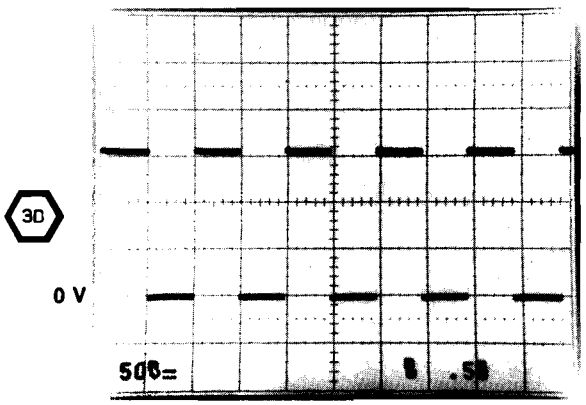
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
DL21	3K	CHASSIS									



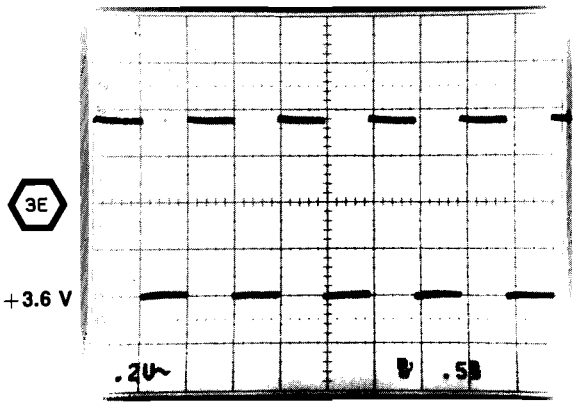
WAVEFORMS FOR DIAGRAM 3



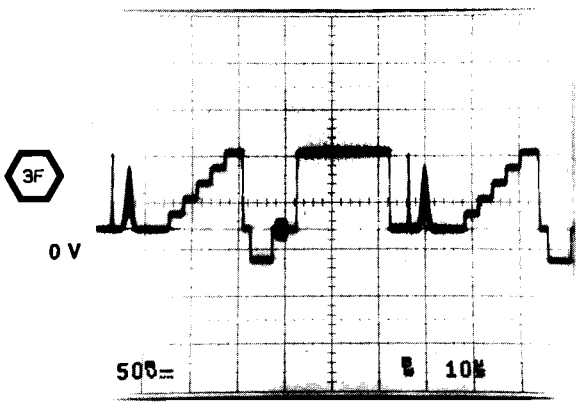




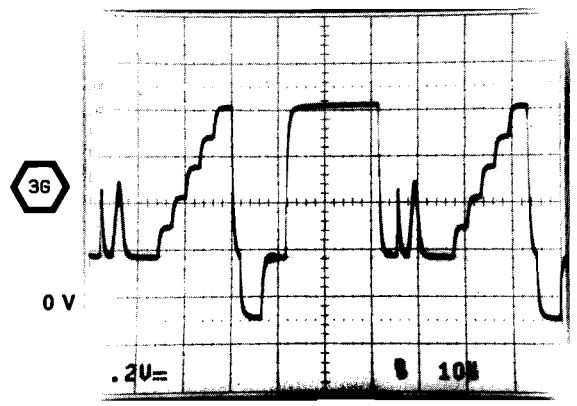
SET HORIZONTAL MODE TO ALT



CONNECT 4-DIVISION COMPOSITE VIDEO SIGNAL. SET TRIGGER MODE TO TV FIELD.

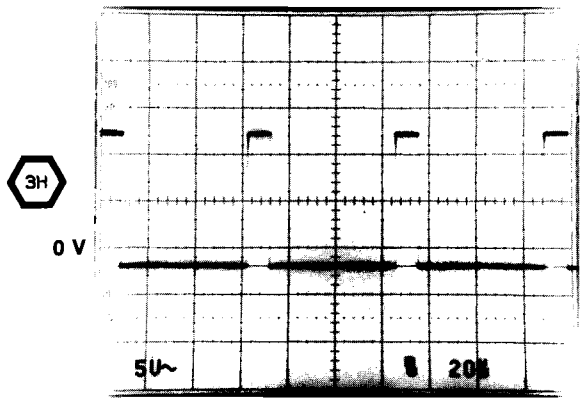


CONNECT 4-DIVISION COMPOSITE VIDEO SIGNAL. SET TRIGGER MODE TO TV FIELD.

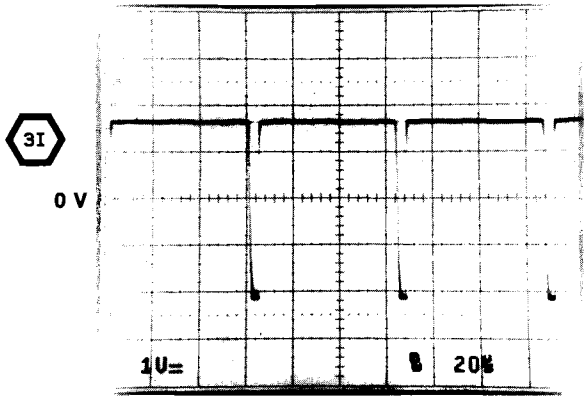


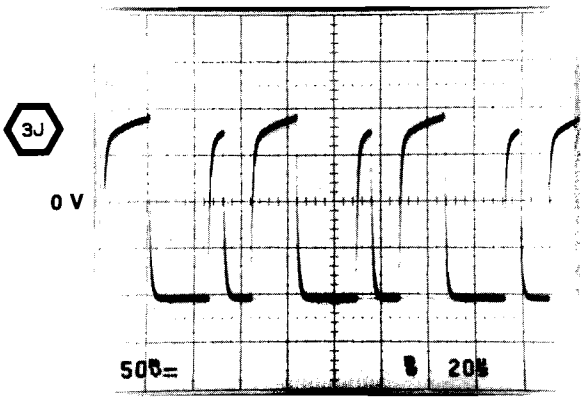
MORE

CONNECT 4-DIVISION COMPOSITE VIDEO SIGNAL.

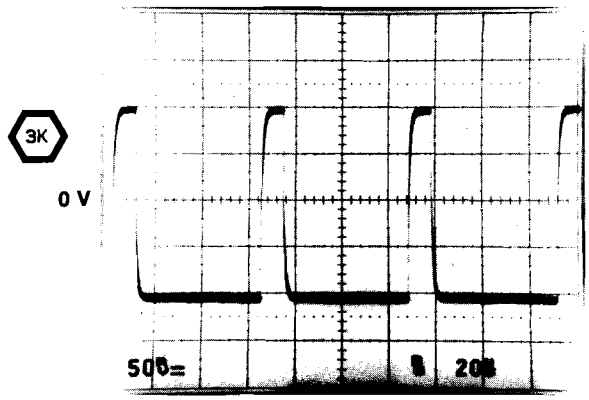


CONNECT 4-DIVISION COMPOSITE VIDEO SIGNAL. SET TRIGGER MODE TO TV FIELD.





CONNECT 4-DIVISION COMPOSITE VIDEO SIGNAL. SET TRIGGER MODE TO TV FIELD.



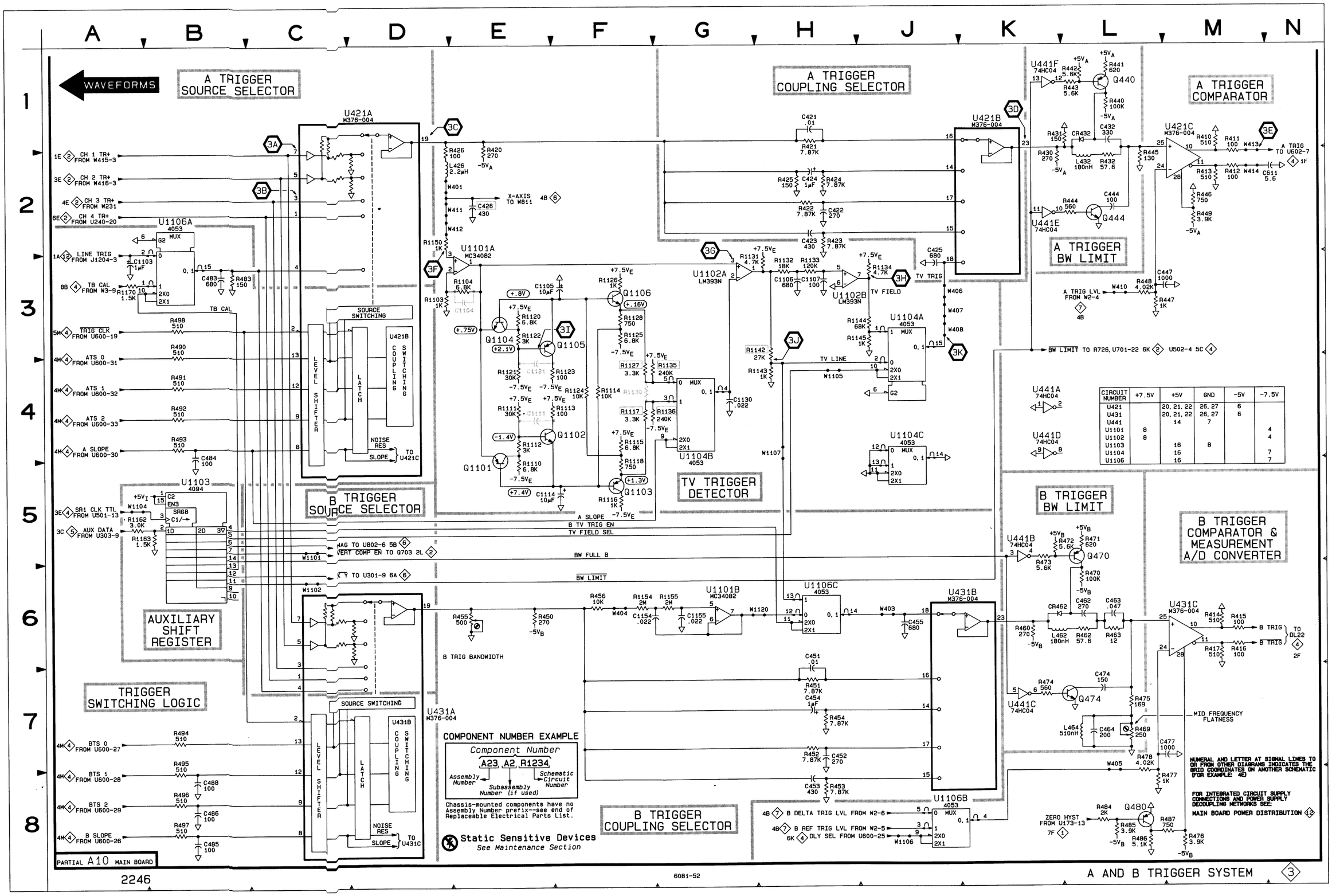
6081-27

A AND B TRIGGER SYSTEM DIAGRAM 3

ASSEMBLY A10

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C421	1H	4G	Q1102	4F	1N	R476	8M	1F	R1162	5A	1K
C422	2H	4H	Q1103	5F	1N	R477	8M	2H	R1163	5A	2K
C423	2H	4G	Q1104	3E	2M	R478	7L	2H	R1170	3A	1K
C424	2H	4G	Q1105	3F	2N	R483	3B	1G			
C425	2J	3G	Q1106	3F	2N	R484	8L	1F	U421A	1D	3G
C426	2E	2H				R485	8L	1F	U421B	1K	3G
C432	1L	3H	R410	1M	3F	R486	8L	1F	U421C	1M	3G
C444	2L	3G	R411	1M	4F	R487	8M	1F	U431A	7D	2G
C447	3M	3G	R412	2M	4F	R490	3B	3J	U431B	6K	2G
C451	6H	2G	R413	2M	4G	R491	4B	3J	U431C	6M	2G
C452	7H	2H	R414	6M	2F	R492	4B	3J	U441A	4K	2H
C453	8H	2G	R415	6M	2G	R493	4B	3J	U441B	5K	2H
C454	7H	2G	R416	6M	2G	R494	7B	3J	U441C	7K	2H
C455	6J	2G	R417	6M	2F	R495	7B	2J	U441D	4K	2H
C462	6L	1H	R420	2E	4G	R496	8B	2J	U441E	2K	2H
C463	6L	1H	R421	1H	4H	R497	8B	2J	U441F	1K	2H
C464	7L	1H	R422	2H	4H	R498	3B	3J	U1101A	2E	2M
C474	7L	1G	R423	2H	4G	R1103	3D	2M	U1101B	6G	2M
C477	7M	1G	R424	2H	4G	R1104	3E	2M	U1102A	3G	1L
C483	3B	1G	R425	2H	4H	R1110	5E	1N	U1102B	3H	1L
C484	4B	3F	R426	2E	4H	R1111	4E	1N	U1103	5B	2K
C485	8B	2G	R430	2K	3H	R1112	4E	1N	U1104A	3J	2L
C486	8B	2F	R431	1K	3H	R1113	4F	1N	U1104B	4G	2L
C488	8B	2F	R432	2L	3H	R1114	4F	1N	U1104C	4J	2L
C611	2N	3J	R440	1L	3H	R1115	4F	1N	U1106A	2B	2J
C1103	3A	4J	R441	1L	3H	R1116	5F	1N	U1106B	8J	2J
C1104	3E	2M	R442	1L	3H	R1117	4F	2N	U1106C	6H	2J
C1105	3E	2N	R443	1L	2H	R1118	5F	1N			
C1106	3H	2L	R444	2L	2H	R1120	3E	2N	W401	2E	2H
C1107	3H	2L	R445	2L	3H	R1121	4E	2M	W403	6J	1J
C1111	4E	1N	R446	2M	3G	R1122	3E	2N	W404	6F	1H
C1114	5E	1N	R447	3M	3H	R1123	4F	2M	W405	7L	1J
C1121	4E	2M	R448	3L	3H	R1124	4F	2N	W406	3J	2H
C1130	4G	2L	R449	2M	3G	R1125	3F	2N	W407	3J	2J
C1154	6F	1M	R450	6E	2G	R1126	3F	2N	W408	3J	1J
C1155	6G	2M	R451	7H	2H	R1127	4F	2N	W410	3L	3J
			R452	7H	2H	R1128	3F	2N	W411	2E	2J
CR432	1L	3H	R453	8H	2G	R1130	4F	2M	W412	2E	1J
CR462	6K	1H	R454	7H	2F	R1131	3G	1L	W413	1M	3J
			R455	6E	2H	R1132	3H	2L	W414	2M	3J
L426	2E	4H	R456	6F	2H	R1133	3H	2L	W1101	5C	2K
L432	2L	3H	R460	6K	2H	R1134	3J	1M	W1102	6C	2K
L462	6K	1H	R462	6L	1H	R1135	4G	1N	W1104	5A	1K
L464	7L	1G	R463	6L	1H	R1136	4G	2N	W1105	4H	1K
			R469	7L	1H	R1142	3H	1L	W1106	8J	2K
Q440	1L	3H	R470	6L	2H	R1143	4H	1L	W1107	4H	2K
Q444	2L	3G	R471	5L	1H	R1144	3J	1M	W1120	6H	2K
Q470	5L	1H	R472	5L	2H	R1145	3J	1M			
Q474	7L	1G	R473	6K	2H	R1150	2D	1M			
Q480	8L	1F	R474	7K	1H	R1154	6F	1M			
Q1101	5E	1M	R475	7L	1H	R1155	6G	1M			

Partial A10 also shown on diagrams 1, 2, 4, 5, 6, 7 and 12.



CIRCUIT NUMBER	+7.5V	+5V	GND	-5V	-7.5V
U421		20, 21, 22	26, 27	6	
U431		20, 21, 22	26, 27	6	
U441		14	7		
U1101	8				4
U1102	8				4
U1103		16	8		
U1104		16			7
U1106		16			7

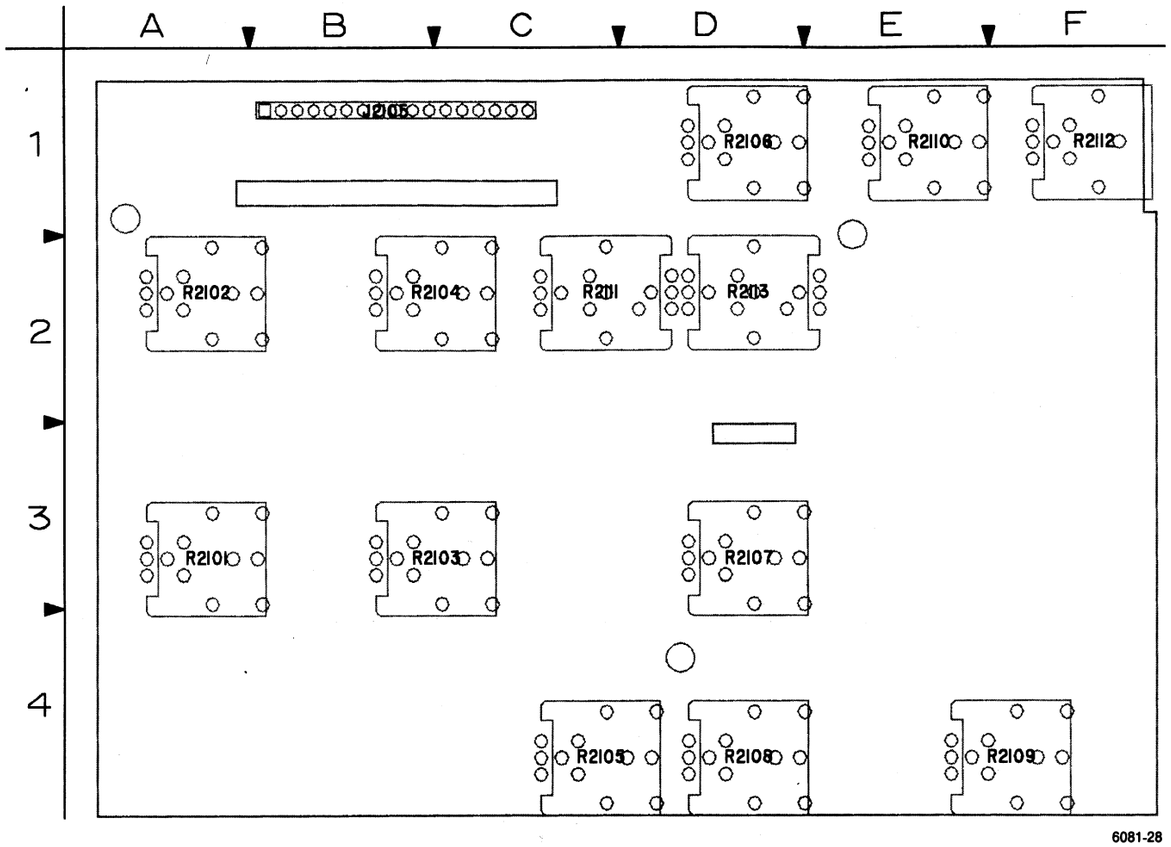
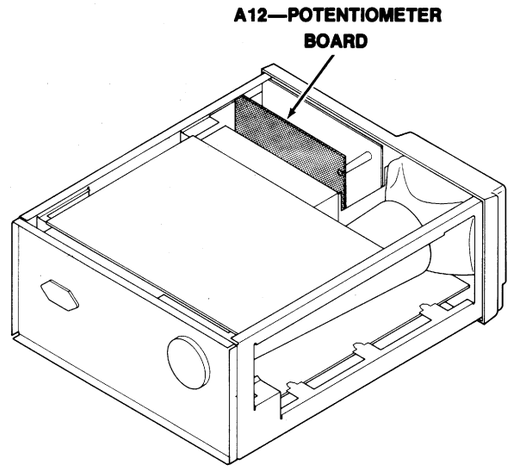


Figure 9-6. A12—Potentiometer board.

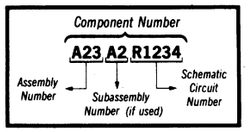
A12—POTENTIOMETER BOARD

CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER
J2105	2	R2102	2	R2109	2
J2105	4	R2103	2	R2110	4
J2105	5	R2104	2	R2111	7
J2105	7	R2105	2	R2112	7
J2105	12	R2106	7	R2113	7
		R2107	5		
R2101	2	R2108	2		



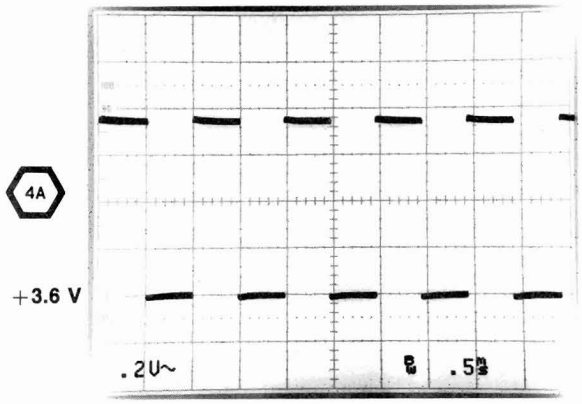
Static Sensitive Devices
See Maintenance Section

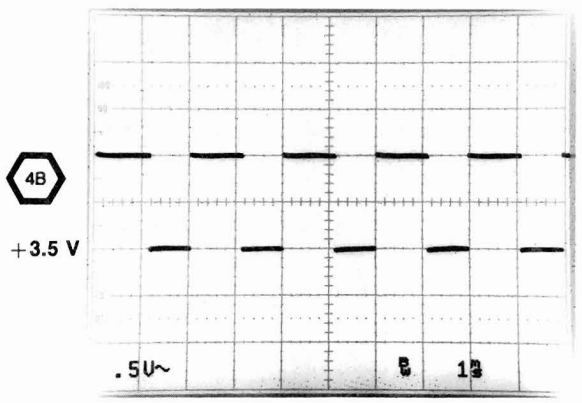
COMPONENT NUMBER EXAMPLE

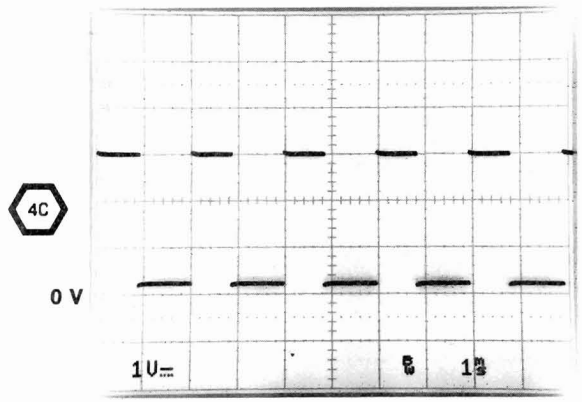


Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

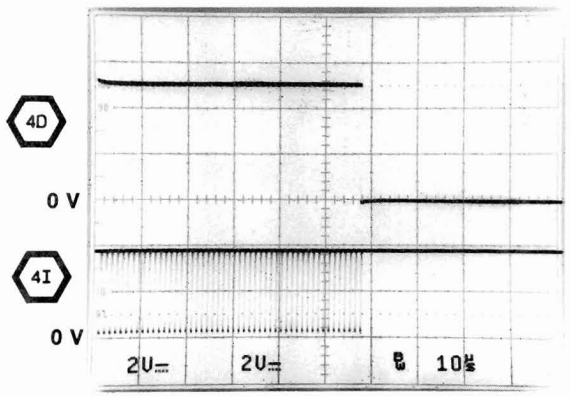
WAVEFORMS FOR DIAGRAM 4



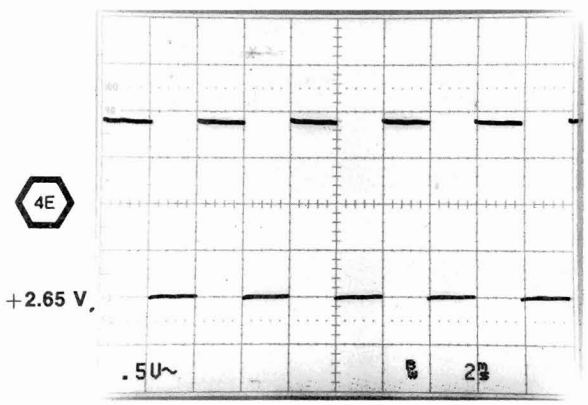


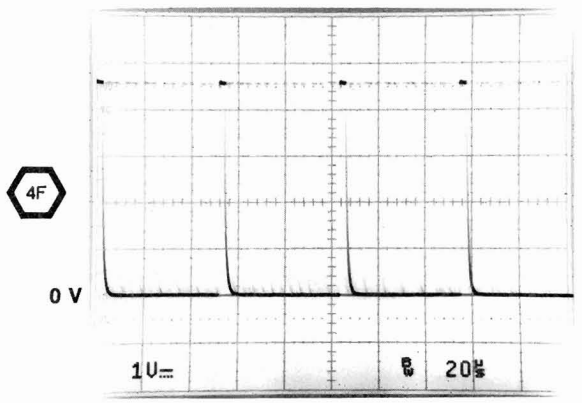


SET SEC/DIV TO 20 μs. WAVEFORM VARIES WITH SETTING OF TRIGGER HOLDOFF CONTROL.



