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

468
DIGITAL STORAGE OSCILLOSCOPE

SERVICE
VOLUME I

INSTRUCTION MANUAL

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

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Product Group 40

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

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

Symbols as Marked on Equipment

DANGER – High voltage.

Protective ground (earth) terminal.

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 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 connecting 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 insulating) 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 2-2.

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.

Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product 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 product 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 conductor in the power cord is essential for safe operation.

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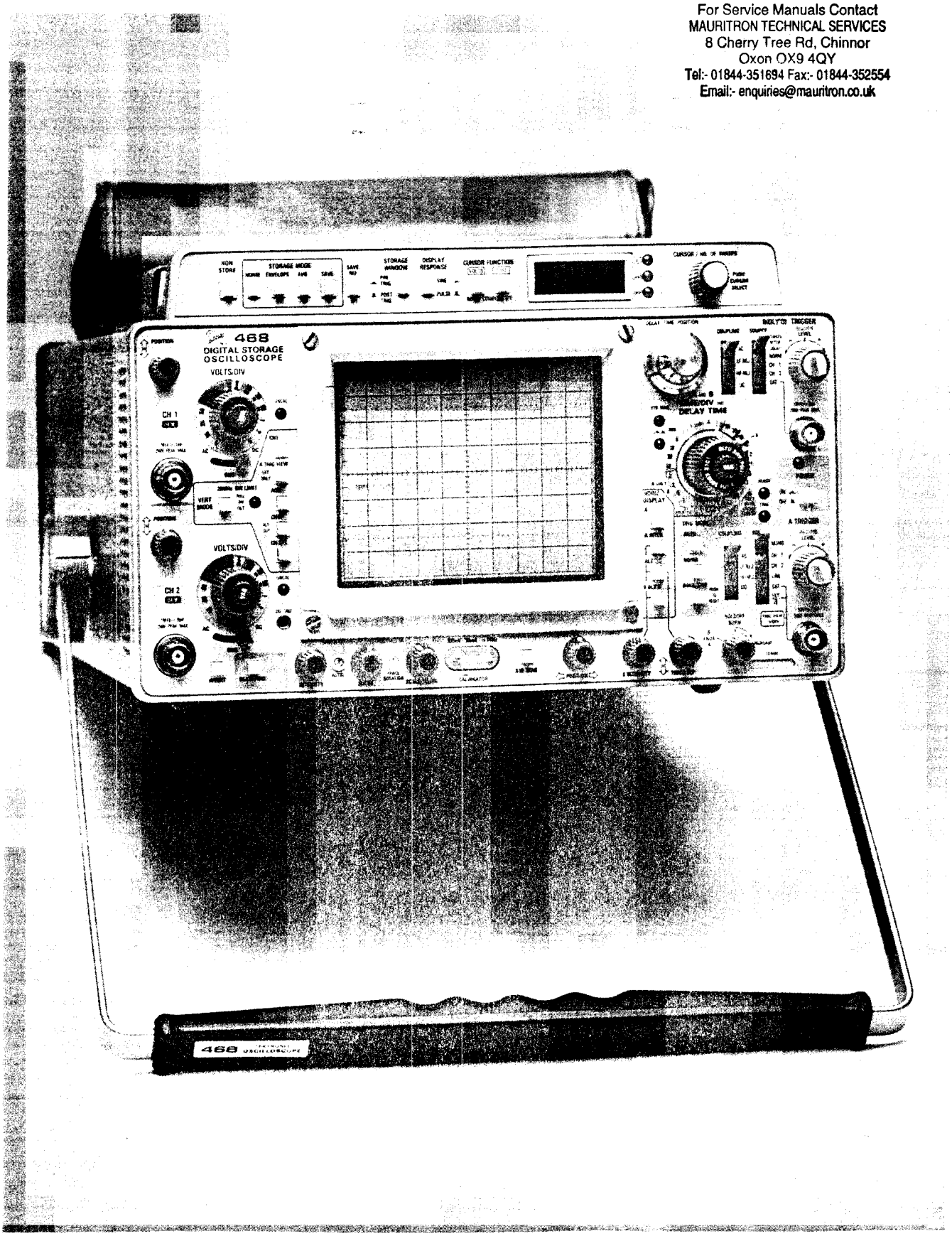

The 468 Digital Storage Oscilloscope.

3515-01

SPECIFICATION

INTRODUCTION

The TEKTRONIX 468 Oscilloscope is a portable digital storage oscilloscope with a four-trace, dc-to-100 MHz, vertical deflection system. The 468 combines an easy-to-use storage function with cursor measurement of time and voltage. Measurement values are indicated on a four-digit, seven-segment LED display.

NON STORE MODE

In the NON STORE mode, the 468 operates as a conventional oscilloscope that can display CH 1, CH 2, ADD, and A TRIG VIEW (external trigger only) simultaneously. The vertical deflection system has calibrated deflection factors ranging from 5 mV to 5 V per division. The horizontal deflection system has calibrated A Sweep rates from 0.5 s to 0.02 μs per division and is capable of operating in the following sweep modes: A, A intensified by B, A alternated with delayed B, and B delayed. The calibrated B Sweep rates are from 50 ms to 0.02 μs per division.

The horizontal magnifier circuit feature increases each sweep rate by a factor of 10. This provides a maximum sweep rate of 2 ns per division when the TIME/DIV switch is in the 0.02 μs per division position.

STORAGE MODE

The 468 digital storage circuitry has a 10 MHz Useful Storage Bandwidth for the acquisition of signals, and will display the acquired waveform with a bright, flicker-free trace. With the digital storage feature, low-frequency signal analysis and waveform measurements—previously difficult or impossible to make—are easily performed. A choice of two standard and one optional signal acquisition modes are available: NORM and ENVELOPE (standard) and AVG (optional). Two storage functions are available to hold a display indefinitely for measurement and comparison: SAVE Storage Mode (stops acquisition) and SAVE REF (holds a reference display and continues acquisition in the selected Storage Mode). Using the PRE TRIG or POST TRIG Storage Window, waveform data may be acquired prior to or after the trigger. Time and voltage measurements on the acquired waveform are easily made using the VOLTS and TIME Cursor Functions, and the measurement values are indicated on a four-digit, seven-segment light-emitting diode (LED) display.

Digital storage adds three TIME/DIV switch positions, increasing the storage time base to 5 s per division (a total sweep time of 50 s). The waveshape of signals acquired at these low frequencies would be impossible to view on a conventional oscilloscope. Digital storage circuitry, however, constantly refreshes an acquired waveform to produce a directly viewable display for ease of analysis and measurement. Three added VOLTS/DIV switch positions increase the digital storage vertical deflection sensitivity up to 0.5 mV per division. Small-amplitude signals are acquired at 5 mV per division and are amplified to produce the added sensitivity.

The digital storage signal acquisition modes are NORM and ENVELOPE Storage Modes and an optional AVG Storage Mode. Selecting NORM Storage Mode causes acquisition and display of a new waveform with each trigger. The display in this mode most resembles conventional oscilloscope displays, and waveforms acquired will react to the oscilloscope front-panel controls with each trigger.

When ENVELOPE Storage Mode is chosen, the maximum and minimum waveform values for a selected number of sweeps are acquired, and the resultant waveform envelope is displayed. This mode is useful for detecting noise and spurious or erratic signals.

Choosing the optional AVG Storage Mode allows waveforms to be acquired for a selected number of sweeps and causes the averaged value of the acquired signals to be displayed. In this mode, signal-to-noise ratio is improved in direct proportion to the square root of the number of sweeps acquired, and noise accompanying the signal is either averaged out or reduced to a small level. The signal acquired in the AVG Storage Mode is processed to increase the vertical resolution of the displayed signal. This feature is very useful for displaying small-amplitude signals acquired in the 0.5, 1, and 2 mV per division positions of the VOLTS/DIV switch.

Once the desired signal is obtained in storage, the signal acquisition may be halted and the display frozen by selecting the SAVE Storage Mode. The waveform will remain displayed indefinitely for analysis and measurement purposes. In the SAVE mode, the next six faster positions of the TIME/DIV switch (if available) horizontally expand the display (up to 100 times). Additionally, signals acquired at sweep rates of 1 μs per division or faster may be reduced back to the 2 μs per division acquisition rate.

The SAVE display may also be expanded vertically (up to 10 times) with the next three higher deflection sensitivity positions of the VOLTS/DIV switch (if available) for the channel used to obtain the SAVE display. Signals obtained in the NORM or ENVELOPE Storage Mode at VOLTS/DIV switch settings 0.5, 1 or 2 mV per division may be reduced back to the 5 mV per division deflection sensitivity if desired. The SAVE display of a waveform acquired in the AVG Storage Mode may be expanded, but it may not be reduced below the deflection sensitivity at which the signal was acquired.

When the SAVE REF push button is pressed in, the waveform being displayed at that time will be stored and held on the display while the digital storage continues to acquire data. The SAVE REF display is then available for comparison with signals obtained from other circuits, or it can be used as a before-and-after check on circuit operation when changes or adjustments are made to the circuit under test. A new reference waveform is obtained each time the button is released and then pressed in again. Displaying the reference signal reduces the number of vertical mode possibilities that the 468 is capable of displaying simultaneously.

The time window used to obtain a stored waveform may be set to acquire either aproximately 8.75 horizontal divisions of waveform data occurring before the triggering signal (in PRE TRIG Storage Window) or the same amount of waveform data occurring after the triggering signal (in POST TRIG Storage Window). The PRE TRIG feature is useful for analyzing events that might cause an error to occur. If the oscilloscope is set to trigger on the error, data immediately prior to the error is stored for analysis. POST TRIG Storage Window most resembles conventional triggering; but while conventional oscilloscope triggering usually starts the sweep, POST TRIG Storage Window triggering does not occur until approximately 1.25 horizontal divisions of waveform data are acquired.

Voltage and time measurements are made directly on the displayed waveform. Pressing in the VOLTS Cursor Function push button causes two horizontal lines (VOLTS Cursors) to be presented on the display. Only one cursor at a time is positionable using the CURSOR control knob. The active cursor is displayed as a dashed line, while the fixed cursor is a solid line. Voltage difference (as represented by the cursor positions) is directly read on the seven-segment LED display, and the appropriate measurement scale factor is shown on the three dual-color (red and green) LED indicators to the right of the seven-segment LED display. Time measurements are made using two bright, positionable dots that appear on the trace when the TIME Cursor Function button is pressed in. The TIME cursor dots are positioned to the desired measurement points, and the time difference between the dots is directly read on the LED display.

A COUPLED V/T measurement mode is made available by pressing in both the VOLTS and TIME Cursor Function push buttons. In this mode, the TIME dots attach to the VOLTS cursors, and the VOLTS cursors will never be displayed beyond the limits of the waveform. The COUPLED V/T mode is useful for slope, peak-to-peak amplitude, and time duration measurements. While the cursors are coupled, the LED readout will display the voltage difference between the cursors.

In instruments factory equipped or converted to firmware version 2.0 or higher, the COUPLED V/T mode is also useful for making asolute dc-voltage measurements with respect to ground.

AVAILABLE OPTIONS

Option 02 is the General Purpose Interface Bus (GPIB), used to transmit the waveform data stored in the display memory. The waveform data transmitted will conform to the Waveform Transmission Standard as specified in the Tektronix Interface Standard—General Purpose Interface Bus (GPIB), Codes and Formats.

Option 12 is the AVE Storage Mode. This option will acquire data for a selected number of sweeps (from 2 to 256 in a binary sequence) and display the average waveform accumulated.

NOTE

The AVE Storage Mode is part of the standard instrument above SN B032430.

Option 04 (EMC provides additional reduction of electromagnetic interference.

Option 05 provides the instrument with front-panel selection of additional trigger-signal processing capabilities to facilitate observation and measurement of composite video and related television waveforms.

Option 11 enables the 468 to convert the digital data stored in memory into analog X and Y outputs for driving an X-Y Plotter.

SPECIFICATION TABLES

The following electrical characteristics (Table 1-1) are valid only if the instrument has been calibrated at an ambient temperature between +20°C and +30°C, the instrument is operating at an ambient temperature between −15°C and +55°C (unless otherwise noted), and the instrument has had a warmup period of about 20 minutes.

Environmental characteristics are given in Table 1-2. The 468 meets the requirements of MIL-T-28800B, Class 3, Style D equipment. Physical characteristics are listed in Table 1-3, and option electical characteristics are presented in Table 1-4.

Table 1-1

Electrical Characteristics

Characteristics	Performance Requirements	Supplemental Information
VERTICAL SYSTEM		
Deflection Factor (Nonstorage Mode)		
Range		5 mV per division to 5 V per division in a 1-2-5 sequence of 10 steps.
DC Accuracy	Graticule indication is within 3% of true input voltage up to ±12 divisions, referenced to instrument ground, for all calibrated VOLTS/DIV switch settings.	Gain set with VOLTS/DIV switch set to 5 mV per division.
Uncalibrated (VAR) Range (Nonstorage Mode)	Continuously variable between settings of VOLTS/DIV switch. Extends deflection factor to at least 12.5 V per division.	
Low-Frequency Linearity		0.1 division or less compression or expansion of a 2-division signal at center screen with waveform positioned to upper and lower extremes of graticule area.
Frequency Response		5-division reference signal from a 25-Ω source; centered vertically, with VAR VOLTS/DIV control in calibrated detent.
Bandwidth (Channel 1 and Channel 2 Nonstorage Mode)		
−15°C to +40°C	Dc to at least 100 MHz.	
+40°C to +55°C	Dc to at least 85 MHz.[a]	
AC Coupled Lower −3 dB Point		
1X Probe	10 Hz or less.	
10X Probe	1 Hz or less.	

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[a]Performance requirement not checked in manual.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
	VERTICAL SYSTEM (cont)	
Step Response (Non-Storage Mode)		5-division reference signal, dc coupled at all deflection factors, from a 25-Ω source; vertically centered with VAR VOLTS/DIV control in calibrated detent.
Rise Time		
0°C to +40°C	3.5 ns or less (calculated).[a]	Rise Time = $\frac{0.35}{\text{BW (in MHz)}}$
Positive-Going Step (Excluding ADD Mode)		
Aberrations		
0°C to +40°C		+4%, −4%, 4% p-p or less. +6%, −6%, 6% p-p or less (5 V setting only).
Position Effect		
0°C to +40°C		Total aberrations less than +6%, −6%, 6% p-p; checked at 5 mV per division.
Negative-Going Step		Add 2% to all positive-going specifications; checked at 5 mV per division.
ADD Mode Operation		Add 5% to all aberration specifications; checked at 5 mV per division.
Common Mode Rejection Ratio (ADD Mode With Channel 2 Inverted)		At least 10:1 at 20 MHz for common mode signals of 6 divisions or less with GAIN adjusted for best CMRR at 50 kHz. (10:1 at 10 MHz for storage mode.)
Trace Shift as VAR VOLTS/DIV Control Is Rotated		1 division or less. Digital Storage scale-factor LED will indicate voltage measurements are in divisions in a storage mode with the VAR control out of calibrated detent.
INVERT Trace Shift		Less than 2 divisions when switching from non-inverted to inverted.
Input Gate Current		
+20°C to +30°C		0.5 nA or less (0.1 division or less trace shift when switching input coupling between DC and GND with VOLTS/DIV switch set to 5 mV per division).
−15°C to +55°C		4 nA or less (0.8 division or less trace shift when switching input coupling between DC and GND with VOLTS/DIV switch set to 5 mV per division).

[a]Performance requirement not checked in manual.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
VERTICAL SYSTEM (cont)		
Channel Isolation		At least 100:1 at 25 MHz (10 MHz in storage).
Vertical POSITION Range		At least +12 and −12 divisions from graticule center.
Chopped Mode Repetition Rate (Nonstorage Mode)	Approximately 500 kHz.	Within 20%.
Input R and C		
Resistance	1 MΩ, within 2%.[a]	
Capacitance	Approximately 20 pF.[a]	
R and C Product (+20°C to +30°C)		Aberrations 2% or less using a P6105 probe.
Maximum Input Voltage		
DC Coupled	250 V (dc + peak ac).[a] 500 V (p-p ac at 1 kHz or less).[a]	
AC Coupled	250 V (dc + peak ac).[a] 500 V (p-p ac at 1 kHz or less).[a]	
Cascaded Operation		CH 1 VERT OUT SIGNAL OUT coupled into CH 2 input; ac coupled, using 50-Ω, 42-inch RG-58 C/U cable, terminated in 50 Ω at the CH 2 input connector.
Bandwidth (Nonstorage)	Dc to at least 50 MHz.	
Cascaded Sensitivity	At least 1 mV per division; terminated in 50 Ω at the CH 2 input connector.	
DIGITAL STORAGE VERTICAL ACQUISITION		
Resolution		8 bits, 25 levels per division. 10.24 divisions dynamic range.
DC Accuracy	Scaled binary value of stored digital word is within 3% of true input voltage up to ±12 divisions, referenced to instrument ground, for all calibrated VOLTS/DIV switch settings.	Gain set with VOLTS/DIV set to 5 mV per division.
Range		0.5 mV to 5 V per division in a 1-2-5 sequence of 13 steps.
Digital Sample Rate		10 Hz to 25 MHz as determined by the TIME/DIV switch setting.

[a]Performance requirement not checked in manual.

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Table 1-1 (cont)

Characteristics	Performance Requirements		Supplemental Information
DIGITAL STORAGE VERTICAL ACQUISITION (cont)			
Digital Chop Rate			5 Hz to 12.5 MHz (1/2 of the non-chopped sample rate at all TIME/DIV switch settings).
Analog Step Response	3% or less acquired overshoot on a 5-division pulse with Display Response set to PULSE.		Checked on a saved waveform display using horizontal expansion (X10 MAG off).
Analog Bandwidth	Dc to 10 MHz, within ±1 dB, measured in ENVELOPE Storage Mode with the TIME/DIV switch set to 1 ms.		At exactly 10 MHz input signal frequency, it is possible for aliasing to occur and produce an envelope with variable amplitude. If aliasing occurs, shift the test frequency slightly to obtain an envelope with flat amplitude.
Useful Storage Bandwidth			
NORM Storage Mode	**Single Trace or Alt**	**CHOP**	
SINE Display Response	Dc to 10 MHz, within +1, −3 dB, measured p-p over any single cycle, with TIME/DIV switch set to 0.2 μs (X10 MAG off).	Dc to 5 MHz, within +0.5, −1.5 db, measured p-p over any single cycle, with TIME/DIV switch set to 0.2 μs (X10 MAG off).	For SINE Display Response, useful storage bandwidth is limited to that frequency where there are 2.5 samples per input cycle period at the maximum sampling rate (max sampling rate is 25 MHz in Single Trace or ALT and 12.5 MHz in CHOP). Accuracy at useful storage bandwidth limit is measured with respect to a 6 division, 50 kHz reference sine wave.
PULSE Display Response	Dc to 3.5 MHz, within +0.5, −1.5 dB, measured p-p over any single cycle, with TIME/DIV switch set to 0.2 μs (X10 MAG off).	Dc to 1.75 MHz, within +0.5, −1.5 db, measured p-p over any single cycle, with TIME/DIV switch set to 0.2 μs (X10 MAG off).	For PULSE Display Response, useful storage bandwidth is limited to that frequency where there are 7 samples per input cycle period at the maximum sampling rate (max sampling rate is 25 MHz in Single Trace or ALT and 12.5 MHz in CHOP). Accuracy at useful storage bandwidth limit is measured with respect to a 6-division, 50-kHz reference sine wave.
Useful Storage Rise Time			Useful storage rise time is defined as 1.6 times the minimum sampling interval (40 ns in Single Trace or ALT and 80 ns in CHOP).
NORM Storage Mode			
PULSE Display Response	64 ns.	128 ns.	

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
	TRIGGERING	
Sensitivity		In EXT/10, multiply requirements by 10.
AC Coupled Signal	0.3 division internal or 50 mV external from 30 Hz to 10 MHz; increasing to 1.5 divisions internal or 150 mV external up to 100 MHz.	
LF REJ Coupled Signal	0.5 division internal or 100 mV external from 50 kHz to 10 MHz; increasing to 1.5 divisions internal or 300 mV external up to 100 MHz.	Attenuates signals below approximately 50 kHz.
HF REJ Coupled Signal	0.5 division internal or 100 mV external from 30 Hz to 50 kHz.	Attenuates signals above approximately 50 kHz.
DC Coupled Signal	0.3 division internal or 50 mV external from dc to 10 MHz; increasing to 1.5 divisions internal or 150 mV external up to 100 MHz.	
Trigger Jitter		
Nonstorage Mode	0.5 ns or less at 100 MHz at 2 ns per division (X10 MAG on).	
Storage Mode	±1 sample period for data transmitted on the GPIB. See Jitter Correction Performance Requirement.[a]	Inherent ±1 sample jitter between sample clock and asynchronous trigger is partially compensated for by the jitter correction circuitry.
External Trigger Inputs		
Maximum Input Voltage	250 V (dc + peak ac).[a] 250 V (p-p ac at 1 kHz or less).[a]	
Input Resistance	1 MΩ within 10%.[a]	
Input Capacitance		Approximately 20 pF, within 30%.
LEVEL Control Range		
EXT	At least + and −2 V, 4 V p-p.	
EXT/10	At least + and −20 V, 40 V p-p.	
A External Trigger View (Nonstorage Mode Only)		
Deflection Factor		Dc trigger coupling only; checked with a 1 kHz signal.
EXT	100 mV per division ±5%.	
EXT/10	1 V per division ±5%.	

[a]Performance requirement not checked in manual.

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Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
TRIGGERING (cont)		
A External Trigger View (Nonstorage Mode Only) (cont)		
Rise Time	5 ns or less.[a]	BW Limit at full (button out).
Delay Difference	⩽±0.20 division (⩽±400 ps at 2 ns per division).	5-div signal with 5 ns rise time or less from a 25-Ω source; centered vertically with equal 50-Ω cable length from signal source to vertical channel and external trigger input connectors; terminated in 50-Ω at each input.
Centering of Triggering Point		Within 1 division of center screen.
Flatness and Aberrations		+10%, −10%, 10% p-p.
HORIZONTAL DEFLECTION SYSTEM		
Sweep Rate (Nonstorage Mode)		
Calibrated Range		
A Sweep		0.5 s/div to 0.02 μs/div in 23 steps in a 1-2-5 sequence. X10 MAG extends maximum sweep rate to 2 ns/div.
B Sweep		50 ms/div to 0.02 μs/div in 20 steps in a 1-2-5 sequence. X10 MAG extends maximum sweep rate to 2 ns/div.
Accuracy	Within the given percentages of the indicated value.	Accuracy specification applies over the full 10 div of the unmagnified sweep.
	Unmagnified / **Magnified**	In X10 MAG, at TIME/DIV switch setting of .02 μs, .1 μs, and .2 μs, exclude the first and last 50 ns of the sweep; and at a TIME/DIV switch setting of .5 μs, exclude the first 100 ns of the sweep.
+20°C to +30°C	Within 2% / Within 3%	
−15°C to +55°C	Within 3%[a] / Within 4%[a]	
Two-Division Linearity Check		±5% over any two-division portion (or less) of the full 10 div. When in X10 MAG exclude first and last magnified div when checking 2 ns,5 ns, and 10 ns/div rates.
Alternate Sweep Trace Separation (Nonstorage Mode Only)		⩾±4 divisions.
Variable Range (A Only) (Nonstorage Mode)	Continuously variable between calibrated settings of the A TIME/DIV switch. Extends slowest A sweep rate to at least 1.25 s/div.	At least 2.5:1.

[a]Performance requirement not checked in manual.

Table 1-1 (cont)

Characteristics	Performance Requirements		Supplemental Information
HORIZONTAL DEFLECTION SYSTEM (cont)			
A Sweep Length (Nonstorage Mode)			10.5 to 11.5 divisions.
A Trigger HOLDOFF (Variable)			Increases A sweep holdoff time by at least a factor of 10 (Nonstorage Mode). Storage holdoff time is a function of microprocessor operation.
Magnifier Registration			Within 0.2 division from graticule center (X10 MAG on to X10 MAG off).
POSITION Range (Horizontal)			Start of sweep must position to right of graticule center. End of sweep must position to left of graticule center.
Differential Time Measurement Accuracy (Nonstorage Mode)	**Measurements of 1 or more major dial divisions**	**Measurements of less than 1 major dial division**	With the A TIME/DIV switch at 0.5 μs per division, or 0.2 μs per division, the differential time measurement accuracy limit is valid only for DELAY TIME POSITION dial settings between 1.50 and 8.50.
+15°C to +35°C	Within 1% of indicated value.	±0.01 major dial division.	
−15°C to +55°C	Within 2.5% of indicated value.[a]	±0.03 major dial division.[a]	
Delay Time Jitter (Nonstorage Mode)	One part or less in 50,000 (0.002% of 10 times the A TIME/DIV switch setting) when operating on an ac-power-source frequency above 50 Hz. One part or less in 20,000 (0.005% of A TIME/DIV switch setting) when operating on a 50-Hz or lower ac-power source frequency.[a]		**For Service Manuals Contact** **MAURITRON TECHNICAL SERVICES** 8 Cherry Tree Rd, Chinnor Oxon OX9 4QY **Tel:- 01844-351694 Fax:- 01844-352554** **Email:- enquiries@mauritron.co.uk**
Calibrated Delay Time (VAR Control in Calibrated Detent)	Continuous from 0.2 μs to at least 5 s after the delaying (A) sweep.		
X-Y Operation (Nonstorage Mode Only)			
X-Axis Deflection Factor	Same as vertical system, with X10 MAG off.		
Variable Range	Same as vertical system.		
X-Axis Bandwidth	Dc to at least 4 MHz.		10-division reference signal.
Input Resistance	Same as vertical system.[a]		
Input Capacitance	Same as vertical system.[a]		

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

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
HORIZONTAL DEFLECTION SYSTEM (cont)		
X-Y Operation (Nonstorage Mode Only) (cont)		
Maximum Usable Input Voltage	Same as vertical system.[a]	
Phase Difference Between X and Y Amplifiers		Within 3° from dc to 50 kHz.
Deflection Accuracy	Graticule indication is within 4% of true input voltage.	
DIGITAL STORAGE HORIZONTAL ACQUISITION		
Horizontal Resolution		
Single Waveform Acquisition		9 bit. 512 data points (50 data points per division across the graticule area).
Chopped Acquisition (NORM Storage Mode Only)		8 bit. 256 data points per division (25 data points per division across the graticule area).
Range		5 s per division to 20 ns per division in a 1-2-5 sequence. At TIME/DIV switch settings of 5 s to 2 μs, waveform sampling rate is determined by the switch setting. From 1 μs to 0.02 μs per division, sampling rate is at the 2 μs per division rate. Interpolation and analog gain are used to expand the signal to the correct horizontal scale.
Accuracy (Sample Period)		Sample clock is within 0.01% of selected sample period, ±50 ps ADC aperture uncertainty. Crystal oscillator: 0°C to +70°C V_{cc} = +5 V ±0.5 V.
Dynamic Range	10.24 divisions.	
STORAGE DISPLAY		
Vertical		
Resolution		1 part in 1024 (10 bit). Calibrated for 100 points per division.
Differential Accuracy	Graticule indication of voltage cursor difference is within 2% of LED readout value, measured over center six divisions.	

[a]Performance requirement not checked in manual.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
	STORAGE DISPLAY (cont)	
Vertical (cont) POSITION Range		Any portion of a stored waveform vertically magnified X10 can be positioned to the top and to the bottom of the graticule area.
Position Registration NON STORE to NORM		Within ± 0.5 division at graticule center at VOLTS/DIV settings from 5 mV to 5 V per division.
NORM, ENVELOPE, or AVG to SAVE		Within ±0.2 divisions at VOLTS/DIV settings from 5 mV to 5 V per division.
SAVE Mode Gain Range (Vertical)		Up to X10 as determined by the setting of the VOLTS/DIV switch.
ENVELOPE Fill		90% or more of a six division ENVELOPE display.
Rise Time	For Service Manuals Contact MAURITRON TECHNICAL SERVICES 8 Cherry Tree Rd, Chinnor Oxon OX9 4QY Tel:- 01844-351694 Fax:- 01844-352554 Email:- enquiries@mauritron.co.uk	⩽ 0.3 horizontal graticule division for a five-division step, with horizontal X10 MAG on. Checked with no samples on the rising edge of the waveform.
Aberrations		+6%, −6%, 6% p-p or less on a five-division step (fast rise) input.
Horizontal Resolution		1 part in 1024 (10 bit). Calibrated for 100 points per division.
Differential Accuracy	Graticule indication of time cursor difference is within 2% of LED readout value, measured over center eight divisions.	
SAVE Mode Gain Range (Horizontal)		Up to X100 as determined by the setting of the TIME/DIV switch.
Position Registration		Sweep start between NON STORE and Storage within ±0.2 division at TIME/DIV switch setting of 1 ms.
Display Response (Selectable) SINE		Microprocessor performs an interpolation between data points that is optimized to produce the best response for input signals that have no frequency components above Fs/2, when Fs is the sampling rate.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
STORAGE DISPLAY (cont)		
Display Response (Selectable) (cont) SINE (cont)		For a 6-division, sinusoidal input, digitized at 2.5 samples per input cycle and expanded 10X with the TIME/DIV switch, SINE Display Response envelope distortion produces a maximum amplitude error at any peak which is less than 5% of the ideally reconstructed reference p-p amplitude, assuming no distortion in the acquired input signal.
PULSE		Microprocessor performs linear interpolation between data points to optimize the display response for fast-rise and fast-fall waveforms (rise and fall times faster than 3 times the sampling interval). For a 6-division, sinusoidal input at seven samples per input cycle period, PULSE Display Response envelope distortion produces a maximum amplitude error at any peak which is less than 5% of the ideally reconstructed reference p-p amplitude.
Jitter Correction		Reduces effect of sample clock-to-trigger jitter.
Gain		0.4 division, ±10%; X10 MAG on.
Resolution		±0.1 sample period for TIME/DIV switch settings of 20 μs to 5 s per division. ±3 ns for switch settings of 0.02 μs to 10 μs per division. **NOTE** *Due to inherent uncertainty involved in the jitter correction, the resolution will occasionally, an random intervals, exceed the limits given above.*
READOUT DISPLAY		
Display Type		Four-digit, seven-segment LED indicators.
VOLTS Readout		Displays calculated voltage difference between horizontal cursors in VOLTS measurement mode. Scale factor is determined by VOLTS/DIV switch setting.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
READOUT DISPLAY (cont)		
Display Type (cont) VOLTS Readout (cont) Resolution		1 part in 1024 (10 bit).
TIME Readout		Displays calculated time difference between cursor dots in TIME measurement mode. Scale factor determined by setting of the appropriate TIME/DIV switch (A or B).
Resolution		1 part in 1024 (10 bit).
	For Service Manuals Contact MAURITRON TECHNICAL SERVICES 8 Cherry Tree Rd, Chinnor Oxon OX9 4QY Tel:- 01844-351694 Fax:- 01844-352554 Email:- enquiries@mauritron.co.uk	**NOTE** *Scale-factor LED indicates measurement is in DIV in the VOLTS measurement mode when vertical UNCAL LED is illuminated, or when different deflection factors are used in a dual-channel mode.*
CRT DISPLAY		
Display Area		8 X 10 cm.
Geometry		0.1 division or less of tilt or bowing.
Trace Rotation Range		Adequate to align trace with horizontal graticule lines. At least ±3°.
Standard Phosphor		P31 (green).
Nominal Accelerating Potential		18.5 kV.
Electrode Voltages to Ground Heater Voltage Between CRT Pins 1 and 14		6.3 Vrms, ±3 V; elevated to −2450 V.
Cathode (Pin 2)		−2450 V, ±2%.
Grid No. 1 (Pin 3)		≈ −2455 V to −2555 V.
Focus (Pin 4)		≈ −1780 V to −2000 V.
Astigmatism (Pin 5)		0 V to ≈ +95 V.
Isolation Shield (Pin 7)		+35 V, ±5 V.
First Anode (Pin 8)		≈ +55 V.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
CRT DISPLAY (cont)		
Electrode Voltages to Ground (cont)		
Geometry (Pin 10)		0 to ≈ +95 V.
Mesh (Pin 12)		≈ −150 V.
CALIBRATOR		
Output Voltage		
0°C to +40°C	0.3 V, within 1.0%	Within 0.5% at 25°C, ±5°C.
−15°C to +55°C		0.3 V, within 1.5%.
Repetition Rate	Approximately 1 kHz.	Within 25%.
Output Resistance		Approximately 10.3 Ω.
Output Current		
+20°C to +30°C	30 mA, within 2%.[a]	
−15°C to +55°C		30 mA, within 2.5%.
Z-AXIS INPUT		
Sensitivity	5 V p-p signal causes noticeable modulation at normal intensity.	Positive-going signal decreases intensity.
Usable Frequency Range	Dc to 50 MHz.[a]	
Input Resistance		25 kΩ, within 10%. Decreases to approximately 200 Ω at 2 MHz and above.
Maximum Input Voltage		25 V (dc + peak ac).
SIGNAL OUTPUTS		
CH 1 VERT SIGNAL OUT		
Output Voltage	At least 50 mV per division of displayed signal into 1 MΩ. At least 25 mV per division of displayed signal into 50 Ω.	
Output Resistance		Approximately 50 Ω.
Bandwidth	Dc to at least 50 MHz into 50 Ω.	
DC Level	Approximately 0 V.	Within 100 mV.

[a]Performance requirement not checked in manual.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
SIGNAL OUTPUTS (cont)		
A and B + GATES		
Output Voltage	Approximately 5.5 V, positive-going rectangular pulse.	Starts at 0 V, within 500 mV.
Output Resistance		Approximately 500 Ω.
POWER SOURCE		
AC-Source Voltage Ranges		
115 V		
(High)	108 V to 132 V.[a]	
(Low)	90 V to 110 V.[a]	
230 V		
(High)	216 V to 250 V.[a]	
(Low)	198 V to 242 V.[a]	
AC-Source Frequency	48 Hz to 440 Hz.[a]	
Power Consumption		
Typical	115 watts (140 VA).[a]	
Maximum	150 watts (190 VA).[a]	48 Hz, 110 Vac, low regulating range.

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Characteristics	Supplemental Information			
INTERNAL POWER SUPPLIES				
	Initial Setting	Any 500-Hour Period After First 200 Hours	Maximum p-p Ripple	Accuracy From −15°C to 55°C
Main Supply Accuracy (+20°C to +30° C)				
−8 V	±0.9%	±1.7%	2 mV	Within 0.5% of 25°C value
+5 V	±0.9%	±1.7%	2 mV	Within 0.5% of 25°C value
+15 V	±0.9%	±1.7%	2 mV	Within 0.5% of 25°C value
+55 V	±0.3%	±0.7%	4 mV	Within 0.5% of 25°C value
−2450 V	±1.2%	±2.2%		
+110 V	±3%		100 mV	

[a]Performance requirement not checked in manual.

Table 1-1 (cont)

Characteristics	Supplemental Information			
INTERNAL POWER SUPPLIES (cont)				
Digital Storage Power Supplies (Not Adjustable)				
Voltage	−6 V	−12 V	+5 V	+12 V
Tolerance	±4%	±5%	±4%	±5%
Maximum p-p Ripple			150 mV	

Table 1-2

Environmental Characteristics

Characteristics	Description
	NOTE *All of the environmental tests performed meet the requirements of MIL-T-28800B,Class 3, Style D equipment.*
Temperature	
Nonoperating (Storage)	−62°C to +85°C.
Operating	−15°C to +55°C.
Altitude	
Nonoperating (Storage)	To 50,000 ft.
Operating	To 15,000 ft.
Humidity (Operating and Nonoperating)	5 cycles (120 hrs) referenced to MIL-T-28800B, Par. 3.9.2.2. Class 3, 95% to 97% relative humidity.
Vibration (Operating)	15 minutes along each of 3 major axes at a total displacement of 0.025 inch p-p (4 g's at 55 Hz), with frequency varied from 10 Hz to 55 Hz to 10 Hz in 1-minute sweeps. Hold 10 minutes at each major resonance, or if no major resonance present, hold 10 minutes at 55 Hz.
Shock (Operating and Nonoperating)	30 g's, half-sine, 11-ms duration, 3 shocks per axis in each direction, for a total of 18 shocks.
EMI	
Option 04 Only	*Meets TEKTRONIX Standard 062-2866-00 with exception of RE-02 specification being relaxed by 20 dB.*

Table 1-3

Physical Characteristics

Characteristics	Description
Weight	
With Panel Cover, Accessories, and Accessory Pouch	33 pounds (15 kg).
Without Panel Cover, Accessories, and Accessory Pouch	30 pounds (13.6 kg).
Domestic Shipping Weight	47 pounds (21.4 kg).
Height	
With Feet and Pouch	7.5 inches (19.0 cm).
Without Pouch	7.2 inches (18.3 cm).
Width	
With Handle	12.9 inches (32.8 cm).
Without Handle	11.5 inches (29.2 cm).
Depth	
Including Panel Cover	21.7 inches (55.1 cm).
Handle Extended	23.7 inches (60.2 cm).

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Table 1-4

Option Electrical Characteristics

Characteristics	Performance Requirement	Supplemental Information
GENERAL PURPOSE INTERFACE BUS (GPIB) OPTION 02		
Interface Function[a]	SH1 Source Handshake. AH1 Acceptor Handshake. T1 Basic talker, talk only mode, serial poll. L0 No Listener. SR1 Service Request. RL0 No Remote/Local. PP0 No Parallel Poll. DC2 Device Clear. DT0 No Device Trigger. C0 No Controller.	
Waveform Data Transmitted[a]	Conforms to Tektronix Interface Standard, GPIB Codes and Formats (Rev. C).	When no waveform has been acquired, only the ID portion of the waveform message will be transmitted.
SIGNAL AVERAGING OPTION 12		
Averaging Range	Two to 256 waveforms in a 2-4-8 binary sequence. Number of sweeps to be averaged set with CURSOR/NO. OF SWEEPS control knob when NO. OF SWEEPS push button (on side panel) is pressed in.	Uncorrelated noise, signal-to-noise ratio is improved by the square root of the number of waveforms averaged.

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

OPERATING INSTRUCTIONS

This section of the manual provides information on instrument installation and power requirements. The functions of controls, connectors, and indicators are described, and procedures intended to familiarize the operator with obtaining basic oscilloscope displays are included. For more complete operating information, refer to the 468 Operators Manual.

INSTALLATION

The 468 is shipped in its carton with its standard accessories (listed on the "Accessories" tab page at the end of Volume II of this manual). At installation time, save the shipping carton and packaging materials for repackaging. Refer to the "Maintenance" section of this manual for repackaging information.

PREPARATION FOR USE

NOTE

For instruments with Option 02 (GPIB), a firmware bug exists in both version 1.0 and version 2.0 ROM. This causes an incorrect transmission of the Y-multiplier and the Y-units of a waveform whenever the acquired waveform is vertically uncalibrated or when an ADD display is obtained with unequal VOLTS/DIV switch settings. To avoid this bug, rotate the VAR VOLTS/DIV controls into the detent position and use the same VOLTS/DIV switch setting on both channels for ADD displays when acquiring the data for transmission.