SET A & B SEC/DIV TO 0.1 ms, READOUT CONTROL CCW (OFF), AND HORIZONTAL MODE TO ALT.





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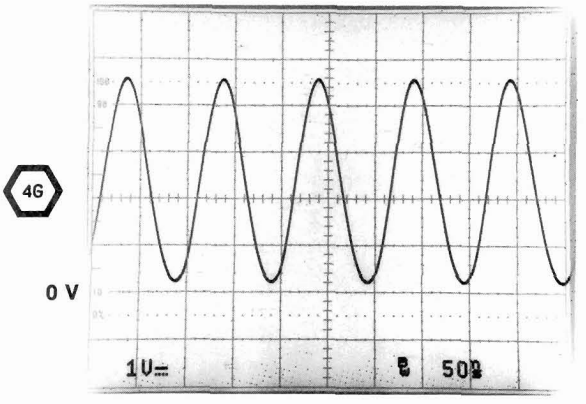
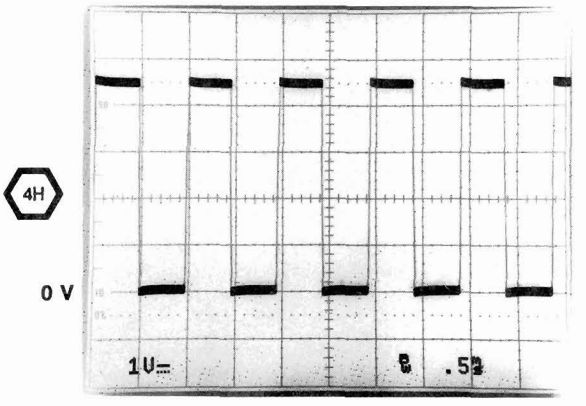
MORE

WAVEFORMS FOR DIAGRAM 4 (cont)





6081-42

DISPLAY AND TRIGGER LOGIC AND PROCESSOR INTERFACE DIAGRAM 4

ASSEMBLY A10

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C600	8J	5K	R615	5F	4K	R665	5H	3J
C601	8J	5K	R616	6F	4K	R666	5J	3J
C602	1H	3K	R617	6F	4K	R669	3H	3M
C603	1H	2K	R618	6F	4K	R670	4J	5M
C607	6J	4L	R619	6F	4L	R671	6K	4L
C608	6K	4L	R620	5F	4K	R672	6J	4K
C612	2G	2J	R621	5G	4L			
			R622	6G	5K	U501	3C	3N
CR603	5J	3J	R623	6G	5K	U502	4D	3N
			R624	4K	5N	U503	3D	5N
DL22	2F	2G	R625	4K	6M	U600	3L	4L
DL22	2F	2L	R626	1H	3L	U601	8K	5K
			R627	1H	2L	U602	1G	3K
P3	2M	1K	R628	4H	4N	U603A	2H	3M
P3	4A	1K	R630	6L	5M	U603B	3H	3M
P5	7H	10D	R631	4K	6N	U603C	1H	3M
			R636	8H	5K	U603D	2H	3M
Q600	8J	5J	R637	8H	4J	U604A	4K	5M
Q601	8J	5K	R638	8J	4J	U604B	7F	5M
Q602	3K	4M	R639	1H	3N	U604C	8F	5M
Q603	3K	4M	R640	2H	3N	U606A	5D	5M
Q604	2K	4M	R641	5H	4J	U606B	3D	5M
Q605	2K	4M	R642	5J	4K	U606C	4E	5M
Q606	2K	4M	R643	5H	3J	U606D	2L	5M
Q607	2K	4M	R644	5J	2K	U606E	2L	5M
Q608	6K	4L	R645	6H	2K	U606F	2D	5M
			R646	4K	5M			
R501	6B	3M	R647	5F	1K	W3	2M	1K
R502	4E	4N	R648	5F	2J	W5	8H	10D
R513	4B	1L	R649	5G	2J	W505	4E	5N
R516	5D	5L	R650	6K	4K	W507	5D	5J
R601	7J	4J	R651	2L	5M	W508	5C	1K
R602	8K	5L	R652	2L	6M	W510	4E	6M
R603	7K	5L	R653	3F	4N	W603	1H	3M
R604	7K	5L	R654	4G	5N	W604	4J	3L
R605	8L	5L	R655	4F	5N	W605	5G	3K
R606	8J	5K	R656	5H	4J	W606	5D	6M
R609	3K	4M	R657	4J	4K	W610	3L	4M
R610	3K	4M	R658	5H	4J	W611	3L	5M
R611	2K	4M	R659	5J	3K	W612	8H	5K
R612	2K	4M	R662	4K	4M			
R613	2K	4M	R663	6H	2K	Y600	6K	4L
R614	3K	4M	R664	6J	2K			

Partial A10 also shown on diagrams 1, 2, 3, 5, 6, 7 and 12.

ASSEMBLY A12

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
J2105	7H	1B	R2110	8G	1E			

Partial A12 also shown on diagrams 2, 5, 7 and 12.

CIRCUIT NUMBER	+5V	GND
U501	16	8
U502	16	8
U503	16	8
U600	40	20
U601	8	4
U602	10, 13, 16, 25, 28, 31	1, 21
U603	1, 16	8
U604	1, 16	8
U606	14	7

WAVEFORMS

PROCESSOR INTERFACE

TRIGGER LOGIC

LEVEL SHIFTERS

DISPLAY LOGIC

HOLDOFF OSCILLATOR

U602 FAST LOGIC IC

U600 SLOW LOGIC IC

U501 74LS138 BIN/OCT

U502 74LS194A

U503 74LS279

U603A MC10101

U603B MC10101

U603C MC10101

U603D MC10101

U604A 10116

U604B 10116

U604C 10116

U606A 7417

U606B 7417

U606C 7417

U606D 7417

U606E 7417

U601 311

Q600

Q601

Q602

Q603

Q604

Q605

Q606

Q607

Q608

Y600 10 MHZ

DL22

TO/FROM J2503

PARTIAL A10 MAIN BOARD

PARTIAL A12 POT BOARD

COMPONENT NUMBER EXAMPLE

Component Number: A23, A2, R1234 (Assembly Number; Subassembly Number (if used); Schematic Circuit Number)

Chassis-mounted components have no Assembly Number prefix--see end of Replaceable Electrical Parts List.

Static Sensitive Devices — See Maintenance Section

NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATES ON ANOTHER SCHEMATIC (FOR EXAMPLE: 4E)

FOR INTEGRATED CIRCUIT SUPPLY CONNECTIONS AND POWER SUPPLY DECOUPLING NETWORKS SEE: MAIN BOARD POWER DISTRIBUTION 12

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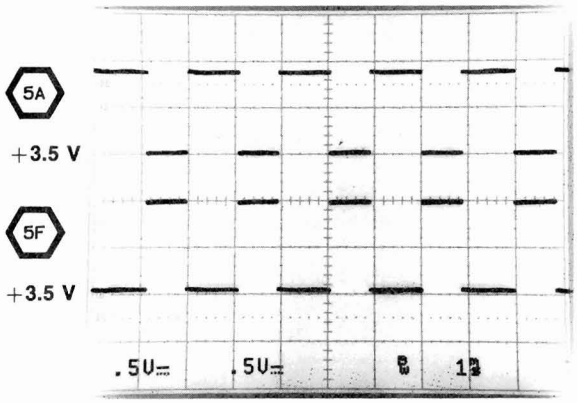
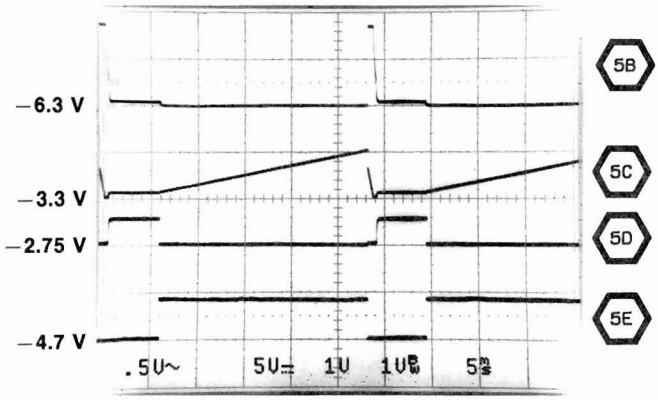
DISPLAY AND TRIGGER LOGIC AND PROCESSOR INTERFACE 4

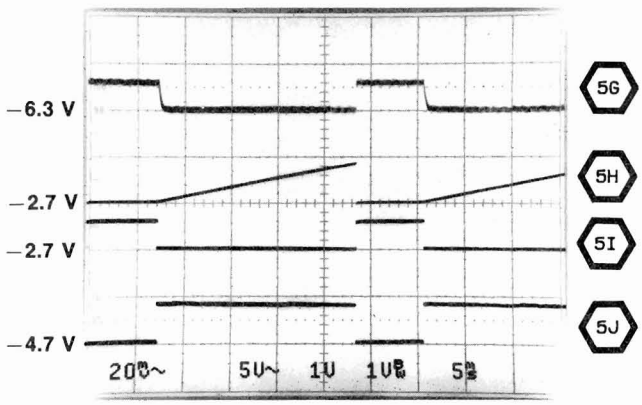
WAVEFORMS FOR DIAGRAM 5

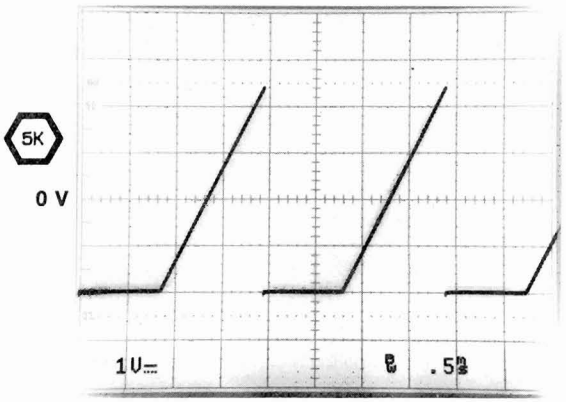


SET A SEC/DIV TO 2 ms.

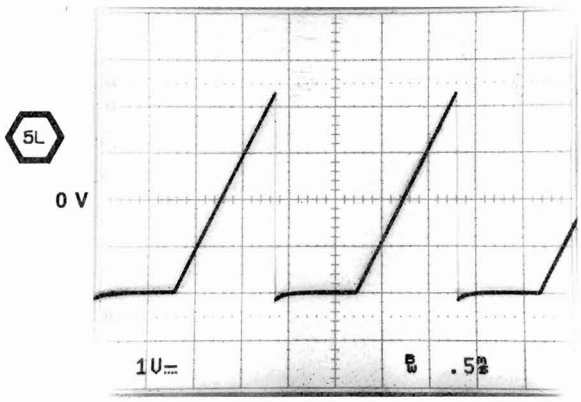


SET B SEC/DIV TO 2 ms, HORIZONTAL MODE TO B.





SET HORIZONTAL MODE TO B.



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A AND B SWEEPS AND DELAY COMPARATORS DIAGRAM 5

ASSEMBLY A10

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C301	4D	8F	R308	4A	7C	R364	8C	9G
C302	7D	9F	R309	3C	9C	R365	7H	10E
C303	3D	7C	R310	3C	7C	R366	1A	8C
C305	4B	9D	R311	3D	8C	R367	2A	8C
C306	4A	7C	R313A	4D	7C	R370	8C	9G
C307A	5J	7E	R313B	3D	7C	R371	8D	9G
C3078	5J	7E	R313C	3D	7C	R372	8D	9G
C307C	7J	10F	R313D	3D	7C	R373	8C	9G
C308	4H	7D	R314	3D	7C	R375	8K	10E
C310	4J	7E	R315	8K	10E	R376	7K	9E
C311	5C	7F	R316	5D	7F	R377	6L	8G
C312	3J	9E	R317	4B	8E	R378	5M	6J
C313	2J	9E	R318	4C	8E	R379	6L	7G
C314	5J	7F	R319	5B	8F	R380	6M	6J
C315	5J	7G	R320	5K	8E	R381	7D	9F
C321	7C	9F	R321A	6F	8D	R382	6L	7G
C322	2L	8E	R321B	6F	8D	R383	8B	9G
C326	7H	10E	R321C	6F	8D	R384	2K	8D
C329	7J	10F	R321D	3F	8D	R385	1M	8F
C330	7J	10G	R321E	3F	8D	R386	1M	9F
			R321F	3F	8D	R387	1M	8F
CR301	3C	7C	R322	5L	7H	R388	3M	8F
			R323	7L	7G	R391	2K	8D
P5	3B	10D	R325	4H	7D	R393	4H	10F
			R326	4J	7D	R394	6H	10E
Q301	3D	7C	R327	7C	9F	R395	5J	7E
Q302	4B	8E	R328	3M	8E	R396	7J	9E
Q303	4C	8E	R329	3J	9E			
Q304	4D	8F	R330	2J	9E	U301A	1K	8D
Q305	4J	7E	R331	3K	8E	U301C	2K	8D
Q306	4J	7D	R332	5C	7G	U302	1B	8C
Q307	3H	8D	R333	5D	7G	U303	2C	9C
Q308	5D	7F	R334	5B	8G	U304A	3H	8D
Q309	5C	7F	R335	3L	8F	U304B	6H	8D
Q310A	5J	7E	R336	3L	8F	U307	2F	7D
Q310B	5J	7E	R337	2M	8E	U308	2G	7D
Q311	5C	8F	R338	4L	8E	U309A	4A	7C
Q312	5K	7E	R340	6C	7G	U3098	3D	7C
Q313	8D	9F	R341	1L	9F	U310	5F	10D
Q315	6B	9E	R342	2L	9E	U311	5G	10D
Q316	7C	9E	R343	1L	9F	U313	3M	8E
Q317	7D	9F	R344	4K	8E	U315A	1M	8F
Q318	7J	10E	R346	6K	8D	U315B	4M	8F
Q320	6H	9D	R347	5K	8E	U315C	2M	8F
Q321	7D	9F	R348	5L	8H	U316A	6M	7H
Q322	7C	9F	R349	5L	7G	U316B	6L	7H
Q323A	7J	9E	R350A	6M	7H	U316C	6L	7H
Q323B	8J	9E	R350B	7M	7H	U316D	6M	7H
Q325	7K	9E	R350C	6L	7H			
Q326	5D	7F	R350E	5L	7H	VR301	6B	6F
Q328	4K	7E	R351	2M	8F	VR302	5B	6F
Q329	6K	9E	R352	6L	7G	VR303	8B	8G
Q330	4H	7E	R354	6B	9E	VR304	7B	8G
Q331	6H	9E	R355	6C	9E	VR308	7C	9F
Q332	7B	9F	R356	7B	9F	VR309	5C	6G
Q333	5B	8F	R357B	1M	8F	VR310	8C	9G
			R357C	1M	8F	VR311	6K	8E
R301	6C	9E	R357D	3M	8F	VR312	8K	10E
R302	4J	7E	R357E	3M	8F			
R303	4C	8F	R359	2M	8F	W5	3B	10D
R304	5C	8F	R360	3M	8F	W301	3J	10E
R305	5C	8G	R361	6D	8G	W302	2J	10E
R306	4B	7C	R362	4C	8F	W304	7K	8G
R307	4A	7C	R363	7C	9F			

Partial A10 also shown on diagrams 1, 2, 3, 4, 6, 7 and 12.

ASSEMBLY A12

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
J2105	3B	1B	R2107	3A	3D			

Partial A12 also shown on diagrams 2, 4, 7 and 12.

A AND B SWEEPS AND DELAY COMPARATORS

SWEEP CONTROL SHIFT REGISTERS

U302 4094 — SR DATA FROM W510 (4E) — R366 1K — SR68 C1/→ — AS0 AS1 AS2 AS3 AS4 AS5

U303 4094 — SR1 CLK FROM U606-4 (3E) — R367 1K — SR68 C1/→ — BS0 BS1 BS2 BS3 BS4

VOLT CAL 2 TO R922 } 36
VOLT CAL 1 TO R923
VOLT CAL 0 TO R924 } 26
AUX DATA TO R1162 5A (3)

WAVEFORMS

DELAY TIME SWITCHING

U301A 74HC4053 MUX — DELTA DELAY FROM W2-8 (4B) — W302 100 — R330 — C313 .022 — R391 20K — R384 10K

U301C 74HC4053 — REF DELAY FROM W2-7 (4B) — W301 100 — R329 — C312 .022

DLY SEL FROM U600-25 (6K)

DELAY TIME COMPARATORS

U315A 10H116 — R385 1.6K — R386 1.6K — R387 82 — R357C 1K — R357B 1K — DLY END 1 TO U602-35 (3F)

U315C 10H116 — R359 1.6K — R360 1.6K — R388 82 — R357E 1K — R357D 1K — DLY END 0 TO U602-36 (3F)

U315B 10H116 — VBB2 FROM U315-11 (1J)

R351 47 — -15V_A — C322 47 — R337 150

R342 1.3K — R335 1.6K — R336 1.6K — R343 1.6K — R341 1.6K — -7.5V_D

U313 CA3054 — R331 3.9K — R344 3.3K — R338 1.3K — R328 100

(+2.9V) TO (+3.1V)

Q328

A SWEEP TIMING

U307 4052 — U308 4052 — U309B MC1458 — U304A MC34082 — Q307 — Q330

R313B, C, D — R321D, E, F — 200K 20K 2K — +2.5V_REF — R309 10.0K — CR301 — R310 47K — R311 6.19K — R314 28.7K — C303 1µF — R313A 2.5K — Q301

TIME VAR TO U505-15 (7 2D)

VAR (A AND B SEC/DIV) — R2107 5K — J2105 — P5 — W5 — +2.5V_P — -2.5V_P

PARTIAL A12 POT BOARD

R393 470 — +2.5V_P

A SWEEP BUFFER

R325 1.3K — R326 1.3K — Q305 — Q306 — C308 .022 — C310 .022 — R302 2.7 — C307B .0099 — C307A 10µF

Q310A — Q310B — +15V_D — R347 2.0K — R395 1K — R346 100 — -15V_A — -2.0V

Q312 — R320 47 — VR311 12V

C315 51 — C314 3.2-32 — A 20nS TIMING

A RAMP TO W802 (6 3B)

A SWEEP START

U309A MC1458 — C305 1µF — R318 680 — R303 1K — A RAMP — Q302 — Q303 — -7.5V — R307 25.5K — R308 20.5K — C306 1µF — R306 5.1 — R317 100 — +2.5V_REF

R362 3.6K — C301 .022 — +.65V — -2.4V — Q304 — R316 27 — -1.5V — Q311 — Q309 — Q308 — Q326 — Q333 — R319 5.6K — C311 51 — R304 47 — -4.4V — -5.7V — R305 510 — VR309 6.2V — R333 12 — R361 20 — -7.5V

VR302 8.2V — A GATE FROM U603-11 (1M) — R332 82 — R334 160 — R340 82

VR301 8.2V — Ā GATE FROM U603-14 (1M)

BASELINE STABILIZER

B SWEEP TIMING

U311 4052 — U310 4052 — U304B MC34082 — Q320 — Q331

R321A, B, C — 200K 20K 2K

R394 470 — +2.5V_P

B SWEEP START

Q315 — Q316 — Q332 — Q317 — Q322 — Q321 — Q313 — Q318 — Q329

R355 680 — R301 1K — B RAMP — R354 100 — -7.5V — R363 3.6K — C302 1000 — +1.8V — -2.0V — R327 47 — R356 5.6K — C321 51 — VR308 7.5V — R381 27 — -2.7V — -3.9V — R364 510 — VR310 6.2V — R371 12 — R372 20 — R373 82 — R383 160 — VR303 8.2V — VR304 8.2V — B GATE FROM U603-9 (1M) — B GATE FROM U603-15 (2M)

R365 1.3K — C326 .022 — C307C 0.1 — C330 62 — C329 3.2-32 — B 20nS TIMING

B SWEEP BUFFER

Q323A — Q323B — +15V_E — R376 3.3K — R396 1K — R375 100 — -15V_A — -2.7V

Q325 — R315 47 — VR312 12V

W304 — B RAMP TO U802-5 (6 4B)

SWEEP END COMPARATORS

U316C 10115 — U316D 10115 — U316B 10115 — U316A 10115 — +3.5V — +3.9V — +5V_G — +2.5V_REF — VBB1 FROM U316-9 (2J)

R322 5.1K — R348 1K — R349 1K — R350E 1K — R352 1K — R382 1K — R379 1K — R377 1K — R350C 1K — R323 5.1K — R378 82 — R350A 1K — A SWP END TO U602-8 (2F) — R380 82 — R350B 1K — B SWP END TO U602-37 (2F)

CIRCUIT NUMBER	+15V	+5V	GND	-5V
U301		16	8	7
U302	16		8	
U303	16		8	
U304	8			4
U307	16		7, 8	
U308	16		7, 8	
U309	8			4
U310	16		7, 8	
U311	16		7, 8	
U315		1, 16	8	
U316		1, 16	8	

COMPONENT NUMBER EXAMPLE

Component Number: A23, A2, R1234 (Assembly Number; Subassembly Number (if used); Schematic Circuit Number)

Chassis-mounted components have no Assembly Number prefix--see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATES ON ANOTHER SCHEMATIC (FOR EXAMPLE: 4E)

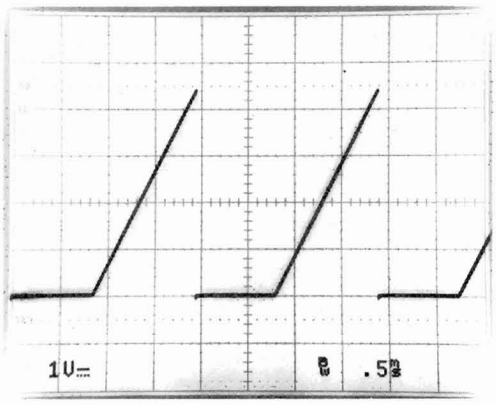
FOR INTEGRATED CIRCUIT SUPPLY CONNECTIONS AND POWER SUPPLY DECOUPLING NETWORKS SEE: MAIN BOARD POWER DISTRIBUTION (12)

PARTIAL A10 MAIN BOARD

WAVEFORMS FOR DIAGRAM 6

6A

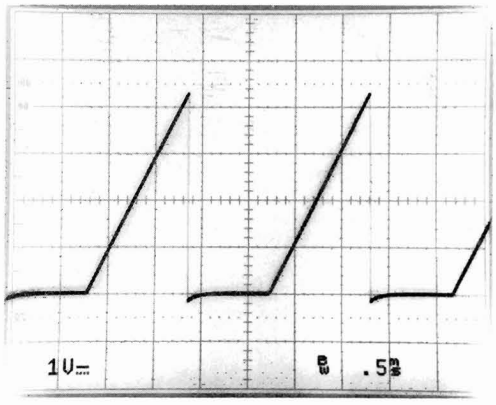
0 V



SET HORIZONTAL MODE TO B

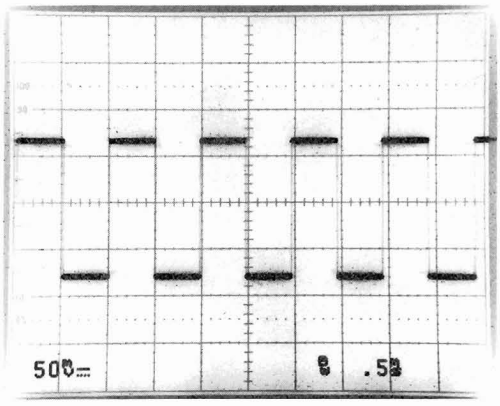
6B

0 V



6C

0 V



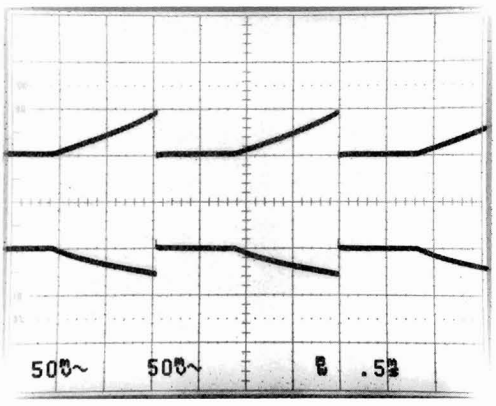
POSITION START OF TRACE AT LEFT GRATICULE LINE. SET READOUT CONTROL CCW (OFF).

6D

+9 V

+9 V

6E



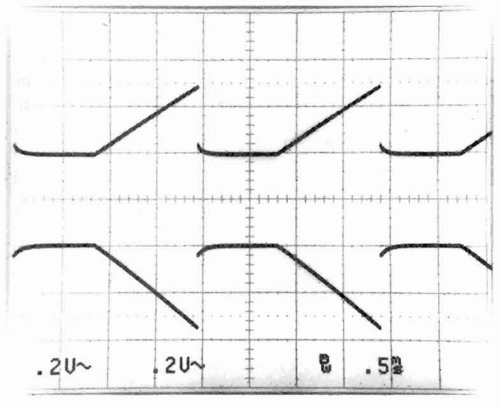
POSITION START OF TRACE AT LEFT GRATICULE LINE. SET READOUT CONTROL CCW (OFF).

6F

+18.5 V

+17.6 V

6G



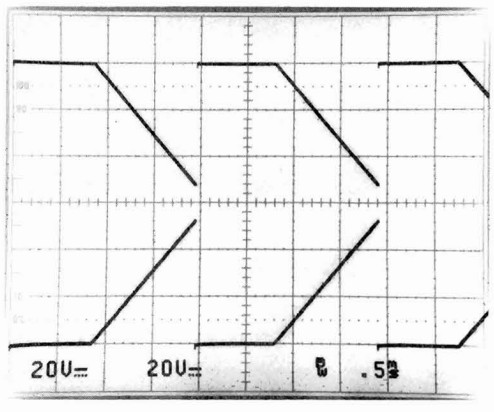
POSITION START OF TRACE AT LEFT GRATICULE LINE. SET READOUT CONTROL CCW (OFF).

+96 V

6H

6I

+46 V



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HORIZONTAL OUTPUT AMPLIFIER DIAGRAM 6

ASSEMBLY A10

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C319	6B	6F	R802	3L	7K	R847	5G	8J
C802	3K	7K	R803	2J	7J	R848	5H	8K
C803	3J	7J	R804	2J	7J	R849	5H	8K
C804	3G	8J	R805	4H	7J	R850	5G	8J
C805	4K	8J	R806	2H	7J	R851	5H	8J
C807	2H	7J	R808	4D	7H	R852	5K	8K
C809	5K	8K	R809	4D	8H	R853	6J	8J
C810	5J	8J	R810	5E	8H	R854	5E	8H
C814	7H	8J	R811	7D	7H	R855	4E	7H
C817	6C	6G	R812	7D	8H	R856	4E	8H
C819	7L	7J	R813	6K	8K	R857	4E	8H
			R814	6J	8J	R858	3K	7J
CR801	4B	9G	R815	6J	8J			
			R816	7H	8J	U301B	6B	8D
P17	3M	7K	R819	5L	8K	U801A	7H	7H
P18	5M	8K	R820	7L	8K	U802	3C	8H
			R821	7L	7K			
Q801	2K	7J	R822	7L	7K	VR801	4K	8J
Q802	3K	7J	R823	4C	8G	VR802	3G	8J
Q803	3H	7J	R825	7C	8H			
Q804	3G	7J	R826	7C	7G	W17	3M	7K
Q805	5K	8J	R827	4C	8H	W18	5M	8K
Q806	6K	8J	R828	3K	7K	W305	6B	10D
Q807	5H	8J	R829	6K	8K	W802	3C	8G
Q808	5H	8J	R836	4C	8H	W804	5B	9G
Q809	5E	8H	R840	2K	7J	W805	5B	6L
Q810	3E	7H	R841	4F	7J	W806	5C	6K
			R842	3F	7J	W807	5B	6M
R353	6B	9D	R843	2G	7K	W808	5C	6K
R358	6B	8D	R844	2G	7K	W810	4B	5G
R369	6B	8D	R845	3H	7J	W811	4B	5H
R801	2K	7K	R846	4K	7J			

Partial A10 also shown on diagrams 1, 2, 3, 4, 5, 7 and 12.

WAVEFORMS

HORIZONTAL PREAMPLIFIER

DRIVER AMPLIFIERS

HORIZONTAL OUTPUT AMPLIFIERS

U802 234-0401-20 HORIZONTAL PREAMP

A RAMP FROM Q312, R347 — W802 — 3 A
B RAMP FROM W304 — 5 B
X-AXIS FROM R1150, W412 — W811 W810 — R827 250 X GAIN — R836 374 — 7 X
-5V$_H$ — CR801
RO HORIZ FROM W2-13 — W804 — R823 500 READOUT GAIN — 1 RO
HD0 FROM U600-24 — W805 W806 — 8 HD0 (LSB)
HD1 FROM U600-23 — W807 W808 — 11 HD1 (MSB)
MAG FROM U1103-6 — 6 MAG
BEAM FIND FROM U503-7 — 14 BF
DIG HORIZ POS FROM W2-3 — W305 — R369 330 — 9 2X0 2X1
X Y FROM U1103-12
C319 .022
U301B 74HC4053 MUX 0, 1
R358 560 R353 1.5K C817 100µF — 15 POSITION
+7.5V — HORIZ 1X GAIN R826 5K — 2 GA1
+7.5V — HORIZ 10X GAIN R825 5K — 10 GA10

LOUT 13 — +8.8V — Q810 — +7.7V — Q804 — +18.4V — Q803 — +17.8V
ROUT 12 — +8.8V — Q809 — +18.1V — Q808 — +17.4V — Q807 — +17.8V — Q805 — +78.2V — Q806

R806 16.5K — 2nS TIMING — C807 0.25-1.5pF
+55V — R843 750 — R844 750 — VR802 24V — C804 .022
+55V — R842 10K — R841 10
R845 10
R805 1.8K
R808 2.4K — R810 2.4K
MAG REG — R809 5K — +15V$_G$
+15V$_G$ — R857 5.49K — R856 9.76K — +9.5V
R855 200 — R854 200
+55V — R848 2.2K — R849 2.2K
R847 10
R850 4.3K
R851 10
C814 0.25-1.5pF — 2nS TIMING — R816 16.5K
R811 5.76K — R812 5.76K
U801A MC1458
R820 150K — R821 150K — C819 100 — R822 5.62K — -5V$_F$

+130V — R801 430 — Q801
+130V — R803 5.6K — R804 100K — +124V — R840 47
R828 20K
C803 .015
C802 0.1
R858 301
R802 75 — 6H — W17 — P17 -HORIZONTAL OUTPUT TO V1 — 3M
R846 39
VR801 15V — C805 .022
R852 56
C809 0.1
C810 0.015
R819 75 — 6I — W18 — P18 +HORIZONTAL OUTPUT TO V1 — 4M
R829 20K
R815 100K — R814 5.6K — +130V — +124V — R853 47 — R813 430 — +130V

CIRCUIT NUMBER	+7.5V	+5V	GND	-5V
U301		16	8	7
U802	16		4	9

COMMON MODE STABILIZER

PARTIAL A10 MAIN BOARD

COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234
A23: Assembly Number
A2: Subassembly Number (if used)
R1234: Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix--see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATES ON ANOTHER SCHEMATIC (FOR EXAMPLE: 4E)

FOR INTEGRATED CIRCUIT SUPPLY CONNECTIONS AND POWER SUPPLY DECOUPLING NETWORKS SEE: MAIN BOARD POWER DISTRIBUTION 12

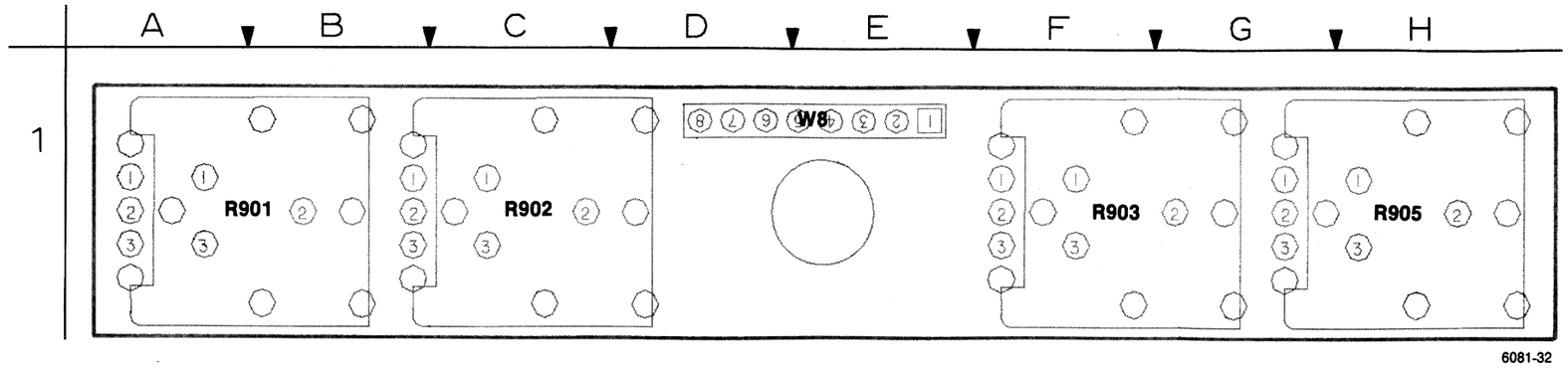
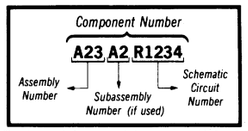


Figure 9-7. A8—CRT Control board.

Static Sensitive Devices
See Maintenance Section

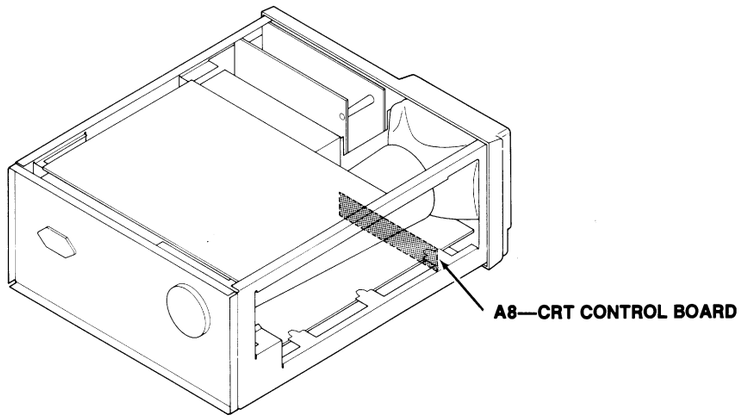
COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

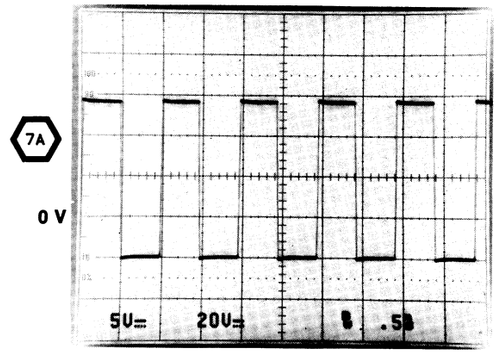
A8—CRT CONTROL BOARD

CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER
R901	7	R905	7	W8	12
R902	7				
R903	7	W8	7		

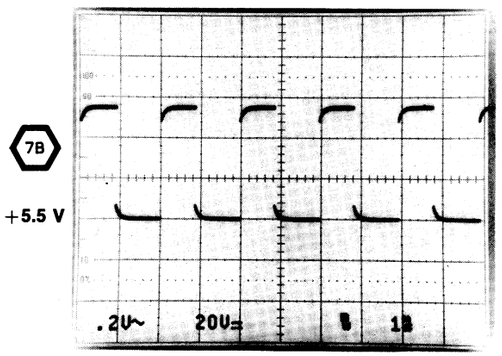


WAVEFORMS FOR DIAGRAM 7

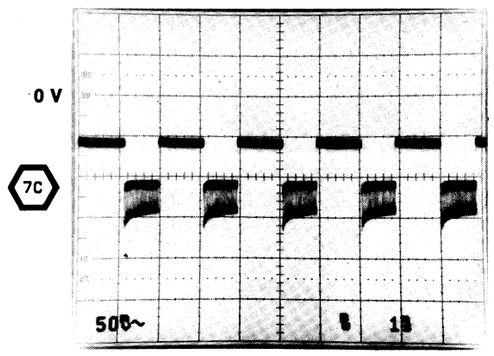
SET READOUT CONTROL CCW (0FF) AND A INTEN CONTROL CW (FULLY ON).



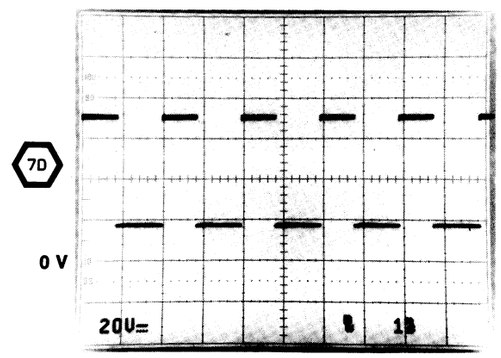
SET READOUT CONTROL CCW (0FF) AND A INTEN CONTROL CW (FULLY ON).



SET READOUT CONTROL CCW (0FF) AND A INTEN CONTROL CW (FULLY ON).

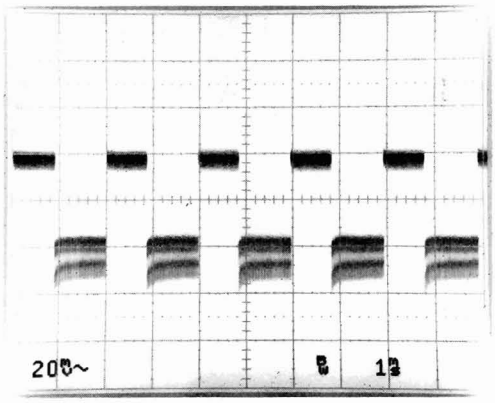


SET READOUT CONTROL CCW (0FF) AND A INTEN CONTROL CW (FULLY ON).



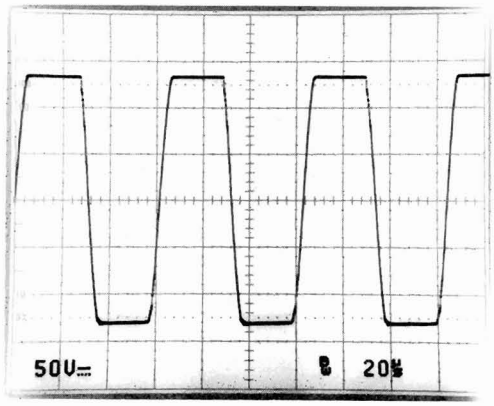
+0.62 V

7E



0 V

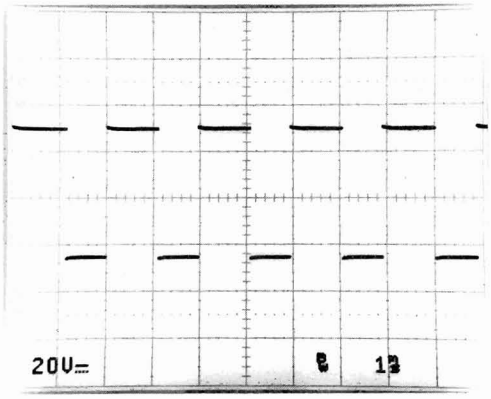
7F



SET READOUT CONTROL CCW (0FF) AND A INTEN CONTROL CW (FULLY ON).

7G

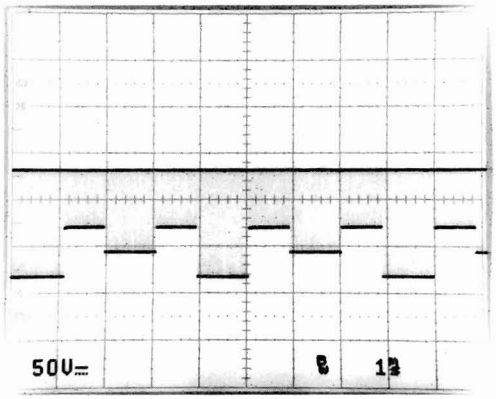
0 V



SET READOUT CONTROL CCW (0FF), A INTEN CCW (0FF), B INTEN CW (FULLY ON), AND HORIZONTAL MODE TO ALT.

7H

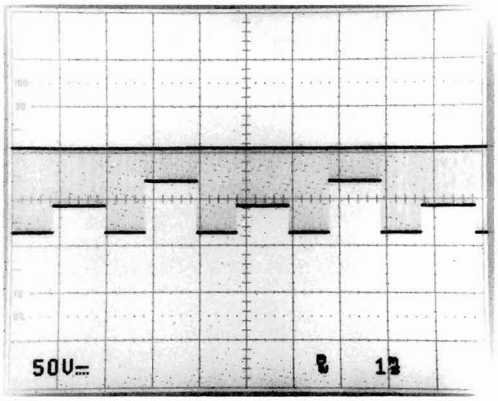
0 V



SET READOUT CONTROL CCW (0FF), A INTEN CCW (0FF), B INTEN CW (FULLY ON), AND HORIZONTAL MODE TO ALT.

7I

0 V



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Z-AXIS, CRT, CALIBRATOR and CONTROL MUX DIAGRAM 7

ASSEMBLY A8

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
R901	5A	1A	R903	6A	1F	W8	4A	1E			
R902	6A	1C	R905	4A	1H						

Partial A8 also shown on diagram 12.

ASSEMBLY A10

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C910	2L	10B	DS2704	6K	9M	R924	2G	9C	R2733	6F	9K
C935	2H	7B				R930	1H	8B	R2734	6F	10L
C1001	5C	7L	J15	2K	6A	R931	1H	7A	R2735	5F	9L
C1002	6B	7M	J927	2L	10B	R932	1H	7A	R2736	5G	10L
C1003	6B	8M				R933	1H	7B	R2737	5G	10K
C1004	7B	7L	P2	3A	10D	R934	2G	7B	R2738	5G	10L
C2703	7G	6M	P5	1B	10D	R935	2H	7B	R2739	4H	10L
C2704	6G	7M	P8	8A	10M	R936	1J	7A	R2740	5J	10L
C2705	7G	7N	P9	3M	8N	R937	2J	7A	R2741	5J	8M
C2706	7H	6N	P9	4M	10N	R938	1G	7B	R2742	6H	8K
C2707	7H	7M				R939	2G	7B	R2743	6H	8L
C2708	6H	7N	Q501	1E	9C	R940	2J	7A	R2745	7J	7N
C2710	7J	7N	Q905	4E	10A	R1001	5C	3K	R2750	6J	8M
C2711	7K	8M	Q907	4E	10A	R1002	6C	3K	R2751	6K	9M
C2712	7K	8N	Q908	4F	10A	R1003	6C	3L	R2758	6L	9L
C2713	8K	6L	Q1001	5D	3K	R1004	7C	3K	R2760	6L	10M
C2715	6G	10L	Q1002	6D	3K	R1005	5C	7L	R2765	7F	7M
C2716	5G	10L	Q1003	6D	3L	R1006	6C	7L	R2784	3L	7N
C2717	5H	10L	Q1004	7D	3K	R1007	7C	8L	R2785	3L	8N
C2719	5J	10M	Q1005	8C	7L	R1008	7D	7L	R2786	4L	6N
C2720	6J	8L	Q2701	7H	7N	R1009	8B	7K	R2787	5L	6N
C2721	6H	6K	Q2702	7H	7M	R1010	8B	7K	R2788	5L	6N
C2723	7E	7L	Q2703	7H	6M	R1020	5B	7L	R2789	5L	8N
C2724	8K	8M	Q2704	8H	6N	R1021	5B	7L	R2795	7E	7L
C2758	6K	10L	Q2705	7G	6M	R1022	6B	7L	R2796	6E	6M
C2759	7F	7M	Q2706	8F	7M	R1023	6B	7L			
C2783	3L	8N	Q2707	7F	6M	R1024	7B	7L	U505	1F	10C
C2784	5L	6N	Q2708	5E	6L	R1025	7B	7L	U506	2F	10C
C2785	5L	8N	Q2709	5E	6L	R1028	5D	4K	U930A	1H	8B
			Q2711	5F	10L	R2701	7E	6L	U930B	2H	8B
CR935	2H	7A	Q2712	5H	10L	R2702	7E	6L	U931	3H	9B
CR936	2J	7A	Q2713	5H	10L	R2703	6E	7L	U1001B	6B	7L
CR1001	5C	4K	Q2715	7E	6M	R2704	6E	7L	U1001C	6B	7L
CR1002	7D	4K				R2705	7E	7L	U1001D	5B	7L
CR1003	8C	8L	R503	3F	10C	R2706	7F	7M	U1101A	7B	2M
CR1004	7C	7L	R505	1B	10B	R2708	6G	7M			
CR1005	5C	5M	R506	2B	10B	R2709	6G	7M	VR2701	7F	6M
CR2701	7K	9M	R507	2B	10B	R2710	8F	6M			
CR2702	8K	9M	R508	1B	10B	R2711	7G	7N	W2	4B	10D
CR2703	7K	8N	R509	1B	10C	R2712	7G	7M	W5	3B	10D
CR2704	7J	6N	R510	1B	10C	R2713	7G	7M	W9	3M	8N
CR2705	8G	6M	R511	2B	10C	R2714	7G	7M	W9	8B	10M
CR2707	7E	7L	R512	2B	10C	R2715	7G	7M	W9	8M	10M
CR2713	6H	10L	R514	3B	10C	R2716	6G	7M	W16	8B	7K
CR2714	5H	10L	R515	1E	9B	R2717	6H	7M	W502	3E	10D
CR2715	5J	9L	R517	1D	9C	R2718	7H	7M	W906	1H	7A
CR2716	5K	8M	R906	4E	10B	R2719	7J	7N	W1000	5C	3L
CR2717	6K	9M	R907	4E	10A	R2720	7J	8N	W1010	7D	4K
CR2718	5H	8L	R908	4F	10A	R2721	7K	9N	W1286	8J	6K
			R909	5D	8B	R2722	7J	6N	W1288	8H	6J
DS901	4E	8A	R910	2L	10B	R2723	7K	9M	W2701	7D	5K
DS902	4E	9A	R911	2K	8A	R2724	7K	9M			
DS903	4F	10A	R920	3G	8B	R2726	5E	6L			
DS2701	8L	9N	R921	3G	8B	R2727	5E	7L			
DS2702	7L	9M	R922	3G	9C	R2728	5E	6L			
DS2703	5K	9M	R923	3G	9C	R2729	6E	7L			

Partial A10 also shown on diagrams 1, 2, 3, 4, 5, 6 and 12.

Z-AXIS, CRT, CALIBRATOR and CONTROL MUX DIAGRAM 7 (cont)

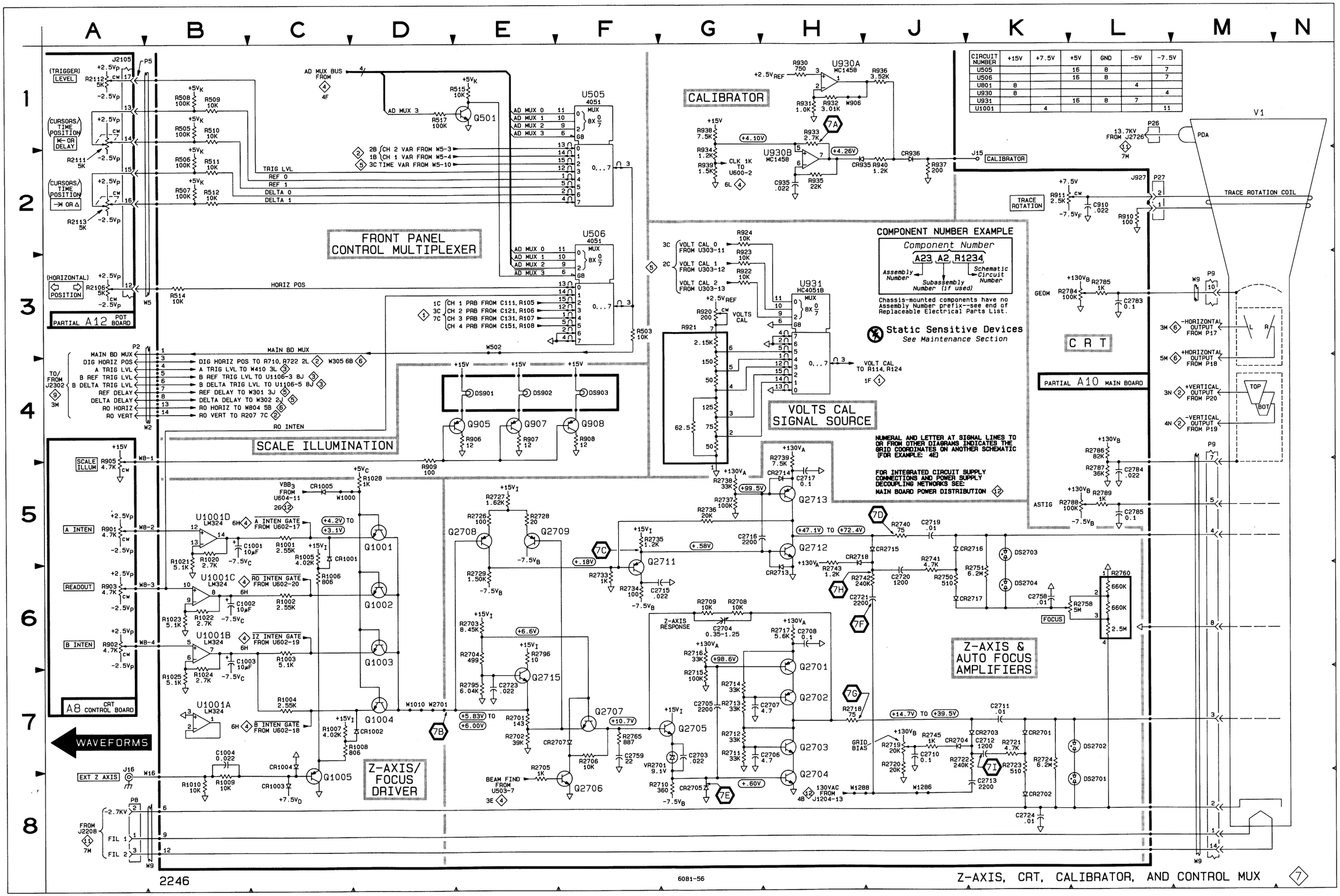
ASSEMBLY A12

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
J2105	1A	1B	R2106 R2111	3A 2A	1D 2C	R2112 R2113	1A 2A	1F 2D			

Partial A12 also shown on diagrams 2, 4, 5 and 12.