Safety Considerations

CAUTION

This instrument may be damaged if operated with either the Line Voltage Selector switch or the Regulating Range Selector switch set for the wrong applied ac-power input source voltage or if the wrong line fuse is installed.

Refer to the Safety Summary at the front of this manual for power source, grounding, and other safety considerations pertaining to the use of this instrument. Before applying power, verify that the Line Voltage Selector switch and the Regulating Range Selector switch are both set for the ac-power input voltage source available and that the proper line fuse is installed.

Line Voltage Selection

This instrument operates from either a 115-V or a 230-V nominal ac-power source with a line frequency from 48 Hz to 440 Hz. To convert the instrument for operation from one ac source to the other, disconnect the power cord from the power input source, and move the Line Voltage Selector (230/115) switch to the position indicating the available nominal voltage (see Figure 2-1). The detachable power cord may have to be changed to match the ac-power-source outlet. (See the "Power Cord" discussion in this manual for optional power cords.) Verify that the proper line fuse is installed (see Table 2-1).

Regulating Range Selection

The Regulating Range Selector (HIGH/LOW) switch is located on the right side panel near the Line Voltage Selector switch (Figure 2-1). Verify that the selector switch

Table 2-1

Fuse Selection

Line Voltage Selector Switch Position	Fuse Size
115 V Nominal	1.5 A, 3AG, Slow-blow
230 V Nominal	0.7 A, 3AG, Slow-blow

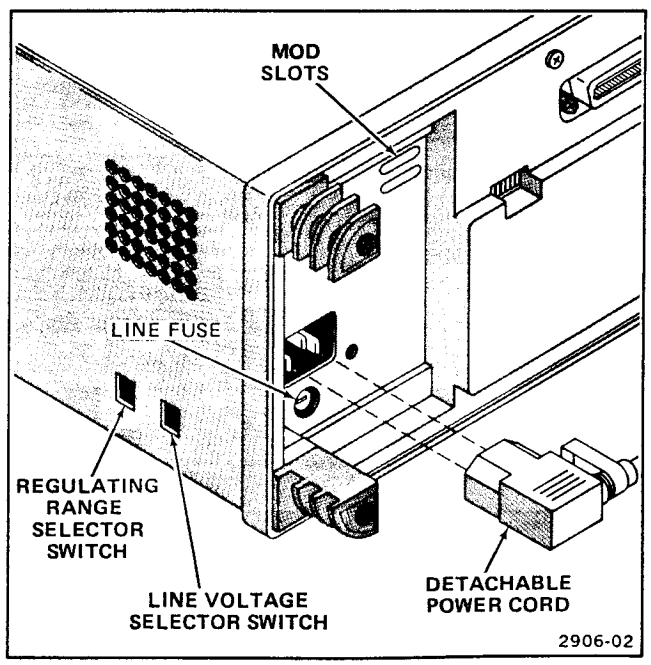

Figure 2-1. Ac-power-source switches, line fuse, and power cord.

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is set for the average line voltage being used. See Table 2-2 for a listing of the regulating ranges.

To change the regulating range:

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

2. Select a range from Table 2-2 that corresponds to the average ac-power-source voltage available and set the selector switch to the required position.

Table 2-2

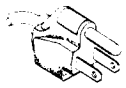
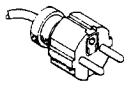
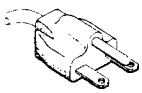
Regulating Ranges

Regulating Range Selector Switch Position	Regulating Range	
	115 V Nominal	230 V Nominal
HIGH	108 V to 132 V	216 V to 250 V
LOW	90 V to 110 V	198 V to 242 V

Power Cord

This instrument has a detachable, three-wire power cord with a three-contact plug for connection to the power source and to protective ground. The plug protective ground contact connects (through the power cord protective grounding conductor) to the accessible metal parts of the equipment. For electrical-shock protection, insert this plug into a power source outlet that has a securely grounded protective-ground contact.

For the non-U.S. customer, the appropriate power cord used is supplied by an option specified when the instrument is ordered. The optional power cords available are illustrated in Figure 2-2. For part numbers, refer to "Replaceable Mechanical Parts" at the end of Volume II of this manual, or contact your Tektronix representative or local Tektronix Field Office.

Plug Configuration	Usage	Nominal Line-Voltage (AC)	Reference Standards	Option #
	North American 120V/ 15A	120V	ANSI C73.11[a] NEMA 5-15-P[b] IEC 83[c]	Standard
	Universal Euro 240V/ 10-16A	240V	CEE (7), II, IV, VII[d] IEC 83[c]	A1
	UK 240V/ 13A	240V	BS 1363[e] IEC 83[c]	A2
	Australian 240V/ 10A	240V	AS C112[f]	A3
	North American 240V/ 15A	240V	ANSI C73.20[a] NEMA 6-15-P[b] IEC 83[c]	A4

[a]ANSI—American National Standards Institute
[b]NEMA—National Electrical Manufacturer's Association
[c]IEC—International Electrotechnical Commission
[d]CEE—International Commission on Rules for the Approval of Electrical Equipment
[e]BS—British Standards Institution
[f]AS—Standards Association of Australia

2931-05

Figure 2-2. Optional power cords for the 468.

Power On Self-Verification

A limited self-test is performed by the digital storage circuitry whenever power is applied to the instrument. If all the self-tests are passed, the oscilloscope will operate. If the system, random-access memory (RAM) or read-only memory (ROM) fails the test, the instrument halts and will not operate.

As an aid to servicing, a failure code is displayed in the seven-segment, light-emitting diode (LED) indicators to help a service technician locate the area of failure. This error code will remain displayed in either the storage or nonstorage mode, and power may be applied with either mode selected.

NOTE

If power is applied while a storage mode is selected and while one of the measurement cursors (VOLTS or TIME) is also selected, a normal display may appear in the LED indicators (after the self-test is completed). To avoid possibly confusing a normal display with an error display, either release the CURSOR FUNCTION push buttons or select the NON STORE mode before applying power to the instrument.

Should an error indication appear in the display, ensure that the NON STORE push button is pressed, then restart the self test by cycling the POWER switch off, then on again. If the error display appears a second time, refer the instrument to qualified service personnel.

Instrument Cooling

To maintain adequate instrument cooling, the ventilation holes in the equipment cabinet must remain open, and the air filter must be clean. The air filter should be visually checked every few weeks and cleaned or replaced if dirty. More frequent inspections are required under severe operating conditions.

CONTROLS, CONNECTORS AND INDICATORS

VERTICAL

Refer to Figure 2-3 for location of items 1 through 11.

(1) **VOLTS/DIV Switches**—Select the vertical deflection factor from 5 mV per division to 5 V per division in 10 steps for Channel 1 and Channel 2 in a 1-2-5 sequence. Three additional switch positions (0.5 mV, 1 mV, and 2 mV) are used in storage modes to vertically expand the waveform acquired at 5 mV per division (up to 10 times). VAR control must be in the calibrated detent to obtain a calibrated deflection factor. These switches also set the scale factor of the digital storage VOLTS measurement LED readout.

When a stored waveform is displayed in the SAVE Storage mode, the VOLTS/DIV switch vertically expands the appropriate channel display up to 10 times in a 1-2-5 sequence. Waveforms acquired in NORM and ENVELOPE Storage modes at VOLTS/DIV settings of 2, 1, or 0.5 mV per division, may be reduced back to 5 mV per division deflection if desired.

NOTE

In firmware version 1.0, SAVE Storage Mode waveforms acquired at VOLTS/DIV attenuator settings of 5 mV per division, and higher, cannot be reduced below the deflection sensitivity at which they were acquired. An attempt to do so will cause an invalid VOLTS readout on the LED indicators.

In instruments factory equipped or converted to firmware version 2.0 or higher, attempting to reduce the display below the limits at which it was acquired will cause the display to cease reducing and the VOLTS readout to change to DIV scale factor. Attempting to expand the display beyond the instruments limits causes the display and the VOLTS readout scale factor to cease changing.

(2) **VOLTS/DIV Readouts**—Consist of two light-emitting diodes (LED) for each channel, located beneath the skirt of each VOLTS/DIV knob. Either one LED or the other will light to indicate the correct deflection factor (if the channel is active). The 10X LED is illuminated only when a 10X probe with a scale-factor-coding-ring contact is connected to the input of the oscilloscope; otherwise, the 1X LED is illuminated. In the 0.5-, 1-, and 2-mV positions of the VOLTS/DIV switch, the LED will not be illuminated for the NON STORE mode.

(3) **VAR Control**—Provides variable uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV switches when storage is off. In a storage mode, if the VAR control is out of the calibrated detent, digitial storage circuitry will continue to acquire data; but the storage scale-factor LED will indicate that VOLTS function measurements are in divisions (DIV).

(4) **UNCAL Indicator**—A LED that is illuminated when the VAR VOLTS/DIV control is out of the calibrated detent. It indicates that the vertical deflection factor is uncalibrated.

(5) **POSITION Controls**—Control the vertical position of the channel displays on the crt both in storage and nonstorage modes. In the X-Y mode, the Channel 2 POSITION control adjusts the vertical positioning of the display.

(6) **CH 1 OR X and CH 2 OR Y Input Connectors**—Provide for application of external signals to the input of the vertical amplifiers. In the X-Y mode (A TIME/DIV switch set to X-Y), the signal applied to the CH 1 OR X connector provides horizontal deflection (X-axis), and the signal applied to the CH 2 OR Y connector provides vertical deflection (Y-axis).

These connectors each include a coding ring that activates the scale-factor-switching circuitry whenever a 10X scale-factor-switching probe is connected.

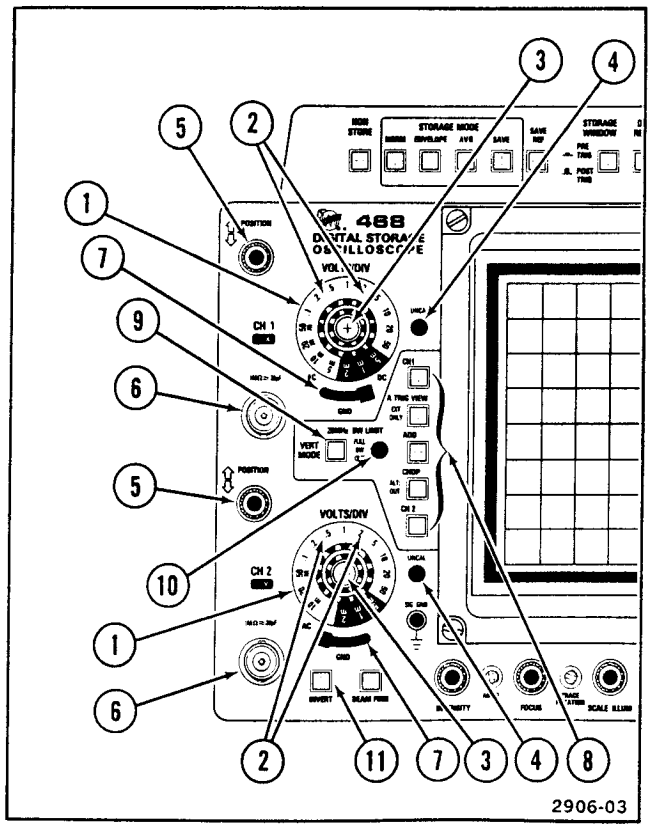


Figure 2-3. Vertical controls, connectors, and indicators.

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(7) **Input Coupling Switches (AC-GND-DC)**—Select the method of coupling the input signal to the vertical deflection system.

AC position—Signals are capacitively coupled to the vertical deflection system. The dc component of the input signal is blocked.

DC position—All frequency components of the input signal are passed to the vertical input amplifier.

GND position—The input of the vertical amplifier is grounded to provide a ground reference and to allow the input coupling capacitor to be precharged to the input signal dc level through a high resistance connected to ground.

When operating in the NORM, ENVELOPE, or AVG Storage Mode, the ground reference is stored in the GND position and displayed as an intensified dot at the left edge of the graticule when the input coupling is switched to AC or DC. In ADD vertical mode, both CH 1 and CH 2 Input Coupling switches must be set to GND to store a ground reference.

In instruments equipped with firmware version 1.0, at the end of the power-on routine a random ground dot may be displayed. Switching the input coupling switch to GND will place the dot at a valid ground reference.

NOTE

If the Vertical POSITION control is adjusted after the ground reference is stored, the dot position is no longer a valid ground reference. Additionally, in firmware version 1.0, vertically expanding either waveform of a dual-channel storage display using the 2 mV, 1 mV, or 0.5 mV VOLTS/DIV switch position will cause an invalid ground dot display. A single-channel display ground dot remains valid during expansion.

In instruments factory equipped or converted to firmware version 2.0 or higher, the ground dot position remains valid as display vertical expansion occurs in a dual-channel display.

(8) **VERT MODE Switches**—Five push-push switches, used to select the vertical mode of operation in both storage and nonstorage modes. The oscilloscope can display any combination of CH 1, CH 2, ADD, and A TRIG VIEW (external trigger only) in either Chopped (CHOP) or Alternate (ALT) mode, when NON STORE is selected. The A TRIG VIEW mode is not functional in storage modes. If A TRIG VIEW is the only vertical mode selected or no vertical mode is selected when a storage mode push button is pressed in, the digital storage will continue to acquire and display the Channel 1 input signal, but all the probe coding LED (X1 and X10) are extinguished. The NON STORE display, with no vertical mode selected, will be a single, unpositionable baseline trace with no vertical deflection.

CH 1—Selects Channel 1 input signal for display or storage when push button is pressed in. To end the NON STORE display of the Channel 1 input signal, push CH 1 VERT MODE button to release it (Channel 1 remains selected in a storage mode if ADD or CH 2 vertical mode is not selected).

A TRIG VIEW—Displays the signal applied to the A External Trigger input connector when push button is pressed in, if the A TRIGGER SOURCE switch is set to either EXT or EXT/10. Remove the A External Trigger View trace from the display by pressing the A TRIG VIEW VERT MODE button to release it. The A TRIG VIEW display cannot be selected in any storage mode.

CH 2—Selects the Channel 2 input signal for display or storage when push button is pressed in. To end the display of the Channel 2 input signal, push CH 2 VERT MODE button to release it.

ADD—Selects the algebraic sum of Channel 1 and Channel 2 input signals to be displayed or stored when push button is pressed in. To end the display of the ADD signal, push the ADD VERT MODE button to release it.

CHOP-ALT:OUT (Nonstorage Mode)—When CHOP is selected (switch pressed in), the oscilloscope Vertical Switching circuitry is switched between two or more of the selected vertical modes at approximately a 500-kHz rate.

When ALT is selected (switch released out), the oscilloscope Vertical Switching circuitry is alternately switched between two or more of the selected vertical modes at the end of each sweep.

CHOP-ALT:OUT (Storage Mode)—When pressed in (CHOP) with the NORM Storage mode selected, the digital storage circuitry interleaves the Channel 1 and Channel 2 input signals into memory. Each channel is chopped to obtain 256 samples of each input signal. The storage chop rate is one half of the sampling rate of the selected sweep speed.

NOTE

For firmware versions 1.0 and 2.0, a horizontal displacement of the displayed signal occurs between ALT and CHOP dual-channel acquisition. The displacement increases from approximately 0.1 division to approximately 1 division as the TIME/DIV switch setting is changed from 1 μs to 0.02 μs per division.

When either the ENVELOPE or AVG Storage mode is selected, the position of the CHOP-ALT: OUT switch has no effect on the storage; and Channel 1 and Channel 2 are alternately sampled to obtain 512 samples of each input signal.

When released out (ALT) with the NORM Storage mode selected, Channel 1 and Channel 2 are alternately sampled to obtain 512 samples of each input signal. However, if ADD Vertical mode is also selected, the ADD waveform is sampled 512 times alternately and Channel 1 and Channel 2 are chopped (256 samples each).

NOTE

CHOP and ALT functions are disabled if only one VERT MODE push button—CH 1, CH 2, ADD, or A TRIG VIEW (nonstorage only) is selected—or if X-Y mode is selected.

(9) **20 MHz BW LIMIT (FULL BANDWIDTH OUT) Switch**—Limits the bandwidth of the vertical preamplifier to approximately 20 MHz when pressed in. Push button must be pressed a second time to release it and regain full 100-MHz bandwidth operation. This control has no affect on the digital storage signal acquisition even though the BW LIMIT LED may be illuminated.

(10) **20 MHz BW LIMIT Indicator**—A LED that is illuminated to indicate that the bandwidth is limited to 20 MHz whenever the 20 MHz BW LIMIT push button is pressed in.

(11) **INVERT**—Inverts Channel 2 display when push button is pressed in. Push button must be pressed a second time to release the button and return to a noninverted display of Channel 2.

DISPLAY AND CALIBRATOR

Refer to Figure 2-4 for location of items 12 through 19.

(12) **Internal Graticule**—Eliminates parallax. Rise time amplitude measurement points are indicated at the left edge of the graticule.

(13) **BEAM FIND Switch**—When held in, the display is compressed to within the graticule area and a visible viewing intensity is provided to aid in locating off-screen displays.

(14) **INTENSITY Control**—Determines the brightness of the crt display (has no effect when BEAM FIND switch is pressed in).

(15) **FOCUS Control**—Adjusts for optimum display definition.

(16) **CALIBRATOR Loop**—A combination 30-mA current loop and 0.3-V square-wave voltage output (at approximately 1 kHz) that permits the operator to compensate voltage and current probes and to check oscilloscope vertical operation. It is not intended to verify precise time-base calibration.

(17) **SCALE ILLUM Control**—Adjusts graticule illumination.

(18) **ASTIG Control**—Screwdriver control used in conjunction with the FOCUS control to obtain a well-defined display. It does not require readjustment during normal use of the instrument.

(19) **TRACE ROTATION Control**—Screwdriver control used to align a baseline trace with the horizontal graticule lines.

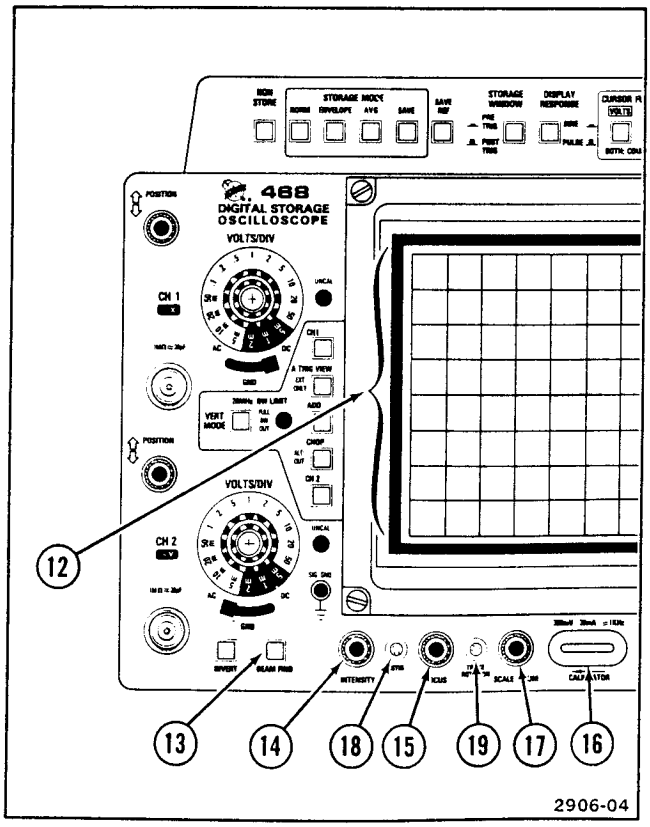

Figure 2-4. Display controls and CALIBRATOR.

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TRIGGERING
(both A and B if applicable)

Refer to Figure 2-5 for location of items 20 through 28.

(20) **TRIG MODE Switches**—Three push-button switches that determine the mode of trigger operation for the instrument.

AUTO—Permits triggering on waveforms with a repetition rate of about 20 Hz or greater. Sweep free runs and provides a bright baseline when either an adequate trigger signal is absent, or if the repetition rate of the trigger signal is below 20 Hz. In a storage mode, the digital storage circuitry will acquire data from the selected time window and display the acquired data.

NORM—Sweep is initiated, or storage acquires data when an adequate trigger signal is applied. NORM Trigger Mode may be used to obtain stored waveforms to ensure that the time window the waveform is acquired from is synchronized with the triggering signal.

SINGL SWP—Sweep is initiated one time (or one time window of data is stored) when an adequate trigger signal is applied. Sweep cannot be initiated again (or a new time window of data cannot be stored) until the sweep logic is reset by pressing the SINGL SWP push button. Stored data from the single time window will remain displayed on the crt.

Any front-panel control change that affects the data acquisition (VOLTS/DIV, VERT MODE, SEC/DIV, HORIZ MODE, etc.,) requires that the SINGL SWP push button be pressed again to obtain a valid display that agrees with the control setting. When storing displays that require two time windows to acquire, the SINGL-SWP push button must be pressed twice to obtain a valid display. If a valid display is not completed after a change affecting the acquisition timing, the TIME dot readout may switch between two different numbers at various settings of the SEC/DIV switch.

NOTE

Applying power to the instrument with either NORM or SINGL SWP Trigger Mode selected without a trigger signal present to acquire a waveform, will cause a dashed line to be displayed in any storage mode. The dashed line will be replaced by an acquired waveform when the instruments is adequately triggered.

In firmware version 1.0 instruments, the first SINGL SWP trigger received after Power on or after a control change that affects the data being acquired is not considered valid. In either case, the SINGL SWP must be reset and a second trigger received before a waveform is stored and displayed. For instruments equipped with firmware version 2.0 and higher, the first SINGL SWP trigger received is valid and a waveform will be stored and displayed.

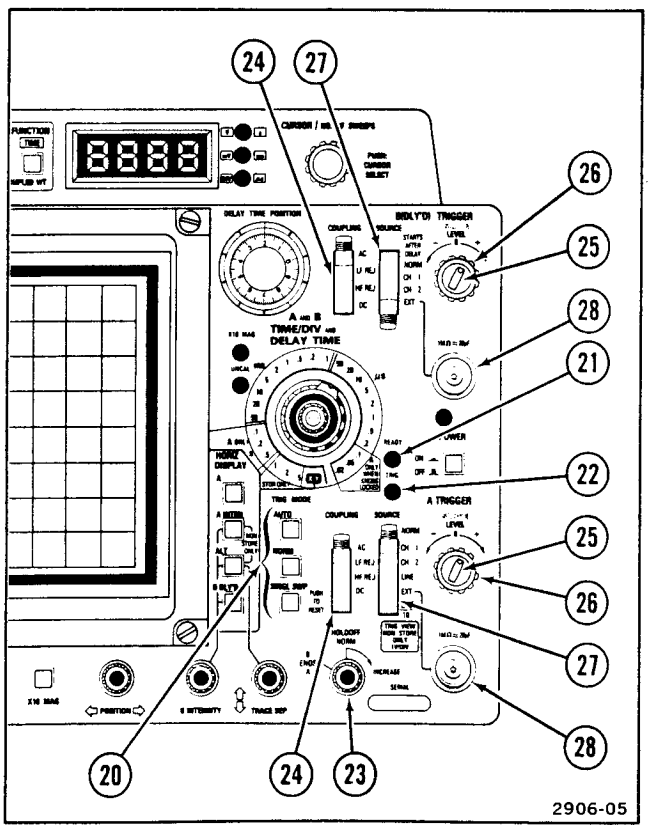

Figure 2-5. Trigger controls, connectors, and indicators.

(21) **READY Indicator LED**—Illuminates in the single-sweep mode to indicate that the sweep circuitry is armed and ready to initiate the sweep when a trigger signal occurs.

(22) **TRIG Indicator LED**—Illuminates to indicate the A Sweep is triggered.

(23) **A TRIG HOLDOFF Control**—Provides continuous control of holdoff time between sweeps. Allows triggering on aperiodic signals (such as complex digital words). In the fully clockwise position (B ENDS A), the A Sweep is automatically terminated at the end of the B Sweep to provide the fastest possible sweep repetition rate for delayed-sweep presentations and low-repetition-rate signals. In the NON STORE mode, holdoff time is variable to approximately ten times NORM holdoff time. Use the A trigger controls to obtain as stable a display as possible before setting the A TRIG HOLDOFF control to a position other than NORM.

The variable holdoff capability is reduced in the storage modes due to the added digital holdoff time required for signal acquisition by the microprocessor.

(24) **COUPLING Switch**—Determines method used to couple a signal to the input of the trigger generator circuit.

AC—Signals are capacitively coupled to the input of the trigger circuit. The dc component is rejected, and signals below approximately 30 Hz are attenuated. Triggering is allowed only on the ac portion of the vertical signal.

LF REJ—Signals are capacitively coupled to the input of the trigger circuits. The dc component is rejected, and signals below approximately 50 kHz are attenuated. This position is useful for providing a stable display of the high-frequency components of a complex waveform.

HF REJ—Signals are capacitively coupled to the input of the trigger circuit. The dc component is rejected, and signals below approximately 30 Hz and above approximately 50 kHz are attenuated. This position is useful for providing a stable display of the low-frequency components of a complex waveform.

DC—All frequency components of a trigger signal are coupled to the input of the trigger circuit. This position is useful for providing a stable display of low-frequency or low-repetition-rate signals.

(25) **SLOPE Switch**—Selects the slope of the signal that triggers the sweep.

+ (plus)—Sweep can be triggered from the positive-going portion of a trigger signal.

– (minus)—Sweep can be triggered from the negative-going portion of a trigger signal.

(26) **LEVEL Control**—Selects the amplitude point on the trigger signal at which the sweep is triggered. This control is usually adjusted for the desired display after the Trigger SOURCE, COUPLING, and SLOPE have been selected.

(27) **SOURCE Switch**—Selects the source of the trigger signal coupled to the input of the trigger circuit.

NORM—The waveform displayed on the crt is the source of a composite trigger signal. Stable triggering of non-time-related signals usually can be obtained by setting VERT MODE to ALT, SOURCE to NORM, COUPLING to LF REJ (high-frequency signals only), and adjusting the Trigger LEVEL control for a stable display. Time relationship between the Channel 1 signal and the Channel 2 signal is not indicated by the display.

CH 1—The signal applied to the CH 1 input connector is the source of the trigger signal. Channel 2 signal display is unstable if it is not time related to the Channel 1 signal.

CH 2—The signal applied to the CH 2 input connector is the source of the trigger signal. The Channel 1 signal display is unstable if it is not time related to the Channel 2 signal.

LINE (in the A Sweep Trigger circuity only)—The ac-power-source waveform is the source of the trigger signal. This position is useful when the input signal is time related (multiple or sub-multiple) to the frequency of the ac-power source or when it is desirable to provide a stable display of a power-source frequency component in a complex waveform.

EXT—The signal connected to the External Trigger Input connector is used for triggering. External signals must be time related to the displayed signal for a stable display. This position is useful when the internal signal is either too small or contains undesired components that cause unstable triggering. The external trigger signal may be viewed by pushing the A TRIG VIEW button in only when the 468 is operating in the NON STORE mode. The A TRIG VIEW display is not selectable in any storage mode.

EXT/10 (in the A Sweep Trigger circuit only)—External trigger signal is attenuated by a factor of 10.

STARTS AFTER DELAY (in the B Sweep Trigger circuit only)—B Sweep starts immediately after the delay time selected by the DELAY TIME POSITION control. In this position, the B Sweep is independent of the B trigger signal. When making differential time measurements with the 468 in the NON STORE Mode, this position of B Trigger SOURCE switch must be selected for valid measurements.

(28) **External Trigger Input Connectors**—Provide for application of external triggering signals to the A TRIGGER and B (DLY'D) TRIGGER circuits, when either EXT or EXT/10 (A Trigger only) SOURCE is selected.

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HORIZONTAL AND POWER

Refer to Figure 2-6 for location of items 29 through 35.

(29) **A and B TIME/DIV Switches**—Select the calibrated sweep rates in the nonstorage mode and the time window for the storage modes.

Nonstorage Mode—The A TIME/DIV switch selects 23 calibrated sweep rates and delay times from 0.5 s to 0.02 μs per division in a 1-2-5 sequence. Extreme counterclockwise position of the switch selects the X-Y horizontal display.

The B TIME/DIV switch selects calibrated sweep rates from 50 ms to 0.02 μs per division in a 1-2-5 sequence.

Storage Mode—The A or B TIME/DIV switch selects the time window to be acquired (10 divisions multiplied by the TIME/DIV switch setting) for TIME/DIV switch settings between 0.02 μs and 5 s per division. Sampling of the analog input signal is done 512 times during one full sweep time (50 in 1 division). Rate of sampling is calculated by dividing the number of samples in 1 division by the sweep time for 1 division:

$$\text{Sample rate} = \frac{50 \text{ samples}}{\text{TIME/DIV}}$$

For TIME/DIV switch settings from 1 μs per division to 0.02 μs per division, a waveform is sampled at the 2 μs per division rate and expanded horizontally, using a combination of digital interpolation and analog gain, to the correct horizontal scale.

The A TIME/DIV switch selects the time for A and A INTEN Horizontal Displays, and the B TIME/DIV switch selects the time for ALT and B DLY'D Horizontal Displays. The 1, 2, and 5 s per division positions of the A TIME/DIV switch are used in the storage modes only. The X-Y position of the A TIME/DIV switch is not used in any storage mode.

The SAVE display of a stored waveform acquired at 2 μs per division and slower may be expanded up to 100 times using the next six faster positions of the TIME/DIV switch associated with the selected Horizontal Display Mode. Waveforms acquired at 1 μs per division and faster are expanded by each of the remaining faster positions of the TIME/DIV switch. Additionally, waveforms acquired at 1 μs per division and faster may be reduced back to the 2 μs per division sweep rate in the steps of the TIME/DIV switch.

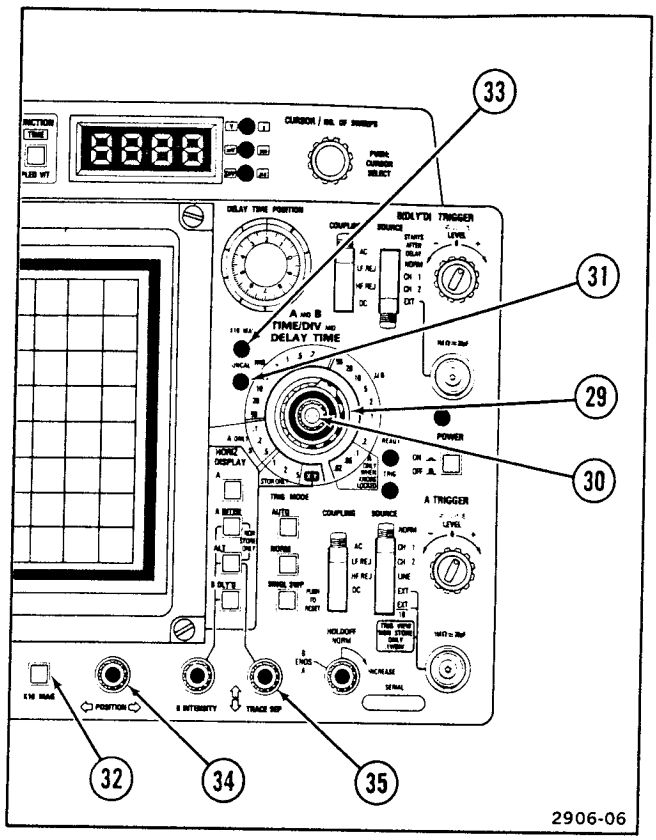

Figure 2-6. Sweep rate and position controls and indicators.

(30) **A Sweep VAR Control**—Provides continuously variable uncalibrated A Sweep rates to at least 2.5 times the calibrated setting (extends slowest NON STORE sweep rate to at least 1.25 s per division). This control is effective only in the NON STORE mode.

(31) **UNCAL Indicator LED**—Illuminates to indicate that the A time base sweep rate is uncalibrated (VAR control is out of calibrated detent).

In the storage modes the VAR control is ignored, and the UNCAL LED is not illuminated when the VAR control is out of calibrated detent. The storage time base is obtained from the setting of the TIME/DIV switch associated with the selected Horizontal Display mode.

(32) **X10 MAG Switch**—When pressed in, increases the displayed sweep rate by a factor of 10. Extends the fastest sweep rate to 2 ns per division. The magnified sweep expands the center division of the unmagnified display (0.5 division either side of the center vertical graticule line).

(33) **X10 MAG Indicator LED**—Illuminates when the X10 MAG push button is in to indicate that the horizontal display is magnified.

(34) **POSITION Control**—Positions the display horizontally for both nonstorage and storage modes. Provides both coarse and fine control action. Reverse the direction of rotation to actuate fine positioning action.

(35) **TRACE SEP Control**—Positions the B Sweep vertically when the ALT horizontal display mode is selected. TRACE SEP has no effect on the stored display.

Refer to Figure 2-7 for location of items 36 through 40.

(36) **B INTENSITY Control**—Controls the intensity of the B trace and interacts with INTENSITY control. The B INTENSITY control has no effect when a storage mode is selected.

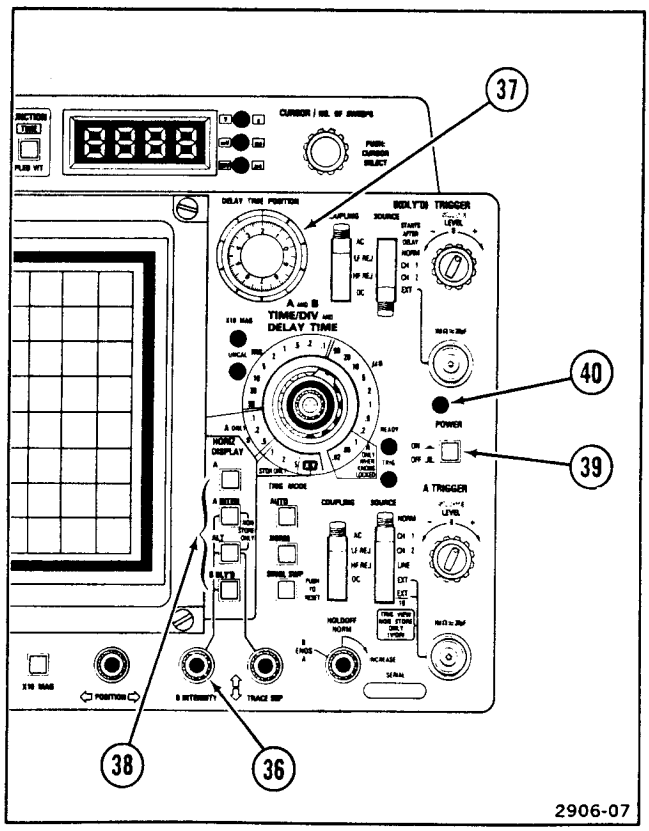

Figure 2-7. Horizontal display, B INTENSITY, DELAY TIME POSITION, and power controls and indicator.

(37) **DELAY TIME POSITION Control**—Selects the amount of delay time between the start of the A Sweep and start of the B Sweep. Delay time is variable to at least 10 times the A TIME/DIV switch setting. This control is used in conjunction with the STARTS AFTER DELAY position of the B TRIGGER SOURCE switch.

(38) **HORIZ DISPLAY Switches**—Select the mode of operation for the horizontal deflection system.

A—Displays only the A Sweep. The digital storage time base and the horizontal deflection rate are determined by the setting of the A TIME/DIV switch.

A INTEN—Displays the A Sweep at a rate determined by the setting of the A TIME/DIV switch. An intensified portion corresponding to the length and position of the B Sweep will appear on the trace when the B Sweep is properly triggered. The INTENSITY and B INTENSITY controls should be adjusted to obtain the proper brightness for viewing. The intensified zone is used to position the B Sweep (delayed) to the desired location within the A Sweep interval to obtain an expanded view of a waveform for examination.

The digital storage time base is determined by the setting of the A TIME/DIV switch in the A INTEN Horizontal Display mode.

ALT—Alternates the display between the A INTEN and B DLY'D sweeps. The TRACE SEP control will position the B display vertically. In the nonstorage mode, the B INTENSITY control will adjust the intensity of the B Sweep whenever it is displayed. The digital storage circuitry time base is determined by the setting of the B TIME/DIV switch.

B DLY'D—Displays only the B Sweep. The B Sweep rate is determined by the setting of the B TIME/DIV switch, and the delay time is determined by both the A TIME/DIV switch and the DELAY TIME POSITION control. The digital storage circuitry time base is determined by the setting of the B TIME/DIV switch.

(39) **POWER Switch**—A push-push switch used to turn instrument power on and off. It must be pushed in to apply power to the instrument and pushed in again to release the switch and remove power from the instrument.

(40) **Power On Indicator LED**—Illuminates when power is applied to the instrument and POWER switch is set to the "on" (in) position.

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DIGITAL STORAGE

Refer to Figure 2-8 for location of items 41 through 49.

(41) **NON STORE Switch**—Selects operation as a conventional oscilloscope. Any data stored in the 468 digital storage memory remains unchanged while NON STORE is selected. The last acquired waveform data may be transmitted via the optional IEEE-488 GPIB interface during NON STORE. While transmitting, the 468 switches to the SAVE Storage Mode to display the waveform being transmitted. At the completion of a transmission the oscilloscope returns to the selected operation. The AVG waveform data cannot be transmitted from the NON STORE Mode unless a completed waveform was saved prior to selecting NON STORE. Switching directly from AVG to NON STORE will abort the AVG acquisition cycle in progress, and an attempt to transmit will result in sending only the instrument ID.

(41A) **STORAGE MODE Switches**—Select storage mode operation. Selection of a switch cancels the remaining switches.

NORM (Normal)—In this mode, the 468 digitizes, stores, and displays data from Channel 1 and Channel 2 at the vertical gain and horizontal sweep speed determined by the oscilloscope front-panel Vertical and Horizontal controls. If the oscilloscope TRIG MODE is SINGL SWP, data will be acquired for that sweep and displayed. If the TRIG MODE is AUTO or NORM, data will be repetitively acquired and displayed.

ENVELOPE—The ENVELOPE mode is a repetitive mode that acquires a selected number of sweeps and displays the resultant waveform envelope. Each data point of the input waveform is compared to the maximum and minimum values of the same data point accumulated from previous sweeps. If the data point is greater than the previous maximum or less than the previous minimum for that data point, the previous data point is replaced by the new data point. If the data point does not meet one of the conditions mentioned, it is discarded.

The ENVELOPE accumulation cycle is restarted whenever any of the following events occurs: the ENVELOPE push button is pressed in, the selected number of sweeps to be accumulated is changed, or any of the front-panel controls affecting the data being acquired is changed (VERT MODE, VOLTS/DIV, STORAGE WINDOW, TIME/DIV, HORIZ DISPLAY, or VAR in and out of detent). A new cycle is also started upon completion of the current cycle.

At TIME/DIV switch settings slower than 20 μs per division, the analog input will be sampled every 200 ns. Only the maximum and minimum values over every data point time interval (4% of the TIME/DIV switch setting) are stored in the digital storage memory.