OTHER PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
J16	7A	CHASSIS	P26	1L	CHASSIS	P27	2L	CHASSIS	V1	1M	CHASSIS



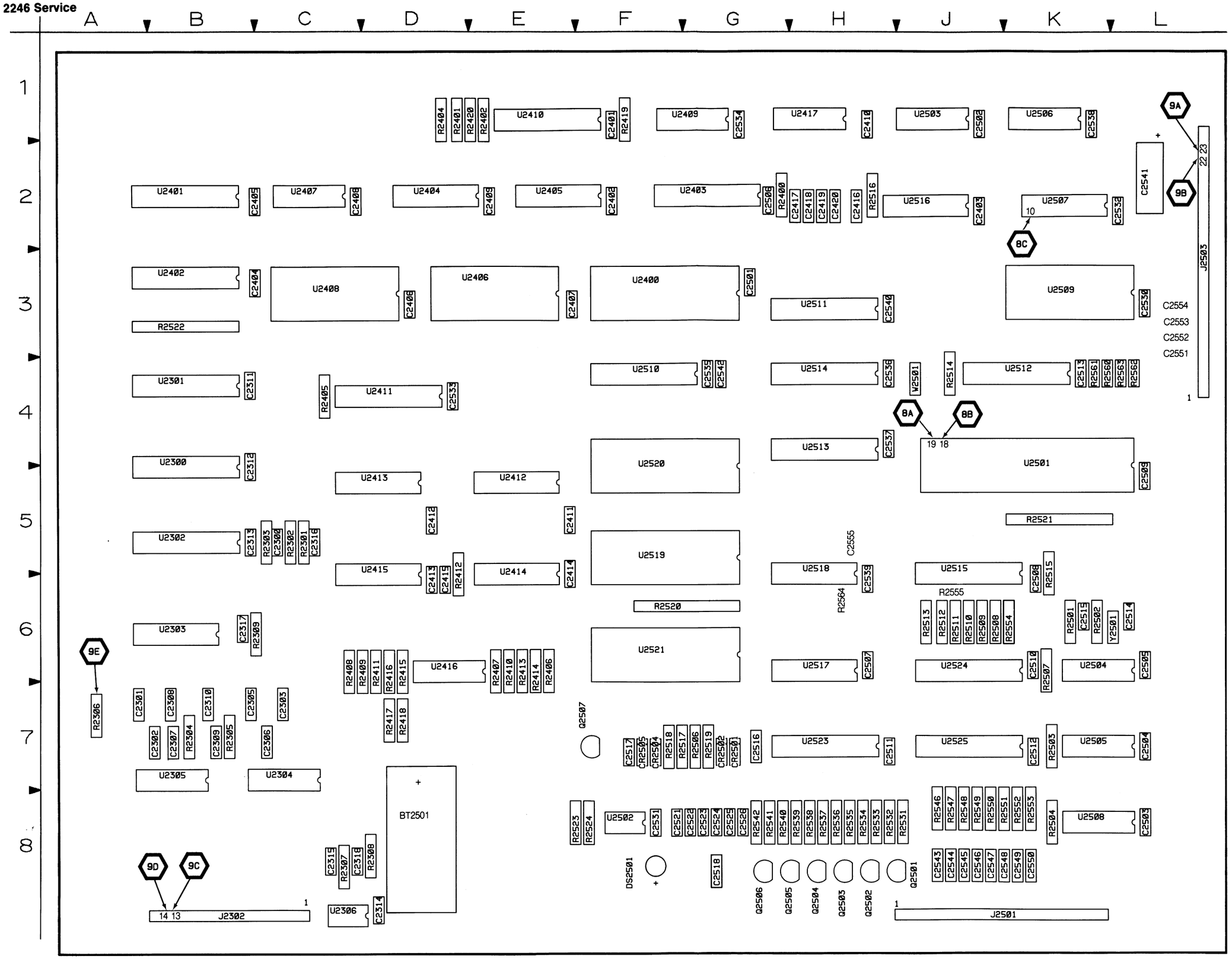


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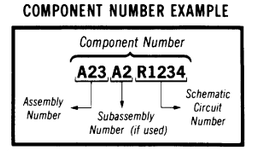
Figure 9-8. A16—Processor board.

Static Sensitive Devices
See Maintenance Section

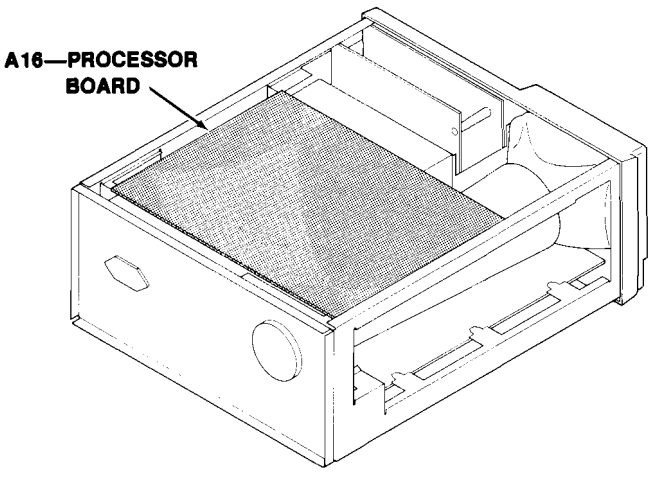
COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

A16—PROCESSOR BOARD

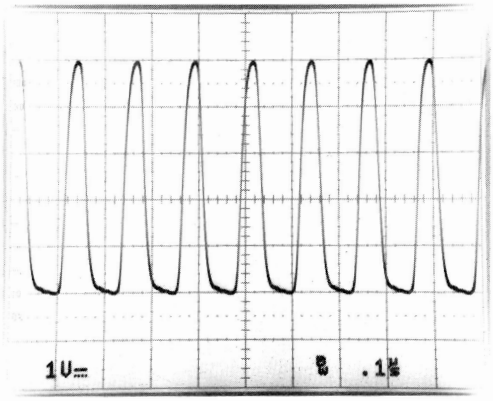
CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER
BT2501	8	C2511	13	J2501	10	R2509	8	U2303	9	U2504	8
		C2512	13	J2501	13	R2510	8	U2303	13	U2504	13
C2300	9	C2513	13	J2503	8	R2511	8	U2304	9	U2505	8
C2301	9	C2514	8	J2503	9	R2512	8	U2304	13	U2505	13
C2302	9	C2515	8	J2503	13	R2513	8	U2305	9	U2506	8
C2303	9	C2516	8			R2514	8	U2305	13	U2506	13
C2305	9	C2517	8	Q2501	10	R2515	8	U2306	9	U2507	8
C2306	9	C2518	8	Q2502	10	R2516	8	U2306	13	U2507	13
C2307	9	C2521	10	Q2503	10	R2517	8	U2400	9	U2508	8
C2308	9	C2522	10	Q2504	10	R2518	8	U2400	13	U2508	13
C2309	9	C2523	10	Q2505	10	R2519	8	U2401	9	U2509	8
C2310	9	C2524	10	Q2506	10	R2520	8	U2401	13	U2509	13
C2311	13	C2525	10	Q2507	8	R2521	8	U2402	9	U2510	8
C2312	13	C2526	10			R2522	8	U2402	13	U2510	13
C2313	13	C2530	13	R2301	9	R2523	8	U2403	9	U2511	8
C2314	13	C2531	13	R2302	9	R2524	8	U2403	13	U2511	13
C2315	13	C2532	13	R2303	9	R2531	10	U2404	9	U2512	8
C2316	13	C2533	13	R2304	9	R2532	10	U2404	13	U2512	13
C2317	13	C2534	13	R2305	9	R2533	10	U2405	9	U2513	8
C2318	9	C2535	13	R2306	9	R2534	10	U2405	13	U2513	13
C2401	13	C2536	13	R2307	9	R2535	10	U2406	9	U2514	8
C2402	13	C2537	13	R2308	9	R2536	10	U2406	13	U2514	13
C2403	13	C2538	13	R2309	13	R2537	10	U2407	9	U2515	8
C2404	13	C2539	13	R2400	9	R2538	10	U2407	13	U2515	13
C2405	13	C2540	13	R2401	9	R2539	10	U2408	9	U2516	8
C2406	13	C2541	13	R2402	9	R2540	10	U2408	13	U2516	13
C2407	13	C2542	13	R2404	9	R2541	10	U2409	9	U2517	8
C2408	13	C2543	10	R2405	9	R2542	10	U2409	13	U2517	13
C2409	13	C2544	10	R2406	9	R2546	10	U2410	9	U2518	8
C2410	13	C2545	10	R2407	9	R2547	10	U2410	13	U2518	13
C2411	9	C2546	10	R2408	9	R2548	10	U2411	9	U2519	8
C2412	9	C2547	10	R2409	9	R2549	10	U2411	13	U2519	13
C2413	13	C2548	10	R2410	9	R2550	10	U2412	9	U2520	8
C2414	13	C2549	10	R2411	9	R2551	10	U2412	13	U2520	13
C2415	13	C2550	10	R2412	13	R2552	10	U2413	9	U2521	8
C2416	9	C2551	8	R2413	9	R2553	10	U2413	13	U2523	10
C2417	9	C2552	8	R2414	9	R2554	8	U2414	9	U2523	13
C2418	9	C2553	8	R2415	9	R2555	8	U2414	13	U2524	10
C2419	9	C2554	8	R2416	9	R2560	8	U2415	9	U2524	13
C2420	9	C2555	8	R2417	9	R2561	8	U2415	13	U2525	10
C2501	13			R2418	9	R2562	8	U2416	9	U2525	13
C2502	13	CR2501	8	R2419	9	R2563	8	U2416	13		
C2503	13	CR2502	8	R2420	9	R2564	8	U2417	9	W2501	8
C2504	13	CR2504	8	R2501	8			U2417	13		
C2505	13	CR2505	8	R2502	8	U2300	9	U2501	8	Y2501	8
C2506	13			R2503	8	U2300	13	U2501	13		
C2507	13	DS2501	8	R2504	8	U2301	9	U2502	8		
C2508	13			R2506	8	U2301	13	U2502	13		
C2509	13	J2302	9	R2507	8	U2302	9	U2503	8		
C2510	13	J2302	13	R2508	8	U2302	13	U2503	13		



A16—PROCESSOR BOARD

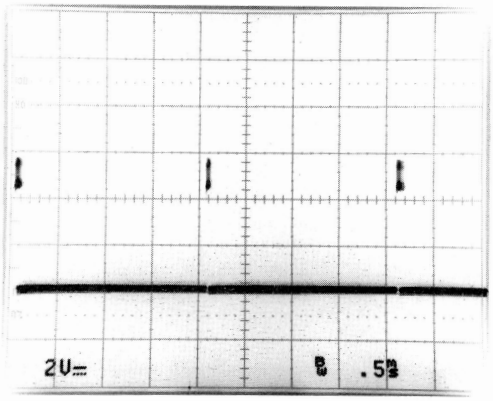
WAVEFORMS FOR DIAGRAM 8

8A



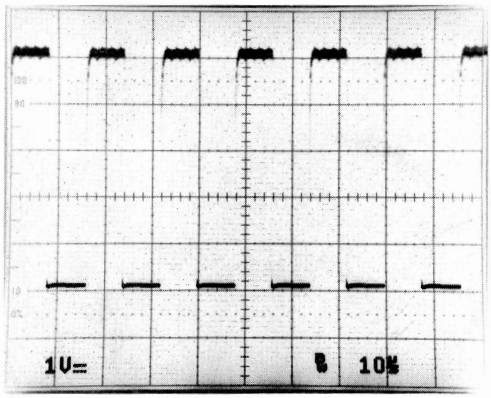
8B

0 V



8C

0 V



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MEASUREMENT PROCESSOR DIAGRAM 8

ASSEMBLY A16

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
BT02501	5G	8D	R2509	1B	6J	U2504C	4A	6K
			R2510	2B	6J	U2504D	1M	6K
C2514	5A	6L	R2511	2B	6J	U2504E	7B	6K
C2515	5A	6K	R2512	2D	6J	U2504F	4A	6K
C2516	5G	7G	R2513	2C	6J	U2505A	4B	7K
C2517	8A	7F	R2514	4D	4J	U2505B	4B	7K
C2518	8A	8G	R2515	6C	5K	U2506A	8J	1K
C2551	4L	3L	R2516	2K	2H	U2506B	8J	1K
C2552	4L	3L	R2517	8D	7F	U2506C	6J	1K
C2553	4M	3L	R2518	8D	7F	U2506D	6J	1K
C2554	4M	3L	R2519	7F	7G	U2507	1L	2K
C2555	5M	5H	R2520	6E	6F	U2508A	1N	8K
			R2521	7E	5K	U2508B	1K	8K
CR2501	5G	7G	R2522	3E	3B	U2509	1L	3K
CR2502	5G	7G	R2523	7A	8F	U2510	2H	4F
CR2504	8C	7F	R2524	8B	8F	U2511	2L	3H
CR2505	8E	7F	R2554	1B	6K	U2512	4G	4K
			R2555	1B	6J	U2513	4E	4H
DS2501	8C	8F	R2560	4L	4K	U2514	2E	4H
			R2561	4L	4K	U2515	1C	5J
J2503	1A	3L	R2562	4L	4L	U2516	4H	2J
J2503	3M	3L	R2563	4L	4L	U2517	4K	6H
			R2564	5M	6H	U2518	5K	5H
Q2507	8F	7F				U2519	7K	5F
			U2501	2C	4K	U2520	7M	4F
R2501	4A	6K	U2502	7A	8F	U2521	6G	6F
R2502	5A	6K	U2503A	8J	1J			
R2503	5B	7K	U2503B	6K	1J	W2501	3D	4J
R2504	1K	8K	U2503C	6J	1J			
R2506	5G	7G	U2503D	8L	1J	Y2501	5A	6L
R2507	1M	6K	U2504A	5A	6K			
R2508	2B	6J	U2504B	4A	6K			

Partial A16 also shown on diagrams 9, 10 and 13.

COMPONENT NUMBER EXAMPLE

Component Number: A23, A2, R1234
(A23 = Assembly Number; A2 = Subassembly Number (if used); R1234 = Schematic Circuit Number)

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATES ON ANOTHER SCHEMATIC (FOR EXAMPLE: 4E)

FOR INTEGRATED CIRCUIT SUPPLY CONNECTIONS AND POWER SUPPLY DECOUPLING NETWORKS SEE: PROCESSOR BOARD POWER DISTRIBUTION 13

DATA BUFFERS

WAVEFORMS

CLOCK

ADDRESS LATCHES

ADDRESS DECODERS

INTERRUPT TIMING

RAM

ROM

MEASUREMENT PROCESSOR

POWER-ON RESET

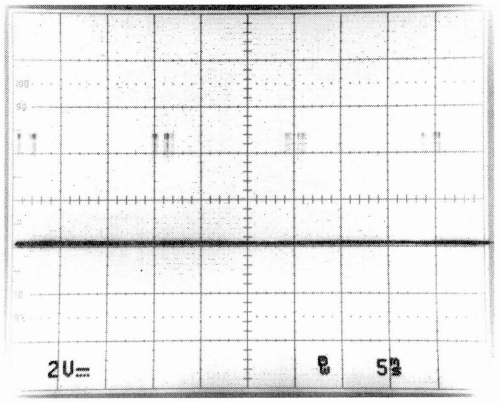
CIRCUIT NUMBER	+5V	GND
U2501	40	1, 20
U2502	8	4
U2503	14	7
U2504	14	7
U2505	14	7
U2506	14	7
U2507	16	8
U2508	14	7
U2509	24	12
U2510	20	10
U2511	20	10
U2512	20	10
U2513	20	10
U2514	20	10
U2515	20	10
U2516	16	8
U2517	16	8
U2518	16	8
U2519	28	14
U2520	28	14
U2521	28	14

PARTIAL A16 PROCESSOR BOARD

WAVEFORMS FOR DIAGRAM 9

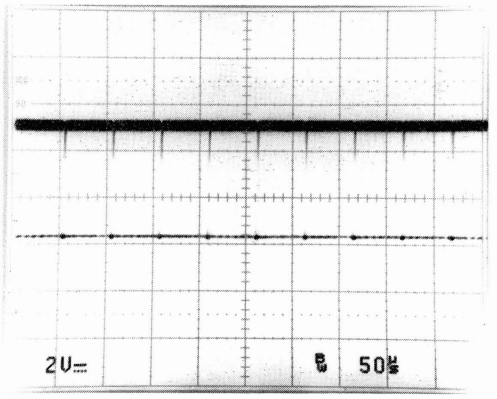
9A

0 V



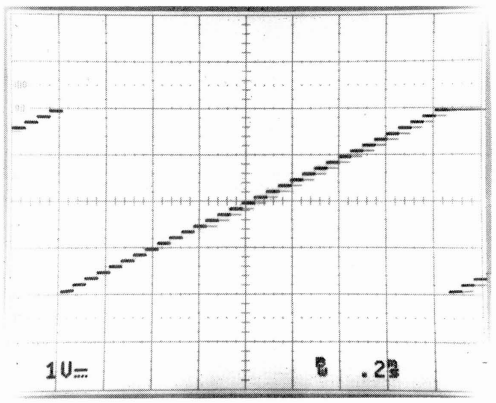
9B

0 V



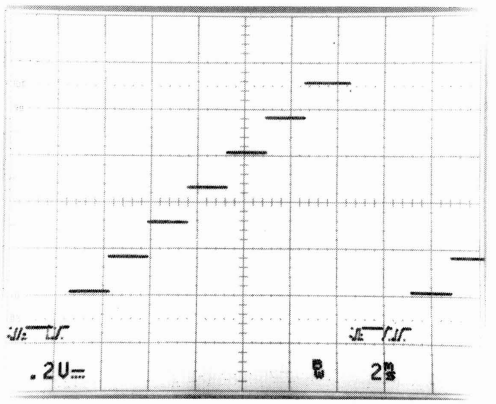
9C

0 V



9D

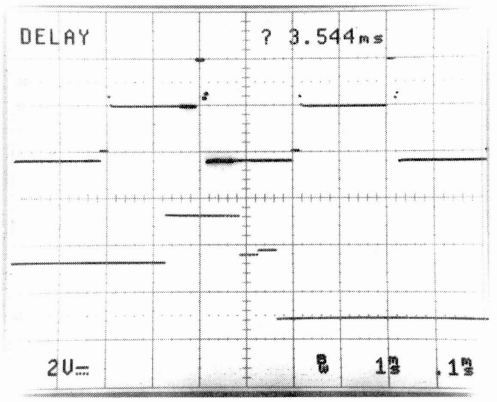
0 V



DISPLAY SERVICE MENU.

0 V

9E



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READOUT AND DAC SYSTEM DIAGRAM 9

ASSEMBLY A16

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C2300	8B	5C	R2308	8E	8D	U2305B	8F	7B
C2301	7G	7A	R2400	2B	2G	U2305C	7H	7B
C2302	8F	7B	R2401	2M	1D	U2305D	6M	7B
C2303	8G	7C	R2402	2F	1E	U2306	8E	8C
C2305	7L	7B	R2404	1G	1D	U2400	1C	3F
C2306	7J	7C	R2405	3G	4C	U2401	3B	2B
C2307	7H	7B	R2406	3K	6E	U2402	5B	3B
C2308	7J	7B	R2407	4K	6E	U2403	1G	2G
C2309	7L	7B	R2408	2K	6C	U2404	5E	2D
C2310	7M	7B	R2409	3K	6D	U2405	5F	2E
C2318	8D	8C	R2410	4M	6E	U2406	4G	3E
C2411	5J	5E	R2411	3M	6D	U2407A	3F	2C
C2412	4J	5D	R2413	5J	6E	U2407B	2F	2C
C2416	2H	2H	R2414	5J	6E	U2408	3G	3C
C2417	2J	2H	R2415	3J	6D	U2409A	1B	1G
C2418	2J	2H	R2416	3J	6D	U2409B	1D	1G
C2419	2J	2H	R2417	3M	7D	U2410	2E	1E
C2420	2K	2H	R2418	3M	7D	U2411	6F	4D
			R2419	2M	1F	U2412	4J	5E
J2302	3M	8B	R2420	2M	1E	U2413	2J	5D
J2503	1A	3L				U2414	3L	5E
J2503	1M	3L	U2300	7B	4B	U2415	2L	5D
			U2301	6B	4B	U2416A	4M	6D
R2301	8B	5C	U2302	7C	5B	U2416B	4L	6D
R2302	8B	5C	U2303	6D	6B	U2416C	2L	6D
R2303	7C	5C	U2304A	7G	7C	U2416D	3M	6D
R2304	7J	7B	U2304B	7K	7C	U2417A	3B	1H
R2305	6M	7B	U2304C	7L	7C	U2417B	1C	1H
R2306	8D	7A	U2304D	7D	7C	U2417C	2B	1H
R2307	8D	8C	U2305A	7J	7B	U2417D	2B	1H

Partial A16 also shown on diagrams 8, 10 and 13.

CLOCK DIVIDER/COUNTER
DOT REFRESHER
RO POSITION ENABLE LATCH
INTERRUPT REQUEST LATCH
CHAR. DOT POS ROM
READOUT POSITION MIXER
CHARACTER DOT COUNTER
READOUT PROCESSOR
CHARACTER POSITION ADDRESS COUNTER
COMMUNICATION LATCHES
D/A, A/D CONVERTERS
FIELD & MIXER CONTROL LATCH
CHARACTER CODES RAM
READOUT DACS
INPUT DATA LATCHES
SAMPLE & HOLD
WAVEFORMS

COMPONENT NUMBER EXAMPLE
Component Number
A23, A2, R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Chassis-mounted components have no Assembly Number prefix--see end of Replaceable Electrical Parts List.