The number of waveforms to be accumulated to develop the display is selectable in a binary sequence of (1, 2, 4, ...) up to 256 sweeps. Press in the NO. OF SWEEPS push button and use the CURSOR/NO. OF SWEEPS control to obtain a new number of sweeps to be accumulated (number is displayed on the LED indicators). An unlimited number of sweeps may also be selected (LED display is 9999), and the digital storage memory will repetitively acquire data until either a new "number of sweeps" selection is made or a control setting is changed to restart the accumulation of data. The NO. OF SWEEPS push button must be pressed again to release it and return the readout to cursor control. During the first ENVELOPE cycle, the readout will count down

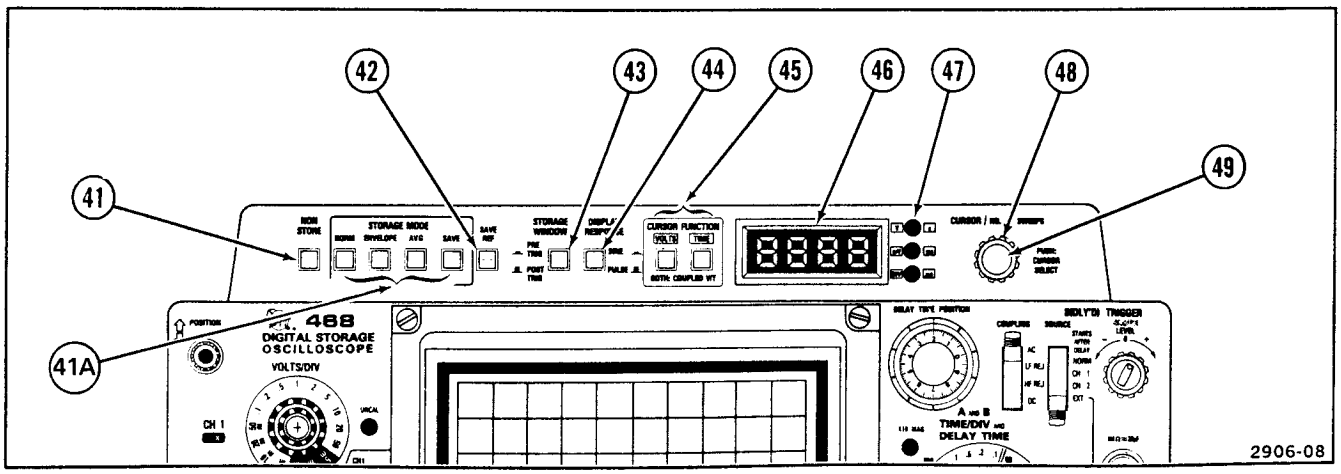

Figure 2-8. Digital storage controls and indicators.

the sweeps as they are being acquired. Thereafter, the readout returns to cursor control. The readout will not count down when an unlimited number of sweeps is selected.

At power on, the number of sweeps to be accumulated is automatically set to 32.

AVG (Average) (Option SN B032429 & Below) —When equipped with this option, the 468 will average the input signal for a selected number of sweeps and display the accumulated waveform. The number of sweeps to be averaged may be altered (from the power on number of 32) by pressing the NO. OF SWEEPS push button to display the number and adjusting the CURSOR/NO. OF SWEEPS control to obtain a new number from 2 to 256 in a binary sequence. The NO. OF SWEEPS push button must be pressed again to release it and return the readout to cursor control. Upon releasing the NO. OF SWEEPS push button, the readout will count down the sweeps as they are being acquired during the first average cycle only. Thereafter, the readout returns to cursor control.

The AVG accumulation cycle is restarted whenever the AVG push button is pressed in, whenever the selected number of sweeps is changed, or if any of the front-panel controls affecting the data being acquired is changed (VERT MODE, VOLT/DIV, TIME/DIV, STORAGE WINDOW, HORIZ DISPLAY, or VOLTS/DIV VAR in and out of detent).

After a control setting change, and before an AVG acquisition is completed that reflects the new control setting, a dashed line will be displayed. The dashed line will be replaced by the AVG waveform upon completion of the current cycle, and a new acquisition cycle will begin. A SAVE REF waveform will remain displayed as acquired during any control setting changes.

SAVE—Pressing the SAVE push button in when NORM Storage Mode is selected will stop acquisition of data, and the displayed waveform will be saved. When either ENVELOPE or AVG Storage Mode is selected, the acquisition cycle in progress will be completed, and the new waveform will be saved. A cycle is defined as the selected number of sweeps in the ENVELOPE and AVG Storage Modes. In the ENVELOPE Storage Mode, if the number of sweeps selected is set to 9999, pressing the SAVE push button will switch the digital storage to the SAVE Storage Mode at the end of the current sweep.

If a dual-trace display is in use, the action that occurs before entering the SAVE Storage Mode after the SAVE button is pressed differs for ENVELOPE and AVG Storage Modes. Since the ENVELOPE display is updated with each sweep alternately, both waveforms will complete the selected number of sweep acquisitions before the SAVE Storage Mode is entered. The AVG display must complete the cycle, acquiring all the sweeps selected for a trace, before that trace is updated. Therefore, for the AVG display, only the waveform being acquired at the time the SAVE button is pressed in will be completed before entering the SAVE Storage Mode.

NOTE

In the event that the storage modes are selected in the following order; AVG, NON STORE, then back to SAVE: the SAVE display will not be valid and a dashed line will be displayed. Switching from NON STORE to SAVE will display the last waveform acquired in either NORM or ENVELOPE Storage Mode.

Additionally, in firmware version 1.0, changing the number of sweeps to be averaged in a dual-channel storage display and then switching to SAVE Storage Mode before the waveform has been acquired at least one time at the new NO. OF SWEEPS setting will prevent a valid expansion (both vertical and horizontal) of one of the waveforms. Instruments equipped with firmware version 2.0 or higher will display the valid acquired waveform only, and the display can be expanded normally.

(42) **SAVE REF**—Pressing in the SAVE REF push button will save one waveform for the purpose of comparing it with waveforms stored later. If more than one VERT MODE is selected, the waveform stored as a reference is in the following priority: ADD, CH 1, then CH 2. If a chopped display of CH 1 and CH 2 is selected, then both traces will be saved as a reference; but if ADD Vertical mode is selected as well, the ADD display will be saved as a reference. See Table 2-3 in "Digital Storage Displays" for a complete listing of references saved and displays available with various selections of Vertical and Storage modes. The number of VERT MODE selections that may be simultaneously displayed is reduced while the SAVE REF display is selected.

NOTE

If power is applied in a storage mode with the SAVE REF push button pressed in, a residual waveform from the power-on self test will remain displayed. Remove the residual waveform by pressing the SAVE REF push button to release it.

Additionally, in firmware version 1.0 when powering on with the TIME/DIV switch set slower than 2 μs per division, a TIME cursors readout will oscillate. Again, release the SAVE REF push button to eliminate the condition.

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Selecting SAVE REF when a chopped dual-channel acquisition is being made, causes the Channel 2, X1 and X10 probe coding LED to be extinguished. The SAVE REF push button must be released to reilluminate them.

In instruments equipped with firmware version 2.0 or higher, both the TIME cursor readout oscillation and the Channel 2 probe-coding LED operation anomalies do not exist.

(43) **STORAGE WINDOW (PRE TRIG or POST TRIG)**—Selects pretrigger or post-trigger storage of data. When pressed in (pretrigger), approximately 8.75 divisions of the waveform are stored before the trigger event. When out (post-trigger), approximately 1.25 divisions of the waveform are stored before the trigger event.

(44) **DISPLAY RESPONSE (SINE or PULSE)**—Controls the interpolation applied to the displayed data at TIME/DIV switch settings from 1 μs per division to 0.02 μs per division only. When pressed in (SINE), interpolation is applied that optimizes the display accuracy for waveforms containing no frequency components above half of the sampling rate. When out (PULSE), linear interpolation is applied to optimize the display accuracy for fast-rise and fast-fall waveforms (rise time or fall time faster than three times the sampling interval) and to eliminate overshoot. The SINE and PULSE Display Response will affect the SAVE Storage mode display. Switching from one to the other will change the interpolation method applied to the displayed waveform.

(45) **CURSOR FUNCTION**—Two push-push switches used to select the cursors (VOLTS or TIME) to be displayed on the crt. Cursors are used to select measurement points on the displayed waveform. Voltage and time differences between the cursors are displayed on the four-digit, seven-segment LED indicators.

VOLTS—When pressed in, cursors displayed consist of two horizontal lines that may be positioned vertically to any location on the crt. The cursor selected to be active is dashed. LED indicators display the voltage difference (represented by the cursor positions) based on the VOLTS/DIV setting of the channel used to obtain the stored waveform. If the VAR control is out of the calibrated detent during acquisition of the signal, the scale factor LED will indicate that the measurement is in divisions rather than voltage units. Press the push button again to release it and remove the VOLTS cursors from the display.

TIME—When pressed in, the displayed cursors are two bright dots on the trace that may be positioned anywhere on the displayed waveform. The seven-segment LED indicators display the time difference between the dots as determined by the TIME/DIV switch setting for the selected time base. In the SAVE Storage Mode, time dots will appear on all the traces simultaneously, with the exception of the SAVE REF waveform. Press the push button again to release it and remove the time dots from the display.

NOTE

In instruments with firmware versions 1.0 and 2.0, the TIME cursor dots can be positioned off the left end of the traces in a SAVE display of the combined CH 1, CH 2, and ADD traces. The TIME dots will remain visible on the ADD trace unless the display is expanded horizontally.

BOTH: COUPLED V/T—Pressing the VOLTS and TIME push buttons in together causes the voltage cursors to couple to the time dots. The coupled cursors may be positioned to any location on the displayed waveform. If more than one VERT MODE is selected, the coupled cursors may be used with only one waveform, determined by the following priority: ADD, CH 1, then CH 2.

In instruments containing firmware version 2.0 or higher, rotating the cursor knob fully counterclockwise into the end-stop spring and holding it, will cause the dashed VOLTS cursor to attach to a previously acquired ground dot. Rotating the control clockwise will detach the VOLTS cursor from the ground dot and reattach it to the time dot on the displayed waveform. In certain instances, the VOLTS cursor may not attach to the ground dot. If this occurs, reacquire a valid ground dot. The VOLTS cursor will then attach to the ground dot as previously described.

While in the COUPLED V/T mode, the seven-segment LED indicators will display the voltage difference between the VOLTS cursors.

Pressing the VOLTS push button to release the 468 from the COUPLED V/T measurement mode will switch the 468 to the TIME measurement mode, and the seven-segment LED indicators will display the time period between the time cursor dots. Time cursors will remain as set in COUPLED V/T.

Pressing the TIME push button to release the 468 from the COUPLED V/T measurement mode will switch the 468 to the VOLTS measurement mode, and the voltage cursors will return to the position they were in before the COUPLED V/T selection was made.

(46) **LED INDICATORS**—Four-digit, seven-segment LED indicators used to display the measurements made on the stored waveform. The LED indicators also display error messages that are generated in the event that an error is detected during the self-test that is performed when power is first applied to the 468. In the NON STORE mode, the LED indicators will not be illuminated after the self-test is completed unless an error message is being displayed.

(47) **Scale-Factor Indicators**—Three dual-color LEDs (red and green under a single lens) used to indicate the scale (V, mV, and DIV; or s, ms, and μs) and the function (red illuminates for V, mV, and DIV measurements; green illuminates for s, ms, and μs measurements).

The DIV scale-factor LED will be illuminated when either both CH 1 and CH 2 are selected or the ADD mode is selected, and the CH 1 and CH 2 VOLTS/DIV switches are set differently. If either VOLTS/DIV VAR control is out of calibrated detent, the DIV LED will illuminate when the VOLTS cursors are selected.

(48) **CURSOR/NO. OF SWEEPS Control**—Combined slow and fast cursor positioning control used to change the position of the selected cursor on the displayed trace. The midrange rotation of the control moves the selected cursor linearly at the slow rate. When the control is rotated into the end-point stop spring, the cursor rate of travel increases to quickly move the cursor to the point of interest.

When the instrument is equipped with the AVG Storage Mode option, this control is used to select the number of sweeps to be averaged. In the ENVELOPE Storage mode, the control is used to set the number of sweeps to be accumulated in the envelope display. While the NO. OF SWEEPS push button is pressed in, rotating the control to the clockwise stop will increase the number of sweeps, and rotating the control to the counterclockwise stop will decrease the number of sweeps. Releasing the NO. OF SWEEPS push button returns the control to its CURSOR positioning function.

(49) **PUSH: CURSOR SELECT**—A momentary contact switch (concentric within the CURSOR/NO. OF SWEEPS control knob) used to alternately select the cursor that will be positioned by the CURSOR control knob. In the VOLTS measurement mode, the cursor selected to be positioned (active cursor) will be displayed as a dashed horizontal line.

Refer to Figure 2-9 for location of items 50 through 52.

(50) **NO. OF SWEEPS (AVG Option and ENVELOPE)**—When pressed in, the number of waveforms (sweeps) selected to be either averaged in the AVG Storage mode or accumulated in the ENVELOPE Storage mode is displayed on the seven-segment LED indicators. This number, for the AVG mode, may be changed in a binary sequence of 2, 4, 8, 16, 32, 64, 126, or 256 by rotating the CURSOR/NO. OF SWEEPS control knob to the end-stop positions. For ENVELOPE Storage mode, the number may also be set to acquire either one waveform or an unlimited number of waveforms (LED indication is 9999). If set for an unlimited number of waveforms, the digital storage circuitry will continually acquire data to be accumulated in the display until a new selection is made.

When the instrument is turned on, the number of sweeps or accumulations is automatically set to 32, and it will remain at this number until a different selection is made by the operator. Switching between any of the modes will not change the number selected for either ENVELOPE or AVG Storage mode.

(51) **TRANSMIT (GPIB Option)**—A momentary contact push-button switch that, when pressed, causes the 468 to go into the SAVE Storage mode to freeze the waveform at the end of the storage cycle in progress.

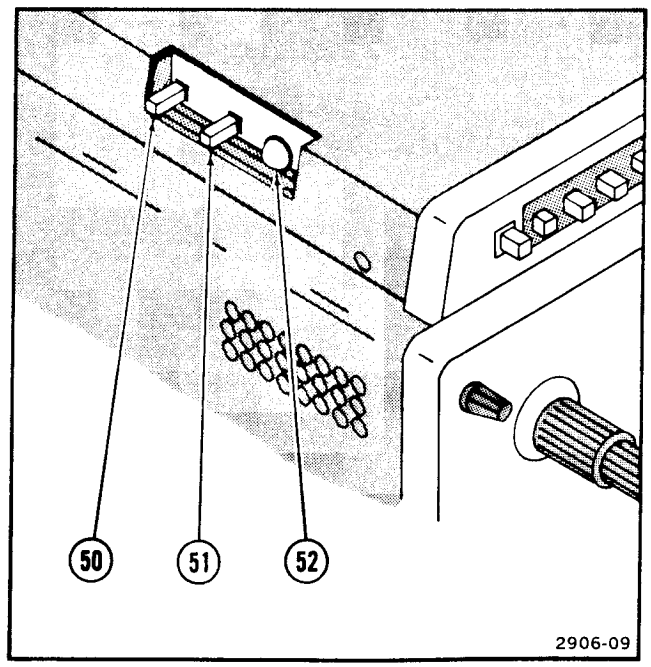

Figure 2-9. Digital storage left side panel controls and indicator.

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The current contents of the digital storage memory are transmitted to the GPIB (General Purpose Interface Bus). During transmission time, cursor functions may be used, but controls that can affect the stored data will not be effective until completion of the data transmission. The oscilloscope will return to the selected operation mode upon completion of the transmission.

NOTE

The waveform data will be transmitted as acquired (no interpolation or expansion) with the exception of the AVG waveform acquired in the 0.5, 1, and 2 mV per division positions of the VOLTS/DIV switch. The AVG data is processed to produce added resolution in these VOLTS/DIV settings, and the processed AVG waveform is sent.

Two ways of entering the TRANSMIT mode are possible as determined by the position (on or off) of the TALK ONLY switch on the 468 rear panel. When the TALK ONLY switch is on, the 468 is always a talker, and the waveform will be transmitted when the TRANSMIT button is pressed if the bus is active.

If the TALK ONLY switch is off, pressing the TRANSMIT button will cause the 468 GPIB option to transmit a service request (SRQ). The bus controller does a serial poll in response to the SRQ, and the 468 status byte indicates that a waveform is available. At the end of the poll, the controller arranges for listeners, if required, then sends the 468 talk address (MTA). Upon receiving MTA, the 468 GPIB interface transmits the waveform to the listener(s) on the bus. If device clear (DCL) is received by the 468 during transmission of a waveform, the GPIB interface will go to a state equivalent to having completed the transmission.

The data presented to the GPIB will conform to the Waveform Transmission Standard as specified by Tektronix Interface Standard—General Purpose Interface Bus (GPIB), Codes and Formats.

NOTE

Pressing the TRANSMIT button with no controller or listener on the bus will put the 468 into SAVE, and it will not return to normal operation. The only way to exit this condition is by cycling the POWER switch off, then on again.

To disable the circuit action of TRANSMIT switch (S612) when the 468 is not connected to a GPIB system, set section 8 of the internal Service/Options switch (S707) to the "OPEN" position. The Service/Options switch is located on the A16 STORAGE DISPLAY board, and is shown in Figure 5-6 in the Maintenance section of this manual.

(52) **GPIB Status Indicator ($\overline{\text{TIDS}}$/SRQ) (Option)**—A dual red/green LED indicator that illuminates to indicate GPIB status.

Red—Indicates that a service request (SRQ) has been issued by the 468. Power-on self-test will issue an SRQ, and the red LED will remain on if there is no device on the GPIB to respond to the SRQ.

Green—Indicates that the GPIB interface has been addressed to talk ($\overline{\text{TIDS}}$), either by a bus controller or by setting the TALK ONLY switch on and pressing the TRANSMIT push button.

In normal operation (with controller on the bus) the red LED will flash on (SRQ issued) when the TRANSMIT push button is pressed, and the green LED will be on ($\overline{\text{TIDS}}$, addressed to talk) during the actual transmission of data.

REAR PANEL

Refer to Figure 2-10 for location of items 53 through 58.

(53) **A +GATE OUT**—Bnc connector providing an approximately 5 V, positive-going square wave coincident with the A Sweep time.

(54) **B +GATE OUT**—Bnc connector providing an approximately 5 V, positive-going square wave coincident with the B Sweep time.

(55) **CH 1 VERT OUT SIGNAL OUT**—Bnc connector providing an output signal with an amplitude of approximately 50 mV per each division of displayed Channel 1 signal into 1 MΩ or 25 mV per each division of displayed Channel 1 signal into 50 Ω.

(56) **EXT Z-AXIS INPUT**—Bnc connector used to apply external signals to the Z-axis Amplifier to intensity modulate the crt display. Intensity modulation does not affect the displayed waveshape. Signals with fast rise and fall time provide the most abrupt intensity change. Positive-going signals decrease the intensity, and a 5 V p-p signal will produce noticeable modulation. Z-axis signals must be time related to the display to obtain a stable intensity modulation pattern on the crt. External Z-axis modulation is useful for the NON STORE mode only.

(57) **GPIB Connector (Option)**—Standard GPIB connector allows interconnection with other devices on a GPIB. Conforms to IEEE-488 Standard of 1978.

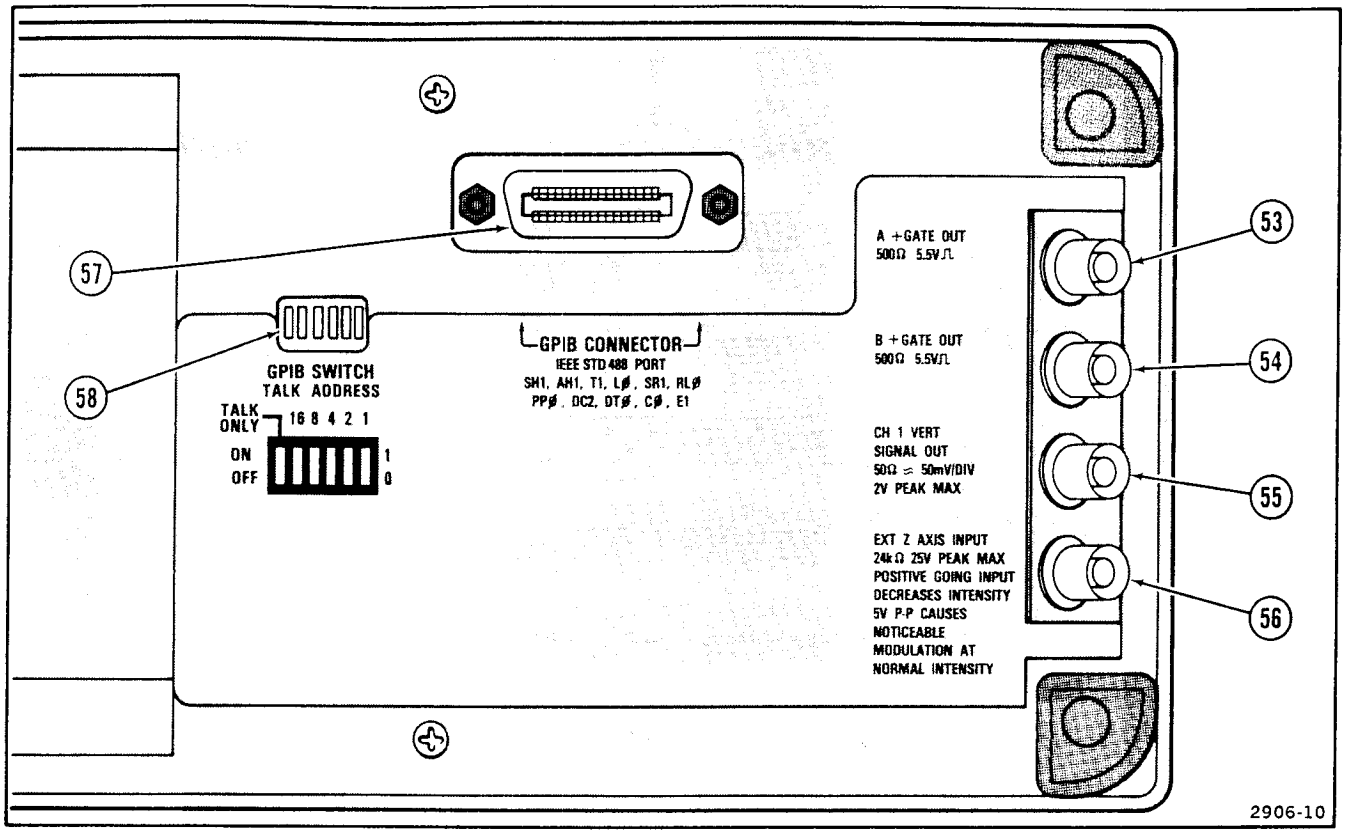

Figure 2-10. Rear panel controls and connectors.

(58) **GPIB Switch (Option)**—The first section of this six-section, two-position switch controls the TALK ONLY local message. In the ON position, the 468 is permanently addressed as a talker. In the OFF position, the 468 must be addressed to talk by a bus controller. The remaining five sections of the switch set the binary talk address of the 468.

Refer to Figure 2-11 for location of items 59 through 64.

(59) **Line Fuse Holder**—Contains the line fuse. See Table 2-1 for fuse change information.

(60) **Detachable Line Cord**—Makes the connection between the oscilloscope and the power source. The cord may be conveniently stored by wrapping it around the feet on the rear panel.

(61) **Power Cord Jack**—Receptacle for detachable line cord.

(62) **Mod Slots**—A number in either slot indicates the instrument contains an option or other modification.

RIGHT SIDE PANEL

(63) **Regulating Range Selector Switch**—Selects the regulating range of the 468 power supplies to match the available ac-power-source voltage. See Table 2-2 for switch change information.

(64) **Line Voltage Selector Switch**—Selects either 115-V or 230-V nominal ac-power-source voltage. Refer to Table 2-2 for switch change information. The line fuse must be changed to match the ac-power-source voltage range selected (see Table 2-1).

LEFT SIDE PANEL

Refer to Figure 2-12 for location of items 65 and 66.

(65) **Vertical Gain Controls (accessible through left side panel)**—Screwdriver adjustments to set the gain of each vertical channel.

(66) **Variable Balance Controls (accessible through left side panel)**—Screwdriver adjustments to set balance of each vertical channel.

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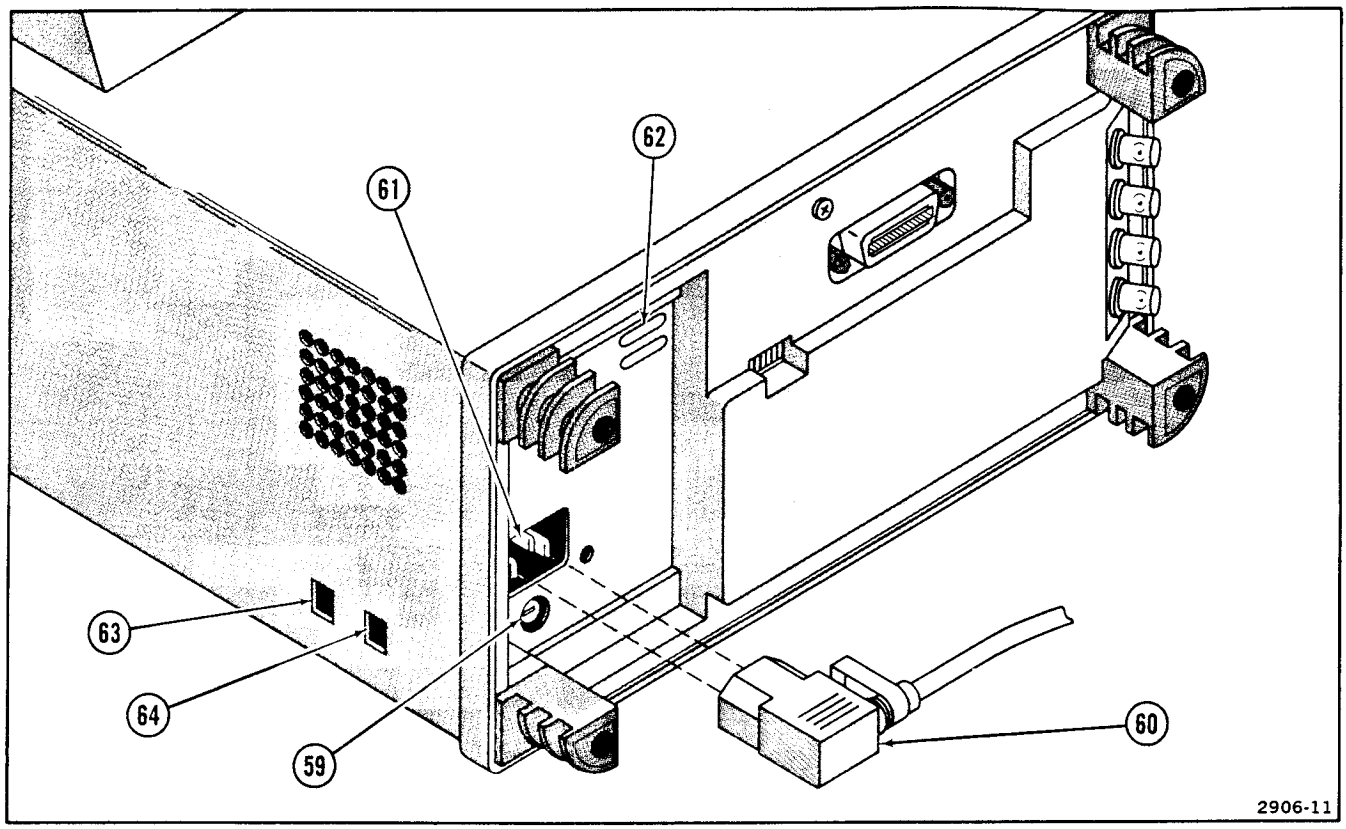

Figure 2-11. Rear panel and right side panel power controls, connectors, and indicators.

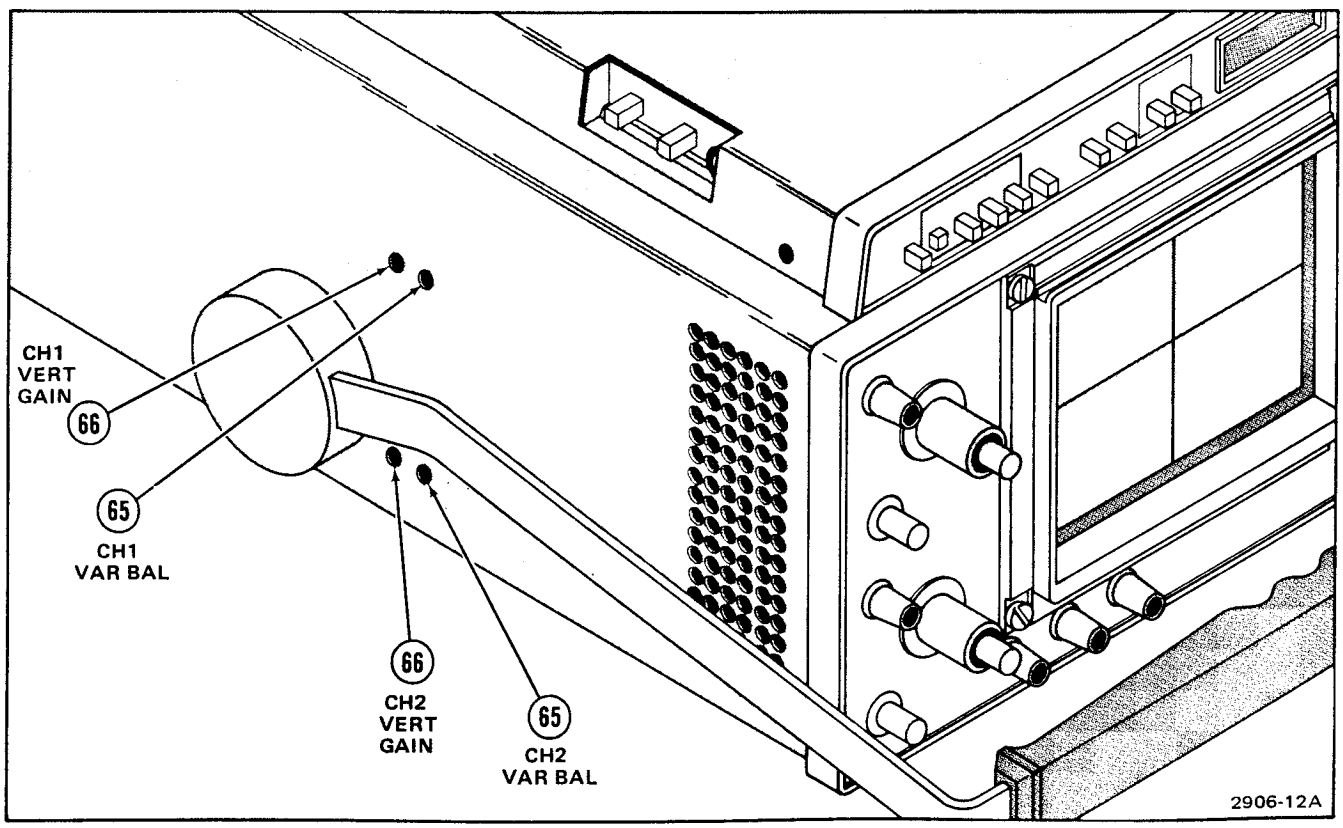

Figure 2-12. Left side panel controls.

OSCILLOSCOPE DISPLAYS

The procedures in this section will allow you to set up and operate your instrument to obtain the most commonly used oscilloscope displays. Before proceeding with these instructions, verify that both the Line Voltage Selector switch and the Regulating Range Selector switch are placed in the proper positions and that the correct line fuse is installed for the ac-power-input voltage being used. Refer to the "Preparation for Use" instructions in this manual for the information and procedures relating to ac-power-input-source voltage, regulating range, and fuse selection. Verify that the POWER switch is OFF (push button out), then plug the power cord into the ac-power-input-source outlet.

NON STORE DISPLAYS

The following procedures are used to obtain the most commonly used conventional oscilloscope displays.

NORMAL SWEEP DISPLAY

1. Preset the instrument controls as follows:

Vertical

VERT MODE	CH 1
VOLTS/DIV	Proper setting determined by amplitude of signal to be applied
VOLTS/DIV VAR	Calibrated detent
AC-GND-DC (Input Coupling)	AC
POSITION	Midrange
20 MH BW LIMIT	Not limited (push button out)
INVERT	Off (push button out)

Display

INTENSITY	Fully counterclockwise
FOCUS	Midrange
SCALE ILLUMINATION	Midrange

Horizontal

TIME/DIV (A and B)	Locked together at 0.1 ms
A TIME/DIV VAR	Calibrated detent
HORIZ DISPLAY	A
X10 MAG	Off (push button out)
POSITION	Midrange

Trigger (both A and B if applicable)

SLOPE	+ (plus)
LEVEL	0 (midrange)
SOURCE	NORM
COUPLING	AC
TRIG MODE (A only)	AUTO
A TRIG HOLDOFF	NORM (fully ccw)

Digital Storage

NON STORE	Push button in

2. Push the POWER push button in (ON) and allow the instrument time to warm up. Using the supplied 10X probe or a properly terminated coaxial cable, apply a signal to the CH 1 input connector. The signal source output impedance determines the termination required when using a coaxial cable to interconnect test equipment.

NOTE

Instrument warmup time required to meet all specification accuracies is 20 minutes.

3. Advance the INTENSITY control until the display is visible. If the display is not visible with the INTENSITY control at midrange, press the BEAM FIND push button and hold it in while adjusting the Channel 1 VOLTS/DIV switch to reduce the vertical display size. Center the compressed display using the Vertical and Horizontal POSITION controls. Release the BEAM FIND push button.

4. Set the Channel 1 VOLTS/DIV switch and the Vertical and Horizontal POSITION controls to locate the display within the graticule area.

5. Adjust the A Trigger LEVEL control for a stable, triggered display.

6. Set the A TIME/DIV switch for the desired number of cycles of displayed signal. Then adjust the FOCUS control (and ASTIG, if necessary) for the best defined display.

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MAGNIFIED SWEEP DISPLAY

1. Obtain a Normal Sweep Display.

2. Adjust the Horizontal POSITION control to move the area to be magnified to within the center crt graticule division (0.5 division on each side of the center vertical graticule line). Change the TIME/DIV switch setting as required.

3. Press the X10 MAG push-button switch in (on) and adjust the Horizontal POSITION control for precise positioning of the magnified display.

4. To calculate the magnified sweep rate, divide the TIME/DIV switch setting by 10.

B DELAYED SWEEP DISPLAY

1. Obtain a Normal Sweep Display.

2. Set the HORIZ DISPLAY switch to A INTEN and the B Trigger SOURCE switch to STARTS AFTER DELAY.

3. Pull out the B TIME/DIV knob to unlock it from the A TIME/DIV knob and turn it clockwise from the counterclockwise stop until the intensified zone is the desired length. Adjust the INTENSITY and B INTENSITY controls as required to make the intensified zone distinguishable from the remainder of the display.

4. Adjust the DELAY TIME POSITION control to move the intensified zone to cover that portion of the A trace that is desired to be displayed on the B trace.

5. Set the HORIZ DISPLAY switch to B DLY'D. The intensified zone adjusted in steps 3 and 4 is now displayed as the B trace at the sweep rate indicated by the white stripe on the B TIME/DIV knob.

6. A more stable display with less jitter may be obtained by setting the B Trigger SOURCE switch to match the position of the A Trigger SOURCE switch and adjusting the B Trigger LEVEL control for a stable display.

NOTE

The DELAY TIME POSITION control will not provide continuously variable delay when the B Trigger SOURCE is set to a position other than STARTS AFTER DELAY. Also, differential time measurements are invalid when the B Trigger SOURCE switch is not set to STARTS AFTER DELAY.

ALTERNATE HORIZONTAL SWEEP DISPLAY

1. Obtain a Normal Sweep Display.

2. Set the HORIZ DISPLAY switch to ALT and the B Trigger SOURCE to STARTS AFTER DELAY.

NOTE

Two traces will be visible: the A trace with an intensified zone, and the B DLY'D trace.

3. Adjust the Channel 1 POSITION control and TRACE SEP control as required to display the A trace above the B trace.

4. Pull out the B TIME/DIV knob to unlock it from the A TIME/DIV knob, and turn it clockwise to the desired B Sweep rate. (The B Sweep rate is indicated by the white stripe on the B TIME/DIV knob.)

5. Adjust the INTENSITY and B INTENSITY controls as required to make the intensified zone distinguishable on the A trace and to set the B trace intensity to the desired brightness.

6. Adjust the DELAY TIME POSITION control to move the intensified zone to cover the portion of the A trace that is to be displayed on the B trace.

X-Y DISPLAY

1. Obtain a Normal Sweep Display. Rotate the INTENSITY control fully counterclockwise and disconnect the CH 1 input signal.

2. Use equal length coaxial cables, or the two supplied 10X probes, and apply the vertical signal (Y-axis) to the CH 2 OR Y input connector and the horizontal signal (X-axis) to the CH 1 OR X input connector.

3. Set the A TIME/DIV switch fully counterclockwise to the X-Y position.

NOTE

For instruments with firmware version 1.0, both the CH 1 and CH 2 VERT MODE push buttons must be pressed in to illuminate the scale-factor LED only. It is not necessary to select any VERT MODE to obtain the X-Y display.

4. Advance the INTENSITY control until the display is visible. If the display is not visible with the INTENSITY control at midrange, press and hold in the BEAM FIND push button while adjusting the Channel 1 and Channel 2 VOLTS/DIV switches until the display is reduced in size, both vertically and horizontally. Center the compressed display with the POSITION controls (Channel 2 POSITION control for vertical movement; Horizontal POSITION control for horizontal movement). Release the BEAM FIND push button. Adjust the FOCUS control for a well-defined display.

NOTE

The display obtained when sinusoidal signals are applied to the X- and Y-axis is called a Lissajous Figure. This display is commonly used to compare the frequency and phase relationship of the two input signals. The frequency relationship of the two input signals determines the pattern seen. The pattern will be stable only if a common divisor exists between the two frequencies.

5. Disconnect the input signals from the channel input connectors and rotate the A TIME/DIV knob to 1 ms per division.

SINGLE SWEEP DISPLAY

1. Obtain a Normal Sweep Display. For random signals, set the A Trigger LEVEL control to trigger the sweep on a signal that is approximately the same amplitude as the random signal.

2. Press the SINGL SWP push button. The next trigger pulse will initiate the sweep, and a single trace will be displayed. If no trigger signal is present, the READY indicator LED should illuminate to indicate that the A Sweep Generator circuit is set to initiate a sweep when a trigger signal is received.

3. When the single sweep has been triggered, and the sweep is completed, the sweep logic circuitry is locked out. Another sweep cannot be generated until the SINGL SWP push button is pressed to set the Sweep Generator to the READY condition.