CIRCUIT NUMBER	+7.5V	+5V	GND	-7.5V	-15V
U2300		20	10		
U2301		20	10		
U2302		20			17
U2303		16	8	7	
U2304	4			11	
U2305	4			11	
U2306	8			4	
U2400		3	1		
U2401		20	10		
U2402		20	10		
U2403		20	10		
U2404		16	8		
U2405		16	8		
U2406		24	12		
U2407		14	7		
U2408		24	12		
U2409		14	7		
U2410		20	10		
U2411		20	10		
U2412		13		3	
U2413		13		3	
U2414		16	8	7	
U2415		16	8	7	
U2416	4			11	
U2417		14	7		

Static Sensitive Devices
See Maintenance Section

NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATES ON ANOTHER SCHEMATIC (FOR EXAMPLE: 4E)

FOR INTEGRATED CIRCUIT SUPPLY CONNECTIONS AND POWER SUPPLY DECOUPLING NETWORKS SEE: PROCESSOR BOARD POWER DISTRIBUTION 13

PARTIAL A16 PROCESSOR BOARD

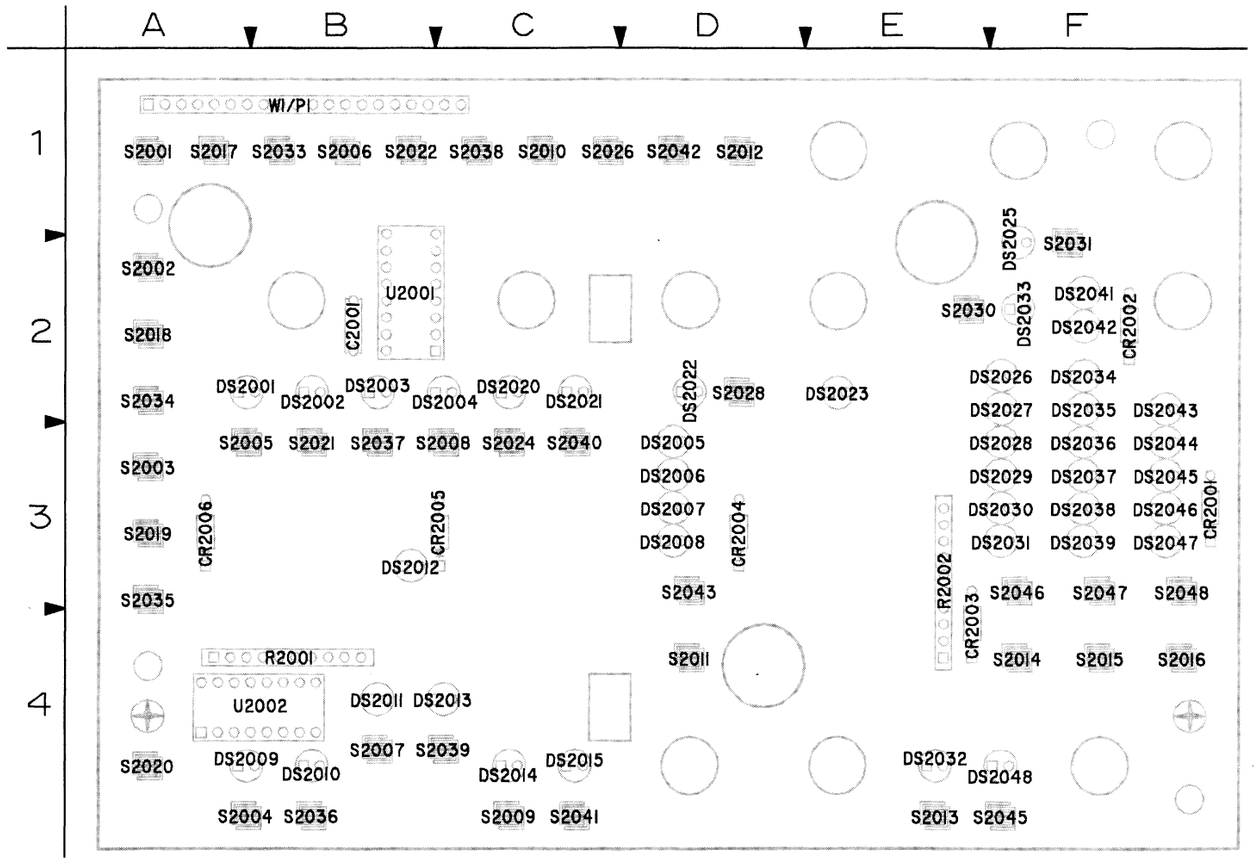

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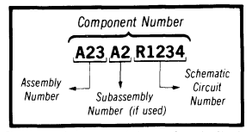
Figure 9-9. A14—Switch board.

A14—SWITCH BOARD

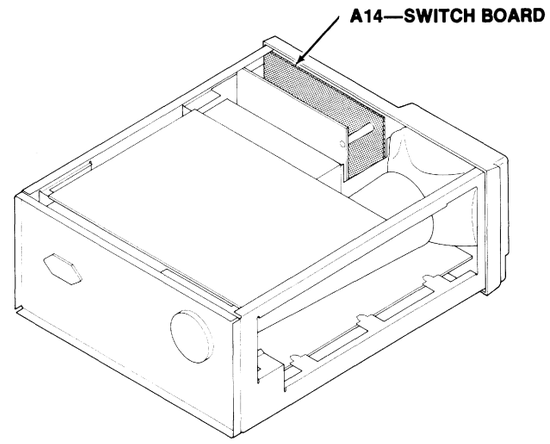
CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER
C2001	13	DS2033	10	S2015	10
		DS2034	10	S2016	10
CR2001	10	DS2035	10	S2017	10
CR2002	10	DS2036	10	S2018	10
CR2003	10	DS2037	10	S2019	10
CR2004	10	DS2038	10	S2020	10
CR2005	10	DS2039	10	S2021	10
CR2006	10	DS2041	10	S2022	10
		DS2042	10	S2024	10
DS2001	10	DS2043	10	S2026	10
DS2002	10	DS2044	10	S2028	10
DS2003	10	DS2045	10	S2030	10
DS2004	10	DS2046	10	S2031	10
DS2005	10	DS2047	10	S2033	10
DS2006	10	DS2048	10	S2034	10
DS2007	10			S2035	10
DS2008	10	P1	10	S2036	10
DS2009	10	P1	13	S2037	10
DS2010	10			S2038	10
DS2011	10	R2001	10	S2039	10
DS2012	10	R2002	10	S2040	10
DS2013	10			S2041	10
DS2014	10	S2001	10	S2042	10
DS2015	10	S2002	10	S2043	10
DS2020	10	S2003	10	S2045	10
DS2021	10	S2004	10	S2046	10
DS2022	10	S2005	10	S2047	10
DS2023	10	S2006	10	S2048	10
DS2025	10	S2007	10		
DS2026	10	S2008	10	U2001	10
DS2027	10	S2009	10	U2001	13
DS2028	10	S2010	10	U2002	10
DS2029	10	S2011	10	U2002	13
DS2030	10	S2012	10		
DS2031	10	S2013	10	W1	10
DS2032	10	S2014	10	W1	13

Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.



SWITCH BOARD AND INTERFACE DIAGRAM 10

ASSEMBLY A14

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
CR2001	3G	3F	DS2034	3D	2F	S2015	3J	4F
CR2002	3G	2F	DS2035	4D	2F	S2016	3J	4F
CR2003	3H	4E	DS2036	5D	3F	S2017	8H	1A
CR2004	3J	3D	DS2037	6D	3F	S2018	8H	2A
CR2005	3J	3C	DS2038	6D	3F	S2019	7H	3A
CR2006	3K	3A	DS2039	7D	3F	S2020	7H	4A
			DS2041	3C	2F	S2021	7H	3B
DS2001	3F	2A	DS2042	3C	2F	S2022	6H	1B
DS2002	3F	2B	DS2043	4C	2F	S2024	6H	3C
DS2003	4F	2B	DS2044	5C	3F	S2026	5H	1C
DS2004	5F	2C	DS2045	6C	3F	S2028	4H	2D
DS2005	6F	3D	DS2046	6C	3F	S2030	3H	2E
DS2006	6F	3D	DS2047	7C	3F	S2031	3H	2F
DS2007	7F	3D	DS2048	8C	4F	S2033	8G	1B
DS2008	8F	3D				S2034	8G	2A
DS2009	3F	4A	P1	2G	1B	S2035	8G	3A
DS2010	3F	4B	P1	3C	1B	S2036	7G	4B
DS2011	4F	4B				S2037	7G	3B
DS2012	5F	3B	R2001	7L	4B	S2038	6G	1C
DS2013	6F	4C	R2002	4L	3E	S2039	6G	4C
DS2014	6F	4C				S2040	6G	3C
DS2015	7F	4C	S2001	8J	1A	S2041	5G	4C
DS2020	5E	2C	S2002	8J	2A	S2042	5G	1D
DS2021	6E	2C	S2003	7J	3A	S2043	5G	3D
DS2022	6E	2D	S2004	7J	4A	S2045	4G	4F
DS2023	7E	2E	S2005	7J	3A	S2046	3G	3F
DS2025	3D	2F	S2006	6J	1B	S2047	3G	3F
DS2026	3D	2F	S2007	6J	4B	S2048	3G	3F
DS2027	4D	2F	S2008	6J	3C			
DS2028	5D	3F	S2009	5J	4C	U2001	2M	2B
DS2029	5D	3F	S2010	5J	1C	U2002	5M	4B
DS2030	6D	3F	S2011	4J	4D			
DS2031	7D	3F	S2012	4J	1D	W1	2N	1B
DS2032	8E	4E	S2013	4J	4E	W1	8C	1B
DS2033	3D	2F	S2014	3J	4F			

Partial A14 also shown on diagram 13.

ASSEMBLY A16

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C2521	2F	8F	Q2501	2G	8J	R2541	1E	8G
C2522	2G	8G	Q2502	2H	8H	R2542	1K	8G
C2523	1H	8G	Q2503	1H	8H	R2546	3B	8J
C2524	1J	8G	Q2504	1J	8H	R2547	4C	8J
C2525	1J	8G	Q2505	1K	8H	R2548	4C	8J
C2526	1K	8G	Q2506	1K	8G	R2549	5B	8J
C2543	3C	8J				R2550	6B	8J
C2544	4C	8J	R2531	1C	8J	R2551	7B	8J
C2545	4C	8J	R2532	2F	8H	R2552	7B	8K
C2546	5B	8J	R2533	1C	8H	R2553	8B	8K
C2547	6B	8J	R2534	1G	8H			
C2548	7B	8K	R2535	1D	8H	U2523	1A	7H
C2549	7B	BK	R2536	1H	8H	U2524	3A	6J
C2550	8B	8K	R2537	1D	8H	U2525	3B	7J
			R2538	1J	8H			
J2501	2F	8J	R2539	1D	8H			
J2501	3C	8J	R2540	1J	8G			

Partial A16 also shown on diagrams 8, 9 and 13.

LED ANODE REGISTER

DATA BUS FROM 8 2F

U2523 74HCT374

D0 8, D1 13, D2 14, D3 7, D4 4, D5 3, +5V 17, +5V 18

1D ▷ 9, 12, 15, 6, 5, 2, 16, 19

1 EN, 11 C1

LED ANODE CLK FROM U2517-14 8 4L

LED CATHODE REGISTER & DRIVER

U2524 74HCT374

D0 13, D1 7, D2 8, D3 4, D4 3, D5 14, D6 18, D7 17

1D ▷ 12 11, 6 8, 9 13, 5 6, 2 4, 15 15, 19 2, 16 17

1 EN, 11 C1

U2525 74S240

1 EN1, 19 EN2

▷ 1∇ 9, 2∇ 12, 1∇ 7, 2∇ 14, 1∇ 16, 2∇ 5, 1∇ 18, 2∇ 3

LED CATH CLK FROM U2517-15 8 4L

CIRCUIT NUMBER	+5V	GND
U2001	16	8
U2002	16	8
U2523	20	10
U2524	20	10
U2525	20	10

COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234

Assembly Number; Subassembly Number (if used); Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix--see end of Replaceable Electrical Parts List.

LED & SWITCH COLUMN DRIVERS

+5V R2531 1K, R2533 1K, R2535 1K, R2537 1K, R2539 1K, R2541 1K

R2532 1K C2521 .001 Q2501

R2534 1K C2522 .001 Q2502

R2536 1K C2523 .001 Q2503

R2538 1K C2524 .001 Q2504

R2540 1K C2525 .001 Q2505

R2542 1K C2526 .001 Q2506

J2501 P1 6 5 4 3 2 1 19 18 20 W1

SW BD SR LOAD FROM U2518-14 5L 8

SW BD SR SHIFT FROM U2518-13 5L 8

SW BD DATA TO R2510 2B 8

AS5 AS4 AS3 AS2 AS1 AS0

CR2001 CR2002 CR2003 S2016 (TRIGGER CPLG) CR2004 CR2005 A AND B SEC/DIV CR2006 (CH 2) VOLTS/DIV (CH 1) VOLTS/DIV

R2546 22 C2543 .0047 J2501 P1 9 BS0

R2547 22 10 C2544 .0047 BS1

R2548 22 11 C2545 .0047 BS2

R2549 22 12 C2546 .0047 BS3

R2550 22 13 C2547 .0047 BS4

R2551 22 14 C2548 .0047 BS5

R2552 22 15 C2549 .0047 BS6

R2553 22 16 C2550 .0047 W1 BS7

DS2041 TRIG'D	DS2033 A/B SELECT A Q B (TRIGGER)	DS2025 (TRIGGER SLOPE)	DS2009 AC GND (CH 1 COUPLING)	DS2001 CH 1 (VERTICAL MODE)		
DS2042 READY (TRIGGER)	DS2034 VERT (TRIGGER SOURCE)	DS2026 A AUTO LEVEL/ B AUTO LEVEL (TRIGGER MODE)	DS2010 DC GND (CH 1 COUPLING)	DS2002 ADD (VERTICAL MODE)		
DS2043 DC (TRIGGER CPLG)	DS2035 CH 1 (TRIGGER SOURCE)	DS2027 A AUTO/ B RUNS AFTER (TRIGGER MODE)	DS2011 SCOPE BW 20 MHZ (VERTICAL)	DS2003 CH 2 (VERTICAL MODE)		
DS2044 NOISE REJ (TRIGGER CPLG)	DS2036 CH 2 (TRIGGER SOURCE)	DS2028 A NORM/ B NORM (TRIGGER MODE)	DS2020 CH 4 (VERTICAL MODE)	DS2012 UNCAL (VERTICAL)	DS2004 CH 3 (VERTICAL MODE)	
DS2045 HF REJ (TRIGGER CPLG)	DS2037 CH 3 (TRIGGER SOURCE)	DS2029 A TV LINE/ B TV LINE FROM A SOURCE (TRIGGER MODE)	DS2021 CHOP Q ALT (VERTICAL MODE)	DS2013 CH 2 INVERT (VERTICAL)	DS2005 A (HORIZON-TAL MODE)	
DS2046 LF REJ (TRIGGER CPLG)	DS2038 CH 4 (TRIGGER SOURCE)	DS2030 A TV FIELD (TRIGGER MODE)	DS2022 X10 MAG (HORI-ZONTAL)	DS2014 AC GND (CH 2 COUPLING)	DS2006 ALT (HORIZON-TAL MODE)	
DS2047 AC (TRIGGER CPLG)	DS2039 LINE (TRIGGER SOURCE)	DS2031 A SGL SEQ (TRIGGER MODE)	DS2023 UNCAL (HORI-ZONTAL)	DS2015 DC GND (CH 2 COUPLING)	DS2007 B (HORIZON-TAL MODE)	
DS2048 .5V Q.1V (CH 4 VOLTS/DIV)	DS2032 .5V Q.1V (CH 3 VOLTS/DIV)				DS2008 X-Y (HORIZONTAL MODE)	

S2048 (TRIGGER CPLG)	S2031 SLOPE (TRIGGER)	S2016 (TRIGGER CPLG)				
S2047 (TRIGGER SOURCE)	S2030 A/B SELECT (TRIGGER)	S2015 (TRIGGER SOURCE)				
S2046 (TRIGGER MODE)		S2014 SS RESET (TRIGGER MODE)				
S2045 VOLTS/DIV (CH 4)		S2013 VOLTS/DIV (CH 3)				
	S2028 X10 MAG	S2012				
S2043 (HORIZONTAL MODE)		S2011 (HORIZONTAL MODE)				
S2042	S2026	S2010				
S2041 DC/GND (CH 2 COUPLING)		S2009 AC/GND (CH 2 COUPLING)				
S2040 CHOP/ALT (VERTICAL MODE)	S2024 CH 4 (VERTICAL MODE)	S2008 CH 3 (VERTICAL MODE)				
S2039 CH2 INVERT (VERT-ICAL)		S2007 SCOPE BW 20 MHZ				
S2038 TIME (MEASURE-MENTS)	S2022 CURSORS (MEASURE-MENTS)	S2006 VOLTMETER (MEASURE-MENTS)				
S2037 CH 2 (VERTICAL MODE)	S2021 ADD (VERTICAL MODE)	S2005 CH 1 (VERTICAL MODE)				
S2036 DC/GND (CH 1 COUPLING)	S2020 BEAM FIND	S2004 AC/GND (CH 1 COUPLING)				
S2035 MENU (6)	S2019 MENU (5)	S2003 MENU (4)				
S2034 MENU (3)	S2018 MENU (2)	S2002 MENU (1)				
S2033 LAST MEAS'MT	S2017 SET MEAS'MT CHAN.	S2001 CLEAR DISPLAY				

U2001 74LS165 SRG8 G1 [SHIFT] C2 [LOAD] 1 ≥1 C3/ 10 11 12 13 14 3 4 5 6 → 3D 2D 2D 9 7

R2002 9 X 1K 10 9 8 7 6 5 4 3 2 1

U2002 74LS165 SRG8 G1 [SHIFT] C2 [LOAD] 1 ≥1 C3/ 10 11 12 13 14 3 4 5 6 → 3D 2D 2D 9 7

R2001 9 X 1K 10 9 8 7 6 5 4 3 2 1

SWITCH BOARD SHIFT REGISTERS

FRONT PANEL SWITCHES

Static Sensitive Devices
See Maintenance Section

NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATES ON ANOTHER SCHEMATIC (FOR EXAMPLE: 4E)

FOR INTEGRATED CIRCUIT SUPPLY CONNECTIONS AND POWER SUPPLY DECOUPLING NETWORKS SEE:
PROCESSOR BOARD POWER DISTRIBUTION 13

FRONT PANEL LEDS

PARTIAL A16 PROCESSOR BOARD

PARTIAL A14 SWITCH BOARD

SWITCH BOARD AND INTERFACE 10

2246 6081-59

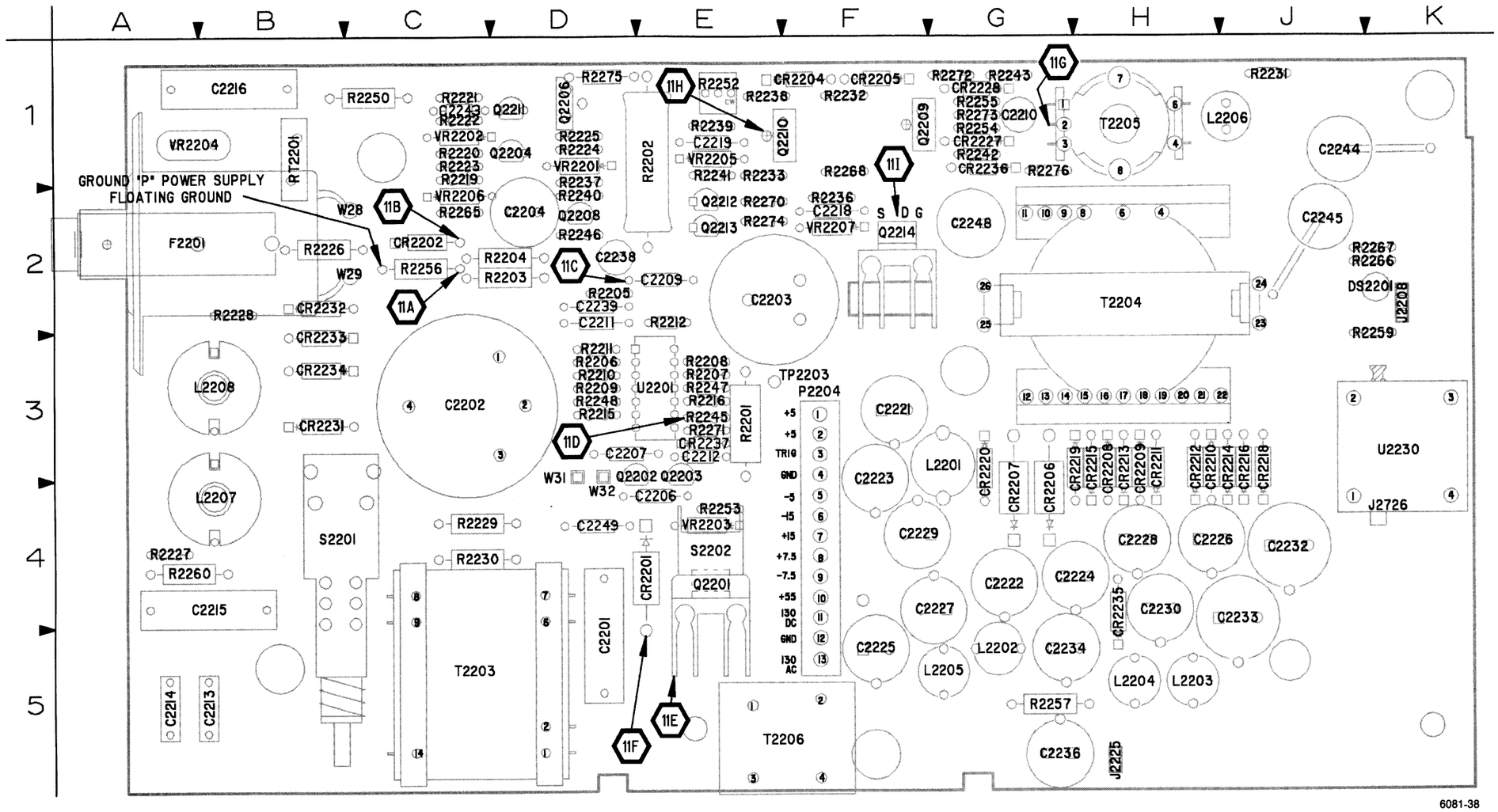


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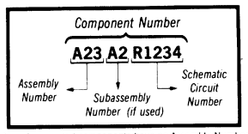
Figure 9-10. A18—Power Supply board.

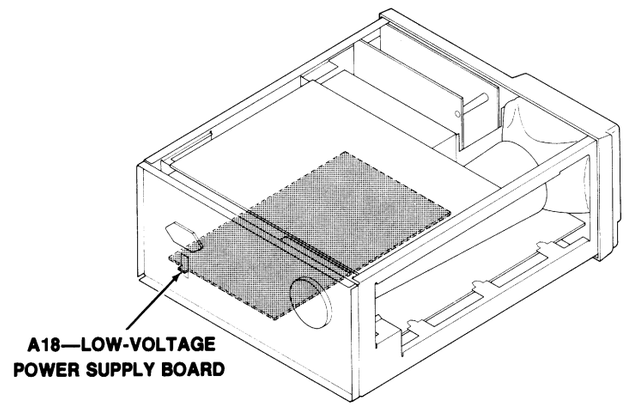
FIG. 9-10
A18—POWER SUPPLY BOARD

Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.