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DIGITAL STORAGE DISPLAYS

The following procedures explain how to set up and use the digital storage capabilities of the 468. Front panel controls set the conditions under which a waveform is acquired for display. Display amplitude is controlled by the VOLTS/DIV switches, and the storage window is controlled by the A or B TIME/DIV switch. Certain conditions of Vertical Mode selection and Storage Mode selection will store waveforms under a priority plan. See Table 2-3 for a complete chart describing the waveform stored for both display and reference with different combinations of Vertical Mode and Storage Mode selections.

NORM STORAGE MODE DISPLAY

1. Obtain a Normal Sweep Display of the waveform to be stored.

2. If the signal is obtained at sweep speeds of 1 μs per division or faster, select either the SINE Display Response for sinusoidal signals or PULSE Display Response for pulse-type signals.

3. Select PRE TRIG or POST TRIG Storage Window. PRE TRIG will cause 7/8 of a waveform to be stored before the trigger event; POST TRIG will cause only 1/8 of a waveform to be stored before the trigger event. In both cases, the remaining portion of the waveform is stored after the trigger event occurs.

4. Press the NORM Storage Mode push button in.

Table 2-3

Priority Storage Plan

Selected Vertical Mode(s)	Selected Storage Mode	CHOP/ALT	Display With SAVE REF Off	Ref Saved	Display With SAVE REF On
CH 1	a	b	CH 1 Only	CH 1	CH 1 and Ref
CH 2	a	b	CH 2 Only	CH 2	CH 2 and Ref
ADD	a	b	ADD Only	ADD	ADD and Ref
CH 1, CH 2	a	ALT	CH 1 and CH 2	CH 1	CH 1 and Ref
CH 1, ADD	a	b	CH 1 and ADD	ADD	ADD and Ref
CH 2, ADD	a	b	CH 2 and ADD	ADD	ADD and Ref
CH 1, CH 2	NORM	CHOP	CHOP of CH 1/CH 2	CH 1/CH 2	CH 1/CH 2 and Ref
CH 1, CH 2, ADD	NORM	b	CHOP of CH 1/CH 2 and ALT ADD	ADD	ADD and Ref
CH 1, CH 2	ENV or AVG	b	CH 1 and CH 2	CH 1	CH 1 and Ref
CH 1, CH 2, ADD	ENV or AVG	b	CH 1 and ADD	ADD	ADD and Ref

[a]**NORM ENV, or AVG Storage Mode selected.**

[b]**Either CHOP or ALT Vertical Mode selected.**

5. In this mode, the display responds to front-panel control changes with each sweep trigger, and the results of changes may be viewed each sweep. Waveforms acquired and displayed at low sweep rates require an increasing time to change as the sweep rate decreases (e.g., a waveform acquired at a sweep rate of 1 s per division requires approximately 10 seconds for the sweep time, and the triggering signal must be received after the sweep in progress is completed). Therefore, at the slower sweep speeds a longer delay is required before the display responds after changing a front-panel control.

NOTE

A signal displayed at 2, 1, and 0.5 mV per division is acquired at 5 mV per division and expanded vertically 2.5, 5, or 10 times in the steps of the VOLTS/DIV switch.

ENVELOPE STORAGE MODE DISPLAY

1. Obtain a Normal Sweep Display of the waveform to be stored.
2. Set TRIG MODE to NORM and adjust the A Trigger LEVEL control to obtain a stable display of the waveform to be stored. (This ensures that the trigger and the waveform to be stored are synchronized, especially on low-repetition-rate waveforms.)
3. Select either PRE TRIG Storage Window to acquire 7/8 of the waveform before the trigger event or POST TRIG Storage Window to acquire 7/8 of the waveform that occurs after the trigger.
4. Press the ENVELOPE Storage Mode push button in.
5. Change the number of sweeps to be accumulated in the waveform envelope display using the following procedure, if necessary. (The number is automatically set to 32 at power on.)
   a. Press the NO. OF SWEEPS push button in. The seven-segment LED indicators will now display the number of sweeps to be accumulated.
   b. Rotate the CURSOR/NO. OF SWEEPS control knob either clockwise to increase the displayed number or counterclockwise to decrease the number.
   c. Press the NO. OF SWEEPS push button again to release it. The number on the display will count down as the sweeps are being acquired for the first storage cycle after the NO. OF SWEEPS push button is released. However, countdown begins as soon as a new selection is made, and the push button must be released immediately if it is desired to view the countdown. After the first ENVELOPE storage cycle countdown is com-

pleted, the LED display will be under the control of the CURSOR FUNCTION mode in use. The displayed number will not count down if the number of sweeps is set to 9999.

NOTE

The number of sweeps to be accumulated in the display is selectable from 1 to 256 in a binary sequence. The digital storage circuitry will display the resultant waveform with each sweep as the selected number of sweeps are acquired, then remove the resultant waveform and start the accumulations again in a repetitive cycle. An unlimited number of sweeps may also be selected (LED indicator display is 9999). In that case, the digital storage circuitry will continue to accumulate sweeps until the operator either makes a new number-of-sweeps selection or starts the accumulation cycle again by changing any oscilloscope front-panel control that will affect the data being acquired.

AVG STORAGE MODE DISPLAY (OPTION) (STANDARD SN B032430 & UP)

1. Obtain a Normal Sweep Display of the waveform to be stored.

2. Set oscilloscope TRIG MODE to NORM, and adjust the A Trigger LEVEL control to obtain a stable display of the waveform to be stored. (This ensures that the trigger and the waveform to be stored are synchronized, especially on low-repetition-rate waveforms.)

3. If waveforms are acquired at a TIME/DIV switch setting of 1 μs per division or faster, select either SINE Display Response for sinusoidal signals or PULSE Display Response for pulse-type signals.

4. Select either PRE TRIG Storage Window to acquire 7/8 of a waveform prior to the trigger or POST TRIG Storage Window to acquire 7/8 of a waveform occurring after the trigger.

5. Press the AVG Storage Mode push button in.

6. Change the number of sweeps to be accumulated in the display using the following procedure, if required. (The number is automatically set to 32 at power on.)

   a. Press NO. OF SWEEPS push button in. The seven-segment LED indicators will now display the number of sweeps to be averaged.

   b. Rotate the CURSOR/NO. OF SWEEPS control knob either clockwise to increase the displayed number or counterclockwise to decrease the number.

   c. Press the NO. OF SWEEPS push button again to release it. The number on the display will count down as the sweeps are being acquired for the first storage cycle after the NO. OF SWEEPS push button is released. Averaging begins as soon as a new selection is made, so the push button must be released immediately if it is desired to view the countdown. After the first AVG storage cycle is completed, the LED display will be under the control of the CURSOR FUNCTION mode in use.

NOTE

The number of sweeps to be accumulated in the averaged waveform is selectable from 2 to 256 in a binary sequence. The digital storage circuitry will acquire the selected number of sweeps to be averaged, then display the averaged waveform while the required sweeps are being accumulated for the next averaged waveform. This cycle continues in a repetitive manner until a new mode is selected. Changing a front-panel control that affects the data being acquired will start the accumulation process over, to obtain the selected number of sweeps at the new control setting.

SAVE STORAGE MODE DISPLAY

1. Acquire a waveform in either NORM, ENVELOPE, or AVG (option) Storage Mode.

2. Press the SAVE Storage Mode push button in.

NOTE

For early serial number instruments, with firmware version 1.0 installed, a minor firmware bug can occur when making voltage cursor measurements in the SAVE STORAGE MODE. The bug occurs when the voltage cursors are positioned at or within 0.05 division of the following spacings: together (one cursor superimposed over the other), 2.5 divisions apart, 5 divisions apart, and 7.5 divisions apart. Under these conditions, an incorrect voltage readout can appear in the seven-segment LED display. (If a 10X scale-factor-switching probe is used to acquire the displayed signal, the incorrect readout can occur over a range of up to 0.6 graticule divisions at each of the preceding voltage cursor spacings.)

Occurence of the bug can be recognized by a decimal point shift in the seven-segment LED display. The digits displayed usually change, but not in every instance.

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NOTE (cont.)

The following methods enable the user to compensate for this problem:

a. *Use the COUPLED V/T CURSOR FUNCTION. The voltage readout appearing in the seven-segment LED display will be correct.*

b. *If an off-waveform voltage measurement must be made, use NORMAL STORAGE MODE. SAVE STORAGE MODE is the only function affected by the bug.*

c. *Check the readout (appearing in the seven-segment LED display) against the graticule and VOLTS/DIV switch setting when making measurements over the small ranges affected when the voltage cursors are spaced at 2.5-graticule-division multiples while operating in SAVE STORAGE MODE.*

NOTE

NORM or continuous ENVELOPE acquisition stops immediately, and the displayed waveform is saved. Acquisition of data will stop at the end of a set ENVELOPE or AVG cycle in progress, and the new waveform will be saved. If a front-panel contol setting is changed after the SAVE push button is pressed in but before an ENVELOPE or AVG cycle in progress is completed, the storage cycle will restart to obtain waveforms at the new control setting.

The SAVE display of a waveform acquired in the NORM or AVG (option) Storage Mode with the TIME/DIV switch set to 1 μs per division or faster, will be affected by the setting of the SINE or PULSE Display Response switch, If the ENVELOPE Storage Mode is selected and the number of sweeps to be accumulated is set to 9999, pressing the SAVE push button will immediately switch the 468 to the SAVE Storage Mode.

3. The SAVE Storage Mode display may be expanded up to 100 times depending on the setting of the TIME/DIV switch that controls the horizontal mode in operation when the waveform was acquired. Waveform data is expanded, using digitial interpolation and analog gain. The display is expanded horizontally in both directions from the POST TRIG trigger point (data point 64) and is correctly scaled for the TIME/DIV switch setting (Data point 64 is approximately 1.3 horizontal graticule divisions from the beginning of the trace). When a chopped waveform acquisition is used, the POST TRIG trigger point is data point 32.

4. The SAVE Storage Mode display may be expanded vertically up to 10 times depending on the setting of the VOLTS/DIV switch of the channel used for the data acquisition.

SAVE REF DISPLAY

1. Acquire a waveform in either NORM, ENVELOPE, or AVG (option) Storage Mode to be used as a reference waveform. Refer to Table 3 for a chart of the waveform stored as a reference with various combinations of Vertical Mode and Storage Mode selection.

2. Press the SAVE REF push button in. The reference waveform will be displayed in the vertical position at which it was acquired. It will not be further affected by any control knob or switch setting change on the oscilloscope front panel except the Horizontal POSITION control.

3. Press the SAVE REF push button again to release it and remove the reference waveform from the display. A new reference waveform will be saved each time the SAVE REF push button is pressed in.

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THEORY OF OPERATION

INTRODUCTION

SECTION ORGANIZATION

This section contains a functional description of the 468 Digital Storage Oscilloscope circuitry. The discussion begins with a general summary of instrument functions broken down into conventional and digital storage operation. Following the General Description, each major circuit is explained in detail, using functional block diagrams and schematic diagrams to show the interconnections between parts of the circuitry, to indicate circuit components, and to identify interrelationships with the front-panel controls. Circuit diagrams and the larger block diagrams are located in the tabbed "Diagrams" section found in Volume II of this manual. The circuit diagram associated with each description is identified in the text and indicated on the tab of the appropriate foldout page by a numbered diamond symbol. For best understanding of the circuit being described, refer to both the appropriate circuit diagram and functional block diagram.

INTEGRATED CIRCUIT DESCRIPTIONS

Digital Logic Conventions

Digital logic circuits perform many functions within this instrument. Function 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 of notation whereby 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 referred to as HI, and the FALSE state is referred to as LO. The specific voltages which constitute a HI or a LO state vary between specific devices.

In the discussion of the General Purpose Interface Bus (GPIB) option, signals are described as asserted (TRUE) or unasserted (FALSE) rather than HI or LO. The GPIB uses negative logic signals for bus operation. Circuitry in the 468 GPIB interface convert the negative-logic GPIB signals to positive logic signals for use within the 468.

Linear Devices

The functioning of individual linear integrated circuit devices is described in this section using waveforms or other techniques to illustrate their operation.

GENERAL DESCRIPTION

In the following overall functional description of the 468 Digital Storage Oscilloscope, refer to basic block diagrams Figures 3-1 and 3-2 and to the detailed block diagrams located in the "Diagrams" section of this manual. Each major block in the diagrams represents a major circuit within the instrument. In Figure 3-1, the numbered diamond symbol in each block refers to the appropriate schematic diagram number.

CONVENTIONAL OPERATION

Signals to be displayed on the crt are applied to the CH 1 OR X input connector or the CH 2 OR Y input connector. These input signals are then amplified by the Preamplifier circuitry. Each channel includes separate vertical deflection factor, input coupling, balance, gain, and variable attenuation switches or controls. A trigger pickoff

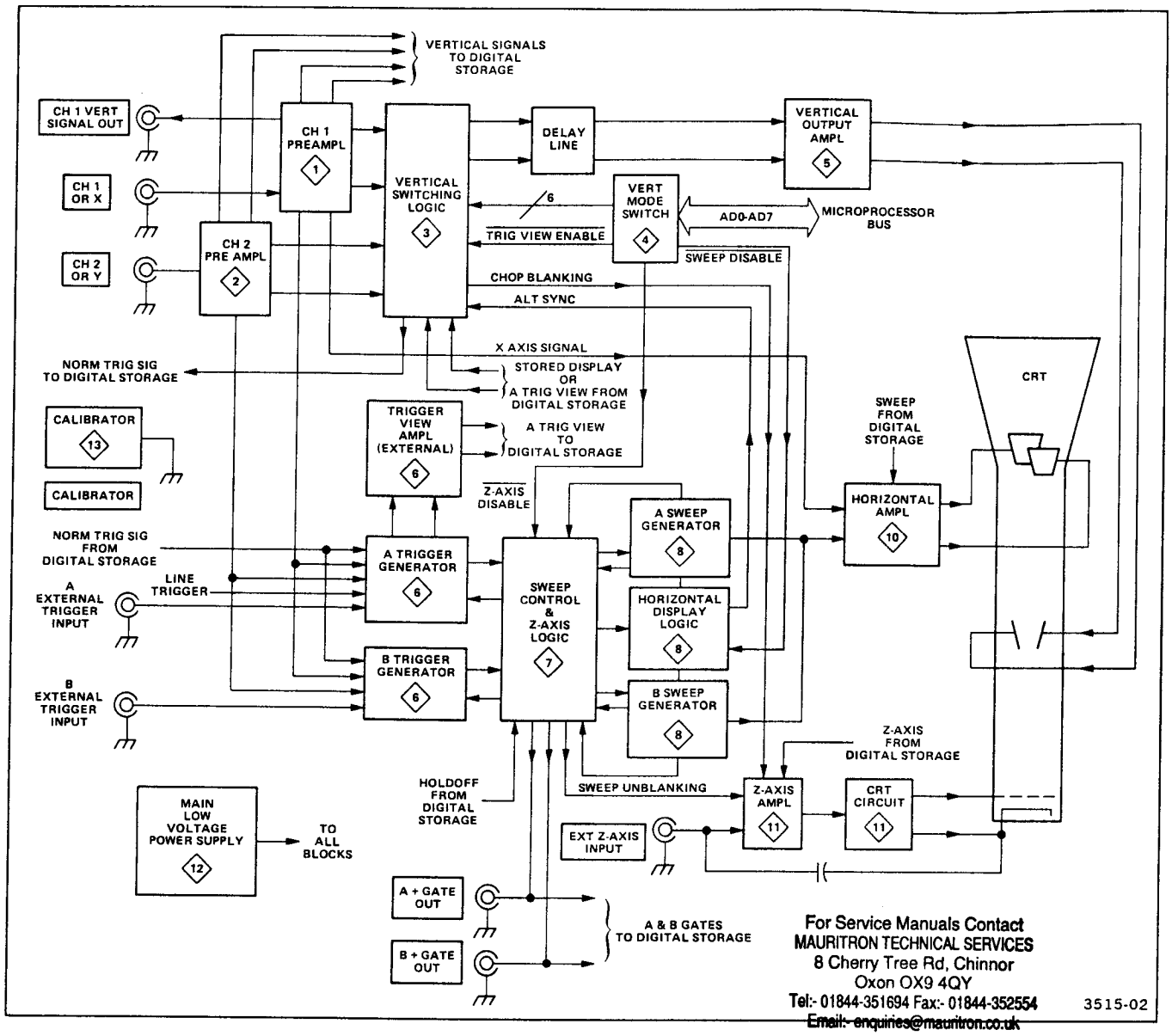

Figure 3-1. Basic block diagram of the 468 Oscilloscope, conventional operating portion.

stage in each vertical Preamplifier supplies a trigger signal from that channel to the Trigger Generator circuits. Another pickoff amplifier supplies the Channel 1 signal to the CH 1 VERT SIGNAL OUT connector on the instrument rear panel. Additional pickoff amplifiers in each Preamplifier supply the Channel 1 and Channel 2 vertical signals to the digital storage input circuitry.

In the X-Y mode of operation, the Channel 1 signal is connected to the input of the Horizontal Amplifier circuit to provide the X-Axis deflection. The Channel 2 signal is amplified by the Vertical Output Amplifier circuit to provide the Y-Axis deflection. The Channel 2 Vertical Preamplifier circuit contains an invert feature to allow the operator to invert the Channel 2 signal displayed on the crt.

The outputs of both vertical Preamplifier circuits, along with the output of the A Trigger View Amplifier via the digital storage circuitry, are connected to the Vertical Switching Logic circuitry. The Vertical Mode Switch circuitry supplies the VERT MODE selection information to the Microprocessor. The Microprocessor then sets the Vertical Switching Logic circuit to the chosen vertical mode of operation. The Vertical Switching Logic circuit selects the input(s) to be displayed on the crt at the appropriate time.

The Chopped Blanking signal (produced in the Vertical Switching circuit and fed to the Z-Axis Amplifier circuit) blanks the switching transients between channels when the chopped mode of operation is selected. A Normal Trigger

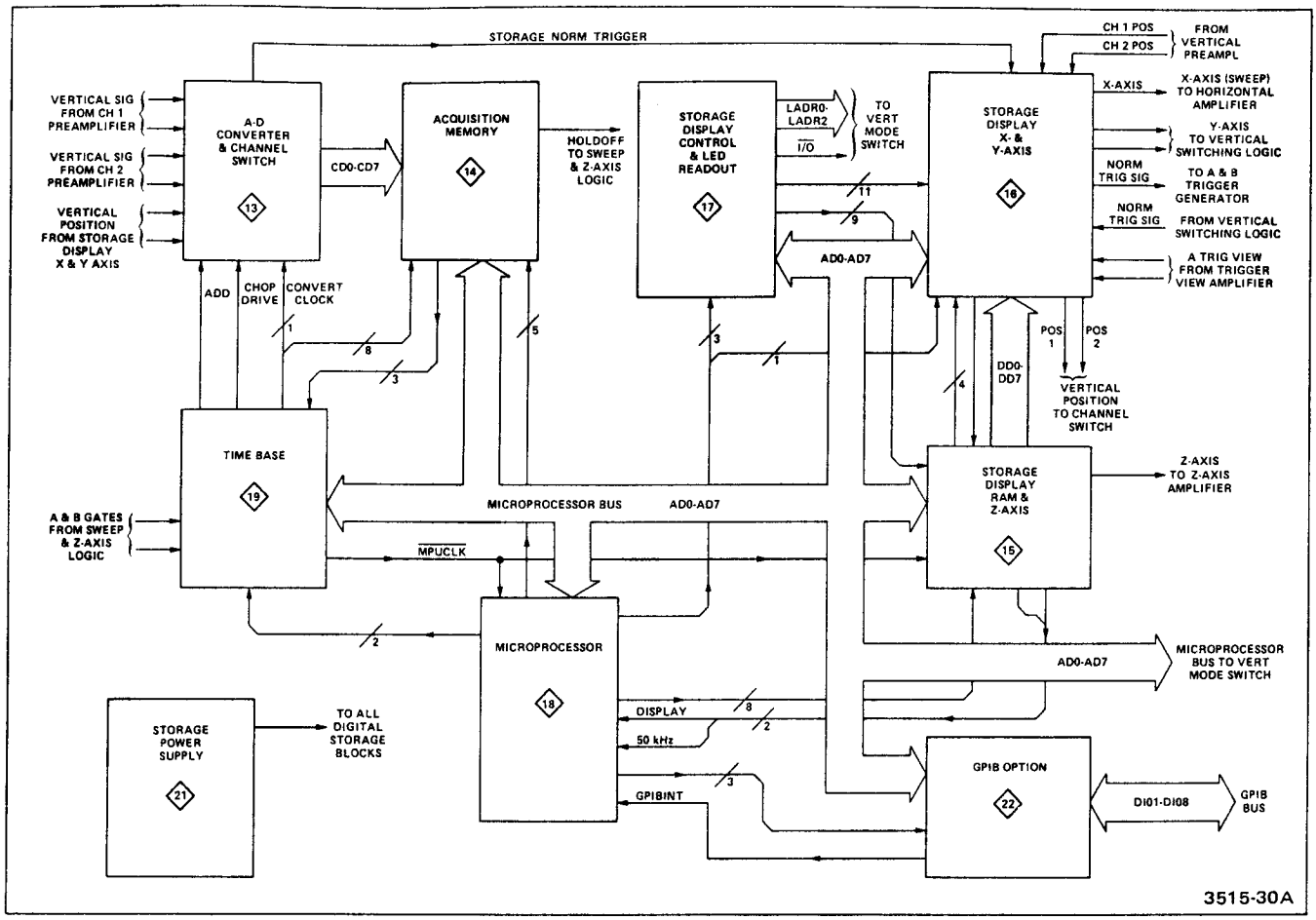

Figure 3-2. Basic block diagram of the 468 digital storage circuitry.

pickoff stage at the output of the Vertical Switching circuit provides a composite trigger (made up of the signal(s) displayed on the crt) to the Trigger Generator circuits via digital storage circuitry.

The Vertical Switching circuit output is connected to the Vertical Output Amplifier through the Delay Line. The Vertical Output Amplifier amplifies the signal and applies it to the crt vertical deflection plates. The vertical portion of the BEAM FIND switch circuitry is included in the Vertical Output Amplifier circuit. When activated, the action of the circuit limits vertical deflection to within the graticule area to aid in locating off-screen or overscanned displays.

The A and B Trigger Generator circuits each create an output pulse that initiates the sweep produced by either the A or B Sweep Generator circuits. Input signals to the A and B Trigger Generator circuits can be individually selected from any of the following sources: Channel 1 signal, Channel 2 signal, signal(s) displayed on the crt (NORM), signal(s) connected to the External Trigger input connectors, or a signal derived from the ac-power source (A Trigger only). Each trigger circuit contains level, slope, coupling, and source controls or switches. The A External Trigger input is also fed to the A Trigger View Amplifier where it is amplified and made available to the Vertical Switching circuitry for viewing on the crt during nonstorage (conventional) oscilloscope operation. The A Trigger View input to the Vertical Switching circuitry is also used to apply the Storage Display signal to the Vertical Switching circuitry during storage operation.

When activated by the A Trigger Generator circuit, the A Sweep Generator circuit produces a linear sawtooth output signal, the slope of which is controlled by the A TIME/DIV switch. The TRIG MODE switches control the operating mode of the A Trigger Generator circuit. When AUTO is selected, absence of an adequate trigger signal for about 100 ms after the end of holdoff causes an A Sweep start gate to be generated. When NORM Trigger Mode is selected, a horizontal sweep is generated only when triggered by an adequate trigger signal. Pushing the SINGL SWP push button sets the Sweep Logic to initiate only one sweep after a trigger pulse is received.

The Z-Axis Logic circuit produces a gate signal to unblank the crt so that the display can be presented. This gate signal is coincident with the sawtooth sweep signal produced by the A Sweep Generator circuit. The A Gate (another signal also coincident with the sawtooth) is fed to the digital storage circuitry to be used as the trigger for ending the acquisition of a signal during storage-mode operation of the oscilloscope. From the digital storage circuitry, the A Gate is made available to the A + GATE output connector on the instrument rear panel.

The Sweep Control Logic circuit produces the Horizontal Alternate Sync pulse that is fed to the Horizontal Display Logic circuit to switch the display between A Intensified and B Delayed sweeps when ALT Horizontal Display mode is selected.

The B Sweep Generator circuit is basically the same as the A Sweep Generator circuit. However, this circuit only produces a sawtooth output signal either when a delay time period (determined by the DELAY TIME POSITION control) has lapsed, or when a trigger pulse is received from the B Trigger Generator circuit. If the B Trigger SOURCE switch is set to the STARTS AFTER DELAY position, the B Sweep Generator produces the sweep immediately following the selected delay time. If the SOURCE switch is set to one of the other available positions, the B Sweep Generator circuit does not produce a sweep until it receives a trigger pulse from the B Trigger Generator circuit. The B Gate signal, produced in the Sweep and Z-Axis Logic circuit coincident with the B Sweep, is fed to the digital storage circuitry for ending the acquisition of a signal at the B Sweep rate for Horizontal Display selections of ALT and B D'LYD. From the digital storage circuitry, the B Gate is made available to the B + GATE output connector on the instrument rear panel.

Sweep signals from either the A or B Sweep Generator are amplified by the Horizontal Amplifier circuit to produce horizontal deflection for the crt except when either the X-Y display mode or storage operation is selected. The Horizontal Amplifier circuit contains a 10X magnifier circuit that may be selected to increase the displayed sweep rate 10 times for any A or B TIME/DIV switch position. External signals may be used for horizontal deflection by using the X-Y position of the A TIME/DIV switch. In the X-Y mode of operation, signals connected to the CH 1 OR X input connector supply the horizontal deflection signal (X-Axis). When operating in a storage mode, the horizontal deflection signal is supplied to the Horizontal Amplifier from the digital storage circuitry.

The Z-Axis Amplifier circuit determines crt intensity and blanking. Input current from the INTENSITY control, the Vertical Switching circuit (chopped blanking), the Z-Axis Logic circuit (unblanking), and the EXT Z-AXIS Input connector are summed in the Z-Axis Amplifier circuit to control the crt trace intensity.

The CRT circuit contains the HV oscillator, the HV multiplier, DC restorer, and HV regulator circuitry. The regulator controls the drive to the oscillator to maintain the correct voltage drive to the HV multiplier. Alternating current from the oscillator is fed to a transformer that is used to supply the HV multiplier drive voltage, the DC restorer drive, and the crt cathode voltage, as well as the focus voltage levels.

The HV multiplier converts the ac input voltage to the high dc accelerating voltage applied to the crt. The sealed multiplier circuitry output is supplied directly to the crt via a HV insulated lead.

DC restoration raises the output level of the Z-Axis amplifier to allow it to be coupled to the crt. Direct coupling is not possible due to the large voltage levels applied to the crt elements.

During storage operation, both the conventional A and B Sweep signals to the Horizontal Amplifier and the Z-Axis signal to the Z-Axis amplifier are disabled, and the horizontal deflection and intensity modulation signals are provided by the digital storage circuitry.

The Main Power Supply circuit provides the low-voltage power for the conventional portion of the 468. Power is distributed as necessary throughout the instrument.

A Calibrator circuit produces a square-wave output (with both accurate voltage and current amplitudes) that is useful for both checking the calibration of the instrument and compensating voltage probes. The CALIBRATOR current loop provides an accurate current source for calibration of current-measuring probe systems.

DIGITAL STORAGE OPERATION

Channel 1 and Channel 2 input signals supplied from the Preamplifier circuits are applied to the digital storage Channel Switch and A-D Converter circuitry. The Channel Switch, under control of the Microprocessor via the Time Base, selects the appropriate channel signal or signals to be digitized by the A-D Converter and supplied to the Acquisition Memory as parallel, eight-bit data byes to be stored.

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The CH 1 and CH 2 vertical position signals (POS1 and POS2), applied to the Channel switch set the dc operating level of the circuit.

A composite storage NORM trigger output signal is provided for application to the A and B Trigger Generator for NORM Trigger Mode storage operation.

The Acquisition Memory is a dual-purpose, random-access memory (RAM). It may be used to either store the waveform data during acquisition of an input signal or as additional system RAM by the Microprocessor during nonacquisition periods. ENVELOPE Storage Mode Min/Max is data determined by four amplitude comparators that locate the minimum and maximum data values at each data point for storage into the Acquisition RAM.

Additional circuitry produces the digital storage holdoff signals to the oscilloscope Sweep and Z-Axis Logic circuit. The digital holdoff prevents another trigger from being generated until the Acquisition Memory has acquired enough data to fill the Pretrigger portion of the input waveform.

Selection of the digital storage sample rate is accomplished in the Time Base circuitry. A 50-MHz Master Clock is divided to produce 25-MHz, 10-MHz and 5-MHz clocks, and the 5-MHz clock is further divided to produce a variable sampling interval under control of the Microprocessor. The selected output clock provides the timing required for signal acquisition.

The Microprocessor sets the Time Base to start acquisition of an input waveform, and the acquisition cycle begins. When either the A Gate or B Gate is received from the oscilloscope Sweep and Z-Axis Logic circuit, the cycle in progress is completed to obtain 512 waveform data points before the acquisition is halted for that cycle.

Each sample clock is counted, and when the required record length is reached, the acquisition cycle is stopped. Additional circuitry in the Time Base measures the time interval between the arrival of the A or B Gate trigger and the occurrence of the next sample clock. The Microprocessor uses the measured time interval data to generate a jitter-correction signal that compensates for signal jitter due to uncorrelated sampling of the input waveform.

Microprocessor clock $\overline{\text{MPUCLK}}$ is provided by buffering the 5-MHz clock frequency through an inverter.

Instrument operation is controlled by the Microprocessor. Devices to perform required circuit operations are addressed by the Microprocessor via address decoding circuitry, and commands are issued to cause the devices under control of the Microprocessor to perform the selected operation. Operating instructions for each routine are stored in the Microprocessor read-only memory (ROM). Instructions are fetched from the ROM, and the Microprocessor determines the required operation to be performed.

At regular intervals, the Microprocessor reads the Status and Switch-position registers that contain the instrument's operating mode. Based on the data obtained from reading these registers, the Microprocessor determines the required sequence of operations necessary to respond to the current conditions.

The operating memory used by the Microprocessor is composed of two random-access memories (Scratch RAM and System RAM). Data being processed by the Microprocessor and the intermediate results of an operation are stored in the two RAM arrays. As stated previously, the Acquisition Memory may also be used by the Microprocessor as additional System RAM between waveform acquisition cycles.

Several interrupting lines are applied to the Microprocessor. The lines allow a routine in progress to be interrupted by another device that either requires service or is signaling the end of an operation.

Processed waveform data is transferred from the Microprocessor memory to the Storage Display RAM and further processed for application to the oscilloscope display circuitry.

The digital storage front-panel controls are read by the Microprocessor from registers located in the Storage Display Control and LED Readout circuitry. Also read is the Service Switch register used for selecting the available service routines when operating the instrument in the service mode.

Under control of the Microprocessor, strobes are generated to control both the display circuitry and the seven-segment LED indicators. The indicators display the VOLTS and TIME cursor differences when waveform measurements are being made. During the power-on routine, the progress of the power-on test is displayed on the seven-segment LED indicators. If an error occurs during the power-on test, an error code will be displayed for use by the service personnel.

In the X- and Y-Axis circuitry, the digital contents of the Display RAM are converted to an analog signal, amplified, then converted into a balanced differential output signal. The signal is applied to the oscilloscope vertical circuitry.

Separate vertical position signals are generated to control the vertical displacement of a channel input signal; one as it is being acquired and the other during a SAVE Storage Mode display of that signal.

The storage display horizontal deflection signal is produced in a ramp generator circuit that starts the ramp on command from the Microprocessor. Correction signals from the Microprocessor are applied to the ramp to reduce the timing jitter that results from the difference in time between the oscilloscope trigger signal and the sampling clock.

Additional circuitry is provided to switch the Normal trigger between the conventional normal trigger signal and the storage display normal trigger signal. Also, switching circuitry selects either the Stored Display or the A Trigger View signal to be applied to the oscilloscope Vertical Output Amplifier circuitry.

The optional General Purpose Interface Bus (GPIB) circuitry provides for transfer of stored digital waveform data to external devices on the bus.

When the GPIB interface is required to function, a GPIBINT signal is generated to interrupt the operation of the Microprocessor and direct it to the section of the ROM containing the GPIB service routine. At the end of interruption and the resulting routine, the Microprocessor returns to the operation that was in progress prior to the interrupt.

The Storage Power Supply produces regulated +5 V, −6 V, +12 V, and −12 V for operation of the digital storage circuitry.

DETAILED CIRCUIT DESCRIPTION

CHANNEL 1 PREAMP

The Channel 1 Preamplifier circuit (Figure 3-3 and diagram 1) provides control of input coupling, vertical deflection factor, gain, and dc balance. Input signals for crt vertical deflection are connected to the CH 1 OR X input connector. When the TIME/DIV switch is set to the X-Y mode, the input signal applied to the CH 1 OR X connector provides the horizontal (X-Axis) deflection.

Input Coupling

Signals applied to the input connector can be either ac-coupled or dc-coupled, or they can be internally disconnected from the input to the Vertical Input Amplifier stages. When Input Coupling switch S30A is set for dc coupling, the input signal is coupled directly to the Input Attenuator stage. When ac coupled, the input signal passes through capacitor C13012, which prevents the dc component of the input signal from passing to the amplifier. In the GND position of S30A, the direct signal path is opened and the input of the amplifier is connected to ground through R3015. This provides a ground reference without the need to disconnect the applied signal from the input connector. Resistor R3014 is a high resistance connected across switch S30A to allow precharging of C13012 when the switch is set to GND. Therefore, the trace remains within the viewing area of the crt when the switch is placed in the AC position.

Input Attenuator

The effective overall deflection factor of each vertical channel of the 468 is determined by the setting of the Channel VOLTS/DIV switch. The basic deflection factor of the vertical deflection system is 5 mV/division of crt deflection.

For VOLTS/DIV switch positions above 5 mV, frequency-compensated voltage dividers (precision attenuators) are switched into the circuit to produce the vertical deflection factors indicated on the front panel. Each channel has a 2X, 4X, 10X, and 100X attenuator which may be selected in various combinations. The selected combination provides constant attenuation at all frequencies within the bandwidth range of the instrument. The Input Attenuators maintain the same input characteristics (1 MΩ and approximately 20 pF) for each setting of the VOLTS/DIV switch. Each attenuator contains an adjustable series capacitor to provide correct attenuation at high frequencies and an adjustable shunt capacitor to provide correct input capacitance.

NOTE

Each attenuator is a hybrid encapsulated plug-in assembly; therefore, replacement of individual components within the attenuator is not possible. Should defects occur, the attenuator must be replaced as a unit.

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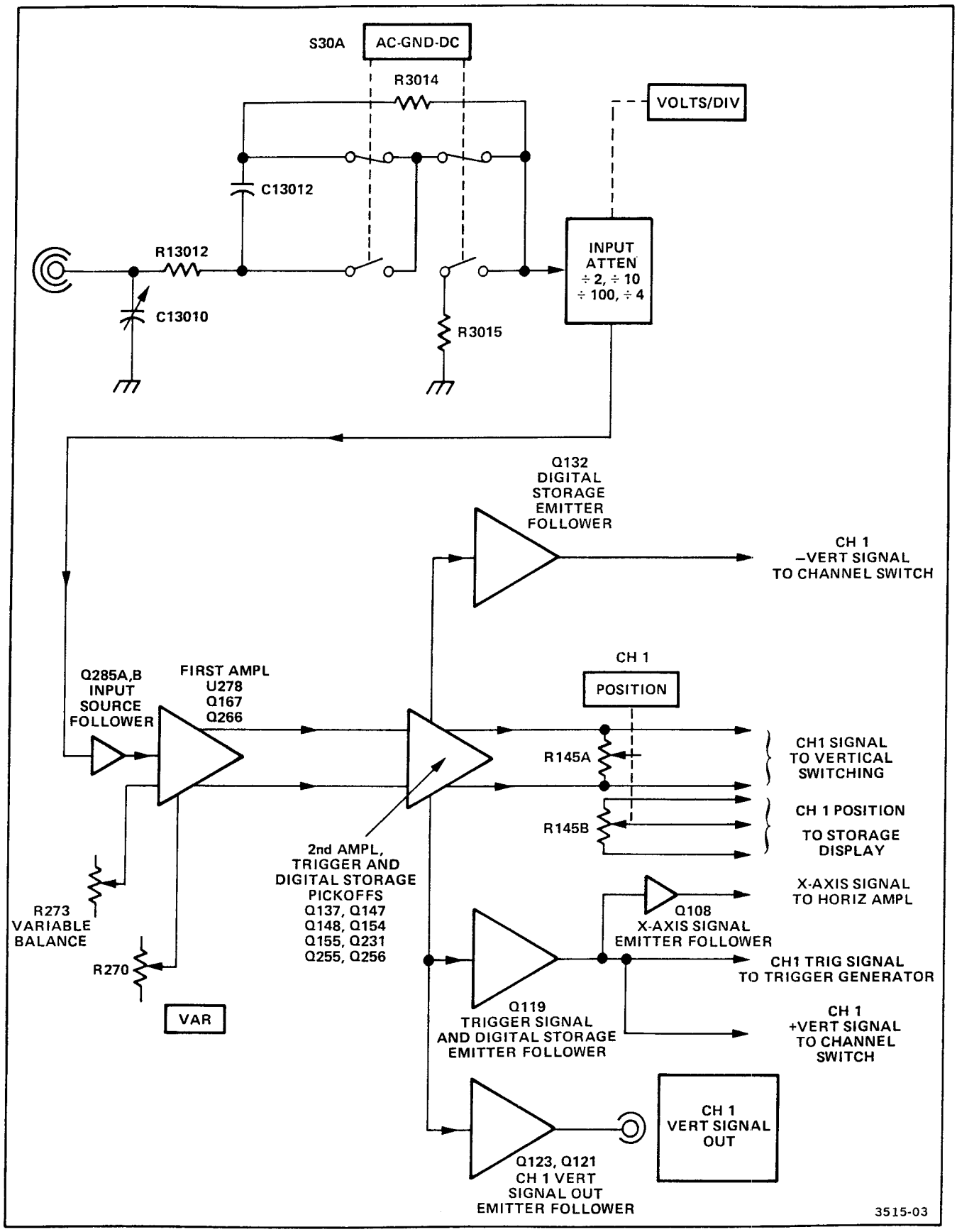

Figure 3-3. Detailed block diagram of the Channel 1 Preamplifier circuit.

Source Follower

The Channel 1 signal from the Input Attenuator is connected to Source Follower Q285A through R3042, C3042, and R3045. Resistor R3039 provides the input resistance and resistor R3045 functions as a damping resistor. A constant current source for Q285A is provided by JFET Q285B. Together, Q285A and B provide a high input impedance for the attenuators and supply the current drive needed for the First Amplifier stage.