A18—LOW-VOLTAGE POWER SUPPLY BOARD

A18—POWER SUPPLY BOARD

CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER
C2201	11	C2239	11	CR2235	11	Q2211	11	R2231	11	R2273	11
C2202	11	C2243	11	CR2236	11	Q2212	11	R2232	11	R2274	11
C2203	11	C2244	11	CR2237	11	Q2213	11	R2233	11	R2275	11
C2204	11	C2245	11			Q2214	11	R2236	11	R2276	11
C2206	11	C2248	11	DS2201	11			R2237	11		
C2207	11	C2249	11			R2201	11	R2238	11	RT2201	11
C2209	11			F2201	11	R2202	11	R2239	11		
C2210	11	CR2201	11			R2203	11	R2240	11	S2201	11
C2211	11	CR2202	11	J2208	11	R2204	11	R2241	11		
C2212	11	CR2204	11	J2225	11	R2205	11	R2242	11	T2203	11
C2213	11	CR2205	11	J2726	11	R2206	11	R2243	11	T2204	11
C2214	11	CR2206	11			R2207	11	R2245	11	T2205	11
C2215	11	CR2207	11	L2201	11	R2208	11	R2246	11	T2206	11
C2216	11	CR2208	11	L2202	11	R2209	11	R2247	11		
C2218	11	CR2209	11	L2203	11	R2210	11	R2248	11	U2201	11
C2219	11	CR2210	11	L2204	11	R2211	11	R2250	11	U2230	11
C2221	11	CR2211	11	L2205	11	R2212	11	R2252	11		
C2222	11	CR2212	11	L2206	11	R2215	11	R2253	11	VR2201	11
C2223	11	CR2213	11	L2207	11	R2216	11	R2254	11	VR2202	11
C2224	11	CR2214	11	L2208	11	R2219	11	R2255	11	VR2203	11
C2225	11	CR2215	11			R2220	11	R2256	11	VR2204	11
C2226	11	CR2216	11	P2204	11	R2221	11	R2257	11	VR2205	11
C2227	11	CR2218	11			R2222	11	R2259	11	VR2206	11
C2228	11	CR2219	11	Q2201	11	R2223	11	R2260	11	VR2207	11
C2229	11	CR2220	11	Q2202	11	R2224	11	R2265	11		
C2230	11	CR2227	11	Q2203	11	R2225	11	R2266	11	W28	11
C2232	11	CR2228	11	Q2204	11	R2226	11	R2267	11	W29	11
C2233	11	CR2231	11	Q2206	11	R2227	11	R2268	11	W31	11
C2234	11	CR2232	11	Q2208	11	R2228	11	R2270	11	W32	11
C2236	11	CR2233	11	Q2209	11	R2229	11	R2271	11		
C2238	11	CR2234	11	Q2210	11	R2230	11	R2272	11		

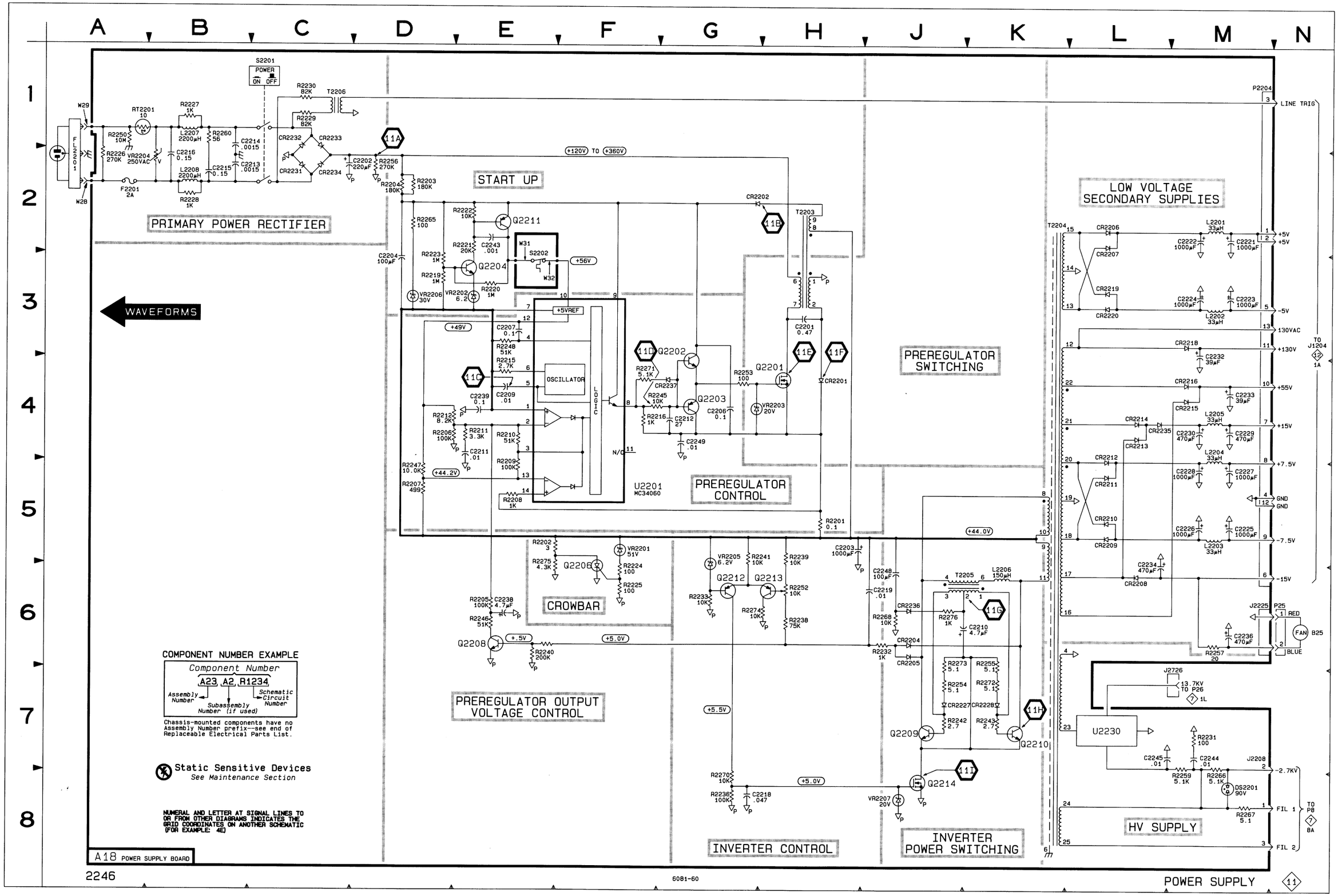
POWER SUPPLY DIAGRAM 11

ASSEMBLY A18

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C2201	3H	5D	CR2235	4L	4H	R2231	7M	1J
C2202	2D	3D	CR2236	6J	1G	R2232	6J	1F
C2203	5H	2E	CR2237	4G	3E	R2233	6G	1E
C2204	3D	2D				R2236	8G	2F
C2206	4G	4E	DS2201	8M	2K	R2237	6E	1D
C2207	3E	3D				R2238	6H	1E
C2209	4E	2E	F2201	2A	2A	R2239	5H	1E
C2210	6K	1G				R2240	6E	2D
C2211	4E	2D	J2208	7M	2K	R2241	5H	1E
C2212	4G	3E	J2225	6M	5H	R2242	7J	1G
C2213	2B	5B	J2726	6M	4K	R2243	7K	1G
C2214	1B	5A				R2245	4F	3E
C2215	2B	4B	L2201	2M	3G	R2246	6E	2D
C2216	2B	1B	L2202	3M	5G	R2247	5D	3E
C2218	8H	2F	L2203	5M	5H	R2248	3E	3D
C2219	6J	1E	L2204	4M	5H	R2250	1A	1C
C2221	2M	3F	L2205	4M	5G	R2252	6H	1E
C2222	2M	4G	L2206	6K	1J	R2253	4G	4E
C2223	3M	3F	L2207	1B	4B	R2254	7J	1G
C2224	3M	4G	L2208	2B	3B	R2255	6K	1G
C2225	5M	5F				R2256	2D	2C
C2226	5M	4H	P2204	1M	4F	R2257	6M	5G
C2227	5M	4G				R2259	8M	3K
C2228	5M	4H	Q2201	4H	4E	R2260	1B	4A
C2229	4M	4F	Q2202	3G	3D	R2265	2D	2C
C2230	4M	4H	Q2203	4G	3E	R2266	8M	2K
C2232	3M	4J	Q2204	3E	1D	R2267	8M	2K
C2233	4M	4J	Q2206	6F	1D	R2268	6J	1F
C2234	5L	5G	Q2208	6E	2D	R2270	8G	2E
C2236	6M	5G	Q2209	7J	1F	R2271	4F	3E
C2238	6E	2D	Q2210	7K	1E	R2272	7K	1G
C2239	4E	2D	Q2211	2E	1D	R2273	6J	1G
C2243	2E	1C	Q2212	6G	2E	R2274	6G	2E
C2244	7M	1J	Q2213	6H	2E	R2275	5E	1D
C2245	7L	2J	Q2214	8J	2F	R2276	6J	1G
C2248	6J	2G						
C2249	4G	4D	R2201	5H	3E	RT2201	1A	1B
			R2202	5E	1E			
CR2201	4H	4E	R2203	2D	2D	S2201	1C	4B
CR2202	2G	2C	R2204	2D	2D			
CR2204	6J	1F	R2205	6E	2D	T2203	2H	5C
CR2205	6J	1F	R2206	4D	3D	T2204	2K	2H
CR2206	2L	4G	R2207	5D	3E	T2205	6K	1H
CR2207	2L	4G	R2208	5E	3E	T2206	1C	5E
CR2208	6L	3H	R2209	5E	3D			
CR2209	5L	3H	R2210	4E	3D	U2201	5F	3E
CR2210	5L	3H	R2211	4E	3D	U2230	7L	3K
CR2211	5L	3H	R2212	4D	2E			
CR2212	4L	3H	R2215	4E	3D	VR2201	5F	1D
CR2213	4L	3H	R2216	4F	3E	VR2202	3E	1C
CR2214	4L	3J	R2219	3D	1C	VR2203	4H	4E
CR2215	4M	3H	R2220	3E	1C	VR2204	2A	1A
CR2216	4M	3J	R2221	2E	1C	VR2205	5G	1E
CR2218	3M	3J	R2222	2E	1C	VR2206	3D	2C
CR2219	3L	3H	R2223	3D	1C	VR2207	8J	2F
CR2220	3L	3G	R2224	6F	1D			
CR2227	7J	1G	R2225	6F	1D	W28	2A	2C
CR2228	7K	1G	R2226	2A	2B	W29	1A	2C
CR2231	2C	3B	R2227	1B	4A	W31	2E	3D
CR2232	1C	2B	R2228	2B	2B	W32	3E	4D
CR2233	1C	3B	R2229	1C	4C			
CR2234	2C	3B	R2230	1C	4C			

OTHER PARTS

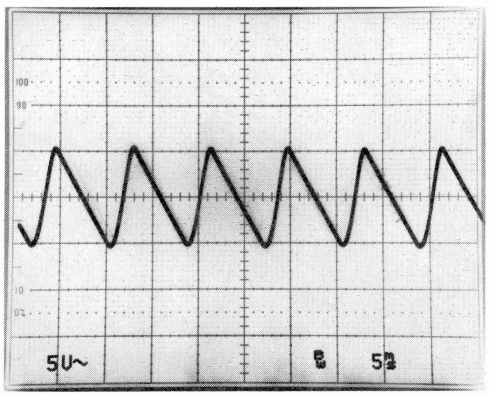
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
B25	6N	CHASSIS	P25	6N	CHASSIS			
FL2201	2A	CHASSIS	S2202	3E	CHASSIS			



WAVEFORMS FOR DIAGRAM 11

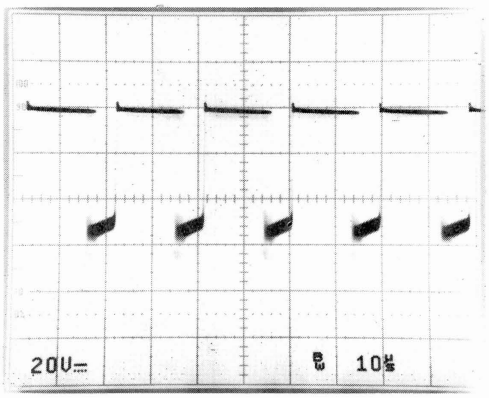
11A

+150 V



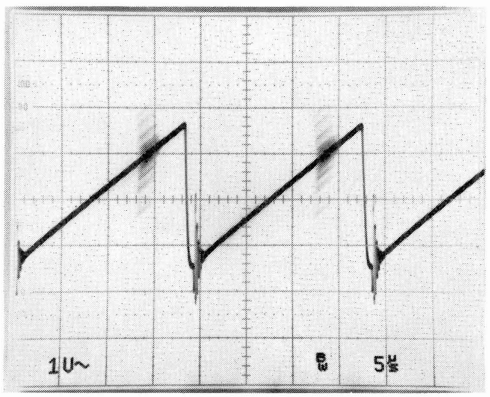
11B

0 V



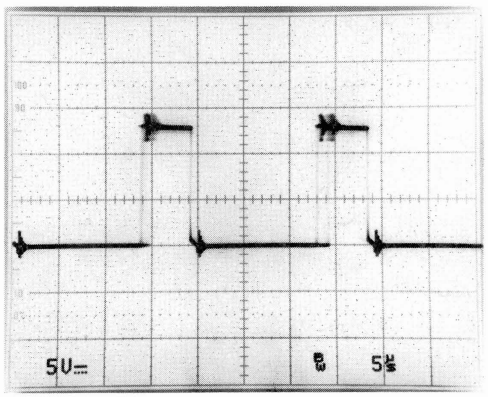
11C

+43.6 V



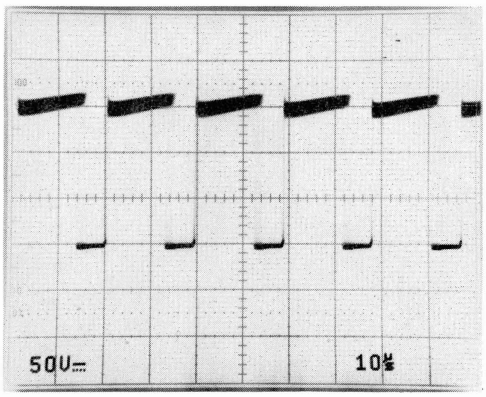
11D

+42 V



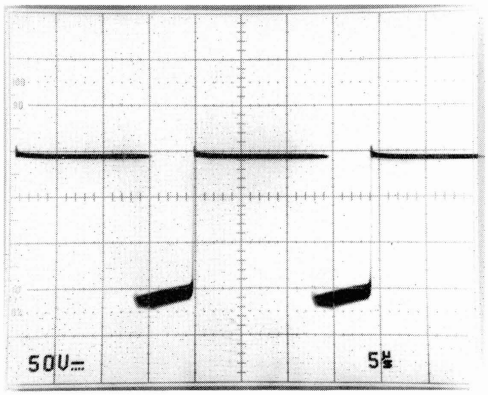
11E

0 V



0 V

11F



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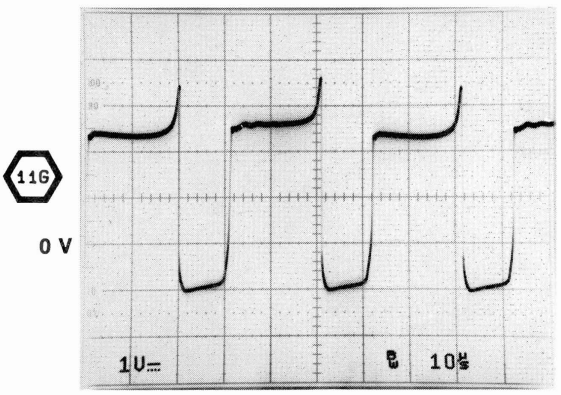
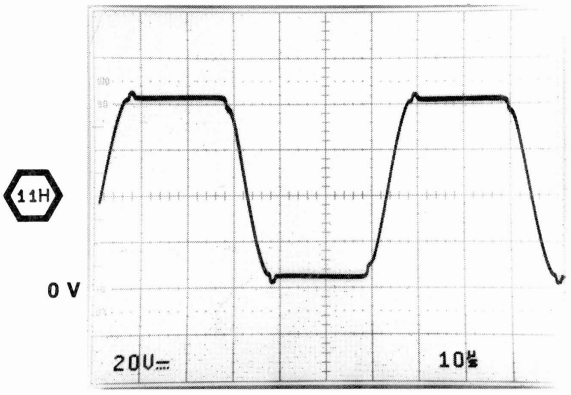
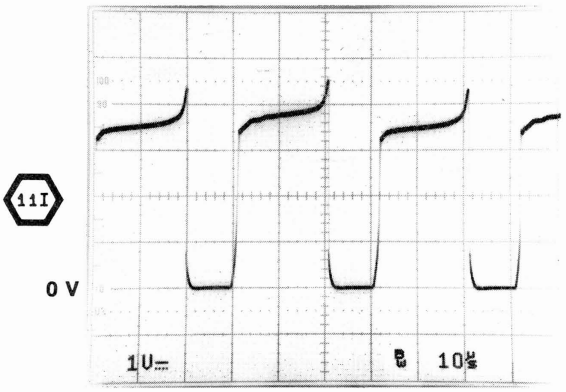
MORE

WAVEFORMS FOR DIAGRAM 11 (cont)







6081-40

MAIN BOARD POWER DISTRIBUTION DIAGRAM 12

ASSEMBLY A8

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
W8	5M	1E									

Partial A8 also shown on diagram 7.

ASSEMBLY A10

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C135	7D	2B	C701	3H	10J	R504	1M	9C	U701	3J	9J
C136	8E	2B	C702	3J	9J	R701	3H	9J	U702	3J	9K
C140	8D	1C	C703	3J	10K	R709	3J	9H	U801	5G	7H
C155	7E	1B	C704	3J	9K	R723	5H	9J	U802	6J	8H
C156	8E	1B	C705	4A	9G	R733	3J	10K	U901A	5L	9A
C171	5A	2B	C708	3H	9J	R734	4B	9H	U901B	5L	9A
C172	1A	3C	C801	4A	8K	R837	7J	8K	U901	5K	9A
C180	8D	6D	C806	5G	8H	R915	5L	9A	U930	5K	8B
C181	7A	6D	C815	6J	7H	R916	5L	9A	U931	3L	9B
C205	3H	10H	C816	7J	8H	R1026	8F	7M	U932	5K	8A
C206	3H	10H	C818	4B	7K	R1027	6F	8L	U1001	7F	7L
C214	7B	4D	C901	5K	9A	R1101	6H	1J	U1101	7H	2M
C215	7B	5D	C902	5K	7A	R1102	8H	1J	U1102	7H	1L
C216	1B	4H	C903	5M	8A	R1158	1L	2J	U1103	1L	2K
C219	7B	5D	C904	5M	9B	R1159	8J	2J	U1104	2L	2L
C224	7B	3D	C1005	7F	7M	R27B3	4D	7N	U1106	2M	2J
C225	7B	3D	C1006	7F	8L						
C229	7B	3D	C1101	6H	1M	U112	7D	6C	W2	8M	10D
C234	7C	2D	C1102	8H	2M	U122	7D	4C	W3	1M	1K
C235	7C	2D	C1158	2L	2K	U171	5A	3B	W5	7M	10D
C239	7C	2D	C1159	3M	2J	U172	6A	3B	W8	5M	9B
C244	7D	1D	C2701	5H	7L	U173	1A	3C	W103	6A	6D
C245	7C	1D	C2702	8G	6L	U201	1B	5H	W235	7E	5D
C249	7D	1D	C2709	4E	7M	U202	1B	5G	W1103	1L	1K
C265	5B	5F				U203	3H	10G	W1200	1H	6F
C282	3B	4F	J1204	1A	5J	U210	7B	5D	W1201	3L	8C
C283	6B	6F				U220	7B	4D	W1202	2H	9H
C297	3C	5F	L101	5A	2C	U230	7C	3D	W1204	1H	7G
C298	3B	3F	L102	8D	2C	U240	7C	2D	W1205	2E	4N
C304	5D	7D	L201	6A	6E	U260	5B	5F	W1209	1E	2J
C309	2H	6H	L445	1C	3H	U301	1K	8D	W1210	1E	4K
C316	5C	8E	L475	1C	1J	U302	5E	8C	W1216	3L	8C
C317	1K	8E				U303	5E	9C	W1217	3G	6H
C318	8J	9E	P2	8M	10D	U304	5F	8D	W1218	3G	5H
C320	1H	8F	P3	1N	1K	U307	5E	7D	W1219	3G	7K
C337	5D	9E	P5	6M	10D	U308	5E	7D	W1221	3B	4H
C338	8A	8G				U309	5F	7C	W1222	8B	6D
C339	8B	9G	R182	8D	6D	U310	5E	10D	W1223	3K	6D
C351	5F	7C	R208	3H	10H	U311	5E	10D	W1231	6F	8K
C445	1C	3G	R216	2B	4H	U315	1H	8F	W1236	8K	9C
C475	1C	1G	R217	1B	4H	U315	2H	8F	W1237	8F	6K
C481	2C	3G	R226	7B	6E	U421	2C	3G	W1247	5C	6D
C482	2D	2G	R245	7C	3D	U431	2C	2G	W1248	5G	6H
C501	1E	2N	R282	3B	3F	U441	1D	2H	W1249	5G	5H
C502	1E	2N	R283	6B	6F	U501	1E	3N	W1250	5H	7K
C503	3E	5N	R297	3C	6F	U502	2E	3N	W1251	8A	6H
C504	1E	3N	R298	3B	3F	U503	3E	5N	W1252	8A	5H
C505	2M	9C	R312	5D	7C	U505	2M	10C	W1255	5B	6F
C506	1L	1J	R339	8J	8E	U506	2M	10C	W1256	8B	10E
C604	2F	5M	R345	5C	8E	U600	1E	4L	W1257	8B	10D
C605	1F	4L	R374	5D	10E	U601	2E	5K	W1277	4D	8K
C606	1F	2J	R390	1K	8F	U602	1F	3K			
C609	1G	3M	R392	8F	7C	U603	1G	3M			
C610	2F	5N	R481	2C	4H	U604	2F	5M			
C613	2E	4K	R482	2C	2H	U606	2F	5M			

Partial A10 also shown on diagrams 1, 2, 3, 4, 5, 6 and 7.

ASSEMBLY A12

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
J2105	6M	1B									

Partial A12 also shown on diagrams 2, 4, 5 and 7.

MAIN BOARD POWER DISTRIBUTION

PARTIAL A10 MAIN BOARD

PARTIAL A8 CRT CONTROL BOARD

PARTIAL A12 POT BD

2246

6081-61

PROCESSOR BOARD POWER DISTRIBUTION DIAGRAM 13

ASSEMBLY A14

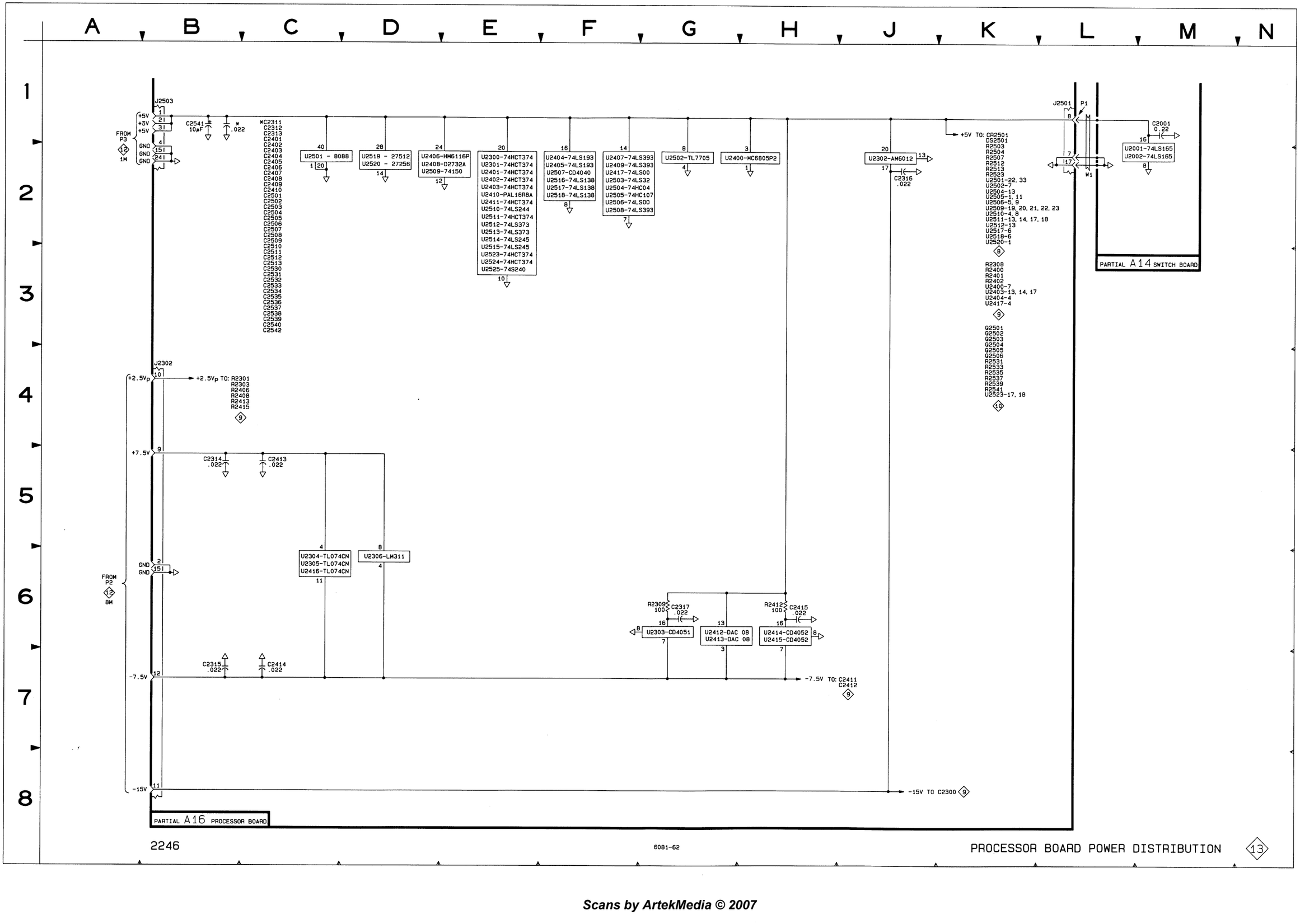
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C2001	1M	2B	U2001	2M	2B	W1	2L	1B
			U2002	2M	4B			
P1	1L	1B						

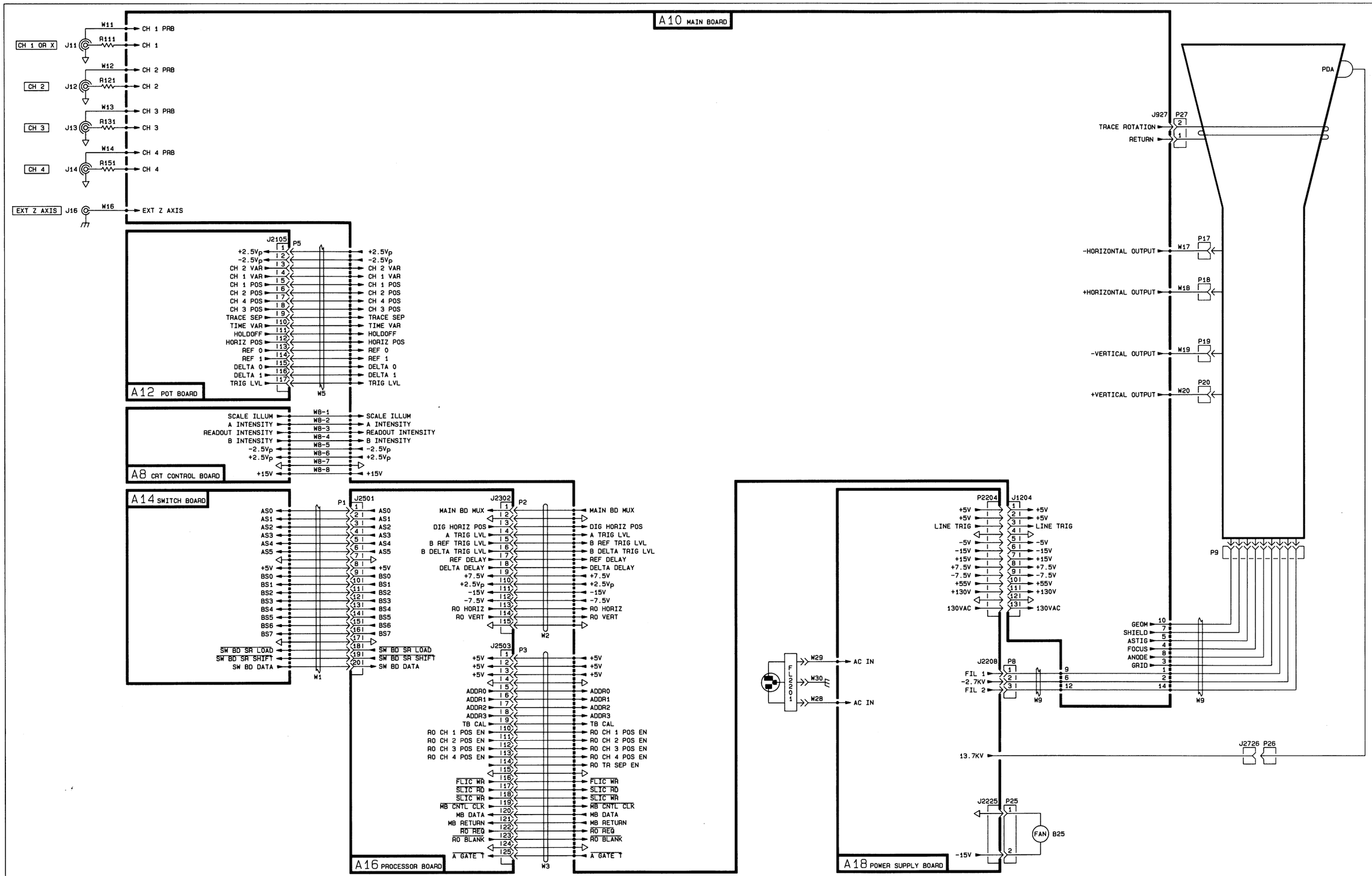
Partial A14 also shown on diagram 10.