In the event that excessively high-amplitude signals are applied to Source Follower Q285A, CR288 and the gate-source junction of Q285A limit the signal amplitude to a safe level for the following circuitry. If the negative signal amplitude causes CR288 to become forward biased, the Q285A gate will be clamped to approximately −8.7 V. Excessive positive-signal amplitude will forward bias the gate-source junction of Q285A. As soon as gate current flows in Q285A, the gate voltage will cease increasing. Gate current is limited to a safe value by the high resistance of R3042.

First Amplifier

The First Amplifier stage (U278) is an integrated-circuit, emitter-coupled, push-pull, cascode amplifier. The single-ended input signal on pins 13 and 16 is converted to a push-pull signal by a paraphase amplifier and then fed to the common-base output stage to produce the current drive to Q167 and Q266. The CH 1 VAR VOLTS/DIV control, from pin 11 of U278, connects into the cascode amplifier stage. The control provides variable vertical deflection for each position of the VOLTS/DIV switch. With the VAR control in its calibrated detent (wiper at ground), the A and D output transistors of U278 are conducting; and the B and C output transistors are biased off. Thus, the signal current available to the following amplifier stage (Q167 and Q266) is the collector current flowing in output transistors A and D.

When the VAR control is rotated out of its calibrated detent, the B and C output transistors of U278 begin to conduct by an amount determined by the position of the VAR control. This causes two events to occur:

1. The signal current flowing in the A and D output transistors is reduced by the amount of signal current flowing in the B and C output transistors; and

2. Output transistors A and C and output transistors B and D conduct current of opposite polarity. The output of transistor C is added to the output of transistor A to reduce the signal current available at pins 5 and 6, and the output current of transistor B is added to the output current of transitor D to reduce the signal current available at pins 8 and 9.

The selected component values provide a variable attenuation ratio of approximately 2.5 to 1.

Channel 1 Variable Balance adjustment R273 is adjusted so that no trace shift occurs in the display when rotating the VAR control. When the Channel 1 VAR control is out of its calibrated detent, the Channel 1 UNCAL LED is illuminated. The components connected between pins 2 and 3 of U278 provide high-frequency compensation for the stage.

Q167 and Q266 are common-base amplifiers that convert the output current signals from U278 into voltage signals to be amplified in the Second Amplifier stage. Gain adjust R269 sets the overall gain of the Channel 1 Vertical Preamplifier by adjusting the signal voltage to the bases of Q255 and Q256.

Second Amplifier

Transistors Q255 and Q256, in conjunction with Q247 and Q248 in the Vertical Switching circuit (diagram 3), form a push-pull, cascode amplifier. High-frequency temperature compensation of the amplifier stage is provided by CR258, CR259, and RT362 to ensure constant gain in the presence of varying ambient temperature. As temperature increases, the resistance value of RT362 decreases, and the reverse bias on both CR258 and CR259 decreases. As the reverse bias decreases, the capacitance value of CR258 and CR259 (voltage-variable capacitors) increases. The increase in capacity at higher temperatures provides additional high-frequency peaking to counteract the effects of increased temperature on the amplifier's gain.

The push-pull signal at the emitters of Q255 and Q256 are converted to a single-ended signal by Q154, Q155, Q147, and Q148. The current signal from Q148 is converted to a voltage signal by common-base amplifier stage Q231 and applied to the bases of Q119 and Q123. Emitter followers Q123 and Q121 provide the output signal to the CH 1 VERT SIGNAL OUT connector located on the instrument rear panel. Diodes CR114, CR119, CR118, and CR112, connected from the CH 1 VERT SIGNAL OUT bus to ground, protect the emitter circuit of Q121 in the event that damaging signal levels are accidentally connected to the output connector.

The output signal at the emitter of Q119 is used both as the trigger source in the CH 1 positions of the A and B Trigger SOURCE switches and as the signal source for the + vertical signal to the digital storage Input Channel Switch (diagram 13). When in the X-Y mode, emitter follower Q108 provides the X-axis signal to the Horizontal Amplifier (diagram 10).

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CH 1 TRIG DC BAL potentiometer R122 adjusts the dc level of the CH 1 trigger source signal. In the nonstorage mode, R145A is the Channel 1 Vertical POSITION control. When the potentiometer is set to its mid-position, the constant current supplied by Q151 flows equally through each side of R145A into the collectors of Q255 and Q256. As the POSITION control is rotated from its midpoint, one side of the amplifier receives more current while the other side of the amplifier receives less current. The proportional change in the amount of current flowing into the Delay Line Drivers causes the trace position to move vertically on the crt. The midrange operating point of the POSITION control is set by adjusting R238.

A common-base amplifier stage (Q137) in the collector circuit of Q147 and emitter follower Q132 together form a circuit used to provide the vertical signal to the digital storage Input Channel Switch.

CHANNEL 2 PREAMP

The Channel 2 Preamplifier circuit (diagram 2) is similar to the Channel 1 Preamplifier circuit. Only the differences between the two circuits are described in this part. Input signals for vertical deflection on the crt are connected to the CH 2 OR Y input connector. When the TIME/DIV switch is set to the X-Y mode, the Channel 2 input signal provides the vertical (Y-axis) deflection.

First Amplifier

Basically, the First Amplifier stage in Channel 2 operates in the same manner as the First Amplifier stage in Channel 1. However, the Channel 2 circuit also contains the INVERT switching function to allow the Channel 2 crt display to be inverted. When pushed in, the INVERT switch changes the biasing on the output transistors of U479 so that the normally inactive transistors (B and C) now carry the signal. Since their outputs are cross-coupled from side to side, the output signal is of opposite polarity from the signal available when the INVERT switch is in the normal (button out) position. Channel 2 Invert Balance potentiometer R566 allows the dc balance of the stage to be adjusted to eliminate baseline shift in the display when switching from a normal to an inverted display.

VERTICAL SWITCHING LOGIC

The Vertical Switching Logic (Figure 3-4 and diagram 3) selects the input signal or combination of input signals to be connected to the Vertical Output Amplifier. Input signal combinations to be displayed are selected by a ROM integrated circuit that is controlled by the Microprocessor via the Vertical Mode Switch (diagram 4).

Diode Gates

Channel 1, Channel 2, and Trig View or Stored Display Diode Gates, consisting of four diodes each, act as switches that are controlled by the Vertical Switching Logic circuit. Outputs Q_0, Q_1, and Q_2 of U409 control the switching transistors that switch the Diode Gates on or off. These output signals also are fed into the A_0, A_1 and A_2 inputs of ROM U408 (pins 5, 6, and 7 respectively) to indicate the state of the switches. (Refer to Table 3-1 for a logic table of the ROM switching functions.) A LO indicates that a particular switch is on, and a HI indicates it is off. The ROM uses the state indicators from U409 and the U408 inputs A3 through A7 (pins 4, 3, 2, 1, and 15) from the VERT MODE Switch to turn on the Diode Gates needed to obtain the desired display.

Nonstorage Display

CHANNEL 1 DISPLAY ONLY. When the CH 1 VERT MODE push button is pressed in, the Microprocessor applies a HI to the A_3 input of U408. The A_4, A_5, and A_6 inputs will be LO, and the A_7 input ($\overline{XY}$ select) will be HI. This combination of inputs is used to switch transistor Q418 on, thereby switching on the Channel 1 Diode Gate. The O_1 output of U408 will be LO, while the O_2 and O_3 outputs will be HI. The O_4 output, which controls the CHOP Clock Oscillator, will also be LO. A LO on O_4 disables the CHOP clock and U409 will remain in a state that allows the diode gates to pass only the Channel 1 input signal to the Delay Line Driver.

With only Channel 1 selected, the Q_0 output of U409 will be LO. The LO turns on transistor Q418, and the junction of CR338 and CR334 in the CH 1 Diode Gate is returned to the +5-V supply through R422 and Q418, thus raising the junction voltage to reverse bias CR338 and CR334. Then CR332 and CR336 are forward biased to pass the Channel 1 input signal on to the Delay Line Driver.

The Trig View or Stored Display Diode Gate diodes, CR325 and CR326, and the CH 2 Diode Gate diodes, CR339 and CR335, remain forward biased through pull-down resistors, R421 and R424, to the −8-V power supply. The A Trigger View signals and the Channel 2 input signals are shunted to the −8-V supply and are blocked from the Delay Line Driver because diodes CR331 and CR330 (in the Trig View or Stored Display Diode Gate) and CR337 and CR333 (in the CH 2 Diode Gate) are reverse biased.

CHANNEL 2 DISPLAY ONLY. When CH 2 VERT MODE is selected, Q419 turns on; Q418 and Q318 remain off. The center diodes of the CH 1 Diode Gate and the center diodes of the Trig View or Stored Display Diode Gate are forward biased, while the center diodes of the

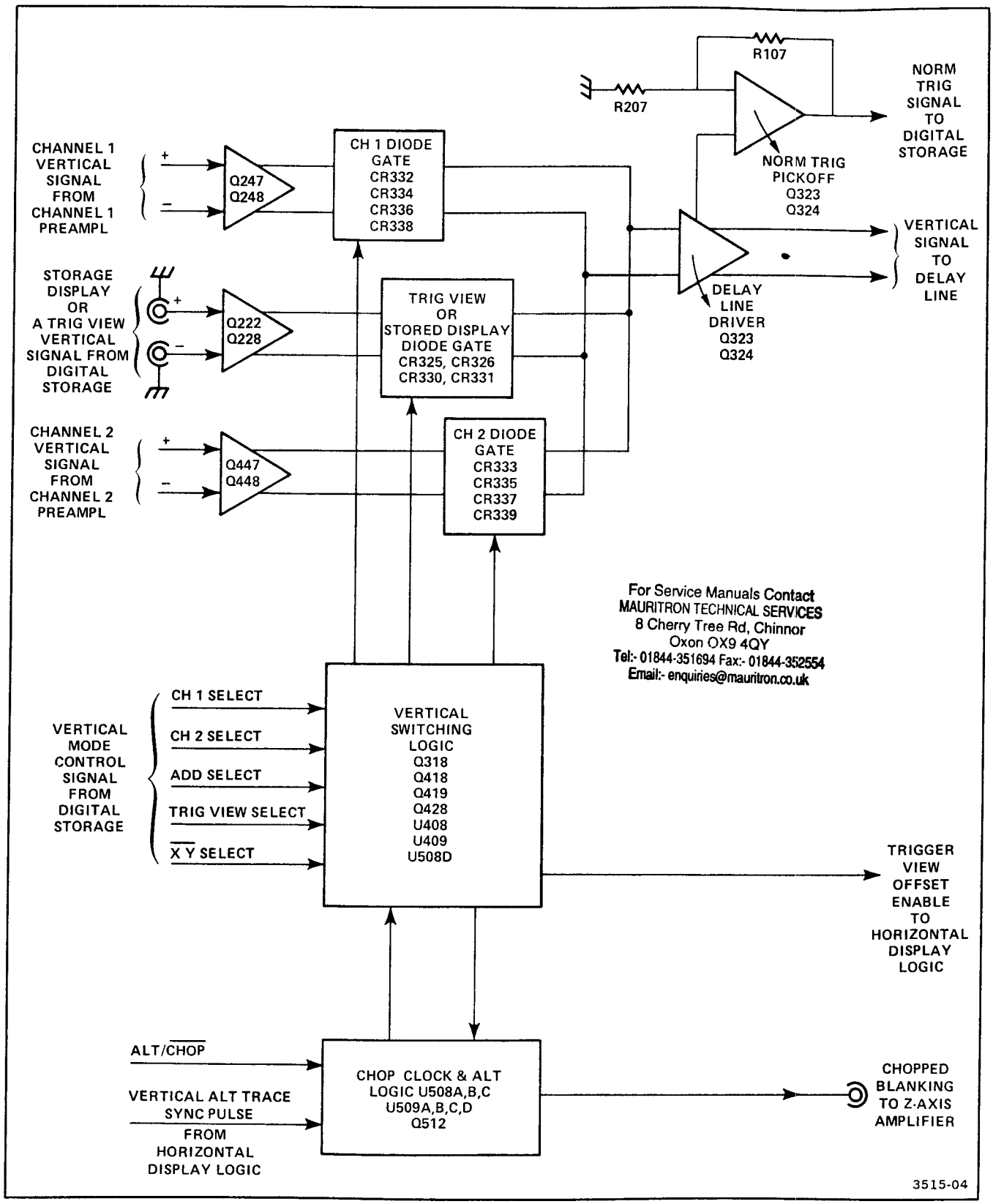

Figure 3-4. Detailed block diagram of the Vertical Switching Logic circuit.

Table 3-1
Read-Only Memory U408 Logic

VERT MODE PRESENT DATA AT U408					UNDEFINED			TRIG VIEW	ADD	CH 2	CH 1	IDLE
$\overline{XY}$	TRIG VIEW	ADD	CH 2	CH 1	$\overline{000}$	$\overline{001}$	$\overline{010}$	$\overline{011}$	$\overline{100}$	$\overline{101}$	$\overline{110}$	$\overline{111}$
1	0	0	0	0	1111	1111	1111	1111	1111	1111	1111	0111
1	0	0	0	1	1110	1110	1110	1110	1110	1110	0110	1110
1	0	0	1	0	1101	1101	1101	1101	1101	0101	1101	1101
1	0	0	1	1	1110	1110	1110	1110	1110	1110	1101	1110
1	0	1	0	0	1100	1100	1100	1100	0100	1100	1100	1100
1	0	1	0	1	1110	1110	1110	1110	1110	1110	1100	1110
1	0	1	1	0	1101	1101	1101	1101	1101	1100	1101	1101
1	0	1	1	1	1110	1110	1110	1110	1110	1100	1101	1110
1	1	0	0	0	1011	1011	1011	0011	1011	1011	1011	1011
1	1	0	0	1	1110	1110	1110	1110	1110	1110	1011	1110
1	1	0	1	0	1101	1101	1101	1101	1101	1011	1101	1101
1	1	0	1	1	1110	1110	1110	1110	1110	1011	1101	1110
1	1	1	0	0	1100	1100	1100	1100	1011	1100	1100	1100
1	1	1	0	1	1110	1110	1110	1110	1011	1110	1100	1110
1	1	1	1	0	1101	1101	1101	1101	1011	1100	1101	1101
1	1	1	1	1	1110	1110	1110	1110	1011	1100	1101	1110
0	0	0	0	0	1101	1101	1101	1101	1101	0101	1101	1101
0	0	0	0	1	1101	1101	1101	1101	1101	0101	1101	1101
0	0	0	1	0	1101	1101	1101	1101	1101	0101	1101	1101
0	0	0	1	1	1101	1101	1101	1101	1101	0101	1101	1101
0	0	1	0	0	1101	1101	1101	1101	1101	0101	1101	1101
0	0	1	0	1	1101	1101	1101	1101	1101	0101	1101	1101
0	0	1	1	0	1101	1101	1101	1101	1101	0101	1101	1101
0	0	1	1	1	1101	1101	1101	1101	1101	0101	1101	1101
0	1	0	0	0	1101	1101	1101	1101	1101	0101	1101	1101
0	1	0	0	1	1101	1101	1101	1101	1101	0101	1101	1101
0	1	0	1	0	1101	1101	1101	1101	1101	0101	1101	1101
0	1	0	1	1	1101	1101	1101	1101	1101	0101	1101	1101
0	1	1	0	0	1101	1101	1101	1101	1101	0101	1101	1101
0	1	1	0	1	1101	1101	1101	1101	1101	0101	1101	1101
0	1	1	1	0	1101	1101	1101	1101	1101	0101	1101	1101
0	1	1	1	1	1101	1101	1101	1101	1101	0101	1101	1101

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CH 2 Diode Gate are reverse biased. Trigger view and Channel 1 signals are blocked from the Delay Line Driver, and the Channel 2 input signal is allowed to pass through its diode gate to the Delay Line Driver.

A TRIGGER VIEW (EXT ONLY). When A TRIG VIEW is selected, the CH 1 and CH 2 Diode Gates are biased off, and the Trig View or Stored Display Diode Gate is biased on to allow either the Stored Display (Storage Mode Operation) or the External Trigger signal to be connected to the Delay Line Driver.

The $\overline{\text{Trigger View Enable}}$ signal is applied to the Trigger View Amplifier to turn it on. The amplifier is disabled when not in use to prevent crosstalk that may occur through the diode gate when large-amplitude trigger signals are applied to the A External Trigger input connector.

In all single-input selections (CH 1 only, CH 2 only, or A TRIG VIEW only) and for a stored waveform display, the switching clock to U409 pin 9 is disabled, and U409 remains in a state to select only the single input chosen for display.

ADD VERTICAL MODE. In ADD, U408 is programmed to turn on both Q419 (CH 1) and Q418 (CH 2). The logic from U409 will also turn on Q428 (ADD) at the same time. It is not necessary to select CH 1 or CH 2 Vertical Modes to obtain the ADD display. With ADD selected, the Q_0 and Q_1 outputs of U409 will be LO, and the $\overline{Q_0}$ and $\overline{Q_1}$ outputs are HI. This switching combination turns both Channel 1 and Channel 2 Diode Gates on. With $\overline{Q_0}$ and $\overline{Q_1}$ HI, AND-gate U508D will be enabled to turn on Q428. The junction of R328 and R330 in the Delay Line Driver input will have −8-V applied to provide sufficient additional current to keep both CH 1 and CH 2 Diode Gates turned on without altering the dc levels associated with the Delay Line Driver circuitry. By selecting additional VERT MODE switches, it is possible to view the Channel 1 signal, the Channel 2 signal, the A External Trigger, and the ADD signal (CH 1 + CH 2) on four separate traces during one display cycle.

X-Y FUNCTION. When the A TIME/DIV switch is set fully counterclockwise to the X-Y position, a LO is applied to ROM U408 pin 15 via the Vertical Mode Switch (diagram 4). This ROM is programmed to produce outputs that turn on Channel 2 switching transistor Q419 and disable the Chop Clock. This action connects the Channel 2 input signal to the Delay Line Driver for use as the Y-axis signal. It is not necessary to select CH 2 Vertical Mode, since the ROM will do all the switching automatically when X-Y function is selected.

ROM Switching

Input signals to ROM U408 are as follows:

1. Input lines A_0 through A_2—The logic levels from the Q_0, Q_1, and Q_2 outputs of U409 are used to indicate the present state of the switching. Q_0, Q_1, and Q_2 outputs are active when LO.

2. Input lines A_3 through A_6—Logic levels applied from the Microprocessor as determined by the VERT MODE switch selection (CH 1, CH 2, ADD, and A TRIG VIEW). A HI logic level is present for the selected Vertical Mode.

3. Input line A_7—This logic level is determined by the X-Y position of the A TIME/DIV switch. A LO logic level is present when X-Y function is selected.

After U409 is clocked, ROM U408 uses the present data on its input lines (A_0 through A_7) to select the next output switching state to be presented to U409 for decoding. On the four output lines of U408, lines O_1 through O_3 carry the future data, and line O_4 is the Chop Clock Oscillator enabling logic (HI enables).

In the partial table shown in Figure 3-5, no Vertical Modes are selected, and the present data from U409 is an undefined column (i.e., 000 is not a Vertical Mode selection). In the example given, the Chop Clock Oscillator will be enabled, and the next clock pulse to U409 will switch U409 output to 111. Table 3-1 shows that column

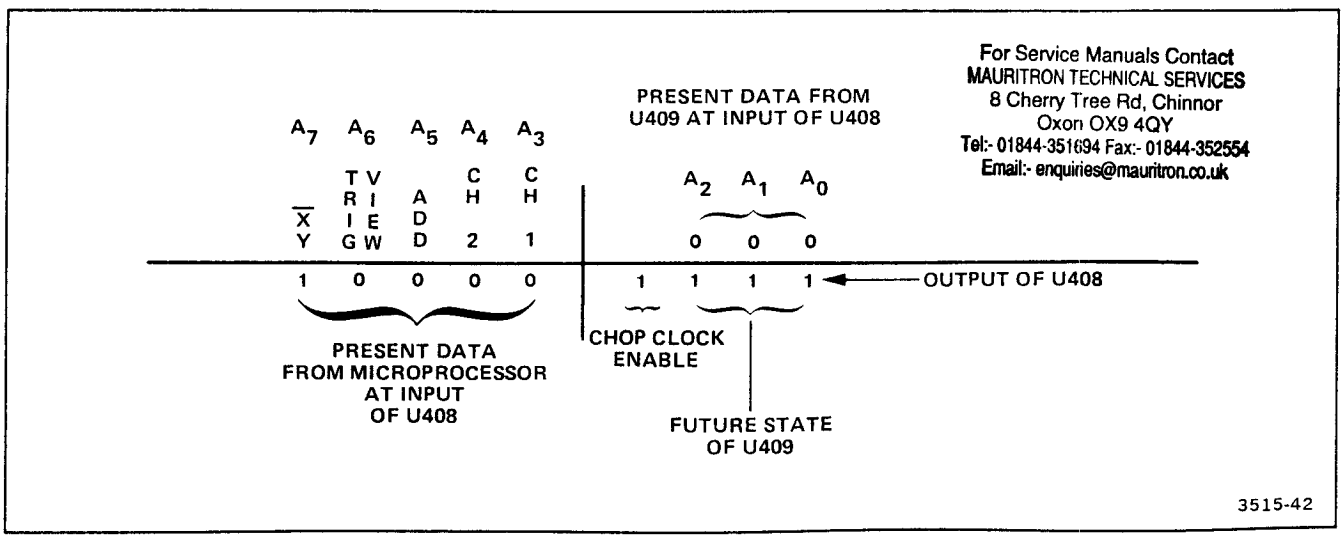

Figure 3-5. Partial Table 3-1.

111 is the idle state of U408 (the state switched to when no Vertical Mode has been selected).

NOTE

In an acquisition storage mode, CH 1 is selected automatically if no Vertical Mode is selected; however, the probe-coding LED will not be illuminated.

In the Idle column of Table 3-1, it is seen that the future state of U409 will remain 111, and the Chop Clock Oscillator will not be enabled. Each row across the table indicates the possible future states of U409, while the column headings indicate the possible present states. The order of priority in switching (when multiple Vertical Modes are selected) is CH 1, CH 2, ADD, and then A TRIG VIEW.

When any Storage Mode is selected, U408 is held in the TRIG VIEW mode. The Stored Display signal is fed to the Delay Line Drivers via the same diode gate that is used for the A Trig View signal.

USING THE LOGIC TABLE. To use the table, determine the Vertical Mode(s) selected. Follow that row across the table. If the output of U409 is at the present state indicated by a column heading, the data given in that column is the future state of U409.

Example 1. Assume CH 1 and CH 2 Vertical Modes are selected. The present data from the Microprocessor is 10011. Move across that row to the 000 column. The data given indicates that if the present state of U409 is 000, the future state will be 110 (CH 1) and that the Chop Clock Oscillator will be enabled. Following across the row, each column, except 110 (CH 1), gives the same future state. If the present state is CH 1, the future state will be 101 (CH 2). From there, it will switch back to CH 1 for the chopped display of the Channel 1 and Channel 2 input signals.

Example 2. Assume that X-Y function is selected. Go to any Vertical Mode selection in the bottom half of the table. All the columns indicate that regardless of the state of U409 output, the future state will be 101 (CH 2). When the output of U409 goes to 101, the Chop Clock Oscillator will be turned off, and the Chop Clock to U409 will cease.

Example 3. Assume ADD Vertical Mode is selected. In the first five columns find 10100. Move across that row (adjacent to 10100) to the 000 column, and note that the future state of U408 is 1100. The output state required to switch to the ADD display is 100. Note that Trig View is not selected, but both CH 1 and CH 2 are selected (LO logic level selects). The Chop Clock Oscillator will be enabled to clock U409. After clocking, the $\overline{Q_0}$ and $\overline{Q_1}$ outputs of U409 (pins 3 and 6 respectively) will be HI to gate U508D thus turning on transistor Q428. This transistor supplies the extra current required to keep both CH 1 and CH 2 Diode Gates forward biased. In the case of the 000 state, it indicates that CH 1, CH 2, and A TRIG VIEW are selected for viewing simultaneously. While this output state exists, the diode gates will not be forward biased during this time and the three signals will not be displayed.

Whenever a Vertical Mode switch is changed, the Microprocessor enables the Chop Clock Oscillator for a specified amount of time to switch U408 to the selected state.

Stored Signal Display

When stored waveforms are displayed, all waveforms (CH 1, CH 2, and ADD) are applied to the Delay Line Driver through the Trig View or Stored Display Diode Gate. The digital storage input Channel Switch (diagram 13) does all the data selection for placing the input signal(s) into the digital storage Acquisition Memory. Input signals are acquired (either chopped or alternately) under control of the Microprocessor. A switching circuit (diagram 16) selects either the stored waveform or the A External Trigger signal for application to the oscilloscope Vertical Output Amplifier.

Chop Clock and Alternate Logic

The Chop Clock Oscillator stage is composed of U509B, U508A, R504, R503, and C504. It supplies the Chop Clock to U409 pin 9 (CLK) for a chopped display of two or more input signals.

When the Q_4 output of U408 is HI and the CHOP VERT MODE is selected, a HI is present on U509B pin 5. A HI, and then a LO will be placed alternately on U509B pin 4 by U508A. For example, assume an initial LO on pin 4 of NAND-gate U509B. The output of this gate will be HI. Capacitor C504 charges forward a HI, and as soon as its charge reaches the threshold level of U508A, U508A will switch to a HI output. The HI output of U508A will assert a HI on U509B pin 4. This HI is NANDed with the HI already present on U509B pin 5 to produce a LO at U509B pin 6. Now C504 must discharge toward a LO. As soon as the charge on C504 reaches the LO threshold of U508B, U508B will switch to a LO output, and the cycle repeats. The Chop Clock Oscillator frequency is approximately 1 MHz and depends on the RC time constant of R503 and C504, as well as the threshold level of U508A (see Figure 3-6).

If CHOP is selected, U509A pin 2 will be LO. Pin 3 of U509A will be HI to enable U508C to pass the Chop Clock

Oscillator frequency to U409 pin 9. Every positive transition of the Chop Clock will cause U409 to change state, thus performing a divide-by-two of the input frequency. Therefore, the chopping frequency is approximately 500 kHz. The Chop Clock Oscillator will not be enabled unless more than one input is selected. As stated previously, a single-input VERT MODE selection will cause U409 to remain in a state that allows only the selected input to be passed on to the Delay Line Driver.

When multiple inputs are selected for chopped display, U409 is clocked to select the appropriate inputs programmed for display. Transistors Q419, Q418, Q318, and Q428 (if ADD is selected) are switched between the input signals at the CHOP frequency. As the displays are incremented, the Q_0, Q_1, and Q_2 outputs of U409 are used as state indicators to the A_0, A_1, and A_2 inputs of ROM U408 to indicate the next input to be selected for display. The order of priority of the switching is: CH 1, CH 2, ADD, then TRIG VIEW.

ALTERNATE TRACE SYNC. With ALT Vertical Mode selected, a HI is present at U509D pin 12. If more than a single-input display is also selected, a HI will be present at pin 13. The CHOP clock is then disabled, and the Alternate Trace Sync pulse is enabled through U508C to the clock input of U409 pin 9. The alternate switching rate between the selected inputs of U409 occurs at a rate determined by the TIME/DIV switch setting.

If a single input is selected for display in the Alternate Vertical Mode, U508B pin 5 will be LO and the Chop Clock Oscillator remains disabled. The Alternate Trace Sync pulse will be present at U409 pin 9, but with only one input selected, U409 will not change state. Therefore, the switching transistor for the selected input to be displayed remains on.

When ALT Horizontal Display is chosen, the Alternate Trace Sync input becomes a square wave with a period equal to twice the time between Alternate Trace Sync pulses. This timing allows the display of both the A Sweep and the B Sweep before switching to the next vertical input signal to be displayed (see Figure 3-7).

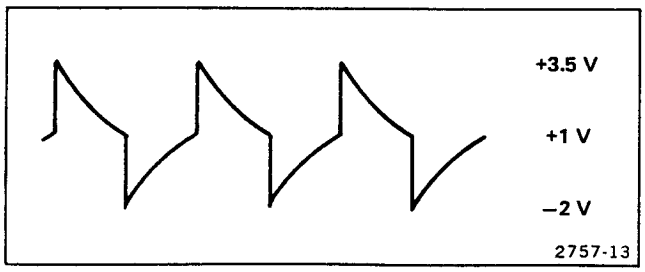

Figure 3-6. Switching waveform at the junction of R503 and R504.

Chopped Blanking Amplifier

When CHOP Vertical Mode is selected, a LO on U509D pin 12 holds U509A pin 11 HI. This HI enables U509C to pass the Chop pulse to C512 and R515. Here it is differentiated to produce positive and negative spikes having sufficiently fast rise times to develop the Chopped Blanking pulse. The positive spike is limited by CR516, and the base current of Q512 is limited by R514. Transistor Q512 is reverse biased by the positive portion of the differentiated waveshape, but when the transition from positive to negative level occurs, Q512 is driven rapidly into conduction. The blanking time is determined by the charging time of C512 through R515. The positive-going output pulse from Q512, which is coincident with trace switching, is applied to the Z-Axis Amplifier in the CRT circuitry (diagram 11) through R513.

Delay Line Driver

The output from each of the diode gates is applied to the Delay Line Driver amplifier composed of Q323, Q324, and associated components. Transistors Q324 and Q323 are connected as a feedback amplifier, with R220 and R319 providing feedback from the collector to the base of its respective transistor. A sample of the composite signal in the collector circuit of Q323 is picked off for triggering the oscilloscope in the NORM Trigger Mode.

Bandwidth Limit switch S310 connects a pi filter (composed of C316, C306, L213, and L310) between the output signal lines of the Delay Line Driver to reduce the upper −3 dB bandwidth of the Vertical Amplifier system

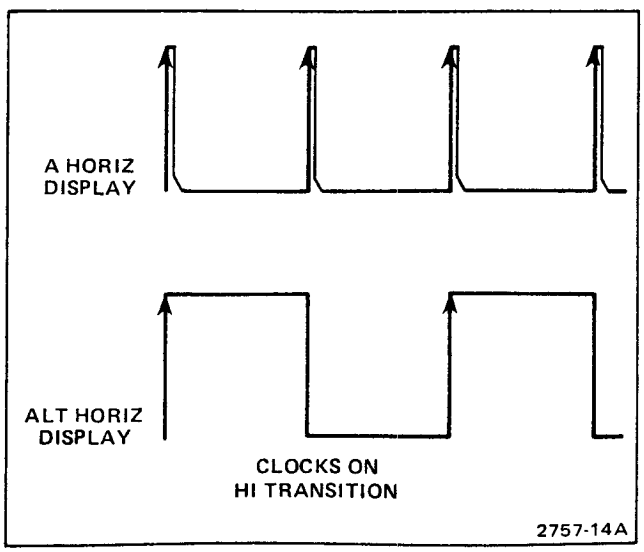

Figure 3-7. Vertical Alt Sync pulse at U409 pin 9.

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to approximately 20 MHz. Storage bandwidth is not affected by the bandwidth limiting provided by this filter circuit.

Reverse termination of the delay line is provided by resistors R214 and R311.

Normal Trigger Pickoff Amplifier

The composite trigger signal for nonstorage NORM Trigger Mode operation is obtained from the collector circuit of Q323. Normal Trigger DC Balance Adjustment R205 is used to set the dc level of the Normal trigger output signal so that the sweep is triggered at the zero level of the displayed signal whenever the trigger LEVEL control is set to zero. A feedback amplifier is formed by Q214 and Q114, with the signal applied to the base of Q214. The feedback path is between the Q114 collector and the emitter of Q214 through R107.

The nonstorage Normal trigger signal is fed to a trigger selection circuit in the digital storage Display X- and Y-Axis circuitry (diagram 16). Here either the nonstorage Normal trigger or storage Normal trigger is selected for application to the oscilloscope A and B Trigger Generator circuitry (diagram 6).

VERTICAL MODE SWITCH

The Vertical Mode Switch circuitry (diagram 4) contains the oscilloscope front-panel buffers through which the Microprocessor reads the control positions. A functional block diagram of the Vertical Mode Switch circuitry is located in the "Diagram" section of Volume II of this manual. The front-panel controls are read at regular intervals by the Microprocessor through the use of enabling strobes to each buffer. The Channel VOLTS/DIV switches, Input Coupling switches (AC-GND-DC), UNCAL (VAR) switches, A and B TIME/DIV switches, HORIZ MODE switches (A, A INTEN, ALT, and B DLY'D), and A Trigger SOURCE switch (EXT and EXT/10) directly control the designated oscilloscope functions, but their positions are sensed by the Microprocessor to set the display scale factors and program the correct sampling rate.

The probe-coding light-emitting diodes (X1 and X10 LED) and the vertical mode switching are under control of the Microprocessor via two write-only control registers. Probe coding is controlled so that the probe scale-factor LED may be disabled to indicate either invalid vertical mode selections or that a selected channel is not being displayed. Vertical mode switching must be under the control of the Microprocessor to ensure that data is acquired in the proper sequence and with the correct timing.

Vertical Mode Strobe Control

Address decoder U358 is used by the Microprocessor to generate the strobes required for either reading from the buffers or writing into the Vertical Mode Switch control registers. Table 3-5 in the discusssion of Microprocessor circuitry contains a listing of the addresses assigned to the front-panel controls. Strobes from U358 are generated when address bus ADRB is HI and the I/O strobe is generated LO. Both conditions must be met to enable the selection of a 1-of-8 output line. The U358 output line that is enabled depends on the latched address on input lines LADR0 through LADR1 (pins 1, 2, and 3 respectively). See Table 3-2.

Table 3-2

Front Panel Strobe Generation

U358 Inputs			Output Selected
LADR2 (C)	LADR1 (B)	LADRO (A)	
0	0	0	Y0 ($\overline{\text{CH 1}}$)
0	0	1	Y1 ($\overline{\text{CH 2}}$)
0	1	0	Y2 ($\overline{\text{ATIME}}$)
0	1	1	Y3 ($\overline{\text{BTIME}}$)
1	0	0	Y4 ($\overline{\text{MODE}}$)
1	0	1	Y5 ($\overline{\text{LIGHTS}}$)
1	1	0	Y6 ($\overline{\text{VSM}}$)
1	1	1	Not Selected

CH 1 and CH 2 Selection Buffers

Two identical buffer circuits, composed of U336 and U346 (tristate octal buffers), transfer the positions of the Channel VOLTS/DIV switches, the Input Coupling switches (AC-GND-DC), the probe coding (X1 or X10), and the VAR control (UNCAL condition) to the Microprocessor bus. At the input to the Channel Selection Buffers, transistors Q1308 (CH 1) and Q1309 (CH 2) act as buffer-inverters for the probe coding signals; they also convert the signals to the TTL (transistor-transistor logic) levels required for proper circuit operation. An UNCAL condition is indicated when the VAR control is out of the calibrated detent and S270 is closed. This allows the UNCAL LED to be illuminated and grounds U336 pin 16 (A7).

The remaining input pins (A1 through A6) are either grounded through contacts on the VOLTS/DIV and Input

Coupling switches or raised to a HI through pullup resistors when the switch contacts are open.

During the interval in which the Microprocessor reads the register, U336 is read when the CH1 strobe is generated, and U346 is read using the CH2 strobe. Transferred data is placed on the Microprocessor bus lines AD0 through AD7. When the registers are not enabled, the output pins are raised to a high impedance level to isolate the bus.

A TIME/DIV and B TIME/DIV Buffers

Two identical buffers (U326 and U320) are used to place the A and B TIME/DIV switch position information on the Microprocessor bus. The A TIME/DIV buffer places five parallel bits of A TIME/DIV data on the bus, while the B TIME/DIV buffer also places an A or B Time Selection bit (U320 pin 18) on the bus in addition to the B TIME/DIV switch data bits.

The ATIME strobe allows U326 to be read, and the BTIME strobe allows U320 to be read. Again, when these buffers are not enabled, their output impedance is high to isolate the devices from the bus.

Probe-Coding LED Control Register

The probe-coding LED, located behind the knob skirt of each Channel VOLTS/DIV switch, are controlled by the Microprocessor via commands placed on Probe-Coding LED Control Register U458. Register U458 is composed of four, D-type flip-flops that transfer the bus data placed on inputs D1 through D4 (pins 4, 5, 12, and 13) to outputs Q1 through Q4 on the rising edge of the LIGHTS strobe. The rising edge of LIGHTS occurs after the data placed on the bus has settled. Data on the output pins remains constant between clocks to provide for constant illumination of the selected probe-coding LED. When an invalid vertical operating mode is selected (i.e., no vertical mode selection or only TRIG VIEW in a storage mode), none of the probe-coding LED will be illuminated. If CH 1 and CH 2 are both selected when a SAVE REF display is also selected, the Microprocessor disables the probe-coding LED of CH 2 to indicate that the CH 2 signal is not being displayed. During the power-on self-test performed by the Microprocessor, all of the probe-coding LED will be illuminated to provide a visual check of their operation.

Vertical Mode Buffer and Control Register

When buffer U466 is strobed by MODE, the Microprocessor reads the vertical mode selected, the A Trigger SOURCE switch for EXT or EXT/10, and the XY enabling signal. The TRIG VIEW ENABLE signal is buffered and inverted by Q369. Transistor Q369 also converts the signal to the correct level for use in TTL circuitry. Whenever the A Trigger SOURCE switch is set to EXT or EXT/10, the A TRIG VIEW vertical mode is enabled in NON STORE mode. When the A TIME/DIV switch is set to the X-Y position, the X-Y function is enabled. Transistor Q366 performs a similar function for the XY line as transistor Q369 does for the TRIG VIEW ENABLE input line.

Once the Microprocessor has read the Vertical Mode Selection Buffer U466, the data is used at the appropriate time to supply the commands to the Vertical Mode Control Register U310. See Table 3-5 in the Microprocessor discussion to determine the appropriate data bit for each output selection of U310.

The U310 Q_1 output (pin 2) is the SWEEP DISABLE line. When a storage mode is selected, the SWEEP DISABLE line is HI and the signal at P130 pin 7 is fed to the TIME/DIV UNCAL LED to prevent it from being illuminated. The TIME/DIV VAR control does not affect the storage sweep time because the sample rate is derived from a crystal-controlled oscillator in the Time Base circuitry.

Two additional disabling strobe outputs are obtained from buffer-inverter Q115. The Z-AXIS DISABLE signal prevents the conventional oscilloscope Z-axis signal from reaching the crt, thus allowing the Stored Display Z-axis signal to provide intensity modulation of the display. The SWEEP DISABLE signal is fed to CR374 and CR471 in the Horizontal Display Logic circuitry (diagram 8) to prevent the A and B Sweep ramps from reaching the Horizontal Output Amplifier. A horizontal deflection signal is supplied by the Storage Display circuitry when a storage mode is selected. Output Q_2 of U310 is HI when the A TRIG VIEW Vertical Mode is selected in the NON STORE mode provided the A Trigger SOURCE switch is set to either EXT or EXT/10. A HI from U310 pin 5 turns transistor Q203 off to allow the collector to float, and transistor Q209 is biased off. With Q209 off, the TRIG VIEW ENABLE line is LO, and the A TRIG VIEW signal is allowed to reach the Stored Display or Trigger View Diode Gate (diagram 3). When U310 pin 5 is LO, Q208 turns on and Q209 saturates to apply +15 V to the TRIG VIEW ENABLE output line. If TRIG VIEW is selected without being enabled, the +15 V turns off the A Trig View Amplifier and supplies a common-mode current to hold the Delay Line Driver transistors (Q323 and Q324) within their linear operating range.

Vertical Mode selection outputs from U310 (Q4 through Q8) are applied to the Vertical Mode Switching Logic circuitry (diagram 3, circuit operation previously discussed) to select the appropriate diode gate to pass the vertical deflection signal on to the Vertical Output Amplifier.

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VERTICAL OUTPUT AMPLIFIER

The Vertical Output Amplifier circuit (Figure 3-8 and diagram 5) provides the final amplification for the vertical deflection signal. The circuit includes the Delay Line, part of the Beam Finder circuitry, and part of the Trace Separation circuitry. Pushing the BEAM FIND button compresses an overscanned display to within the graticule viewing area. The Trace Separation circuit provides vertical positioning of the B trace when the ALT Horizontal Display mode is selected.

Delay Line

Delay Line DL208 (diagram 3) provides approximately 120 ns delay of the vertical signal to allow the Sweep Generator circuits sufficient time to initiate a sweep before the vertical signal reaches the deflection plates of the crt. When using internal triggering, the instrument is allowed to display the leading edge of the signal that originates the trigger pulse. Resistors R211 and R210 provide the correct termination impedance for the Delay Line.

Input Amplifier

Input Amplifier U218 is an integrated-circuit cascode amplifier. Differential vertical signals from the Delay Line are applied to pins 14 and 16 (the bases of the common-emitter input transistors). The output transistors of U218 are arranged as common-base amplifiers with cross connections between the two sides to maintain equal amplitude differential signals from both outputs. Gain of the Input Amplifier is adjusted with R117 by changing the base bias voltage on one of the pair of output transistors on each side.

Emitter current for the input transistors is provided from a network connected between pins 2 and 3. The network circuitry contains the compensation components. the vertical portion of the Beam Finder circuit, and a portion of the Trace Separation circuit.

Beam Finder

The dynamic range of the input transistors is reduced when BEAM FIND push button S175 is pressed in. During normal (noncompressed) operation, either Q108 or Q101 will be conducting to supply emitter current to the input transistors. When S175 opens, the direct −8 V supplied to the emitter circuits of Q103 and Q202 is removed, and emitter voltage is supplied through resistor R349 to reduce the emitter current available to the Input Amplifier. The vertical gain is then reduced to compress an overscanned or off-screen display.

Trace Separation

During display of the B trace, when ALT Horizontal Display mode is selected, a circuit composed of Q108, Q205, Q206, and U105 permits adjustment of the separation between the A and B traces. When the ALT mode is not in use, Q108 is biased off by a LO on its base, and Q202 is conducting to supply equal emitter currents to both sides of the Input Amplifier via R201 and R202.

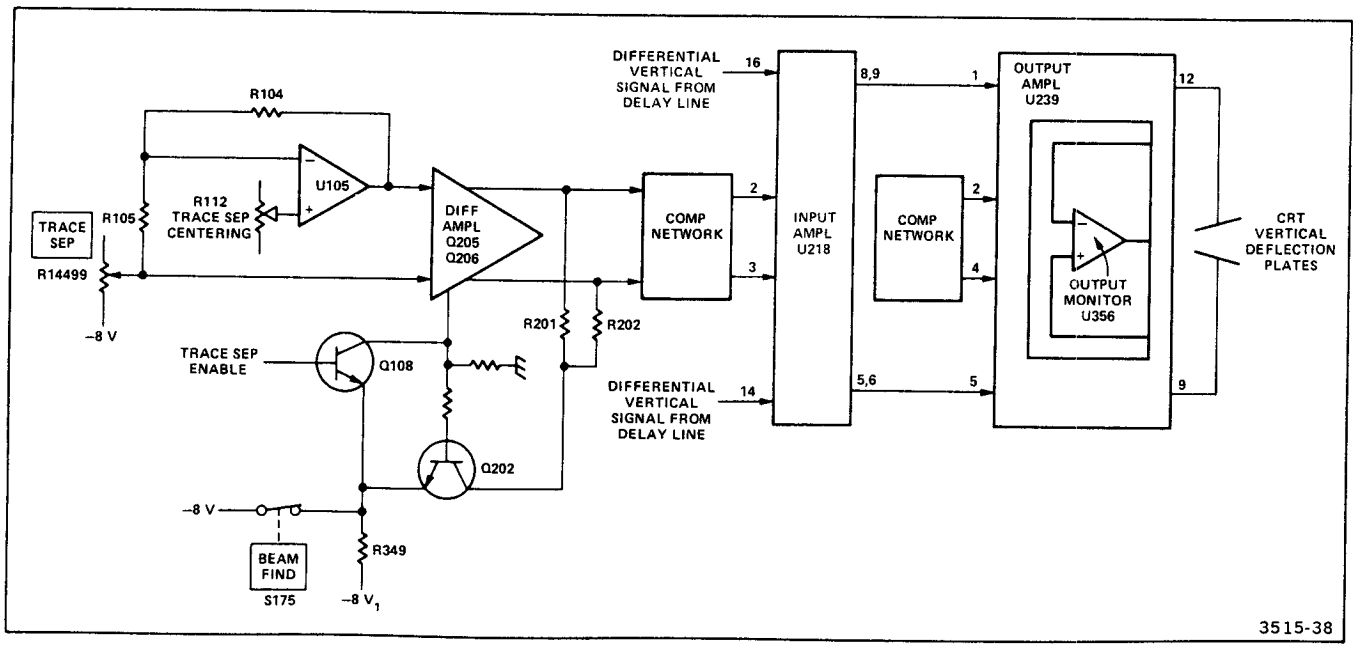

Figure 3-8. Simplified diagram of the Vertical Output Amplifier circuit.

When the Trace Separation circuit is enabled during an ALT Horizontal Display B trace, a HI is applied to the base of Q108 to forward bias it. Transistor Q202 is biased off, and the Differential Amplifier, composed of Q205 and Q206, is supplied a constant-current source from the collector current of Q108. Emitter current to both sides of the Input Amplifier is then supplied from Q205 and Q206.

The TRACE SEP front-panel control supplies a position signal to the base of Q206 and (through a unity-gain, inverting amplifier U105) to the base of Q205. By changing the balance between Q205 and Q206, an offset current is supplied to the emitters of the Input Amplifier to change the vertical position of the B trace. The operating range of the TRACE SEP control is centered with Trace Sep Centering adjustment R112.

Output Amplifier

Integrated circuit U239 is a multi-stage, cascode amplifier that provides final amplification for the vertical signal. The differential input signal is applied to pins 1 and 5, and the output signal to the crt vertical deflection plates is taken from pins 12 and 9. Output Control amplifier U356 monitors the emitter currents of the output transistors and automatically sets the dc level of the output stage to obtain the maximum, undistorted gain from U239. Compensating adjustment components for the Output Amplifier are connected between pins 2 and 4.

A AND B TRIGGER GENERATORS

The Trigger Generator circuits (diagram 6) produce trigger pulses to start the Sweep Generator circuits. These trigger pulses are derived either from the internal trigger signal (sampled from the vertical deflection system), from an external signal connected to the external trigger connectors, or from a sample of the line voltage applied to the instrument. Controls are provided in each circuit to select trigger level, slope, coupling, and source.

An A Trigger View Amplifier circuit amplifies the external A Trigger signal for application to the Trigger View Diode Gate, where the trigger signal may be selected for viewing. The trigger view display provides a method of making a quick and convenient check of the external trigger signal being used to trigger the A Sweep Generator. The external trigger input signal may be continually monitored, when in the NON STORE mode, by selecting the A TRIG VIEW Vertical Mode. The external trigger signal is not viewable in any storage mode.

Since the A and B Trigger Generator circuits are similar, only the A Trigger Generator circuit action and the differences between the A and B Trigger Generator circuits are described.

Trigger Source

Trigger SOURCE switch S320A selects the source of the trigger signal. The sources available to the A Trigger Generator circuit are: the signal(s) being displayed (NORM), Channel 1 (CH 1), Channel 2 (CH 2), LINE, and EXT. The EXT/10 switch position (for the A Trigger circuit only) attenuates the external trigger signal by a factor of 10. The B Trigger SOURCE switch does not have a LINE or an EXT/10 position, but it does have a STARTS AFTER DELAY position.

The STARTS AFTER DELAY position of the B Trigger SOURCE switch is used in conjunction with the DELAY TIME POSITION control. When STARTS AFTER DELAY is selected as a trigger source for the B Sweep, +5 V is applied to the Free Run input of U240, causing the B sweep to start immediately after the delay time (selected by the DELAY TIME POSITION control) has elapsed.

In the LINE mode of triggering, a sample of the power line frequency is obtained from the secondary of power transformer T14500 located in the Low Voltage Power Supply circuit. To prevent unwanted attenuation of the trigger signal by the LF REJ circuit, the A Trigger COUPLING switch should not be set to LF REJ when using line voltage as a trigger source.

Trigger Coupling

The Trigger COUPLING switches offer a means of accepting or rejecting certain components of the trigger signal. In the AC, LF REJ, and HF REJ modes of trigger coupling, the dc component of the trigger signal is blocked by coupling capacitors C423 or C327. Frequency components below 60 Hz are attenuated when using AC coupling, and components below about 50 kHz are attenuated when using LF REJ coupling. The higher frequency components of the trigger signal are passed without attenuation. In the HF REJ mode of trigger coupling, the high-frequency components of the trigger signal (above about 50 kHz) and low-frequency components (below 60 Hz) are attenuated, while the remaining frequency components are passed with minimal attenuation. The DC mode of trigger coupling passes all signals from dc to at least 100 MHz without attenuation.

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Input Source Follower

Field-effect transistor (FET) Q430A is a source follower. It provides both a high input impedance for the trigger signal and isolation between the Trigger Generator circuit and the trigger signal source. Diode CR330 provides input protection for Q430A if an excessively high amplitude negative-going input signal is present. If a high-amplitude positive signal is applied, the source-gate junction of Q430A becomes forward biased and clamps the voltage at that level. The second FET of the matched pair, Q430B, is a high-impedance, constant-current source for Q430A. Since both FET are matched and mounted in the same heat sink, both will display equal temperature effects, and Q430B will provide temperature compensation for Q430A.

Trigger Generator

Monolithic integrated circuit U445 generates a stable Trigger Gate output to the A Sweep Start Comparator composed of Q360 and Q316. Trigger Level Centering adjustment R330 sets the level at U445 pin 9 so the display is correctly triggered when the LEVEL control is centered. LEVEL control R17305 varies the level at U445 pin 9 to select the point on a trigger signal where triggering occurs.

The slope of the input signal that triggers the Sweep Generator circuit is determined by the setting of SLOPE switch S17305. When the SLOPE switch is set to the + position, the output signal at U445 pin 14 switches HI only on a positive slope of the input signal at pin 7. When the SLOPE switch is set to the – position, the output signal at pin 14 switches HI only on a negative slope of the input signal at pin 7. The A Slope Center adjustment, R349, balances U445 so that triggering occurs at the same level on both the positive and negative slopes. The A Trigger Sensitivity adjustment, R351, adjusts the built-in hysteresis in U445 to a level that will not allow triggering to occur on low-level noise at the input.

At the end of the sweep time and during holdoff, a HI level is applied to U445 pin 17, resetting the IC and causing the output at pin 14 to go LO. The HI reset level remains on pin 17 during holdoff time to ensure that a sweep-gating signal will not be generated at pin 14 until the sweep circuit has returned to its quiescent state.

Trigger View Amplifier

Transistors Q433 and Q432 make up half of a cascode, push-pull amplifier. In the Vertical Switching Logic circuit, Q222 and Q228 form the rest of the Trigger View Amplifier. The Trigger View Amplifier requires that the A Trigger SOURCE switch be set to EXT or EXT/10, the A TRIG VIEW Vertical Mode be selected, and the NON STORE mode be selected before the amplifier is enabled to pass the external trigger signal to the diode gate and on to the Vertical Output Amplifier. If the trigger view display is selected, the Vertical Switching Logic circuit will turn on the Trigger View Diode Gate during the proper time to pass the signal on to the Delay Line Driver.

A sample of the push-pull external trigger signal is taken from U445 pins 7 and 9 and amplified by Q433 and Q432. Trigger View Centering control R534 is used to vertically position the trigger view display. Potentiometer R443 is adjusted to set the Gain of the Trigger View Amplifier; C438, L532, C538, and R435 provide HF compensation. Diodes VR526, CR530, and CR541 are used to clamp the collectors of Q433 and Q432 to approximately +5.7 V whenever the Trigger View feature is disabled. Transistors Q222 and Q228 will be reverse biased during this time.

SWEEP AND Z-AXIS LOGIC

The Sweep and Z-Axis Logic circuit (Figure 3-9 and diagram 7) develops the logic levels necessary to control the sequence of events associated with sweep generation and crt unblanking. The A + Gate and B + Gate signals are also generated in this circuit.

A Sweep Gate

The A Sweep Gate circuit includes Q360 and Q361. They form an emitter-coupled stage where only one transistor can be conducting at any time. The input signal to the stage is the positive-going trigger signal from the A Trigger Generator circuit (diagram 6). The signal at the collector of Q360 is connected to the A Sweep Z-Axis Gate circuit to control the crt unblanking and to generate the A + Gate signal. The signal at the collector of Q361 is connected to the emitter of Sweep Disconnect Amplifier Q890 in the A Sweep Generator circuit (diagram 8) to initiate A Sweep generation.

B Sweep Gate

The B Sweep Gate circuit includes Q160 and Q161. These transistors also form an emitter-coupled stage where only one transistor can be conducting at any time. The input signal to the stage is the positive-going trigger signal from the B Trigger Generator circuit. The signal at the collector of Q160 is connected to the B Sweep Z-Axis Gate circuit (Q1007 and Q1006) for control of crt unblanking, and to Q1005 for generating the B + Gate signal. The signal at the collector Q161 is connected to the emitter of Sweep Disconnect Amplifier Q864 in the B Sweep Generator circuit to initiate B Sweep generation.

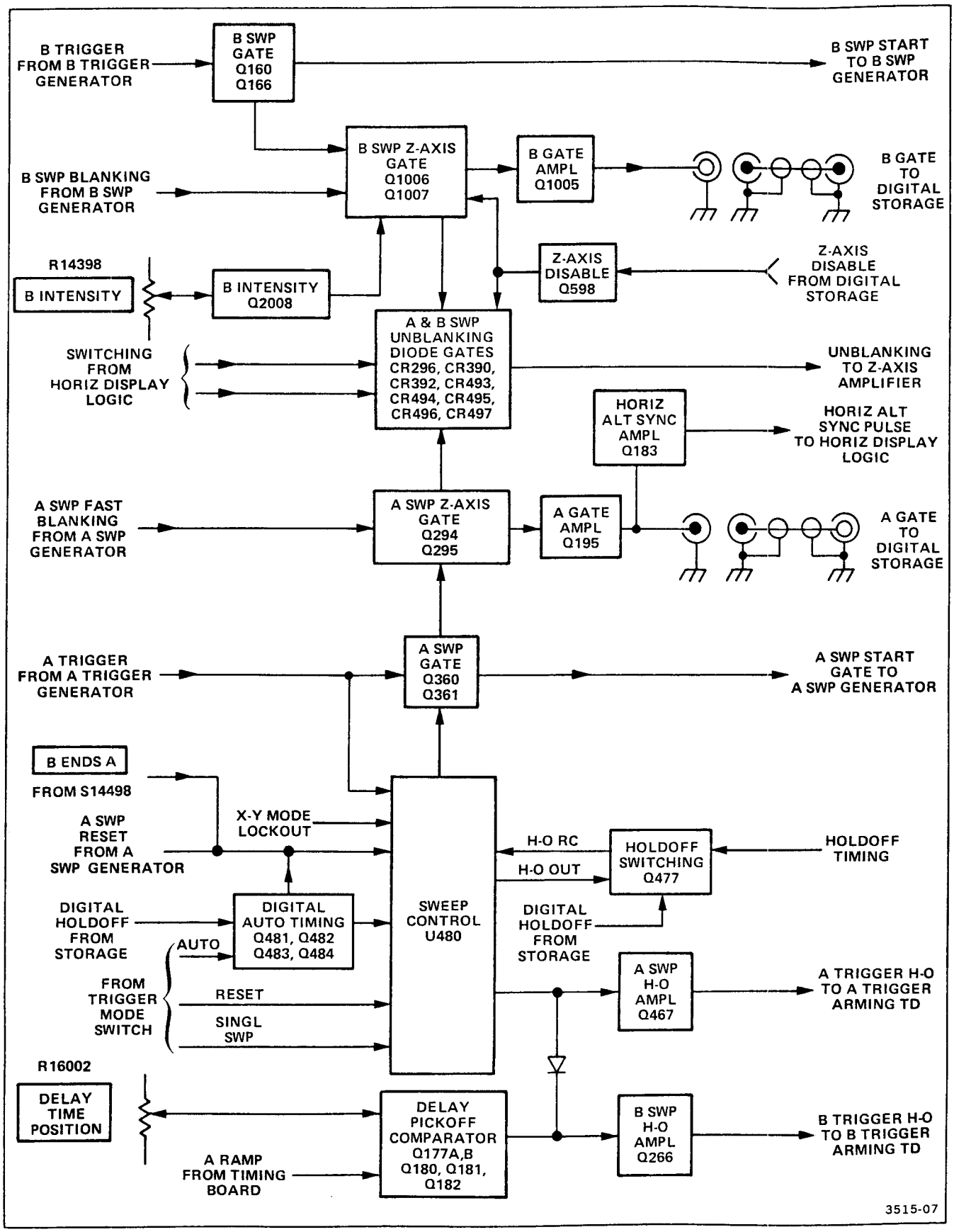

Figure 3-9. Detailed block diagram of the NON STORE Sweep and Z-Axis Logic circuit.

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Sweep Control Integrated Circuit

The Sweep Control integrated circuit is U480. Several functions are performed in this stage, depending on the mode of operation of the instrument sweep generators. The following is a brief explanation of the function associated with each pin of the IC.

Pin 1 is the positive Auto Sense input. The signal connected here comes from the A Trigger Generator.

Pin 2 is a reference input to the Auto Sense circuit. A fixed dc level established by R383 and R382 is connected here.

Pin 3 is the + auto gate terminal. In the AUTO mode of operation, if no trigger signals are applied to pin 1 of U480 during the approximately 100 ms following the end of holdoff, the gate level at pin 3 steps LO to turn Q361 on, thus initiating a sweep.

Pin 4 is the auto gate terminal and is not used in this application. The pin is held at a positive level.

Pin 5 is the input terminal for the negative voltage supply. Zener diode VR383 provides some regulation of the negative supply at pin 5.

Pin 6 is the auto gate timing terminal. R380 and C380 determine the amount of time between the end of holdoff and the generation of the auto gate when no triggering signal is received. A feedback capacitor, C381, provides positive feedback to pin 6 from pin 4 to speed up the edge of the auto gate output at pin 3.

Pin 7 output illuminates the TRIG LED when a triggered gate has occurred.

Pin 8 is the holdoff timing terminal. An RC network connected to this terminal and selected by the A TIME/DIV switch (see diagram 9) determines the length of holdoff time. The digital holdoff signal, BHOF, holds this pin LO to disable the trigger until the digital holdoff time is completed.

Pin 9 is the ground terminal.

Pin 10 is the holdoff output terminal. The gate level present here is LO during sweep holdoff time and HI otherwise.

Pin 11 output illuminates the READY LED when operating in the single-sweep mode.

Pin 12 is the single-sweep mode terminal. When +5 V is applied to this terminal, the sweep operates in the single-sweep mode; when the terminal is left open or grounded, the sweep operates in the repetitive mode.

Pin 13 is not used in this application. The pin is grounded.

Pins 14 and 15 are the single-sweep reset terminals. Pushing the SINGLE SWP button prepares the single sweep circuitry to respond to the next triggering event and causes the READY LED to illuminate.

Pin 16 is the holdoff start input terminal. The HI sweep reset gate pulse from the sweep generators is applied here to initiate sweep holdoff. The digital holdoff signal is applied here to reset the sweep and Trigger Generator ICs.

Pin 17 is the sweep disable output terminal. The gate level at this terminal is HI during holdoff and LO otherwise. A HI gate level at pin 17 holds a reset level on the A and B Trigger Generator ICs (diagram 6) until holdoff time has elapsed. The gate goes LO at the end of holdoff to allow the Trigger Generators to respond to an input triggering signal.

Pin 18 is the sweep lockout input. When +5 V is applied to this terminal in the X-Y display mode, all sweep action is disabled.

Pin 19 is the auto mode terminal. Grounding this terminal enables auto sweep operation.

Pin 20 is the input terminal for positive supply voltage.

NON STORE Holdoff Timing

A resistor and capacitor network located in the A and B Timing Switch circuit (diagram 9) connects to U480 pin 8 via J550 pin 8. Various resistor and capacitor combinations switch into the circuit, depending on the setting of the A TIME/DIV switch. At sweep end, pin 16 of U480 receives a reset pulse, releasing pin 8. Now the timing capaciators in the holdoff timing network start to charge. A LO from U480 pin 10 biases Q477 off during the sweep holdoff time to allow the voltage at pin 8 to rise as the timing capacitors charge. When the charge on the capacitors rises to approximately +4 V at pin 8, pin 10 goes HI to turn

on Q477. The holdoff timing capacitors discharge rapidly through Q477, and pin 8 goes LO. At this time, the sweep disable output pin 17 also goes LO to remove the reset level from the A and B Trigger Generator ICs.

In the A and B Timing Switch circuit, C435, C437, C429, R431, and R432 are switch-selectable holdoff timing components that set the various timing holdoff ranges selected by the TIME/DIV switch. The A Trigger HOLDOFF control, R14498 (diagram 9), is a variable resistor that allows lengthening of the time constant to increase holdoff time for each holdoff range.

Digital Holdoff

When the storage feature of the instrument is in use, timing of the operation requires that the Storage Time Base circuitry has control of the sweep circuitry. A digital holdoff signal (BHOF) is applied to the Sweep Control IC to disable the Trigger and Sweep circuits until the necessary processing time has elapsed.

The rising edge of BHOF is coupled through C480 to forward bias CR488. A positive pulse is applied through CR488 to U480 pin 16 to reset the Sweep Control IC. The duration of the pulse is determined by the RC time constant of C480 charging through R487.

A HI BHOF signal also forward biases CR478 to supply base current to Q477 and saturate it. With Q477 on, U480 pin 8 is held LO to keep the sweep disabled until BHOF goes LO. When the digital holdoff time passes, Q477 is turned off and the holdoff RC network in the A and B Timing Switch circuitry can begin charging.

The circuit composed of Q481, Q482, Q483, and Q484 functions as a digital auto timer for the AUTO trigger mode of operation. During digital holdoff time, BHOF is HI and CR480 is forward biased. Saturation current flows in both Q483 and Q484, and C593 charges up to approximately +5 V. As C593 charges, the base voltage of Q482 rises until the transistor becomes saturated and Q481 is cut off. With Q481 off, pin 19 of the Sweep Control Logic IC, U480, will float HI to place the IC in its NORM trigger operating mode.

When BHOF goes LO, CR480 becomes reverse biased and both Q483 and Q484 turn off. Now C593 will discharge through R482 and R481 to reduce the forward bias on Q482 and eventually turn off the transistor. With Q482 off, Q481 becomes forward biased to place a LO on U480 pin 19, and the Sweep Control Logic IC goes into the AUTO trigger mode. The time interval between the end of the BHOF signal and the point that Q481 turns on permits a triggering signal to occur before an AUTO trigger is generated.

If either the NORM or SINGL SWP trigger mode of operation is selected, the base of Q483 is ungrounded. With the base of Q483 held forward biased through R591, the BHOF signal cannot switch Q483 off when it goes LO, and the Sweep Control IC will not generate an AUTO trigger.

A Sweep Holdoff Amplifier

The A Sweep Holdoff Amplifier is Q467. The holdoff gate waveform from U480 pin 17 is applied to the emitter of Q467 through CR470. When Q467 is turned off (during holdoff time), its collector is HI, thus placing a HI on the A Trigger Generator reset input (diagram 6). When U480 pin 17 goes LO at the end of holdoff time, Q467 is biased on, and its collector voltage goes LO to remove the reset level from the A Trigger Generator IC, U280. Once the reset level has been removed, the IC is allowed to respond to the next adequate triggering signal.

B Sweep Holdoff Amplifier

The B Sweep Holdoff Amplifier is Q266. Its circuit action is controlled both by the holdoff gate from U480 pin 17 (through CR471) and the collector current of Q182 in the Delay Pickoff Comparator. Both control sources must be in their LO state for the B Trigger Generator reset level to be removed. Either source in its HI state will keep Q266 biased off to hold a HI on the reset input of B Trigger Generator U445.

Delay Pickoff Comparator

A circuit composed of Q177, Q180, Q181, and Q182 is used to compare the A Sweep ramp voltage with the level set by the DELAY TIME POSITION potentiometer, R16002.

When B Sweep is enabled, Q181 is biased to supply a constant current to Q177. At the start of an A Sweep, the right half of Q177 is biased on, and the left half, with the level from the DTP control, is off. At the point that the A Sweep ramp runs down to meet the level from the DELAY TIME POSITION control, the left half of Q177 becomes forward biased and the right half turns off. Transistor Q182, in the collector circuit of the right side of Q177, will turn off and allow the emitter of Q266 to go LO. The reset level is removed from the B Trigger Generator when Q266 conducts, and the B Sweep either will start immediately if the STARTS AFTER DELAY B Trigger SOURCE is selected or will start when the next triggering signal occurs when any other B Trigger SOURCE is selected.

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A Sweep Z-Axis Gate

The A Sweep Z-Axis Gate is an emitter-coupled bistable stage composed of Q294 and Q295. Only one of these transistors can be conducting. The controlling signals consist of inputs from: the collector of Q360 in the A Sweep Gate, the A Sweep Fast Blanking signal from Q986 in the A Sweep Generator circuit (via J550 pin 2), and Q791 in the Horizontal Display Logic circuit. The unblanking signal for use in the Z-Axis Amplifier is taken from the collector of Q295 through CR495. The collector signal of Q294 is applied to the A + Gate Emitter Follower, Q195.

The Horizontal Display Logic circuit controls the bias voltage on CR296. When the diode is reverse biased, as it is for all horizontal modes except B DLY'D, −8 V is connected to the anode of CR296 through Q791 (diagram 8). The gate signal at the collector of Q295 is allowed to pass through CR495 to create the unblanking signal to the Z-Axis Amplifier. In the B DLY'D mode, Q791 is turned off and CR296 is forward biased through R294 to the +5-V supply level. Now CR495 will be reverse biased, and the A unblanking signal is blocked from reaching the Z-Axis Amplifier. In the ALT Horizontal Display mode, CR296 will be reverse biased during the A sweep and forward biased during the B sweep.

B Sweep Z-Axis Gate

The B Sweep Z-Axis Gate is composed of transistors Q1006 and Q1007. These transistors form an emitter-coupled stage where only one transistor can be conducting at a time, as in the A Sweep Z-Axis Gate circuit. The controlling signals come from the collector of Q160 (B Sweep Gate), and the blanking signal from the collector of Q956 in the B Sweep Generator. The emitter current in the gate transistors is supplied partly by Q2008, which is controlled by B INTENSITY control R14398. The B INTENSITY control sets the level of the B Sweep unblanking signal to control the B Sweep intensity separately from the overall display intensity. The collector of Q1007 supplies the unblanking signal to the Z-Axis Amplifier, and the collector of Q1006 supplies the signal to the B + Gate Emitter Follower (Q1005).

When the A Horizontal display is selected, −8 V from Q790 in the Horizontal Display Logic circuit is applied to the cathode of CR390. This reverse biases CR392 and allows the collector of Q1007 to be pulled positive, through CR493 and R390, to the +5-V supply level. Diode CR494 will be reverse biased, and the B Sweep Z-Axis Gate (Q1006 and Q1007) will not affect crt unblanking. When either A INTEN, ALT, or B DLY'D Horizontal Display is selected, −8 V is supplied from S469 to the anode of CR493, reverse biasing it and allowing the Horizontal Display Logic circuit to control the B Sweep Z-Axis Gate.

In the A Intensified Horizontal Display mode, CR390 becomes reverse biased and CR392 becomes forward biased. Diode CR494 is still reverse biased, but when B Sweep starts, the collector of Q1007 steps negative enough to forward bias CR494, adding a slight amount of unblanking to the A Sweep unblanking already present. This provides further intensification for the B Sweep portion of an A Intensified display.

In the ALT Horizontal Display mode, the Horizontal Display Logic circuit controls the A Sweep Z-Axis Gate (Q294 and Q295) and the B Sweep Z-Axis Gate (Q1006 and Q1007). The B Sweep unblanking signal is added to the A Sweep unblanking signal during the A Intensified display. The A Sweep unblanking signal is blocked during the B DLY'D Sweep display. In B DLY'D Horizontal Display, the A Sweep Z-Axis Gate output diode CR494 is held reverse biased, and the only unblanking signal presented to the Z-Axis Amplifier input is the B Sweep unblanking signal.

A + Gate and B + Gate Emitter Followers

Emitter followers Q195 and Q1005 provide the A + Gate and B + Gate signals to trigger the Digital Storage Time Base. The positive-going gate signals are also made available from connectors on the instrument rear panel. The amplitude of the rectangular gate signals is set at the collectors of Q294 and Q1006 at approximately +5.5 V. When Q294 is conducting, the base of Q195 can go no more negative than approximately −0.7 V (limited by CR189). When Q294 is not conducting, the base of Q195 rises to the +5-V power supply level through R295. Diodes CR1000, CR1001, CR1100, and CR1101 protect Q195 and Q1005 from accidental application of damaging voltage levels to the A + Gate and B + Gate output connectors.

Horiz Alt Sync Pulse Amplifier

The pickoff amplifier for the Horiz Alt Sync pulse is Q183. Biased into saturation, its quiescent output voltage is approximately zero. A sample from the A + Gate is coupled to the base of Q183 by C284 where the positive-going gate is integrated by the action of C284 and R280. The positive-going portion of the integrated signal cannot increase the collector current of Q183 beyond its saturation level, so no signal output is obtained. When the A + Gate negative-going edge occurs, C284 cannot change its charge instantaneously and the entire negative transistion is impressed on the base of Q183 across R280. The negative peak of the signal is enough to cut off Q183, and the collector voltage rises in response to the base voltage decrease. The base voltage rapidly returns to a positive level, the transistor again saturates, and ends the Horiz Alt Sync Pulse.

A AND B SWEEP GENERATORS

The A and B Sweep Generators (diagram 8) produce sawtooth voltages which are amplified by the Horizontal Amplifier circuit to provide horizontal deflection on the crt for the nonstorage displays. These sawtooth voltages are produced on command (Sweep Start gate) from the Sweep Logic circuits. The Sweep Generator circuits also produce gate waveforms that are used by the Z-Axis Logic circuit to unblank the crt during sweep time and by the Sweep Logic circuit to terminate sweep generation. Figure 3-10 shows a detailed block diagram of the A Sweep Generator circuit that is described in the following paragraphs. Since the B Sweep Generator circuit is very similar to the A Sweep Generator, discussion of the B Sweep Generator is about the differences in operation between the two.

Disconnect Amplifier

After holdoff, but before the next sweep, Disconnect Amplifier Q890 is biased on and conducts through R888 and R_t back to $+V_t$. This sets the charge on C_t in preparation for the beginning of the next A Sweep and prevents current from the Miller Integrator circuit from changing the charge on C_t. When the positive-going A Sweep Start Gate is applied to the emitter of Q890, CR889 becomes forward biased and turns off Q890. Now the A Sweep starts, and the Miller Integrator circuit begins to change the charge on C_t. Disconnect Amplifier Q890 remains biased off until retrace is initiated and the A Start Sweep Gate is removed. Then Q890 will become forward biased again, and C_t will rapidly charge to its quiescent value for the start of the next A Sweep.

Sawtooth Generator

The Miller Integrator circuit is made up of Q891 and Q998. It works on the principle that if the charging current to a capacitor can be held constant, then the charging curve will be linear rather than exponential. The action starts when Disconnect Amplifier Q890 is turned off by the A Sweep Start Gate. The selected capacitor for the chosen setting of the TIME/DIV switch (C_t) begins to charge through the R_t. This causes the junction of C_t and R_t to start positive in the direction of $+V_t$, thereby causing the gate of Q891 to start positive. The Q891 source then starts in a positive direction and increases the forward bias on

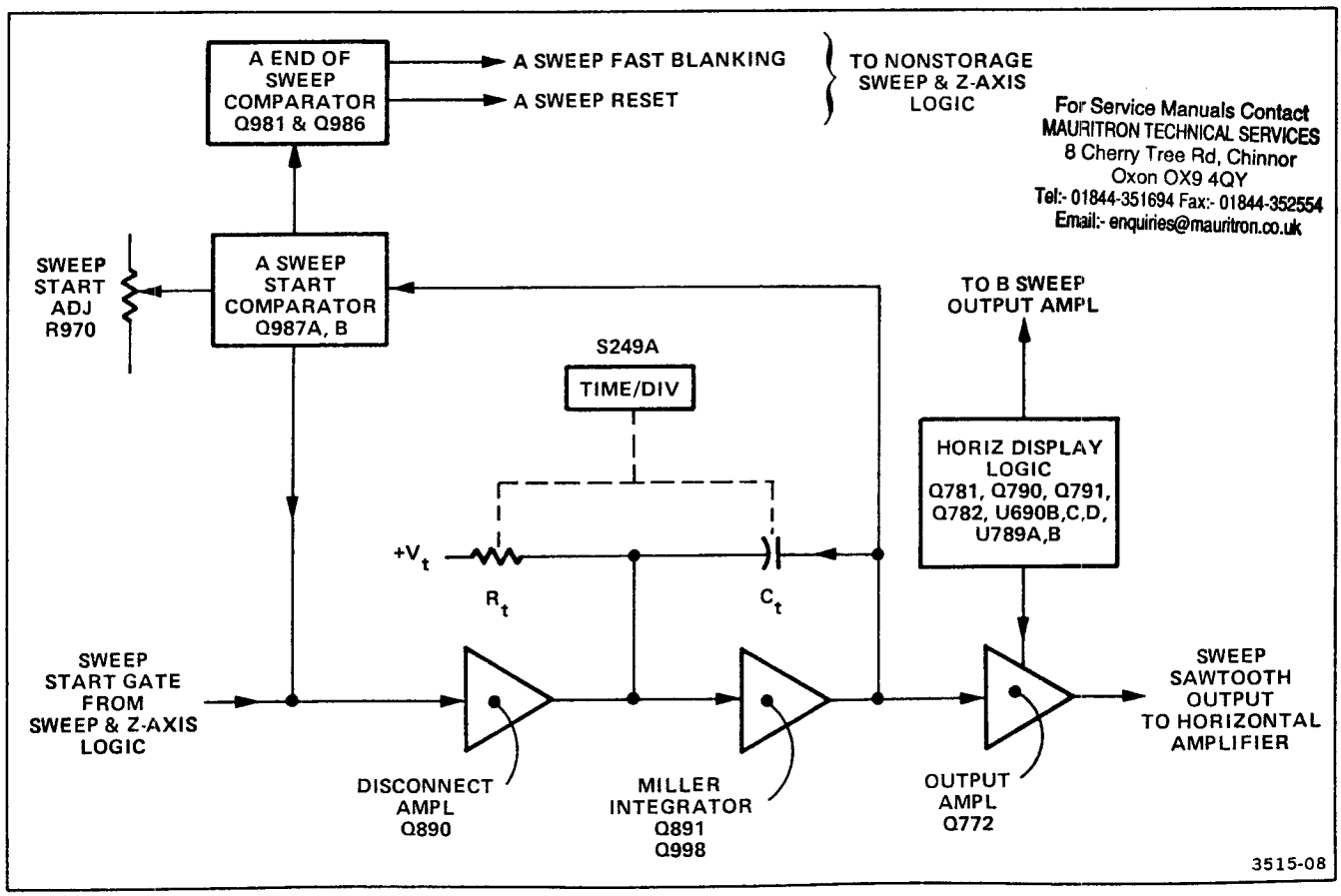

Figure 3-10. Detailed block diagram of the A Sweep Generator circuit.

Q998; causing the collector voltage to move in a negative direction (less positive). This couples back through C_t and opposes the positive change at the gate of Q891. Capacitor C_t is attempting to charge toward $+V_t$, but the action of both the Q891 gate being held virtually constant and the collector of Q998 going more negative results in reduction of the charge on C_t (it discharges). The gate of Q891 rises positive about 10 mV over the entire sweep generation time. Since the voltage at the gate of Q891 remains relatively constant, both the voltage across R_t and the current through R_t (current discharging from C_t) remain constant. The linear rate of discharge of C_t results in a linear ramp across it. The resultant output at the collector of Q998 appears as a negative-going ramp, dropping from approximately +13 V to approximately +2 V.

When the ramp reaches +2 V, Q981 sends a pulse to U480 to initiate retrace. Transistor Q890 turns on, and its collector goes more negative. The gate of Q891 moves in the negative direction, causing the voltage on the base of Q998 to go more negative and its collector voltage to go more positive. Now C_t charges rapidly through Q890 to its quiescent state in preparation for the next A Sweep start gate.

Output Amplifier

Output Amplifier Q772 is a common-base amplifier with the signal current-driven into the emitter. It provides the output sawtooth current signal to the Horizontal Amplifier and a measure of isolation between the Sawtooth Generator and the Horizontal Amplifier. The Horizontal Display Switching circuit connects to this stage and controls the A sawtooth output in the various horizontal modes of operation. In the A and A INTEN modes of operation, the A sweep signal passes through Q772 to the Horizontal Amplifier. In the ALT mode, Q772 is enabled for the A sweep and turned off for the B sweep by the Horizontal Display Logic circuit. In the B DLY'D mode, Q772 is held off, and Q760 in the B Sweep Generator is held on, passing the B sweep sawtooth to the Horizontal Amplifier.

For stored waveform displays, both the A and B sawtooth outputs are not allowed to pass to the Horizontal Amplifier, and the horizontal deflection signal is supplied by the digital storage X-Axis circuitry (diagram 16).

A Sweep Start Comparator

Just before the sweep starts to run down, the levels at the bases of Q987A and Q987B are approximately equal. When the sweep starts to run down, the base of Q987B goes negative, following the collector of Q998. The forward bias on CR984 increases, which in turn decreases the forward bias on CR980. Very shortly after start of the sweep, CR980 becomes reverse biased and interrupts the current through Q987A. The circuit remains in this condition until after the sweep retrace is complete. When the circuit returns to quiescence, Q987A again begins to conduct through R888, thereby setting the current available to Disconnect Amplifier Q890 and establishing the starting point of the sweep. Sweep Start adjustment R970 is used to set the base voltage of Q987A. The sweep start level is also applied to the base of Q958 in the B Sweep Start Comparator to ensure that the B sweep starts at the same level as the A sweep.