ASSEMBLY A16

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C2311	1C	4B	C2531	3C	8F	U2407	2F	2C
C2312	1C	4B	C2532	3C	2L	U2408	2D	3C
C2313	1C	5B	C2533	3C	4D	U2409	2F	1G
C2314	5B	8D	C2534	3C	1G	U2410	2E	1E
C2315	7B	8C	C2535	3C	4G	U2411	2E	4D
C2316	2J	5C	C2536	3C	4H	U2412	6G	5E
C2317	6G	6B	C2537	3C	4H	U2413	6G	5D
C2401	1C	1F	C2538	3C	1K	U2414	6H	5E
C2402	2C	2F	C2539	3C	5H	U2415	6H	5D
C2403	2C	2J	C2540	3C	3H	U2416	6C	6D
C2404	2C	3C	C2541	1B	2L	U2417	2F	1H
C2405	2C	2C	C2542	3C	4G	U2501	2C	4K
C2406	2C	3D				U2502	2G	8F
C2407	2C	3E	J2302	4B	8B	U2503	2F	1J
C2408	2C	2C	J2501	1L	8J	U2504	2F	6K
C2409	2C	2E	J2503	1B	3L	U2505	2F	7K
C2410	2C	1H				U2506	2F	1K
C2413	5C	5D	R2309	6G	6C	U2507	2F	2K
C2414	7C	5E	R2412	6H	5D	U2508	2F	8K
C2415	6H	5D				U2509	2D	3K
C2501	2C	3G	U2300	2E	4B	U2510	2E	4F
C2502	2C	1J	U2301	2E	4B	U2511	2E	3H
C2503	2C	8L	U2302	2J	5B	U2512	2E	4K
C2504	2C	7L	U2303	6G	6B	U2513	2E	4H
C2505	2C	6L	U2304	6C	7C	U2514	2E	4H
C2506	2C	2G	U2305	6C	7B	U2515	3E	5J
C2507	2C	6H	U2306	6D	8C	U2516	2F	2J
C2508	2C	5K	U2400	2H	3F	U2517	2F	6H
C2509	2C	5L	U2401	2E	2B	U2518	2F	5H
C2510	3C	6K	U2402	2E	3B	U2519	2D	5F
C2511	3C	7H	U2403	2E	2G	U2520	2D	4F
C2512	3C	7K	U2404	2F	2D	U2523	3E	7H
C2513	3C	4K	U2405	2F	2E	U2524	3E	6J
C2530	3C	3L	U2406	2D	3E	U2525	3E	7J

Partial A16 also shown on diagrams 8, 9 and 10.





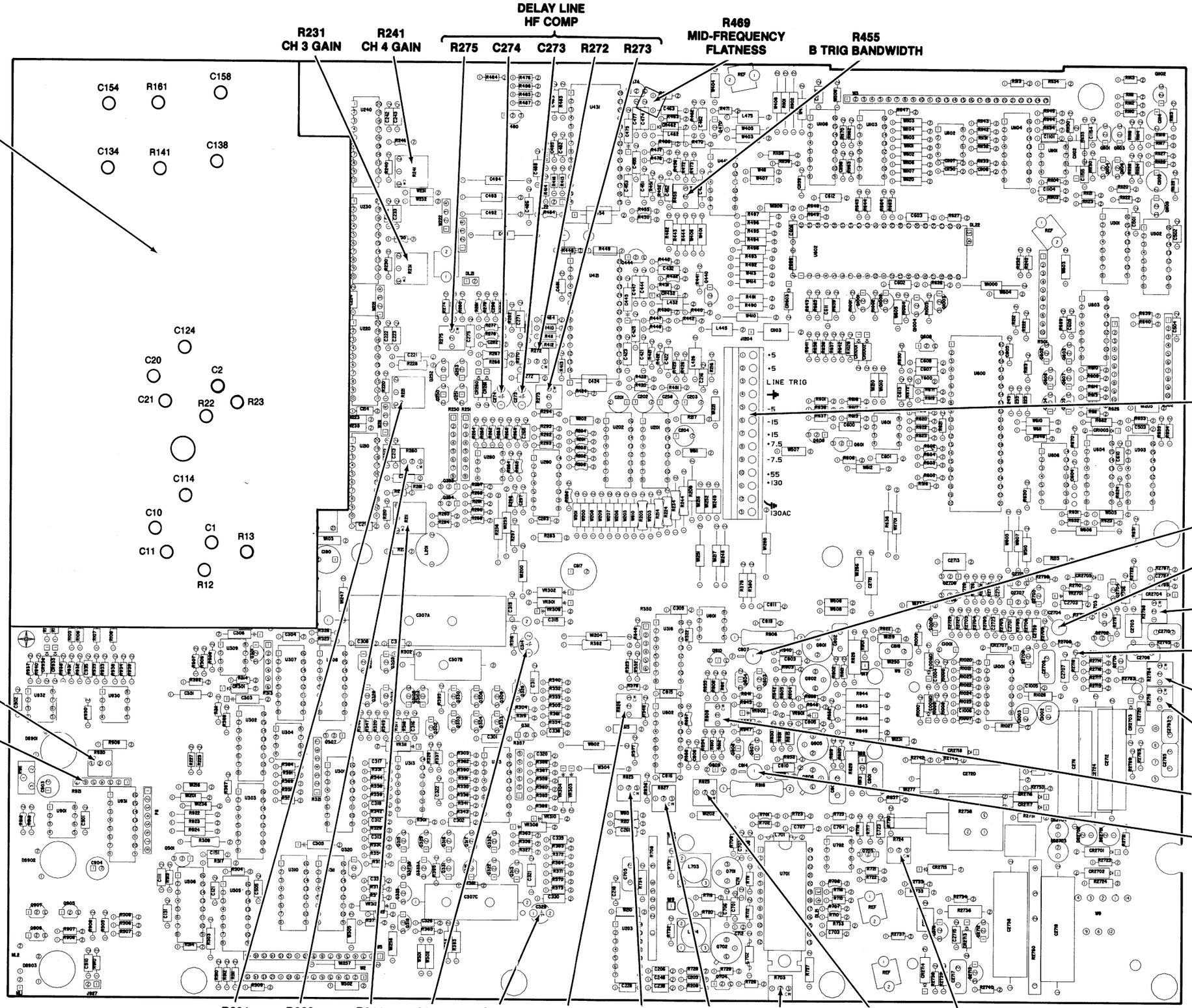


Figure 9-11. A10—Main board adjustment locations.

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

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

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

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part 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
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	COVER
CPLG	COUPLING
CRT	CATHODE RAY TUBE
DEG	DEGREE
DWR	DRAWER
ELCTRN	ELECTRON
ELEC	ELECTRICAL
ELCTLT	ELECTROLYTIC
ELEM	ELEMENT
EPL	ELECTRICAL PARTS LIST
EQPT	EQUIPMENT
EXT	EXTERNAL
FIL	FILLISTER HEAD
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FR	FRAME or FRONT
FSTNR	FASTENER
FT	FOOT
FXD	FIXED
GSKT	GASKET
HDL	HANDLE
HEX	HEXAGON
HEX HD	HEXAGONAL HEAD
HEX SOC	HEXAGONAL SOCKET
HLCPS	HELICAL COMPRESSION
HLEXT	HELICAL EXTENSION
HV	HIGH VOLTAGE
IC	INTEGRATED CIRCUIT
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IMPLR	IMPELLER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATOR
INTL	INTERNAL
LPHLDR	LAMPHOLDER
MACH	MACHINE
MECH	MECHANICAL
MTG	MOUNTING
NIP	NIPPLE
NON WIRE	NOT WIRE WOUND
OBD	ORDER BY DESCRIPTION
OD	OUTSIDE DIAMETER
OVH	OVAL HEAD
PH BRZ	PHOSPHOR BRONZE
PL	PLAIN or PLATE
PLSTC	PLASTIC
PN	PART NUMBER
PNH	PAN HEAD
PWR	POWER
RCPT	RECEPTACLE
RES	RESISTOR
RGD	RIGID
RLF	RELIEF
RTNR	RETAINER
SCH	SOCKET HEAD
SCOPE	OSCILLOSCOPE
SCR	SCREW
SE	SINGLE END
SECT	SECTION
SEMICOND	SEMICONDUCTOR
SHLD	SHIELD
SHLDR	SHOULDERED
SKT	SOCKET
SL	SLIDE
SLFLKG	SELF-LOCKING
SLVG	SLEEVING
SPR	SPRING
SQ	SQUARE
SST	STAINLESS STEEL
STL	STEEL
SW	SWITCH
T	TUBE
TERM	TERMINAL
THD	THREAD
THK	THICK
TNSN	TENSION
TPG	TAPPING
TRH	TRUSS HEAD
V	VOLTAGE
VAR	VARIABLE
W/	WITH
WSHR	WASHER
XFMR	TRANSFORMER
XSTR	TRANSISTOR

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
06383	PANDUIT CORP	17301 RIDGELAND	TINLEY PARK IL 60477
06915	RICHCO PLASTIC CO	5825 N TRIPP AVE	CHICAGO IL 60646
12327	FREEWAY CORP	9301 ALLEN DR	CLEVELAND OH 44125
13103	THERMALLOY CO INC	2021 W VALLEY VIEW LANE P O BOX 34829	DALLAS TX 75234
16428	BELDEN CORP ELECTRONIC DIV	2200 US HWY 27 SOUTH P O BOX 1980	RICHMOND IN 47374
24931	SPECIALTY CONNECTOR CO INC	2620 ENDRESS PLACE P O BOX D	GREENWOOD IN 46142
28520	HEYCO MOLDED PRODUCTS	147 MICHIGAN AVE P O BOX 160	KENILWORTH NJ 07033
52676	S. K. F. INDUSTRIES, INC.	P O BOX 6731	PHILADELPHIA, PA 19132
70903	BELDEN CORP	2000 S BATAVIA AVE	GENEVA IL 60134
71400	BUSSMANN MFG CO MCGRAW EDISION CO	114 OLD STATE RD PO BOX 14460	ST LOUIS MO 63178
75915	LITTELFUSE INC	800 E NORTHWEST HWY	DES PLAINES IL 60016
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF DIVISION	ST CHARLES ROAD	ELGIN IL 60120
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
83385	MICRODOT MANUFACTURING INC GREER-CENTRAL DIV	3221 W BIG BEAVER RD	TROY MI 48098
86113	MICRODOT MFG INC CENTRAL SCREW- KEENE DIV	149 EMERALD ST	KEENE NH 03431
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61101
S3109	FELLER ASA ADOLF AG C/O PANEL COMPONENTS CORP	355 TESCONI CIRCLE	SANTA ROSA CA 95401
S3629	SCHURTER AG H C/O PANEL COMPONENTS CORP	2015 SECOND STREET	BERKELEY CA 94170
TK1373	PATELEC-CEM (ITALY)	10156 TORINO	VAICENTALLO 62/45S ITALY

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-1	334-6445-00			1	MARKER,IDENT:MKD TEKTRONIX 2246	80009	334-6445-00
-2	367-0289-00			1	HANDLE,CARRYING:13.855,SST	80009	367-0289-00
					ATTACHING PARTS		
-3	212-0144-00			2	SCREW,TPG,TF:8-16 X 0.562 L,PLASTITE	93907	225-38131-012
					END ATTACHING PARTS		
-4	200-3233-00			1	COVER,REAR:	80009	200-3233-00
					ATTACHING PARTS		
-5	211-0691-00			4	SCREW,MACHINE:6-32 X 0.625,PNH,STL	93907	ORDER BY DESCR
					END ATTACHING PARTS		
-6	334-6707-00			1	MARKER,IDENT:MKD CAUTION	80009	334-6707-00
-7	334-6708-00			1	MARKER,IDENT:MKD REAR PANEL Z-AXIS	80009	334-6708-00
-8	----- -----			2	FOOT,CABINET:BLACK POLYURETHANE		
					(NOT REPLACEABLE AT THIS TIME)		
					ATTACHING PARTS		
-9	----- -----			2	(PART OF FIG. 1-8)		
					END ATTACHING PARTS		
-10	390-0980-00			1	CABINET,OSC:GPSB	80009	390-0980-00
-11	213-0882-00			1	SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	83385	ORDER BY DESCR
-12	348-0659-00			2	FOOT,CABINET:BLACK POLYURETHANE	80009	348-0659-00

FIG. 1 CABINET

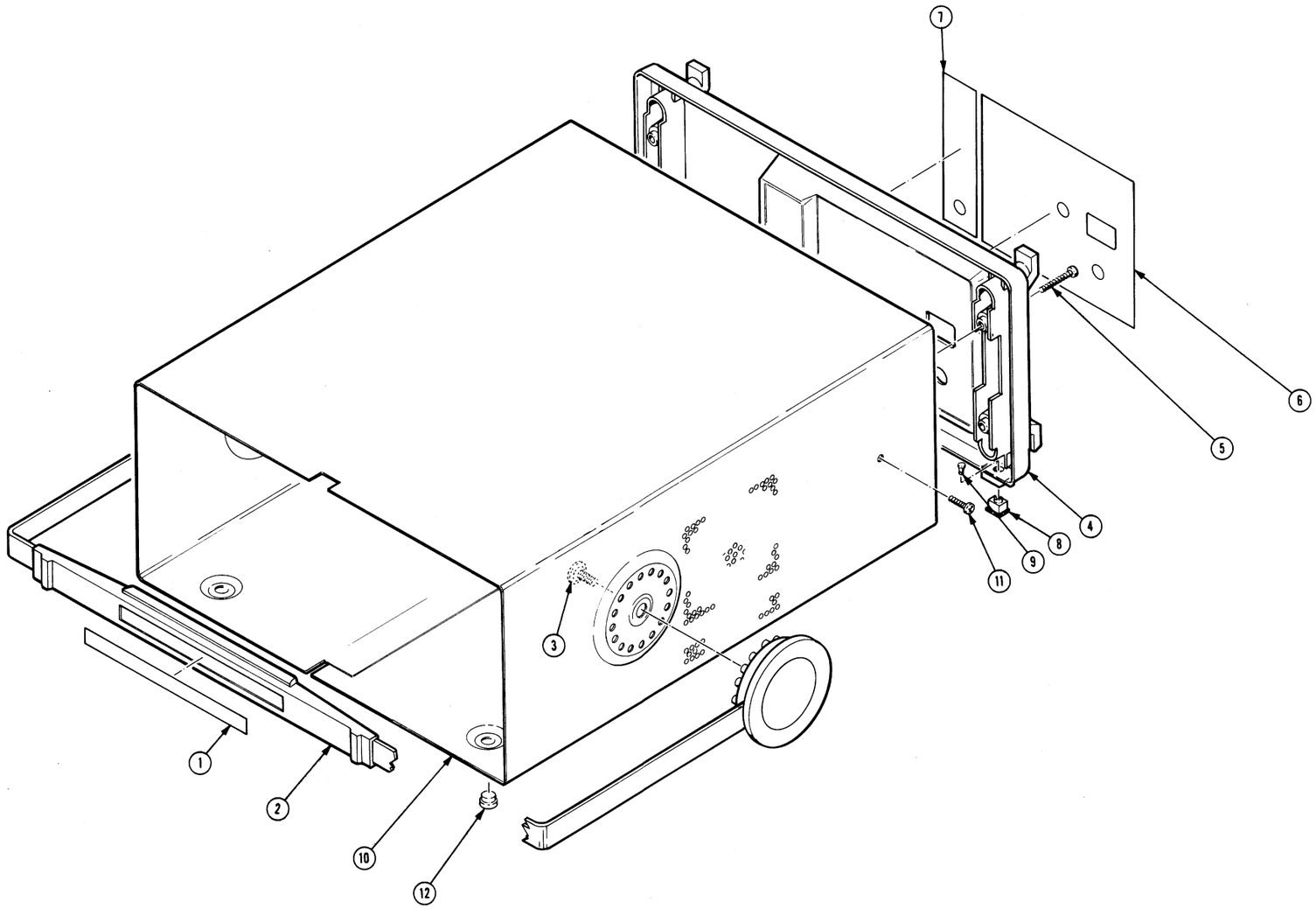


FIG. 2 CHASSIS

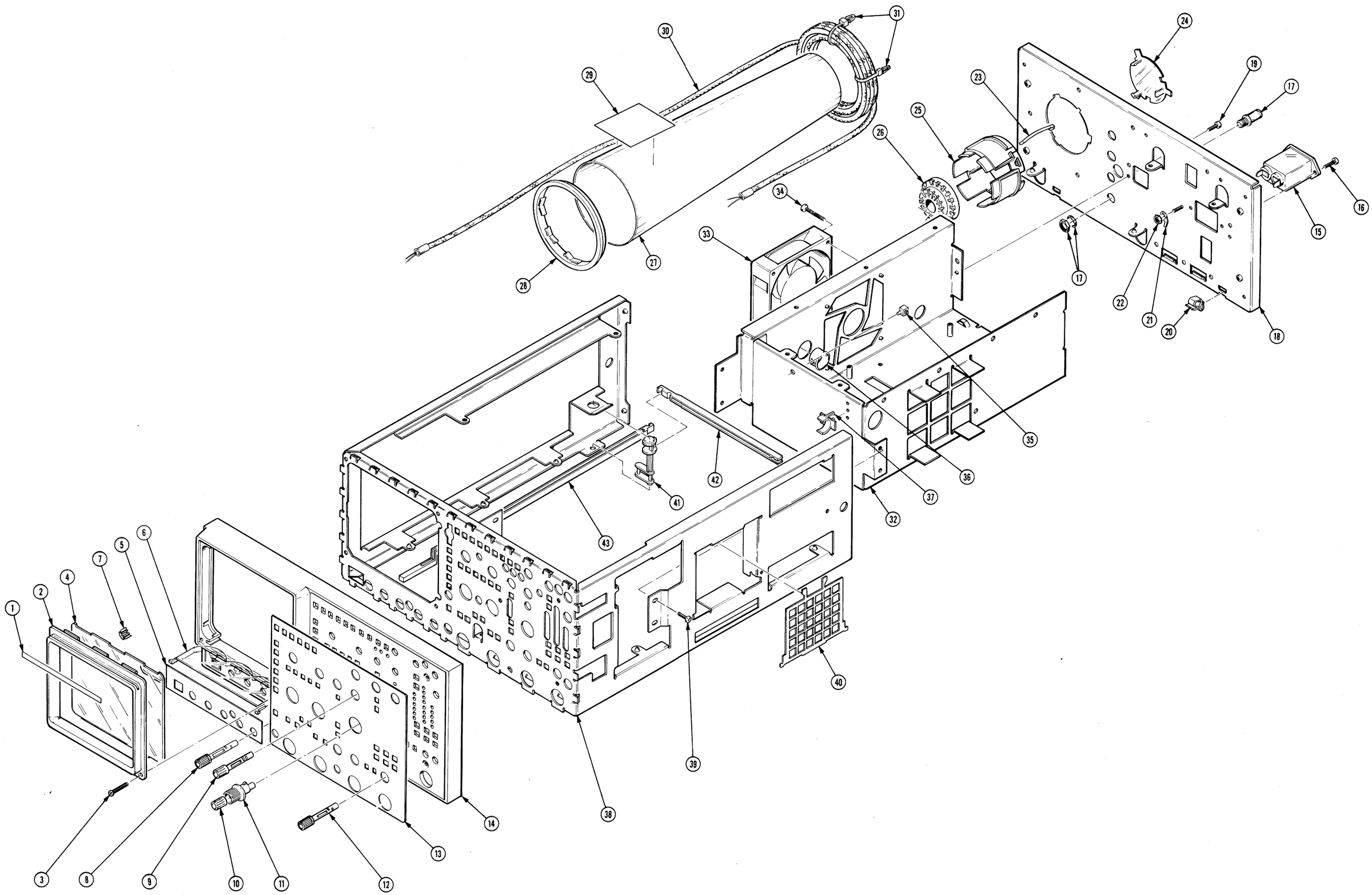


Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-1	334-6446-00			1	MARKER,IDENT:MKD TEKTRONIX 2246	80009	334-6446-00
-2	426-1765-02			1	FRAME,CRT:POLYCARBONATE,GRAY	80009	426-1765-02
					ATTACHING PARTS		
-3	211-0690-01			2	SCREW,MACHINE:6-32 X 0.875 PNH,SST	86113	ORDER BY DESCR
					END ATTACHING PARTS		
-4	337-2775-00			1	SHLD,IMPLOSION:FILTER,BLUE 2211/2213/2215	80009	337-2775-00
-5	333-3290-00			1	PANEL,FRONT:	80009	333-3290-00
-6	351-0752-00			1	GUIDE,LIGHT:ACRYLIC GRATICULE	80009	351-0752-00
-7	348-0660-00			4	CUSHION,CRT:POLYURETHANE	80009	348-0660-00
-8	366-2089-00			5	KNOB:GRAY,PUSH ON,0.185 X 0.392 X 0.495	80009	366-2089-00
-9	366-2093-00			2	KNOB:DOVE GRAY,0.235 X 0.36 X 0.495	80009	366-2093-00
-10	366-1510-00			3	KNOB:DOVE GRAY,VAR,0.127 X 0.392 X 0.466	80009	366-1510-00
-11	366-2090-00			3	KNOB:GRAY,VAR,0.2 ID X 0.546 OD X 0.69 H	80009	366-2090-00
-12	366-2089-00			8	KNOB:GRAY,PUSH ON,0.185 X 0.392 X 0.495	80009	366-2089-00
-13	333-3282-00			1	PANEL,FRONT:	80009	333-3282-00
-14	386-3339-00			1	SUBPANEL,FRONT:	80009	386-3339-00
-15	----- -----			1	FILTER,RFI:(SEE FL2201 REPL)		
					ATTACHING PARTS		
-16	213-0882-00			2	SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	83385	ORDER BY DESCR
					END ATTACHING PARTS		
-17	----- -----			1	CONN,RCPT,ELEC:BNC,FEM (SEE J16 REPL)		
-18	441-1721-00			1	CHASSIS,REAR:GPSB	80009	441-1721-00
					ATTACHING PARTS		
-19	213-0882-00			10	SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	83385	ORDER BY DESCR
					END ATTACHING PARTS		
-20	343-1240-00			2	CLAMP,CABLE:0.25 ID,NYLON	80009	343-1240-00
-21	195-3990-00			1	LEAD,ELECTRICAL:18 AWG,4.5 L,5-4	80009	195-3990-00
					ATTACHING PARTS		
-22	210-0457-00			1	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
					END ATTACHING PARTS		
-23	214-1061-05			1	SPRING,GROUND:PLATED	80009	214-1061-05
-24	200-2519-00			1	CAP,CRT SOCKET:NATURAL LEXAN	80009	200-2519-00
-25	426-1766-00			1	MOUNT,RESILIENT:CRT,REAR	80009	426-1766-00
-26	----- -----			1	WIRE SET ELEC:CRT SOCKET ASSY (SEE A10W9)		
-27	337-2774-00			1	SHIELD,ELEC:CRT,STEEL	80009	337-2774-00
-28	386-4443-00			1	SUPPORT,SHIELD:CRT,FRONT,PLASTIC	80009	386-4443-00
-29	334-1951-00			1	MARKER,IDENT:MKD WARNING,CRT VOLTAGES	80009	334-1951-00
-30	----- -----			1	DELAY LINE,ELEC: (SEE DL21 REPL)		
-31	343-0549-00			2	STRAP,TIEDOWN,E:0.091 W X 4.0 L,ZYTEL	06383	PLT1M
-32	441-1720-00			1	CHAS,PWR SUPPLY:GPSB	80009	441-1720-00
-33	----- -----			1	FAN,TUBEAXIAL: (SEE 825 REPL)		
					ATTACHING PARTS		
-34	213-0991-00			4	SCREW,TPG,TC:6-32 X 1.25 L,TYPE T,PNH,STL	93907	235-30200-024
					END ATTACHING PARTS		
-35	343-1305-00			1	CLP,WIRE SADDLE:0.437 ID,NYLON	80009	343-1305-00
-36	348-0532-00			2	GROMMET,PLASTIC:BLACK,ROUND,0.625 ID	28520	SB-750-10
-37	344-0347-00			1	CLIP,ELECTRICAL:ANODE,0.72 OD,NYLON	80009	344-0347-00
-38	441-1719-00			1	CHASSIS,MAIN:GPSB	80009	441-1719-00
					ATTACHING PARTS		
-39	213-0882-00			6	SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	83385	ORDER BY DESCR
					END ATTACHING PARTS		
-40	378-0295-00			1	GRILLE,AIR DUCT:ALUMINUM	80009	378-0295-00
-41	214-3835-00			1	ARM,PIVOT:POWER SWITCH	80009	214-3835-00
-42	384-1697-00			1	EXTENSION SHAFT:6.25 L X 0.285 OD,NYLON	80009	384-1697-00
-43	384-1696-00			1	EXTENSION SHAFT:12.2 L X 0.285 OD,NYLON	80009	384-1696-00

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
3-1	----- -----			1	CIRCUIT BD ASSY:POTENTIOMETER (SEE A12)		
					ATTACHING PARTS		
-2	214-3826-00			4	LATCH,PLUNGER:BLACK	80009	214-3826-00
	348-0904-00			4	GROMMET,FSTNR:0.187 DIA,BLACK	80009	348-0904-00
					END ATTACHING PARTS		
-3	376-0130-00			3	COUPLER,SHAFT:2.260 L X 0.132 ID,POLY	80009	376-0130-00
	614-0802-00			1	SWITCH PNL ASSY:	80009	614-0802-00
-4	----- -----			1	.CIRCUIT BD ASSY:SWITCH (SEE A14 REPL)		
-5	260-2271-00			1	.SWITCH,PUSH:42 BUTTON,2 POLE	80009	260-2271-00
-6	366-2088-00			21	.PUSH BUTTON:GRAY,0.172 SQ X 0.3 H	80009	366-2088-00
-7	105-0984-01			3	.ACTR SWITCH AS:M/CONTACT	80009	105-0984-01
-8	214-1126-01			3	.SPRING,FLAT:0.7 X 0.125,CU BE GRN CLR	80009	214-1126-01
-9	214-0274-00			3	.BALL,BEARING:0.125 DIA,SST,GRADE 100	52676	ORDER BY DESCR
-10	366-2091-00			17	.PUSH BUTTON:CLEAR,0.312 DIA X 0.3 H	80009	366-2091-00
-11	380-0767-00			1	.HOUSING,SWITCH:POLYCARBONATE	80009	380-0767-00
-12	----- -----			1	CIRCUIT BD ASSY:PROCESSOR (SEE A16 REPL)		
					ATTACHING PARTS		
-13	213-0882-00			12	SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	83385	ORDER BY DESCR
-14	211-0691-00			2	SCREW,MACHINE:6-32 X 0.625,PNH,STL	93907	ORDER BY DESCR
					END ATTACHING PARTS		
-15	337-3290-00			1	SHIELD,ELEC:TOP	80009	337-3290-00
	131-1428-00			1	CONTACT,ELEC:GROUNDING,CU BE CD PL	80009	131-1428-00
-16	----- -----			1	CIRCUIT BD ASSY:LV PWR SPLY (SEE A18 REPL)		
					ATTACHING PARTS		
-17	213-0882-00			6	SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	83385	ORDER BY DESCR
					END ATTACHING PARTS		
-18	204-0906-00			1	.BODY,FUSEHOLDER:3AG & 5 X 20MM FUSES	S3629	TYPEFAU031.3573
-19	200-2264-00			1	.CAP,FUSEHOLDER:3AG FUSES	S3629	FEK 031 1666
-20	214-3821-00			1	.HEAT SK,XSTR:PWR SPLY,GOLD M/CHROMATE PL	80009	214-3821-00
-21	----- -----			1	.TRANSISTOR: (SEE REPL)		
					ATTACHING PARTS		
-22	213-0882-00			2	.SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	83385	ORDER BY DESCR
					END ATTACHING PARTS		
-23	----- -----			1	.TRANSISTOR: (SEE REPL)		
					ATTACHING PARTS		
-24	213-0882-00			1	.SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	83385	ORDER BY DESCR
					END ATTACHING PARTS		
-25	----- -----			1	.TRANSISTOR: (SEE REPL)		
					ATTACHING PARTS		
-26	213-0882-00			1	.SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	83385	ORDER BY DESCR
					END ATTACHING PARTS		
	344-0410-00	B040222		1	.CLIP,COIL SPRT:1 X 1.46,POLYCARBONATE	80009	344-0410-00
-27	342-0781-00			1	INSUL,PWR SPLY:POLYCARBONATE	80009	342-0781-00
-28	----- -----			1	CIRCUIT BD ASSY:MAIN (SEE A10 REPL)		
-29	337-3342-00			2	.SHIELD,ELEC:SAFETY	80009	337-3342-00
-30	334-4251-00			2	.MARKER,IDENT:MKD CAUTION	80009	334-4251-00
-31	337-3358-00			1	.SHIELD,ATTEN:MAIN BOARD	80009	337-3358-00
					ATTACHING PARTS		
-32	211-0690-01			2	.SCREW,MACHINE:6-32 X 0.875 PNH,SST	86113	ORDER BY DESCR
					END ATTACHING PARTS		
-33	337-3279-00			1	.SHIELD,ATTEN:ALUMINUM	80009	337-3279-00
					ATTACHING PARTS		
-34	213-0882-00			10	.SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	83385	ORDER BY DESCR
					END ATTACHING PARTS		
-35	344-0286-00			6	.CLIP,ELECTRICAL:FUSE,SPR BRS	75915	102074
-36	343-0003-00			1	.CLAMP,LOOP:0.25 ID,PLASTIC	06915	E4 CLEAR ROUND
					ATTACHING PARTS		
-37	213-0882-00			1	.SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	83385	ORDER BY DESCR
-38	210-0949-00			1	.WASHER,FLAT:0.141 ID X 0.5 OD X 0.062,BRS	12327	ORDER BY DESCR
					END ATTACHING PARTS		
-39	407-3416-00			1	.BRACKET,ATTEN:BRASS	80009	407-3416-00
-40	----- -----			4	.CONN,RCPT,ELEC:BNC,MALE		
					.(SEE A10J11,J12,J13,J14 REPL)		
					ATTACHING PARTS		
-41	220-0497-00			4	.NUT,PLAIN,HEX:0.5-28 X 0.562 HEX,BRS CD PL	80009	220-0497-00
-42	210-1039-00			4	.WASHER,LOCK:0.521 ID,INT,0.025 THK,SST	24931	ORDER BY DESCR
					END ATTACHING PARTS		

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
3-43	214-3136-00			2		.HEAT SINK,XSTR:TO-5,ALUMINUM	13103	22288
-44	384-1702-00			1		.EXTENSION SHAFT:9.97 L X 0.25,POLYMIDE	80009	384-1702-00
-45	----- -----			1		CIRCUIT BD ASSY:CRT POT CONTROL (SEE A8)		
-46	358-0715-00			1		.BUSHING,SNAP:0.25 X 0.234,NYL,0.375	28520	2810

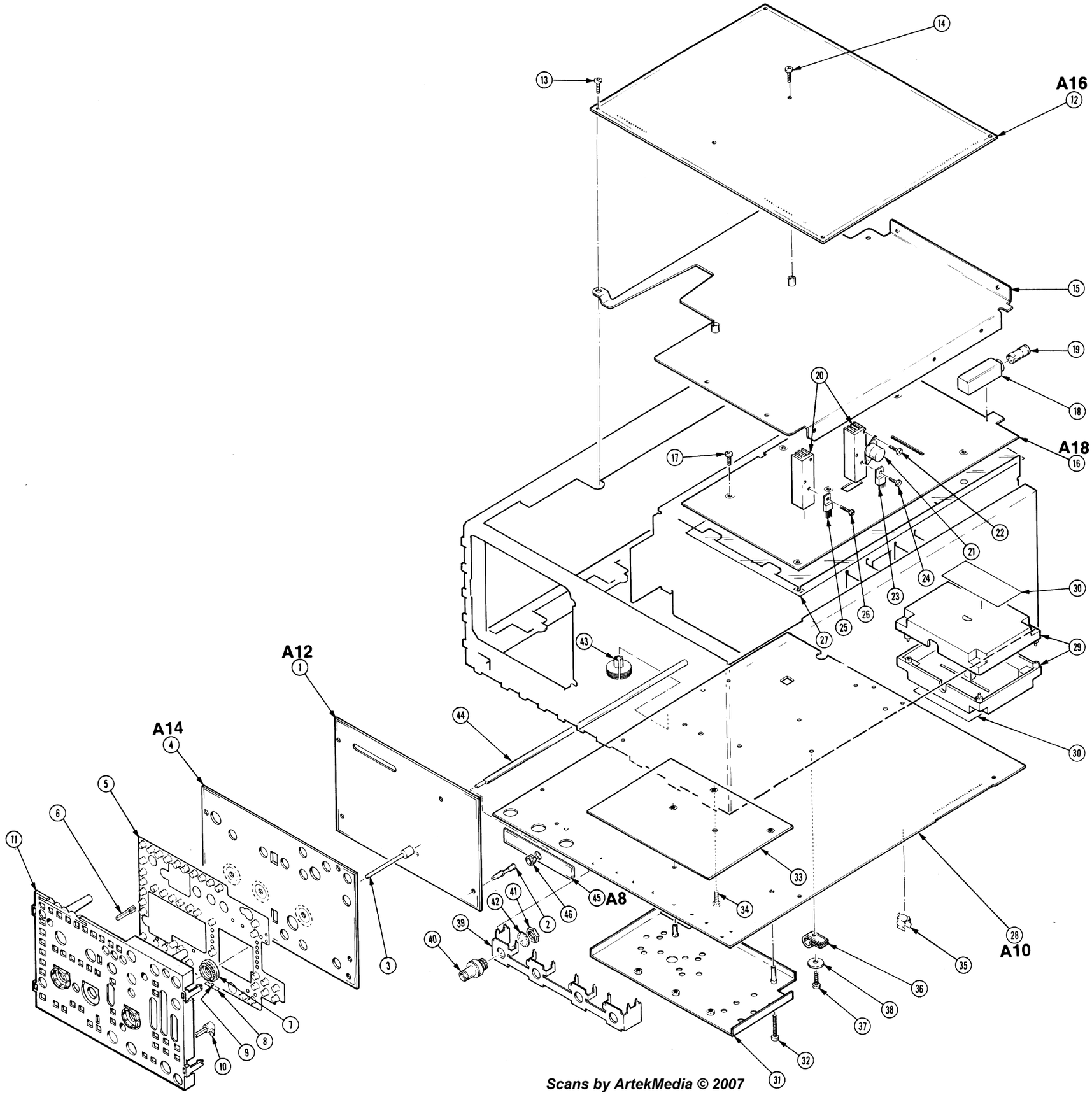


FIG. 4 ACCESSORIES

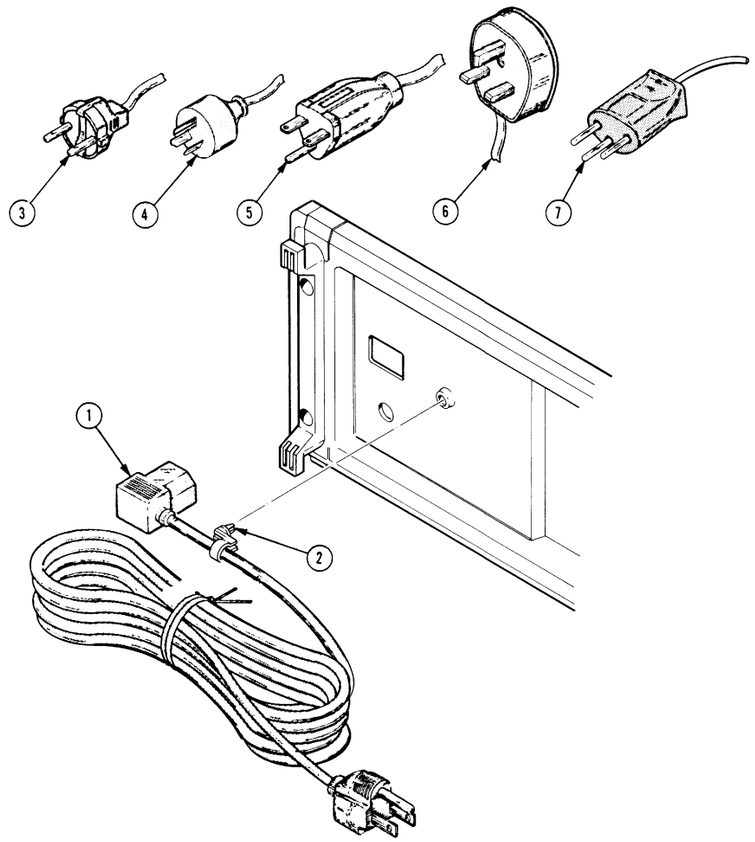


Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
4-								
						STANDARD ACCESSORIES		
-1	161-0104-00	B010100	B041094	1		CABLE ASSY,PWR,:3 WIRE,98.0 L,W/RTANG CONN	16428	CH8352, FH-8352
	161-0230-00	B041095		1		CABLE ASSY,PWR,:3,18 AWG,115V,74.0 L	16428	ORDER BY DESCR
-2	343-1213-00			1		CLAMP,PWR CORD:POLYMIDE	80009	343-1213-00
-3	161-0104-06			1		CABLE ASSY,PWR,:3 X 0.75MM SQ,220V,98.0 L (OPTION A1 - EUROPEAN)	S3109	ORDER BY DESCR
-4	161-0104-05			1		CABLE ASSY,PWR,:3,18 AWG,240V,98.0 L (OPTION A3 - AUSTRALIAN)	S3109	ORDER BY DESCR
-5	161-0104-08			1		CABLE ASSY,PWR,:3,18 AWG,240V,98.0 L (OPTION A4 - NORTH AMERICAN)	70903	ORDER BY DESCR
-6	161-0104-07			1		CABLE ASSY,PWR,:3 X 0.75MM SQ,240V,98.0 L (OPTION A2 - UNITED KINGDOM)	TK1373	A25UK-R0
-7	161-0167-00			1		CABLE ASSY,PWR,:3.0 X 0.75,6A,240V,2.5M L (OPTION A5 - SWITZERLAND)	S3109	ORDER BY DESCR
	004-0130-00			1		BAG,PLASTIC:12.0 X 16.0 X 3 MIL	80009	004-0130-00
	----- -----			1		ACCESSORY PKG:TWO P6109;01 W/ACCESSORIES		
	070-6082-00			1		CARD,INFO:OPERATORS,2246	80009	070-6082-00
	070-6083-00			1		MANUAL,TECH:OPERATORS,2246	80009	070-6083-00
	159-0023-00			1		FUSE,CARTRIDGE:3AG,2A,250V,SLOW BLOW	71400	MDX2
	337-2775-01			1		SHLD,IMPLOSION:	80009	337-2775-01
						OPTIONAL ACCESSORIES		
	----- -----			1		C7 CAMERA W/OPTIONS 03 & 30		
	016-0180-00			1		VISOR,CRT:FOLDING	80009	016-0180-00
	016-0359-01			1		ADAPTER HOOD:	80009	016-0359-01
	016-0592-00			1		VISOR,CRT:	80009	016-0592-00
	016-0848-00			1		COVER,PROT:WATERPROOF VINYL	80009	016-0848-00
	016-0857-00			1		ACCESSORY POUCH:W/PLATE,2246	80009	016-0857-00
	070-6081-00			1		MANUAL,TECH:SERVICE,2246	80009	070-6081-00
	200-3232-00			1		COVER,FRONT:	80009	200-3232-00
	----- -----			1		RACK MOUNT KIT:2245,2246 FIELD INSTALLABLE		
	346-0199-00			1		STRAP,CARRYING:MKD TEKTRONIX	80009	346-0199-00

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: 3-13-87 Change Reference: C1/0387

Product: 2246 SERVICE Manual Part No.: 070-6081-00

DESCRIPTION Product Group 46

Environmental Specification Information

The environmental testing and limits stated in the specification section of this manual were based on an advance copy of the Military Standard publication MIL-T-28800D. That publication has since been scheduled for more revision before its official release. The operating and non-operating temperature and mechanical shock limits stated for the 2246 are valid for the instrument, but the specification limits are not the same as found in Military Standards MIL-T-28800C for Class 3 instruments. As of printing date of this Service manual, MIL-T-28800C is still the official revision.

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MANUAL CHANGE INFORMATION

Date: 4-6-87 Change Reference: C2/0487(REV)

Product: 2246 SERVICE Manual Part No.: 070-6081-00

DESCRIPTION Product Group 46

SEE BELOW FOR EFFECTIVE SERIAL NUMBERS

REPLACEABLE ELECTRICAL PARTS LIST CHANGES

CHANGE TO:

A16	670-9401-02	B041316	CKT BD ASSY: PROCESSOR	M62944
A10CR2701	152-0400-00	B041951	SEMICOND DVC,DI: RECT,SI,400V,1A	M63104
A10CR2702	152-0400-00	B041951	SEMICOND DVC,DI: RECT,SI,400V,1A	M63104
A10CR2703	152-0400-00	B041951	SEMICOND DVC,DI: RECT,SI,400V,1A	M63104
A10CR2704	152-0400-00	B041951	SEMICOND DVC,DI: RECT,SI,400V,1A	M63104
A10CR2714	152-0400-00	B041951	SEMICOND DVC,DI: RECT,SI,400V,1A	M63104
A10CR2715	152-0400-00	B041951	SEMICOND DVC,DI: RECT,SI,400V,1A	M63104
A10CR2716	152-0400-00	B041951	SEMICOND DVC,DI: RECT,SI,400V,1A	M63104
A10CR2717	152-0400-00	B041951	SEMICOND DVC,DI: RECT,SI,400V,1A	M63104
A10CR2718	152-0400-00	B041951	SEMICOND DVC,DI: RECT,SI,400V,1A	M63104
A10R446	313-1201-00	B041657	RES,FXD,FILM: 200 OHM,5%,0.2W	M63103
A10R460	313-1102-00	B041457	RES,FXD,FILM: 1K OHM,5%,0.2W	M63157
A10R1117	313-1162-00	B041203	RES,FXD,FILM: 1.6K OHM,5%,0.2W	M62816
A10R1127	313-1162-00	B041203	RES,FXD,FILM: 1.6K OHM,5%,0.2W	M62816
A16C2521	281-0772-00	B041316	CAP,FXD,CER DI: 4700PF,10%,100V	M62944
A16C2522	281-0772-00	B041316	CAP,FXD,CER DI: 4700PF,10%,100V	M62944
A16C2523	281-0772-00	B041316	CAP,FXD,CER DI: 4700PF,10%,100V	M62944
A16C2524	281-0772-00	B041316	CAP,FXD,CER DI: 4700PF,10%,100V	M62944
A16C2525	281-0772-00	B041316	CAP,FXD,CER DI: 4700PF,10%,100V	M62944
A16C2526	281-0772-00	B041316	CAP,FXD,CER DI: 4700PF,10%,100V	M62944
A16U2519	160-4082-02	B041316	MICROCKT,DGTL: 65536 X 8 EPROM W/3 ST OUT	M62944
A16U2520	160-4083-02	B041316	MICROCKT,DGTL: 256K UV ERASEABLE PROM,PRGM	M62944

ADD:

A10C489	281-0765-00	B041657	CAP,FXD,CER DI: 100PF,5%,100V	M63103
A10CR802	152-0061-00	B041564	SEMICOND DVC,DI: SW,SI,175V,0.1A	M63001
A10R607	313-1510-00	B041657	RES,FXD,FILM: 51 OHM,5%,0.2W	M63103

DESCRIPTION

DIAGRAM CHANGES

DIAGRAM 3 A AND B TRIGGER SYSTEM

Change the value of resistors R1117 and R1127 (location 4F) to 1.6KΩ. M62816

Change the value of resistor R446 (location 2M) to 200Ω. M63103

Change the value of resistor R460 (location 6K) to 1KΩ. M63157

Add capacitor C489 (100pF) between pins 9 and 12 of U421 (location 4C). M63103

Add resistor R607 (51Ω) in series between W414 and C611 (location 2M) as shown here. M63103

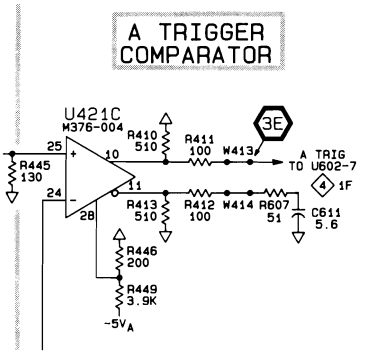

DIAGRAM 6 HORIZONTAL OUTPUT AMPLIFIER

Add diode CR802 at location 3L as shown here. M63001

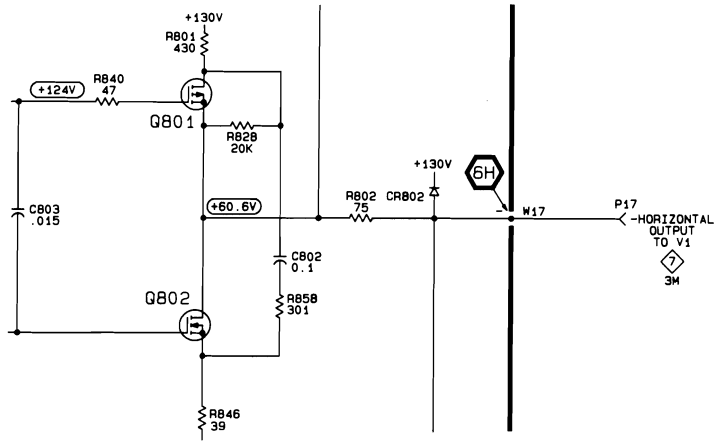

DIAGRAM 10 SWITCH BOARD & INTERFACE

Change the value of capacitor C2521 (location 2F) to 4700pF. M62944

Change the value of capacitor C2522 (location 2G) to 4700pF. M62944

Change the value of capacitor C2523 (location 1H) to 4700pF. M62944

Change the value of capacitor C2524 (location 1J) to 4700pF. M62944

Change the value of capacitor C2525 (location 1J) to 4700pF. M62944

Change the value of capacitor C2526 (location 1K) to 4700pF. M62944

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MANUAL CHANGE INFORMATION

Date: 4-8-87 Change Reference: M63369

Product: 2246 SERVICE Manual Part No.: 070-6081-00

DESCRIPTION Product Group 46

EFFECTIVE SERIAL NUMBER: B042397

REPLACEABLE ELECTRICAL PARTS LIST CHANGES

ADD:

A10XU210	136-0252-07	SOCKET,PIN CONN: W/0 DIMPLE (QUANTITY 15)
A10XU220	136-0252-07	SOCKET,PIN CONN: W/0 DIMPLE (QUANTITY 18)
A10XU230	136-0252-07	SOCKET,PIN CONN: W/0 DIMPLE (QUANTITY 18)
A10XU240	136-0252-07	SOCKET,PIN CONN: W/0 DIMPLE (QUANTITY 18)

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MANUAL CHANGE INFORMATION

Date: 4-14-87 Change Reference: M63453

Product: 2246 SERVICE Manual Part No.: 070-6081-00

DESCRIPTION Product Group 46

EFFECTIVE SERIAL NUMBER: B042334

REPLACEABLE ELECTRICAL PARTS LIST CHANGES

CHANGE TO:

A10R171	313-1471-00	RES,FXD,FILM: 470 OHM,5%,0.2W

DIAGRAM CHANGES

DIAGRAM 1 VERTICAL INPUTS

Change the value of resistor R171 (location 5B) to 470Ω.