A Sweep End of Sweep Comparator

The A Sweep End-of-Sweep Comparator is a switching circuit composed of Q981 and Q986. At quiescence, Q986 is conducting and Q981 is biased off. When the sweep starts to run, the negative-going ramp at the collector of Q998 is coupled through the base of Q987B and through CR984 to the cathode of CR975. When the collector of Q998 reaches about +2 V, the cathode of CR975 reaches about +4 V. At this point, CR975 begins conducting to turn on Q981, which then turns off Q986. The resulting positive step at the collector of Q981 is fed to U480 pin 16 where it is used to initiate retrace and holdoff. The negative-going pulse at the collector of Q986 is applied to the A Sweep Z-Axis Logic Gate to blank the crt as soon as a sweep-end command is generated.

B Sweep Generator Differences

The B Sweep Generator differs from the A Sweep Generator in two respects. The first is that Q946 is used as a constant-current source in the B Sweep Start Comparator circuit. The second is that one of the outputs of the B Sweep Generator is controlled by the B ENDS A switch associated with the A Trigger HOLDOFF control. In the B ENDS A position, the end of the B sweep resets the Sweep Control IC (diagram 8) to also end the A Display on the crt.

Horizontal Display Logic

The Horizontal Display Logic circuit produces the signals that switch both the A and B Sweep Generator outputs and the A Sweep and B Sweep Z-Axis Gates. The circuit also provides a Vertical Alt Sync pulse to the Vertical Switching circuitry. In addition, an enabling voltage is produced via VR695 to allow the Trace Separation circuitry to function for ALT Horizontal Displays.

VERT ALT SYNC PULSE. A gating circuit is formed by U690B and U690D to control the Vertical Alt Sync pulse. The pulse is used in the Vertical Switching circuit for clocking U409 whenever the ALT Vertical Mode is selected. In all Horizontal Display modes except ALT, a HI at U690B pin 6 will put a LO at U690D pin 3. The positive-going Horiz Alt Sync pulse is applied to U690D pin 2. The

pulse is inverted through U690D and fed to the Vertical Switching circuit at U509A, pin 1 (diagram 3). In ALT Horizontal Display mode, pin 6 of U690B will be LO, and the signal at pin 5 will control the output at pin 4. The signal present at U789A pin 6, which changes state with every Horiz Alt Sync pulse, now controls U690D, and the Vert Alt Sync pulse becomes a rectangular pulse having a period equal to twice the time between Horiz Alt Sync pulses.

TRACE SEPARATION. During the B Sweep time the TRACE SEP potentiometer is used to supply an offset signal to Q205 and Q206 (in the Vertical Output Amplifier circuitry) for controlling the vertical separation between the A trace and the B trace. During B Sweep, in ALT Horizontal Display mode, a HI will be present on pin 4 of U690B. The HI forward biases Q108 (diagram 5) on and enables the Trace Separation circuitry. See the "Vertical Output Amplifier" circuit description for a discussion of the Trace Separation circuitry.

A AND B SWEEP SWITCHING. Flip-flop U789A controls Horizontal Display Switching transistors Q782 and Q781 in the A and B Sweep Generators. HORIZ DISPLAY switch S469 sets the flip-flop to perform one of the following actions:

1. Turn off Q781 and turn on Q782, allowing the A Sweep signal to go to the Horizontal Amplifier;

2. Turn off Q782 and turn on Q781, allowing the B Sweep signal to go to the Horizontal Amplifier; or

3. Alternately turn the two transistors off and on to display both sweeps in Alt Horizontal Display mode.

During a stored waveform display, a Sweep Disable signal is applied to both the set and reset input of U789A through CR471 and CR374. The Q and $\overline{Q}$ outputs of U789A go HI, and both sweep switching transistors will be biased on to shunt the A and B Sweep current to ground.

Flip-flop U789A is clocked by the Horiz Alt Sync pulse when the Horizontal Display is set to ALT. When the Horizontal Display is set to A, A INTEN, or B DLY'D, the state of the outputs of U789A is determined by the logic levels present at pins 1 and 4. The HORIZ DISPLAY switches set these logic levels.

Flip-flop U789B controls the A and B Sweep Z-Axis Gate switching transistors Q791 and Q790. These transistors switch the bias on CR390 and CR296 in the A and B Sweep Z-Axis Gates to either allow the unblanking gates to pass to the Z-Axis Amplifier or block them. U789B is controlled by both the signal on U789A pin 5 and the A position of the HORIZ DISPLAY switch.

A AND B TIMING SWITCH

The components shown in diagram 9 include the cam activated switch contacts that select the timing components for the A and B Sweep Generator circuits. Added switch contacts on cam segments 21 through 25 of the A TIME/DIV switch and contacts 16 through 20 of the B TIME/DIV switch supply a binary input signal to A and B TIME/DIV Registers in the Vertical Mode Switch circuitry (diagram 4). The registers are read at regular intervals by the Microprocessor to determine if a timing change is required for the stored waveform display.

Many of the adjustments for both the A and B Sweep timing calibration are located in the A and B Timing Switch circuitry.

HORIZONTAL AMPLIFIER

The Horizontal Amplifier circuitry (Figure 3-11 and diagram 10) provides the output signals that drive the horizontal deflection plates of the crt. The source of the signal applied to the input of the Horizontal Amplifier is determined by the TIME/DIV switch, the HORIZ DISPLAY switch, and the digital STORAGE MODE switches. The deflection signal can come from either of the sweep generators within the instrument, from the CH 1 OR X input connector (X-Y mode), or from the digital storage horizontal display system (if operating the instrument in a storage mode).

Horizontal positioning controls, X10 magnifier circuitry, and the horizontal portion of the beam finder circuitry are also contained in the Horizontal Amplifier.

X-Axis Amplifier

The sawtooth horizontal deflection signals to U564A and U564B come from either the A or B Sweep Generator (nonstorage mode) or the Storage Display X-Axis output (when operating the instrument in a storage mode). However, in the nonstorage mode, when the X-Y position of the A TIME/DIV switch is selected, the signal applied to U564A and U564B comes from the Channel 1 Preamplifier via the X-Axis Amplifier. The X-Axis Amplifier is composed of Q582, Q583, and associated components.

Transistor Q582 is connected as a feedback amplifier, with R486 as the feedback element. The input resistance of the amplifier is made up of R679 and the gain-setting adjustment of R681. When not operating in the X-Y mode, the base of Q582 rises toward the +15-V supply, but the base is clamped at approximately +5.7 V by CR587 and R587. The base-emitter junction of Q582 is reverse biased.

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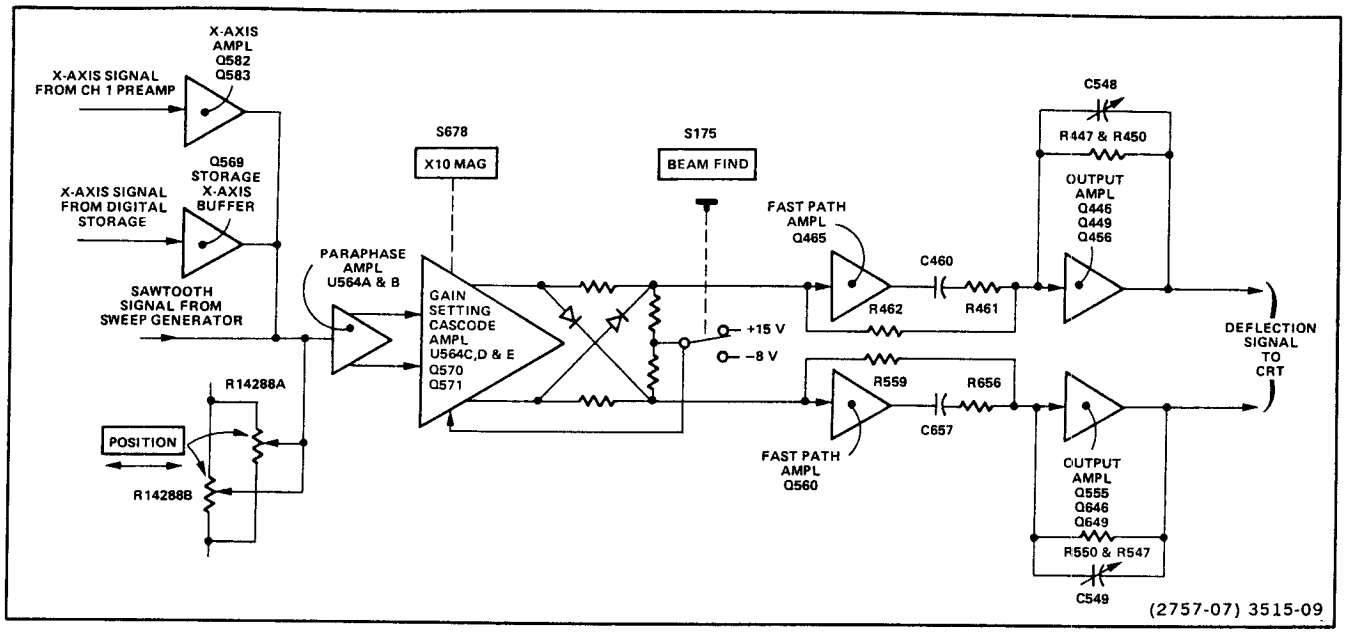

Figure 3-11. Detailed block diagram of the Horizontal Amplifier circuit.

The base of Q583 also rises to approximately +5.7 V and is biased off.

When the A TIME/DIV switch is set to X-Y (fully counterclockwise), −8 V is applied to the junction of R682 and R683. In addition, +5 V is applied to the emitter circuit of Q583, through CR486, to bias the X-Axis Amplifier into conduction. Diode CR679 is now forward biased to allow the X-Axis signal to pass to the base of Q582. The +5 V is also applied via P970 pin 4 and J550 pin 4 to U480 pin 18 in the Sweep and Z-Axis Logic circuit, disabling sweep generation during the X-Y function display.

Input Paraphase Amplifier

The Input Paraphase Amplifier is composed of U564A and U564B (part of a transistor array). The transistors form an emitter-coupled amplifier stage that converts the single-ended input signal to a differential output signal. The signal at the collector of U564A is opposite in phase to the input signal, while the signal at the collector of U564B is in phase with the input signal. Temperature compensation for U564A and U564B is provided by RT672 which varies in resistance value with changes in ambient temperature.

Horizontal POSITION potentiometers R14288A (coarse) and R14288B (fine) are mounted on the same shaft in a mechanical arrangement that allows R14288B to rotate about one-eighth turn in either direction before R14288A moves. The fine potentiometer has approximately one-tenth the positioning range of the coarse potentiometer.

Gain Setting Cascode Amplifier

A cascode, push-pull amplifier stage composed of Q570, Q571, U564C, U564D, and associated circuitry provides the current drive to the output stage and sets the overall gain of the Horizontal Amplifier circuit. The gain of the Cascode Amplifier is controlled by adjusting the resistance connected between the emitters of Q570 and Q571. The X1 Gain adjustment, R572, is used to adjust the unmagnified horizontal gain, and the X10 Gain adjustment, R571, is used to adjust the magnified horizontal gain. Magnifier Registration adjustment R578 is used to balance the quiescent dc current in Q570 and Q571 so that a center screen display does not change position horizontally when switching between magnified and unmagnified display.

The horizontal portion of the Beam Finder circuitry is activated when the BEAM FIND push button is pressed in. The +15 V is disconnected from the junction of R464 and R655, and −8 V is applied at that junction through R273. This causes the following circuit actions to occur:

1. The base voltage of U564C and U564D is lowered, thus decreasing the current through the two transistors. The reduced current flow decreases the voltage drop across R463 and R558, and the diode clamps (CR560 and CR561) clamp at a much lower voltage to limit the horizontal deflection on the crt; and

2. Less current flows through R464 and R655 to compensate for the decreased current flowing through U564C and U564D. This maintains the output stage in a linear operating region.

Output Amplifier

The differential signal from the Gain Setting Cascode Amplifier is directly connected to the bases of Q465 and Q560. It is also applied to the bases of Q456 and Q455 through R462 and R559. At lower sweep frequencies, the signal path is through R462 and R559 to the bases of Q456 and Q555. These transistors are arranged as inverting amplifiers whose collector signals drive the emitters of complementary amplifiers Q446-Q449 and Q646-Q649, respectively.

Capacitor C555 provides emitter peaking for fast ac signals. Capacitors C450 and C644 transfer part of the high-frequency signal to the emitters of Q446 and Q646 to maintain the gain of the output stage at high sweep speeds. Resistors R447-R450 and R547-R550 are the feedback elements, with C548 and C549 providing high-frequency compensation.

As the frequency of the sweep signal increases, the reactance of C548 and C549 decreases and feedback current increases. To compensate for the increase in drive required to maintain the gain of the output stage, Q465 and Q560 (fast-path amplifiers) increase signal current to the bases of Q456 and Q555. High-frequency signal current is shunted around R462 by C460 and R461, while C657 and R656 shunt high-frequency signal current around R559.

The Output Amplifiers are limited from being overdriven by CR560 and CR561. If the output signal from U564C and U564D becomes too large, the diodes become forward biased and prevent further increase in the signal level. These diodes operate mainly to clamp the signal whenever the X10 Magnification function is in use. The signal level is limited to the forward drop across the diodes plus the drop across R463 and R558.

CRT CIRCUIT

The CRT circuit (Figure 3-12 and diagram 11) provides the voltage levels and control circuitry necessary for operation of the cathode-ray tube.

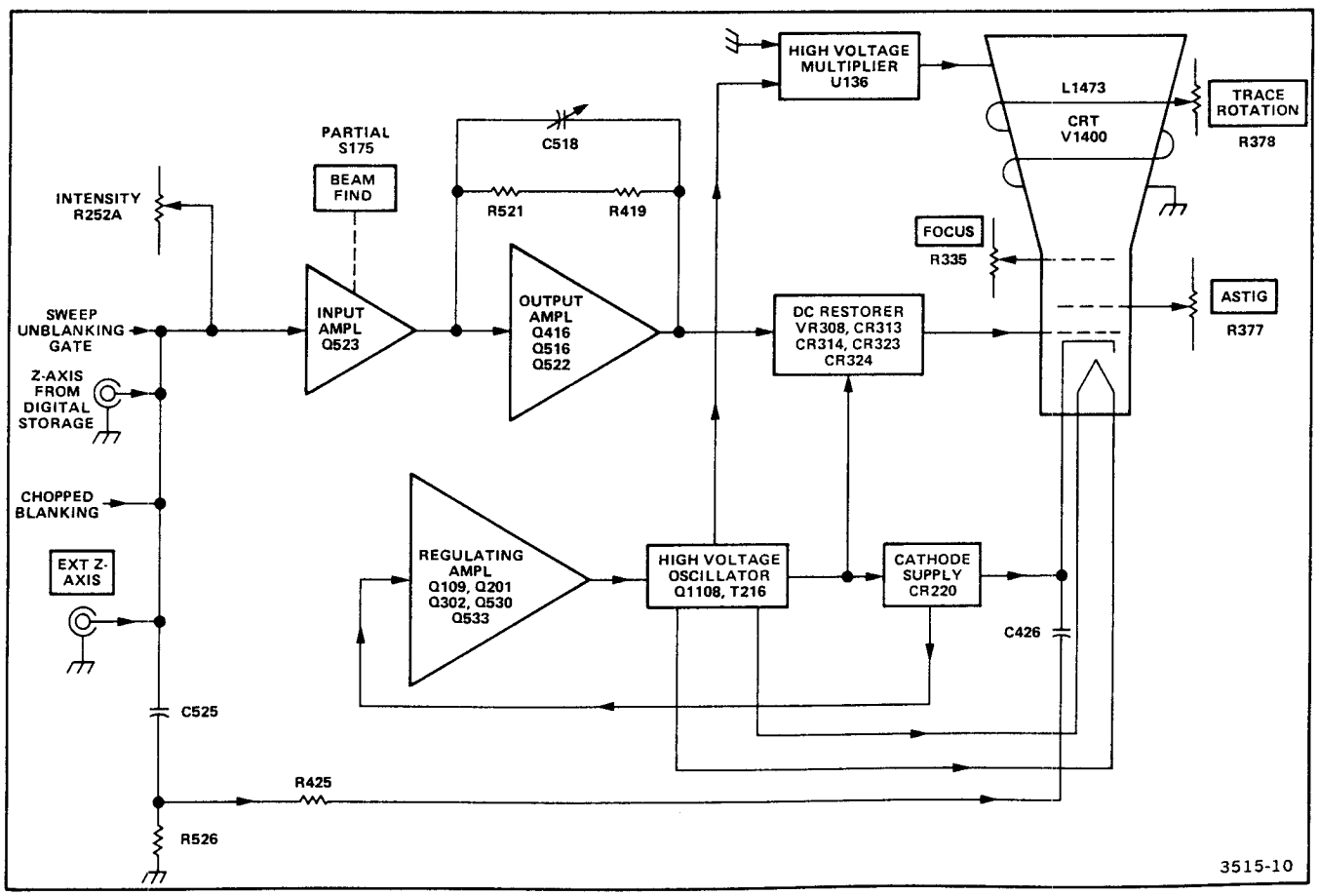

Figure 3-12. Detailed block diagram of the CRT and Z-Axis Amplifier circuits.

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High-Voltage Oscillator

The high-voltage oscillator includes Q1108 and associated circuitry. It produces the drive for high-voltage transformer T216. When the instrument is turned on, transistor Q109 is forward biased and conducts through the base circuit of Q1108 to forward bias Q1108. The increasing collector current of Q1108 through the primary winding of T216 induces a voltage across the positive feedback winding, pins 6 and 7. The positive feedback to the base of Q1108 causes the collector current to rapidly increase toward saturation. Soon the rate of increase slows to a point where the voltage induced in the positive feedback winding starts to decrease. Then the current through Q1108 decreases, further decreasing the feedback voltage. The circuit action continues until Q1108 turns off, and the magnetic field around the primary winding of T216 starts to collapse. Transistor Q1108 is held off until the field has collapsed sufficiently to allow the base of Q1108 to become biased into conduction again, and the cycle is repeated as the circuit oscillates.

The voltage waveform at the collector of Q1108 is a sinusoidal wave at the resonant frequency of T216. The amplitude of sustained oscillations depends on the average current delivered to the base of Q1108. Frequency of oscillation is approximately 50 kHz. Fuse F809 protects the unregulated +15-V supply in the event the High-Voltage Oscillator stage becomes shorted. The stage is decoupled from the unregulated +15-V supply by C108 and L107 to prevent current changes (in the High-Voltage Oscillator stage) from affecting the +15-V supply.

High-Voltage Regulator

After the instrument is turned on and the output voltage from the High-Voltage Oscillator has reached its stable level, regulation occurs as follows. A sample of the −2450-V crt cathode voltage supply is applied to the base of Q530 through R429D which, with the voltage supplied by the bias network (R633, R429C, C629, and CR631), sets the forward bias on Q530. Any change in the −2450 V changes the conduction level of Q530 to produce a proportional dc change on its collector current.

Assume that the −2450-V supply starts to go positive (less negative). The positive-going change is applied to the base of Q530 to cause the collector current to increase, which in turn causes Q533 and Q109 to conduct harder. A resulting greater bias current is applied to the base of Q1108 through the feedback winding of T216. Now Q1108 is biased closer to its conduction level, and it will start conducting sooner in the oscillation cycle of T216, increasing the average current delivered to the primary of T216. The increase in the amplitude of oscillation induces a larger voltage into the high-voltage secondary of T216 to correct the original positive-going change. By sampling the output of the crt cathode supply in this manner, the total output of the High-Voltage Supply is held relatively constant.

Overvoltage protection is provided by Q201, Q302, and associated circuitry. Normally Q201 and Q302 are biased off, but if the crt cathode supply voltage approaches approximately −3000 V, the voltage level at the emitter of Q109 will be approximately −6 V. At this point Q201 will be biased into conduction, which in turn biases Q302 into conduction to reduce the forward bias on Q109. Thus, the base drive to Q1108 is reduced, limiting the amplitude of oscillations in T216, and the crt cathode supply is prevented from going more negative than approximately −3000 V.

High-Voltage Rectifiers and Output

High-voltage transformer T216 has two secondary windings. One winding provides heater voltage for the cathode-ray tube. The heater voltage is supplied from the High-Voltage Supply, since the cathode-ray tube has a very low heater current drain. This allows the cathode and heater of the crt to be connected together to prevent cathode-to-heater breakdown. The high-voltage secondary winding is the source for both the negative crt cathode potential and High-Voltage Multiplier U136.

A sample of the signal in the high-voltage winding is applied to a dc restorer circuit. The sample level and dc levels supplied by both the Z-Axis Amplifier and the crt negative cathode potential set the crt grid bias voltage.

The positive accelerating potential is supplied by High-Voltage Multiplier U136. Regulated output voltage is approximately +15,500 V. The negative cathode potential of −2450 V is supplied by half-wave rectifier CR220.

CRT Control Circuits

Focus of the crt display is controlled by FOCUS control, R335. ASTIG adjustment R377, which is used in conjunction with the FOCUS control to provide a well-defined display, varies the positive level on the astigmatism grid. Geometry adjustment R267 varies the positive level on the horizontal deflection plate shields to control the overall geometry of the display.

Two adjustments control the trace alignment by varying the magnetic field around the crt. The Y-Axis adjustment, R270, controls current through L14175 to affect the crt beam after vertical deflection but before horizontal deflection. Therefore, it affects only the vertical (Y) components of the display. The TRACE ROTATION adjustment, R378, controls current flow through L14176 and affects both vertical and horizontal alignment of the trace.

Z-Axis Amplifier

The Z-Axis Amplifier circuit controls the crt intensity level via several input signal sources. The effect of these input signals is to either increase or decrease the trace intensity or to completely blank portions of the display. Input transistor Q523 is a current-driven, low-input-impedance amplifier. It provides proper termination for the input signals and isolates the input signals from the following stages. Current signals from the various control sources are connected to the emitter of Q523, and the algebraic sum of these signals determines the collector conduction level.

Transistors Q522, Q516, and Q416 are configured in a feedback amplifier arrangement, with R419 and R521 as feedback elements. The high-frequency compensation for the circuit is provided by C518. Emitter follower Q522 provides the drive to complementary amplifier Q516-Q416. Diodes CR622, CR517, and CR414 provide protection to the circuitry feeding the Z-Axis Amplifier in the event of high-voltage arcing.

The Z-axis portion of the Beam Find circuit acts on the input to the Z-Axis Amplifier. When the BEAM FIND push button is pressed, two events occur: First, +15 V is applied to the anode of CR437 which lifts the emitter of Q523 sufficiently positive to ensure cutoff of the transistor. Second, R621 connects to −8 V through R619 to establish a fixed and predetermined unblanking level at the output of the amplifier. Thus the INTENSITY control and all of the input unblanking signals have no control over the intensity level of the crt display whenever the BEAM FIND push button is pressed, and a bright trace will be displayed.

DC Restorer

The DC Restorer circuit provides crt control grid bias and couples both dc and low-frequency components of the Z-Axis Amplifier unblanking signal to the crt control grid. This circuit allows the Z-Axis Amplifier output to control the intensity of the crt display. The potential difference between the Z-Axis Amplifier output and the control grid (about 2465 V) prevents direct signal coupling.

The DC Restorer circuit's ac drive is taken from the center tap of T216. Voltage on the center tap is approximately 300 V p-p to 50 kHz. A sample of this sinusoidal voltage is fed through C210 and R313 to the junction of CR313, CR314, and R312. CRT Bias Adjust R409 sets the voltage level on the cathode of CR313 to approximately +100 V. When the ac sample voltage rises to +100 V, CR313 becomes forward biased and clamps the junction of CR313 and CR314 to approximately +100 V.

The Z-Axis Amplifier output voltage level is applied via R316 to the anode of CR314. This voltage level varies between +15 V and +95 V, depending on the setting of the INTENSITY control. The sample voltage will hold CR314 reverse biased until the voltage falls below the Z-Axis Amplifier output level. At that point CR314 becomes forward biased and clamps the junction of CR313 and CR314 to the Z-Axis Amplifier output level (Figure 3-13). Clamping the sample between +100 V and the positive voltage level set by the INTENSITY control produces an approximate square-wave signal with a positive dc offset level.

The DC Restorer circuit is referenced from the −2450 V, crt cathode voltage, through R327 and CR324 to the junction of C318 and CR323. Initially C318 will charge to a level determined by the difference between the Z-Axis Amplifier output level and the −2450-V reference voltage. The charging path is from the −2450-V line, through R327, CR324, C318, R312, CR314, and R316 to the Z-Axis output.

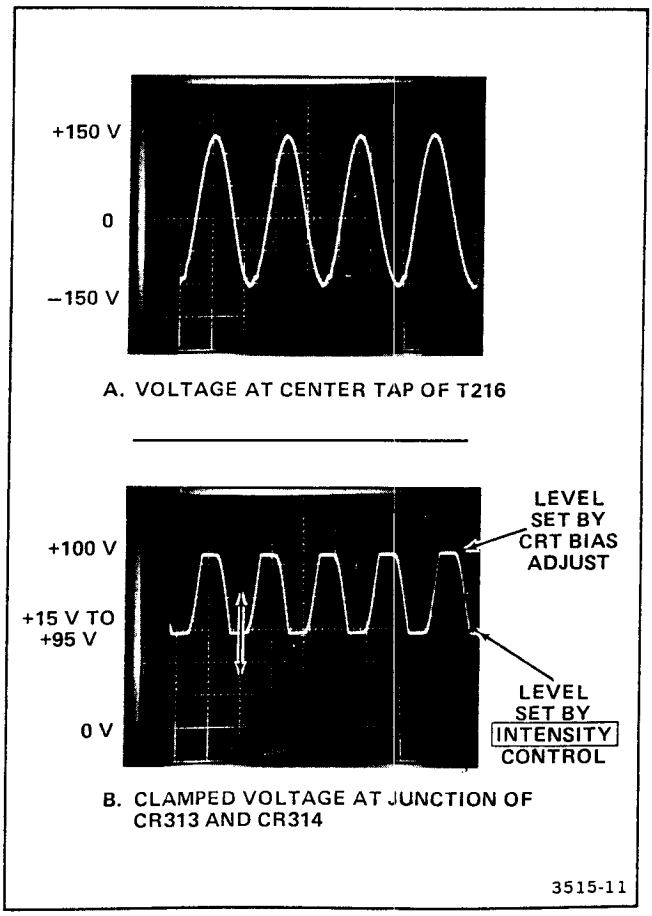

Figure 3-13. DC Restorer ac drive signal.

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Initially, C319 will also be charged to approximately the same voltage as C318, through R327, CR324, and CR323 to the Z-Axis output.

When the sinusoidal sample voltage starts its positive transition from the lower clamped level (+15 V to +95 V) toward the higher clamped level (+100 V), the charge on C318 increases due to the rising voltage at the anode of CR313. The additional charge acquired by C318 is proportional to the amplitude of the positive transition of the clamped sample voltage.

When the sample voltage starts its negative transition from its upper clamped level toward its lower clamped level, the negative transition is coupled through C318 to reverse bias CR324 and forward bias CR323. When CR323 becomes forward biased, the charge on C318 is transferred to C319 as C318 attempts to discharge to the Z-Axis output. The amount of charge that is transferred depends on the setting of the INTENSITY control because the INTENSITY control sets the lower clamping level of the sample voltage from T216 (Figure 3-14).

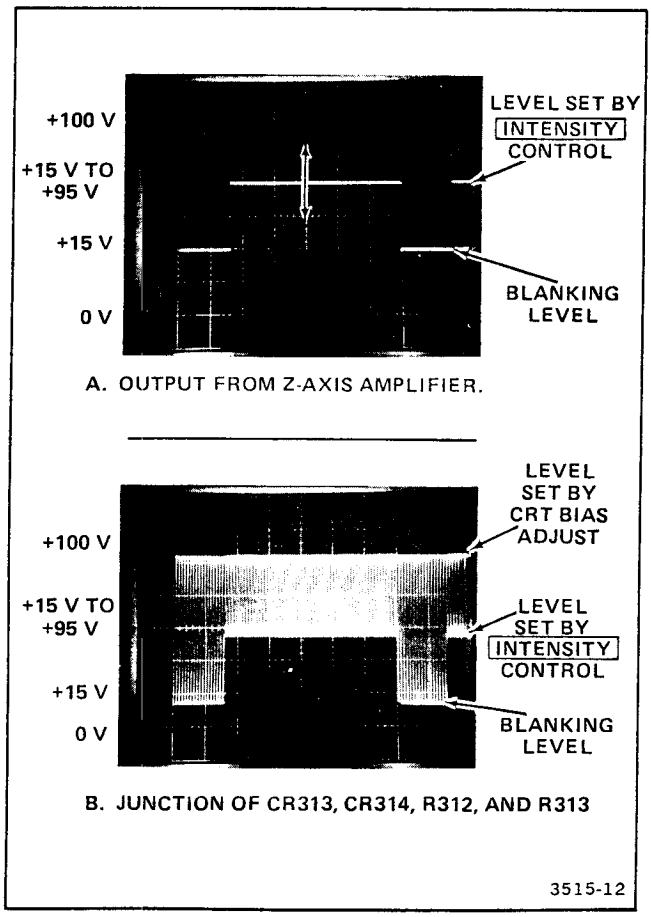

Figure 3-14. Effect of Z-Axis output on the DC Restorer signal.

If the INTENSITY control is set so the lower level of the sample voltage is clamped at +15 V, a voltage change of approximately 75 V is coupled through CR323. The 75-V negative excursion is added to the charge already present on C319. This causes the control grid to be sufficiently negative with respect to the crt cathode to keep the crt blanked. When the INTENSITY control is set to increase the display intensity, the lower clamping level of the sample voltage is moved toward the +100-V upper clamping level. This action reduces the swing of the negative transitions, therefore less charge will be added to C319. The voltage on the crt control grid becomes less negative with respect to the cathode and allows more beam current to flow in the crt. A more positive lower clamping level causes a brighter trace on the crt.

During periods that C318 is charging, the voltage on the control grid is held constant by the filter action of C319 as it discharges through R325 back to the −2450-V line. The resistance value of R325 is very high, so the RC time constant of C319 and R325 is long with respect to the frequency of the sample voltage from T216. Whatever charge is leaked off of C319 during the positive transitions of the sample voltage will be replaced by C318 when the sample voltage makes its negative transitions.

The fast rise and fall of the unblanking pulses from the Z-Axis Amplifier are coupled by C314 to the control grid to start the crt beam current change. The DC Restorer output level then follows the Z-Axis output level to set the new bias level on the control grid.

In the event of a failure that causes a loss of potential on either the control grid or the cathode, protection against internal arcing in the crt is provided by DS323 and DS324.

CALIBRATOR

The Calibrator circuit (Figure 3-15 and diagram 12) produces a square-wave output signal with accurate voltage and current amplitudes. The output signal is available as both a voltage and a current at the CALIBRATOR current loop on the instrument front panel.

Multivibrator

Transistors Q380 and Q396 and associated circuitry are configured as an astable multivibrator. The basic frequency of the multivibrator is approximately 1 kHz and is primarily determined by the resistance and capacitance of C486, R387, R391, R385, and R386. Transistors Q380 and Q396 alternately conduct, producing a square-wave output signal taken from the collector circuit of Q396.

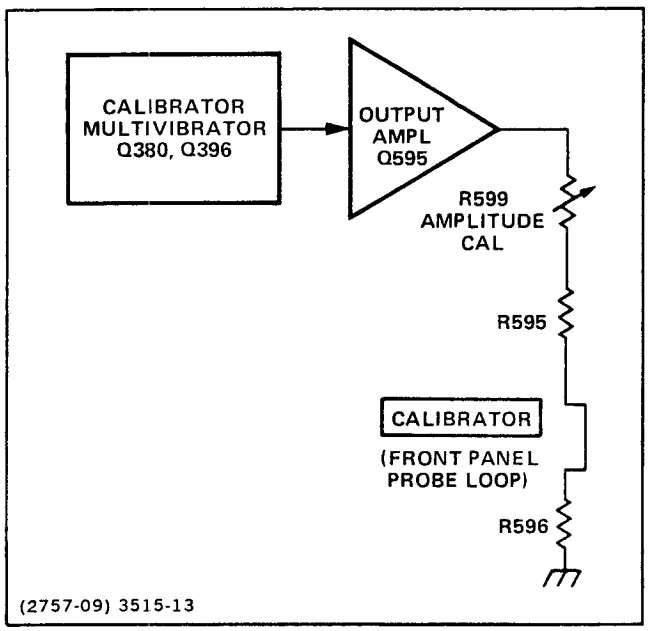

Figure 3-15. Detailed block diagram of the Calibrator circuit.

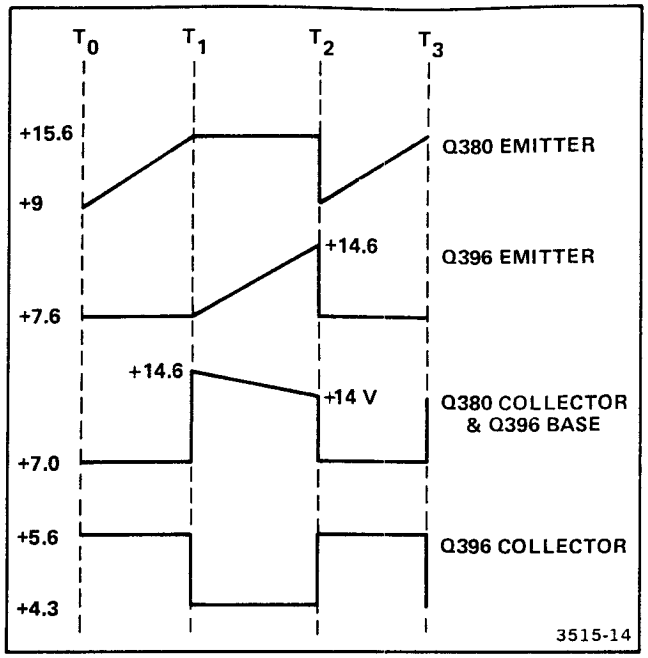

Figure 3-16. Calibrator circuit waveform diagram.

Refer to Figure 3-16 for the following discussion. At T_0 assume that the circuit has reached its normal operating conditions. Also assume Q380 is off and Q396 is on. At T_0 the emitter of Q380 is at approximately +9 V, and the emitter of Q396 is at +7.5 V, with its base at approximately +7.0 V. From T_0 to T_1, C486 charges toward the +55-V supply through R387. When the emitter of Q380 reaches +15.6 V, Q380 becomes forward biased. At T_1 the collector of Q380 rises to approximately +14.6 V, and since the base of Q396 is directly connected to the collector of Q380, Q396 is cut off.

Now C486 charges in the opposite direction. At T_1, as C486 starts charging through R391 and Q380, the emitter of Q396 rises from +7.6 V to approximately +14.6 V. When +14.6 V is reached at T_2, Q396 begins to conduct. This action reduces both the charging current through C486 and the collector current of Q380. At T_2 the collector voltage of Q380 drops in a negative direction, and Q396 conduction increases. The emitter of Q396 drops from +14.6 V to +7.6 V. This negative voltage transition is coupled through C486 to the emitter of Q380 to cut Q380 off, and the cycle just described is repeated.

Output Amplifier

The output signal from the Multivibrator drives Output Amplifier Q595 to produce a square wave at the output. When the base of Q595 goes positive, the transistor is cut off, and the collector voltage drops to zero. When the base goes negative, Q595 is biased into saturation, and the collector voltage rises in a positive direction to about +5 V. Amplitude calibration adjustment R599 is used to control the amount of resistance between the collector of Q595 and ground to control the amount of current allowed to flow. This in turn determines the voltage developed across R596. When the output voltage at the CALIBRATOR current loop on the instrument front panel is adjusted to 300 mV ±1 percent, the output current is 30 mA ±2 percent.

A/D CONVERTER AND CHANNEL SWITCH

The acquisition channel(s) used to obtain the waveform data is selected by Channel Switch U328 (diagram 13), and converted from a balanced signal to a single-ended signal before being digitized. Digitization occurs in A/D Converter U456 to produce a parallel, eight-bit digital output. A functional block diagram of the A/D Converter and Channel Switch circuitry is located in the "Diagrams" section of Volume II of this manual.

Channel Switch

A circuit composed of U328, Q336, Q333, Q327, and Q326 performs the channel switching, gain, and position functions for the vertical input signals. Channel Switch U328 is controlled by the ADD and $\overline{\text{CHAN1}}$ signals from the Time Base (diagram 19). See Table 3-3 for a listing of the switching logic and output functions.

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Table 3-3

Channel Switch Control Logic

ADD	$\overline{\text{CHAN1}}$	OUTPUT SIGNAL
0	0	CH 1
0	1	CH 2
1	0	ADD (CH 1 + CH 2)
1	1	Not Selected

The Channel Switch provides high impedance differential inputs (pins 2 and 15 for CH 1; pins 8 and 9 for CH 2) for the vertical input signals. Proper 50-ohm termination of the signal lines from the Vertical Preamplifiers (diagrams 1 and 2) is provided by R331 and R332 for Channel 1 and by R326 and R327 for Channel 2. A differential output signal current is obtained from U328 at pins 12 and 13.

Adjustable current sources, composed of Q336 and Q333 for CH 1 and of Q327 and Q326 for CH 2, set the dc quiescent current for the Channel Switch. The sum of the differential output currents at U328 pins 12 and 13 is equal to the sum of the CH 1 and CH 2 position differential input currents at pins 1, 8, 9, and 16; the dc bias current to the A/D Converter Driver Amplier remains constant regardless of the channel selection.

Vertical positioning of the CH 1 input signal is accomplished by varying the differential output current of Q333 and Q336. The front-panel Vertical POSITION control output voltage is applied to a unity-gain buffer on the Storage Display board (diagram 16) to generate a vertical positioning signal (POS1). When varied, the single-ended POS1 signal applied to the base of Q336 produces a changing differential output current applied to U328 at pins 1 and 16. The differential position current is added to the CH 1 vertical signal current to change the CH 1 + and CH 1 – output dc levels, thus positioning the CH 1 signal.

Vertical positioning of the CH 2 signal is accomplished in an identical manner by Q326 and Q327 in the CH 2 Position circuit using the POS2 signal.

Channel gain of the CH 1 input is adjustable with potentiometer R335 which is in series with fixed resistance R333. The CH 2 gain adjust potentiometer is R420.

Switching between the CH 1 and CH 2 input signals is controlled by the $\overline{\text{CHAN1}}$ signal from Time Base Chop Drive flip-flop U150B (diagram 19). When CHOP Vertical Mode is selected, U328 output is switched between CH 1 and CH 2 at one-half the SAVE clock rate determined by the Time Base circuitry. Otherwise, the Chop Drive flip-flop is controlled by the Microprocessor via the Acquisition Mode Register (diagram 19) to select the appropriate channel signal for acquisition.

Selecting ADD Vertical Mode for acquisition of waveform data produces the ADD control signal from Time Base Acquisition Mode Register U236 pin 12. When ADD is HI, the differential output of U328 is the algebraic sum of the CH 1 and CH 2 vertical input signals.

A/D Converter Driver Amplifier

An amplifier stage composed of Q221, Q224, Q225, Q324, Q210, and Q115 converts the differential output current from U328 into a single-ended voltage used to drive the A/D Converter. Input transistors Q221 and Q224 form a common-base differential amplifier that presents a low-impedance load for the output current of Channel Switch U328.

Output current from the collector of Q221 is applied to the base of Q225, a shunt-feedback inverting amplifier. The inverted output signal voltage from Q225 is developed across R219 in the collector circuit, with L219 providing high-frequency peaking. The output signal of Q224 is developed across R220 in series with the signal developed across R219. The two signals add at the collector of Q224 to produce a single-ended replica of the differential input signal.

Components R315 and C315, in parallel with R220, provide step-response thermal compensation for the amplifier. Constant bias current is supplied to the Driver Amplifier by a circuit comprised of Q324 and associated components.

The single-ended vertical signal from the collector of Q224 is applied to the base of emitter-follower Q210. The emitter follower supplies the current drive to A/D Converter U456. A constant-current load for Q210 is provided by Q115 and associated components. Diode CR315, between the collector of Q221 and the collector of Q224, limits the peak voltage applied to the base of Q210. Compensation of the vertical signal line to the A/D Converter analog input is provided by potentiometer R271.

The storage NORM trigger signal is obtained from the collector circuit of Q224 via emitter-follower Q236. Potentiometer R126 is used to adjust the Storage NORM trigger dc level.

A/D Converter

The A/D Converter is an eight-bit parallel-output device, capable of digitizing an analog input signal with a sampling rate ranging from 10 Hz to 25 MHz. The rising edge of the CONVERT signal from the Time Base Sample Rate Timing Generator enables the internal comparators to make a 225-level comparison of the input signal. A 255-to-8 encoder produces an eight-bit parallel output on the falling edge of the CONVERT signal, and on the next rising edge of the CONVERT signal the eight data bits are transferred into the internal output latch circuit of the A/D Converter.

Since the output of the internal encoding circuit does not start changing to new data immediately, a new sample may be obtained on the same CONVERT rising edge that transfers the previous conversion data into the output latch. An additional delay is encountered before the digital output responds to input changes. The overall result is that the digital output data is read two sample times later than the input analog signal is sampled.

The output digitized waveform is applied to an input latch in the Acquisition Memory (diagram 14) to be processed for storage.

Reference Voltage

A −2.0-V reference voltage required for operation of the internal A/D comparators is developed by a circuit composed of U274, U264, Q260, and associated components.

The +2.5-V reference output from U274 is applied to the inverting input of U264. The output voltage from U264 is held to −2 V by the negative feedback current through R266. Additional current-handling capability is provided by emitter-follower Q260 at the output of U264. Reference voltage is applied to U456 pin 22 at the bottom of a resistive voltage divider within the A/D Converter. The resistive divider provides 255 different reference levels for comparison with the input analog signal.

The top of the reference divider string is grounded at U456 pin 11, and bypass capacitor C266 shunts hf noise away from the reference input to ground.

ACQUISITION MEMORY

The Acquisition Memory (diagram 14) is a dual-function circuit. One of its functions is the storage of converted waveform data during the acquisition cycle. When not being used to store acquired waveform data, it may be used by the Microprocessor for additional system random-access memory. A functional block diagram of the Acquisition Memory circuitry is located in the "Diagrams" section of Volume II of this manual.

When acquiring a signal, the memory functions as a write-only, circular memory. Configured in a 256-by-16 bit array, it requires an 80-ns write cycle. The output of A/D Converter U456 (diagram 13) is parallel eight-bit data bytes, at a maximum rate of 40 ns per byte. To fulfill the maximum limit requirement of the memory write cycle, a double-buffer storage system converts the data to 16-bit byte pairs at a maximum rate of 80 ns.

During a waveform acquisition cycle, data storage in the memory is directed by a modulo-256 address counter. The counter allows only the last 512 converted waveform samples to be stored at any one time (record length is 512 bytes).

During nonacquisition periods, the Microprocessor can either write into or read from the Acquisition Memory. The waveform acquisition signal path is not enabled during Microprocessor read or write periods.

Acquisition Control

Waveform acquisition is controlled by the Time Base circuit (diagram 19) using the RSTACQ, STORON, and ENVL control lines and the SAVE and CONVERT clock signals. The Acquisition Control circuitry produces buffer control clocks and enabling signals. The buffer control clocks direct the storage of data into the odd and even halves of the memory, while the enabling signals start and end an acquisition cycle.

When STORON is HI at U332A pin 4, a LO RSTACQ (restart acquisition) pulse clears the Acquire flip-flop. A LO is placed on pin 5 ($\overline{\text{ACQUIRE}}$) and a HI on pin 6 (ACQUIRE). The ACQUIRE signal is applied to the Sample Rate Timing Generator in the Time Base (diagram 19) to enable the SAVE and CONVERT clocks. It is also applied to Time Base Status Register U240 to be read by the Microprocessor.

In a NORM Storage Mode acquisition (ENVL = 0), the CONVERT clock drives First Buffer U248 through pin 11, but it has no effect on the Envelope Control circuitry at U326 pin 11 or U340B pin 5. The SAVE clock is applied to U440A pin 3, where it is divided-by-two to produce $\overline{\text{SAVE0}}$ at the Q output (pin 5) and SAVE0 at the $\overline{\text{Q}}$ output (pin 6). SAVE0 is used to develop the Write Enable signals to the Acquisition Memory and clock the buffers to transfer data into the Acquisition Memory. The SAVE0 signal is also applied to Chop Drive flip-flop U150B in the Time Base to supply the drive to the Input Channel Switch.

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Therefore, each time a chopped sample of the waveform is acquired, it will be stored in the same half of the memory as other samples of that waveform.

At the end of an acquisition, the Record Counter in the Time Base generates and transfers the DONE signal to U340D pin 12. Going HI, the DONE signal clocks U332B to record the level of SAVE0 (HI or LO). The A0M signal produced at U332B pin 9 is applied to Time Base Status Register U240. Here it is read by the Microprocessor to determine whether a trigger occurred in an odd or even memory address. The A0M signal is used by the Microprocessor to determine the most significant bit of the jitter-correction signal that is applied to the horizontal ramp in the Display X- and Y-Axis circuitry (diagram 16).

On the next rising edge of SAVE0 (from U440A pin 6), Acquire flip-flop U332A will clock a HI to pin 5 and a LO to pin 6, causing the acquisition cycle to stop. When the Microprocessor reads the Time Base Status Register and finds ACQUIRE HI, the stored waveform data can be read from the Acquisition Memory.

BUFFER CLOCK SELECTION. Clocks to buffers U448 and U548 are selected by dual four-line-to-one-line data selector U540. In a normal acquisition cycle, ENVL is LO at AND gate U340B pin 5, and both sections of the dual data selector will be enabled (U540 pins 1 and 15). This LO is also applied to the BSEL input of U540 (pin 2). The logic level present at the ASEL input (pin 14) is obtained from a circuit composed of U326A and U326B.

Flip-flops U326A and U326B are arranged into a circuit that initializes and controls buffers U448 and U548 during the ENVELOPE Storage Mode. When ENVELOPE is not selected, U326A pin 4 is held LO to preset the flip-flop output HI at pin 5. On the rising edge of the CONVERT clock (U326B pin 11), the HI from U326A pin 5 is clocked through to place a HI on U326B pin 9 and a LO on U326B pin 8. The LO from pin 8 is then applied to U326A pin 1. At this point, both pin 4 and pin 1 of U326A are LO, and the output at pin 5 is held HI. Each CONVERT clock to U326B pin 11 will continue to hold a HI on U326B pin 9. Therefore, during a NORM Storage Mode acquisition, U540 pin 14 (ASEL) will be held HI. See Figure 3-17 for a simplified switching illustration of U540. When BSEL is LO and ASEL is HI, the inputs at $1C_1$ and $2C_1$ are transferred to the outputs of U540 ($1C_1$ to 1Y and $2C_1$ to 2Y). In a NORM Storage Mode acquisition, U448 is clocked by the rising edge of $\overline{\text{AWE0}}$ (derived from SAVE0), and U548 is clocked by the rising edge of $\overline{\text{SAVE0}}$ (Figure 3-18).

Data Acquisition (NORM Storage Mode)

Eight-bit waveform data from the A/D Converter is clocked into First Buffer U248 on the rising edge of a CONVERT clock. From U248 the data is alternately

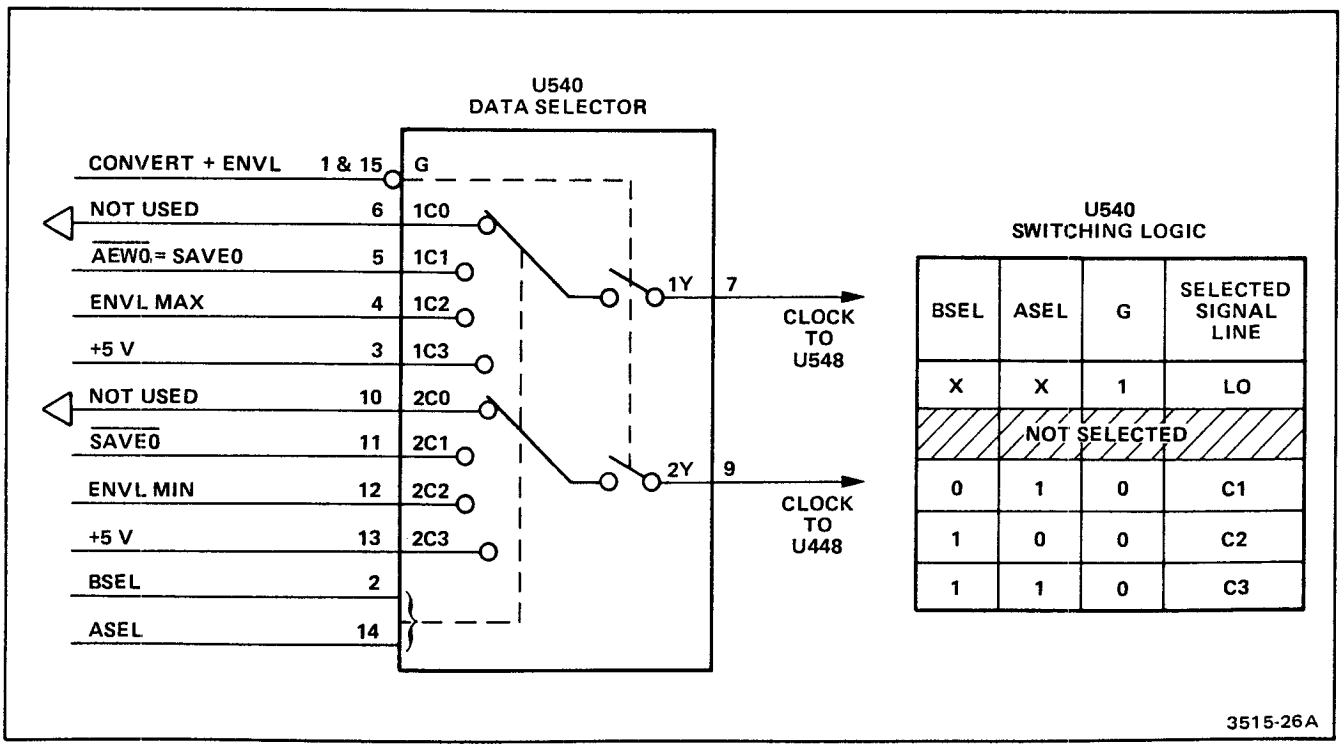

Figure 3-17. Simplified illustration of Data Selector U540 switching operation.

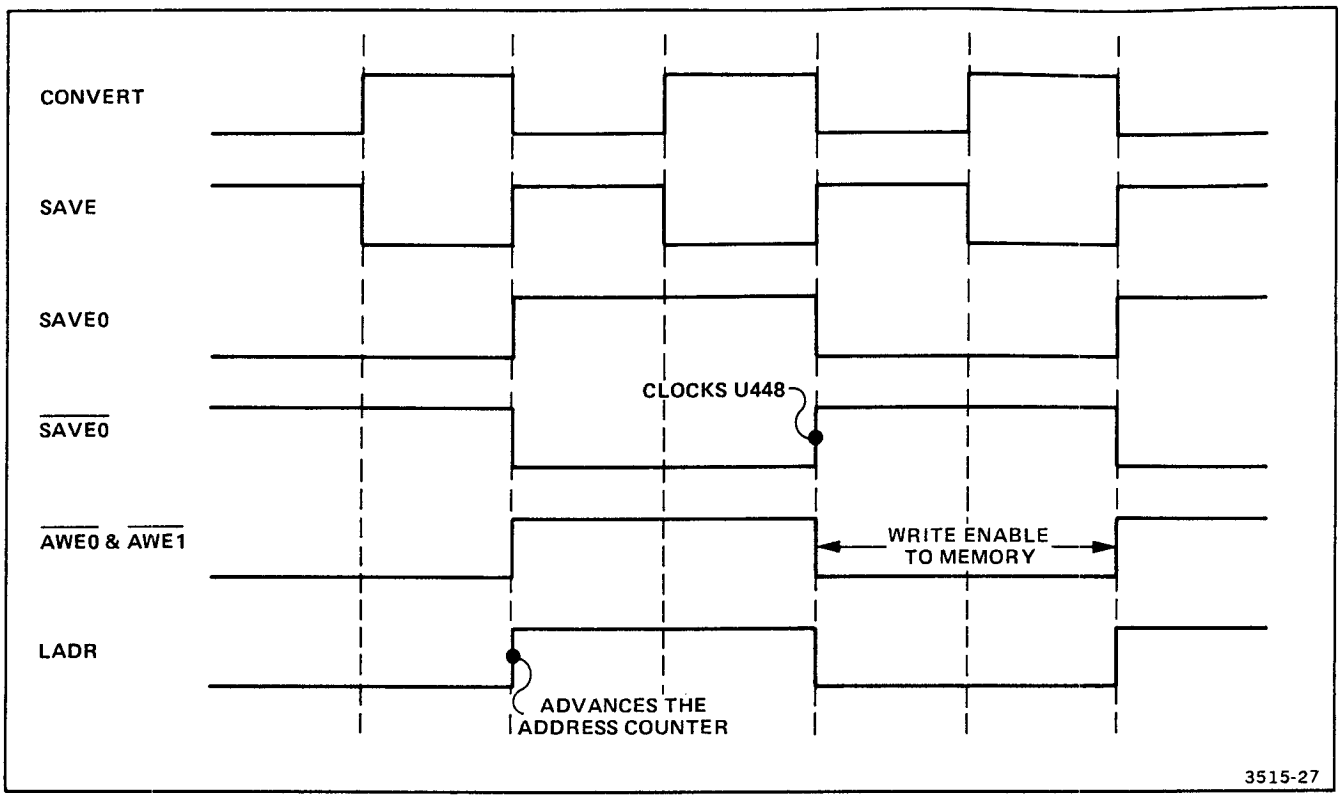

Figure 3-18. NORM Storage Mode Acquisition timing diagram.

transferred to Even Buffer U548 and Odd Buffer U448 by AWE0 and SAVE0. Data from U548 and U448 is transferred into Acquisition Data Buffers U520 and U320 by the rising edge of the Acquisition Memory write-enabling signals AWE0 and AWE1 (both are SAVE0 during acquistion). However, due to a propagation delay of the AWE0 clock through U540, the data from buffer U548 is clocked into buffer U520 before the new data byte is clocked into U548. As the data byte is being clocked into U520 from U548, the data byte in U448 is concurrently clocked into Memory Input Buffer U320 by the rising edge of AWE1.

When AWE0 and AWE1 go LO to enable the memory write inputs, the two eight-bit data bytes present in Acquisition Data Input Buffers U520 and U320 are written into the memory as a full 16-bit data byte.

Address Counters U210 and U206 are incremented by the LADR signal from U216 (Figure 3-19). In normal acquisition, the counters are incremented on the rising edge of SAVE0. Each time the memory is written into, the address is retained in Memory Address Register U112. At the end of an acquisition cycle, the Microprocessor reads register U112 (using the RDMAR strobe) to determine the address of the last data byte stored. The next address in the Acquisition Memory is the location of the first data point of the acquired waveform.

Envelope Acquisition

In the ENVELOPE Storage Mode, data bytes are written into the memory in a manner similar to that for NORM Storage Mode acquisition. The difference is that the CONVERT clock is much faster than the SAVE clock for ENVELOPE acquisition, and only selected data bytes are stored at each data point. The method used to select the data byte for storage at each memory location involves the use of Amplitude Comparators U432, U436, U532, and U526 for determining the maximum and minimum values of the waveform occurring at each data point.

At the beginning of each sample interval, buffers U448 and U548 are initialized by a pulse developed by AND gate U340B and flip-flops U326A and U326B. When ENVL (Figure 3-20) is HI (ENVELOPE Storage Mode selected), U326A pin 4 is HI and does not affect the state of U326A. When SAVE0 occurs, its rising edge clocks the fixed HI on U326A pin 2 onto pin 5 (the U326A Q output). The next rising edge of the CONVERT clock at U326B pin 11 clocks the HI at pin 12 onto the Q output (pin 9) to the U540 ASEL input pin 14. The $\overline{Q}$ output of U326B (pin 8) goes LO, placing a LO on U326A pin 1 and resetting the U326A Q output (pin 5) LO.

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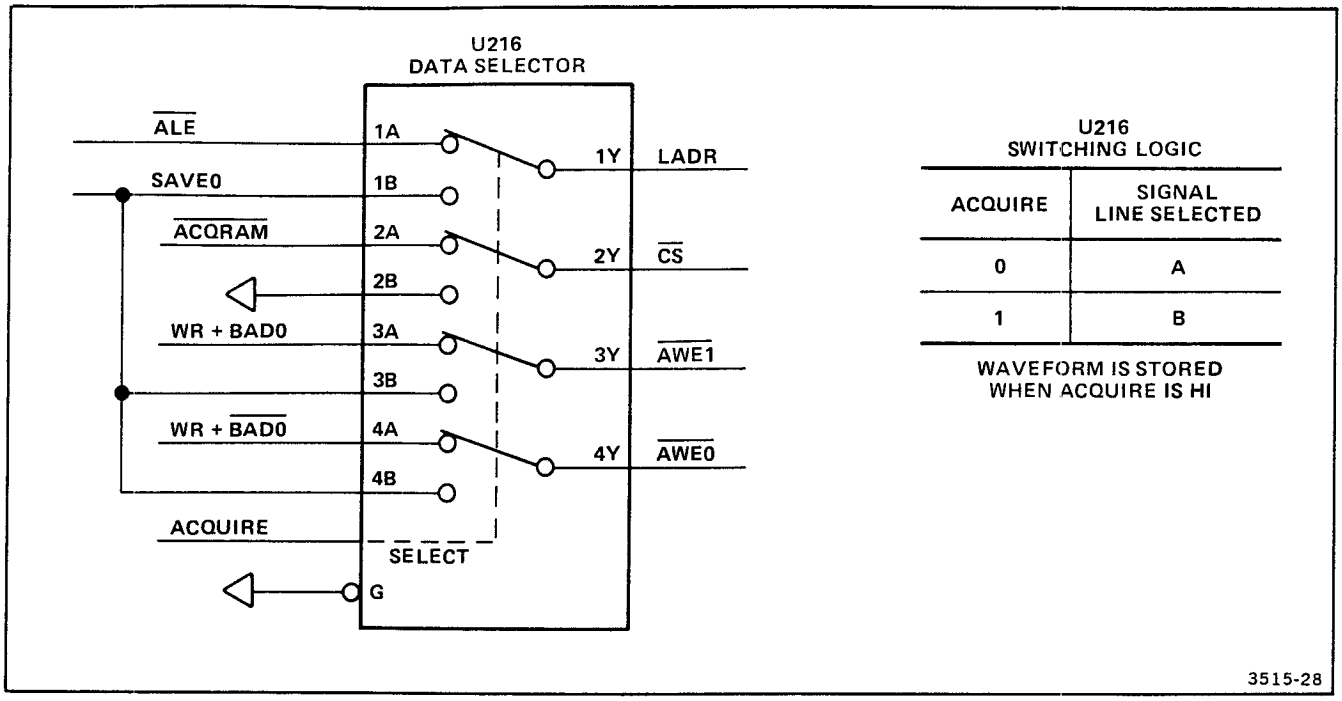

Figure 3-19. Simplified illustration of Data Selector U216 switching operation.

With both ASEL and BSEL of U540 HI, the $1C_3$ and $2C_3$ inputs of U540 are switched to the output pins; but while CONVERT and ENVL are HI, both halves of U540 are disabled, and its outputs are LO (Figure 3-20). On the falling edge of the CONVERT clock, the output of AND gate U340B goes LO to enable U540 for the duration of the CONVERT clock pulse. The HI pulses from the outputs of U540 are applied to both U448 and U548 to clock in the first data point value, thus initializing the ENVELOPE acquisition cycle.

The next CONVERT clock rising edge clocks the LO previously placed on U326A pin 5 onto the U326B Q output (pin 9) and U540 ASEL input goes LO. The $\overline{Q}$ output of U326B goes HI, and U326A is no longer affected.

Now U540 BSEL is HI and ASEL is LO. During the CONVERT clock LOs, the C_2 inputs are selected for transfer to the output. The envelope MAX signal is applied to the $1C_2$ input, and the envelope MIN signal is applied to $2C_2$ (from the Amplitude Comparators). When new maximum or minimum data point values occur, they are transferred either into U448 by the envelope MIN signal or into U548 by the envelope MAX signal. During the CONVERT clock HIs, both of the U540 outputs will be LO.

Envelope Comparators

A circuit composed of four, four-bit comparators performs the task of finding the minimum and maximum signal magnitudes for each data point during an envelope acquisition cycle. Waveform data transferred into buffers U548 and U448 during each $\overline{SAVE0}$ initializing pulse is compared with new data clocked into First Buffer U248 on each CONVERT clock rising edge. The four-bit magnitude comparators are cascaded to compare the full eight bits of each data byte.

For minimum data comparison, the four least significant bits of the waveform data in buffer U448 are applied to comparator U432 at the A inputs; the four most significant bits are applied to the A inputs of U426. New data being transferred into U248 with each CONVERT clock is applied to the B inputs of U432 and U426 in the same order as the data on the A inputs. If a comparator pair receives an amplitude value less than the previous value, U426 A>B output at pin 5 goes HI. This HI is applied to U448 (via U540) to clock the new data minimum value into U448. The comparison continues in this manner until a rising edge of SAVE0 occurs, and the data present in U448 at that time is transferred into the Acquisition Data Input Buffer U320 (Figure 3-20).

In the same way, waveform data maximum value comparison is performed by U532 and U526 producing a MAX clock when a larger maximum value is found. A MAX signal applied to buffer U548 (via U540) clocks in the new

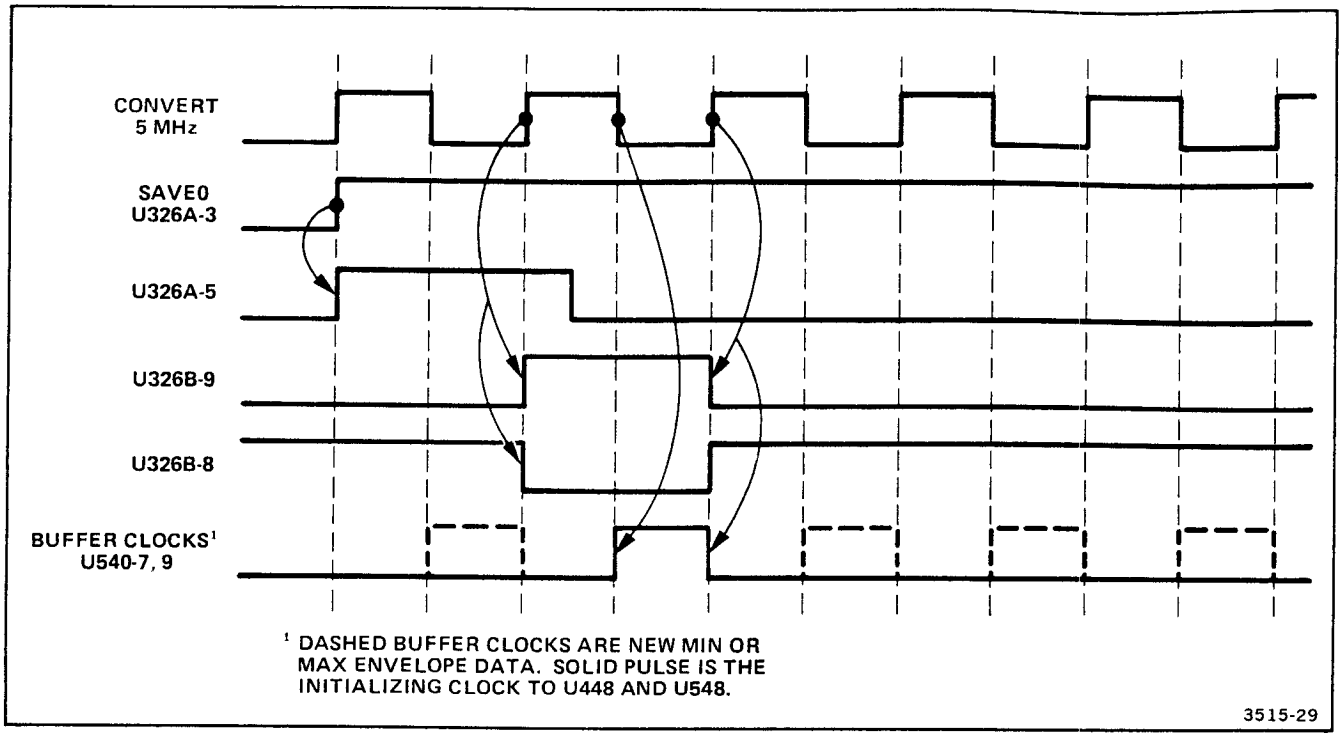

Figure 3-20. ENVELOPE Storage Mode Acquisition timing diagram.

maximum data. When the SAVE0 rising edge occurs, data present in U538 and U448 is simultaneously transferred into both Acquisition Data Input Buffers U320 and U520 (Figure 3-20).

Memory Control

Data selector U216, in the Memory Control circuit, selects the control signal presented to the Acquisition Memory and Address Counters. During a waveform acquisition, ACQUIRE on U216 pin 1 is HI, and the memory write enables ($\overline{\text{AWE0}}$ and $\overline{\text{AWE1}}$) and the address counter incrementing signal (LADR) are all derived from the SAVE0 clock (see Figure 3-19). The memory chip selects are held enabled by the LO on U216 pin 6 (the B_2 input).

Acquired waveform data is read from the Acquisition Memory while ACQUIRE is LO. The Microprocessor reads from any location in the memory by addressing that location through the buffered address lines (BAD0 through BAD7) from Memory Address or Data Buffer U240. The address is loaded into Address Counters U206 and U210 by LADR from U216. The RD (read) and $\overline{\text{ACQRAM}}$ (acquisition memory select) signals are then produced from the Microprocessor. The RD signal is applied to NAND gate U220B pin 5 and $\overline{\text{ACQRAM}}$ (inverted by U220A) is applied to U220B pin 4 to produce an enabling LO to Memory Output Buffer U108.

The BAD0 bit is latched into flip-flop U120B to select which half (odd or even) of the memory is to be read. When BAD0 is LO, the even half of memory (U512 and U508) is enabled for reading. When BAD0 is HI, the $\overline{\text{Q}}$ output of U120B (pin 8) will be LO, enabling U312 and U306 (the odd half of memory) to be read.

The Microprocessor writes into the Acquisition Memory by performing a memory-write cycle to the address in the Acquisition Memory. Addressing is done in the same manner as a memory read, but the WR signal is used (along with the BAD0 bit) to enable the data into the selected memory half. During a write cycle, RD is LO so the Memory Output Buffer is not enabled.

Data to be written into the Acquisition Memory passes from the BAD0 through BAD7 lines via Microprocessor Data Input Buffers U226 and U232. It is written into the selected memory address by either the $\overline{\text{AWE0}}$ or $\overline{\text{AWE1}}$ memory write enabling signal.

Digital Holdoff

When an input trigger occurs, the Acquisition Memory acquires the remaining data point samples necessary to fill a 512-byte record length. The memory is continually

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acquiring waveform samples before a trigger occurs. To ensure that enough samples are obtained prior to a trigger for the PRETRIGGER data to be acquired, a holdoff signal is produced which prevents a trigger from being generated until Address Counters U210 and U206 overflow.

At the beginning of an acquisition cycle, the Address Counters are loaded with either a PRETRIGGER or a POST-TRIGGER Display Window count. For a single-trace, PRETRIGGER acquisition, the counters will be loaded with 448_{10}; for POST-TRIGGER, the counters will be loaded with 64_{10}. When the Address Counters reach a count of 512, the ripple carry output of U206 pin 15 goes HI and Digital Holdoff flip-flop U120A is clocked to place a LO on U120A pin 5. The LO is ANDed with the STORON HI, and the holdoff signal (BHOF) to the Oscilloscope Sweep and Z-Axis Logic circuitry (diagram 7) goes LO, releasing the holdoff.

The first incoming trigger is now accepted to generate the A and B gate triggers to the digital storage Time Base (diagram 19). When a trigger occurs, pin 4 of U120A (TRIG) goes LO and sets U120A pin 5 to a HI. This asserts the BHOF signal and prevents triggering until the next acquisition cycle.

When the trigger is accepted, the Record Counter in the Time Base begins counting the SAVE clocks. When enough SAVE clocks have been counted to complete the POST TRIGGER portion of the waveform, the DONE signal is generated and is applied to Acquire flip-flop U332A in the Acquisition Control circuitry to end the acquisition cycle.

In the NON STORE mode, the BHOF signal is prevented from being applied to the digital holdoff circuitry in the Sweep and Z-Axis Logic circuit while STORON is LO at U340A pin 1 to disable the AND gate.

MICROPROCESSOR

The Microprocessor (diagram 18) contains the necessary circuitry to control the operation of the oscilloscope. A functional block diagram of the Microprocessor circuitry is located in the "Diagrams" section of Volume II of this manual. In addition to the 8-bit Microprocessor IC, this circuit contains: 16 k bytes of read-only memory, 2 k bytes of random-access memory (1 k for system RAM and 1 k for scratch RAM), address decoding circuitry to select appropriate components for performing an operation, and necessary timing and gating circuits that enable the Microprocessor to control the circuit functions.

Power-On Sequence

A power-on restart circuit comprised of CR172, C174, R172, and R173 provides the proper timing for resetting the digital circuitry (initialize) each time power is applied to the instrument. When power is applied, the charge on C174 is zero, and the $\overline{\text{RESET IN}}$ signal on pin 36 of Microprocessor (U364) is initially held LO. While $\overline{\text{RESET IN}}$ is LO, U364 pin 3 (RESET OUT) is held HI, causing the initializing signal ($\overline{\text{INIT}}$) from inverter U272G to be LO.

The $\overline{\text{INIT}}$ signal remains LO until the voltage on capacitor C174 (charging through R173) reaches the HI input threshold of an internal Schmitt trigger circuit at the $\overline{\text{RESET IN}}$ input of U364. At that time, RESET OUT goes LO and $\overline{\text{INIT}}$ goes HI, ending the reset period. The time constant of C174 and R173 is such that the reset period is greater than 10 ms.

When power is removed from the instrument, the charge on C174 forward biases diode CR172, and C174 discharges quickly to allow rapid on-off power cycling. This is necessary to ensure initialization each time the power is applied to the instrument.

Jumper plug P182 provides a means for service personnel to manually reset the digital circuitry without cycling the power off-and-on. When the jumper is used to connect R172 to ground, $\overline{\text{RESET IN}}$ is forced LO to reset the digital circuitry. Removing the jumper then starts the charging cycle of C174 to end the reset period. A measure of protection from static discharge damage to Microprocessor U364 is provided by R172.

Processor Operation

The Microprocessor is clocked from an external 5-MHz clock signal ($\overline{\text{MPUCLK}}$). This signal is buffered by U272D, and a pull-up resistor R263 is used to bring the HI clock level up to the required voltage at the X_1 clock input (pin 1). The processor clock is divided-by-two internally and can be tested at U364 pin 37 (CLK OUT).

ADDRESS AND DATA DEMULTIPLEXING. Signals generated by the Microprocessor are used to address peripheral devices which perform the different operations required to control the 468. These signals also determine whether the information on the bus is either an address or data. Through selection of proper address and control signals, information is transferred either into or out of the Microprocessor. Low-order addresses (A0 through A7) are multiplexed with data on the bus lines. To obtain address information, it is therefore necessary to demultiplex the AD0 through AD7 bus lines.

Timing of the demultiplexing and data transfer is based on clock periods (Figure 3-21). On the MPU Board, demultiplexing is performed by Address Latch U550. When an address appears on the AD0 through AD7 lines during clock period T_1, the address latch enable signal (ALE) at U364 pin 30 goes HI, enabling the Address Latch U550. Also, the ALE signal is inverted by U272C and resets flip-flop U255A. The Q output of U255A goes LO to enable Address or Data Buffer U452. Approximately 200 ns later ALE returns LO, and the address on AD0-AD7 is latched into U550. Address information latched into U550 is available only on the Microprocessor circuit board. Other address latch-circuits throughout the instrument must latch addresses from the bus (via U452) on the rising edge of $\overline{ALE}$ from P130 pin 30.

ADDRESS DECODING AND STROBE GENERATION. Selection of a particular device address is performed in the Address Decode and Strobe Generator circuitry (Figure 3-22). The high-order addresses from the Microprocessor are decoded to determine the desired peripheral(s) to be activated, and an enabling strobe is generated to turn on the selected device. High-order addresses (A8 through A15) appearing on Microprocessor pins 21 through 28 are not multiplexed, and they are presented to the decoder input during clock periods T_1 through T_3 (Figure 3-21).

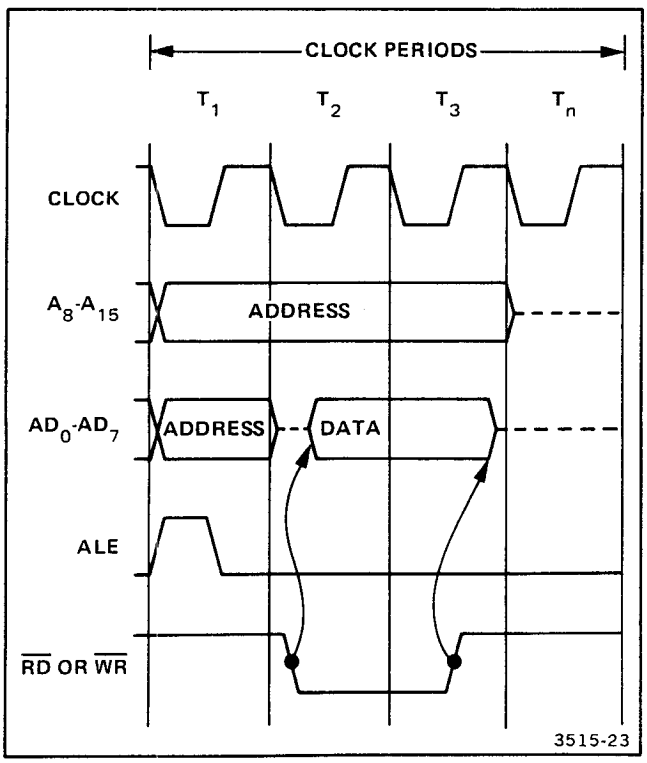

Figure 3-21. Address decoding timing diagram.

Decoder timing is controlled by the read or write signal $\overline{RD + WR}$ from U278B pin 4. The three highest address lines (A13 through A15) are applied to 1-in-8 decoder U478 where they are decoded to access eight address blocks, each containing 8k addresses. Six of the decoded blocks are assigned to certain areas of circuit operation, and two address blocks are unassigned. See Table 3-4 for a listing of address block assignments.

Table 3-4

Address Block Assignments

BLOCK ASSIGNMENT, SIZE, AND BOUNDARIES	
$\overline{ROML}$ (8 k) 000-13FF: SERVICE ROM (5 k) 000-13FF	ACQ RAM COPY (0.5 k) C200-C3FF
	ACQ RAM COPY (0.5 k) C400-C5FF
$\overline{ROMH}$ (8 k) 2000-3FFF	ACQ RAM COPY (0.5 k) C600-C7FF
ROM DEVELOPMENT (16 k) 4000-7FFF	ACQ RAM COPY (0.5 k) C800-C9FF
SYSTEM RAM (1 k) 8000-83FF	ACQ RAM COPY (0.5 k) CA00-CBFF
SYSTEM RAM COPY (1 k) 8400-87FF	ACQ RAM COPY (0.5 k) CC00-CDFF
SCRATCH RAM (1 k) 8800-8BFF	ACQ RAM COPY (0.5 k) CE00-CFFF
SCRATCH RAM COPY (1 k) 8C00-8FFF	ACQ RAM COPY (0.5 k) D000-D1FF
UNASSIGNED (4 k) 9000-9FFF	ACQ RAM COPY (0.5 k) D200-D3FF
DISPLAY RAM (2 k) A000-A7FF	ACQ RAM COPY (0.5 k) D400-D5FF
DISPLAY RAM COPY (2 k) A800-AFFF	ACQ RAM COPY (0.5 k) D600-D7FF
DOT RAM (1 k) B000-B3FF	ACQ RAM COPY (0.5 k) D800-D9FF
DOT RAM COPY (1 k) B400-B7FF	ACQ RAM COPY (0.5 k) DA00-DBFF
DOT RAM COPY (1 k) B800-BBFF	ACQ RAM COPY (0.5 k) DC00-DDFF
DOT RAM COPY (1 k) BC00-BFFF	ACQ RAM COPY (0.5 k) DE00-DFFF
ACQ RAM (0.5 k) C000-C1FF	I/O (8 k) E000-FFFF

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Blocks Y_0 and Y_1 are assigned to ROM U565 and U575 respectively. Therefore, these decoded address blocks are used directly as select strobes, $\overline{\text{ROML}}$ and $\overline{\text{ROMH}}$ (U478 pins 14 and 15 respectively), to choose either the high-order or low-order ROM. A section of the ROML addresses is assigned to the service ROM that is used when running service routines.

Blocks Y_2 and Y_3 are not assigned.

Address block Y_4 (U478 pin 11) is assigned to the Microprocessor RAM and produces the $\overline{\text{RAM}}$ strobe. This block of addresses is further decoded by U378 into two address blocks containing 2k addresses each. The $2Y_1$ block (U378 pin 12) is assigned to select the system RAM with the $\overline{\text{SYSRAM}}$ strobe, and the $2Y_0$ block (U378 pin 11) is assigned to select the scratch RAM, using the $\overline{\text{SCRRAM}}$ strobe. The RAM-select strobes go directly to the chip select inputs of the RAM ($\overline{\text{SYSRAM}}$ to U540 and U545 pin 8 and $\overline{\text{SCRRAM}}$ to U525 and U530 pin 8).

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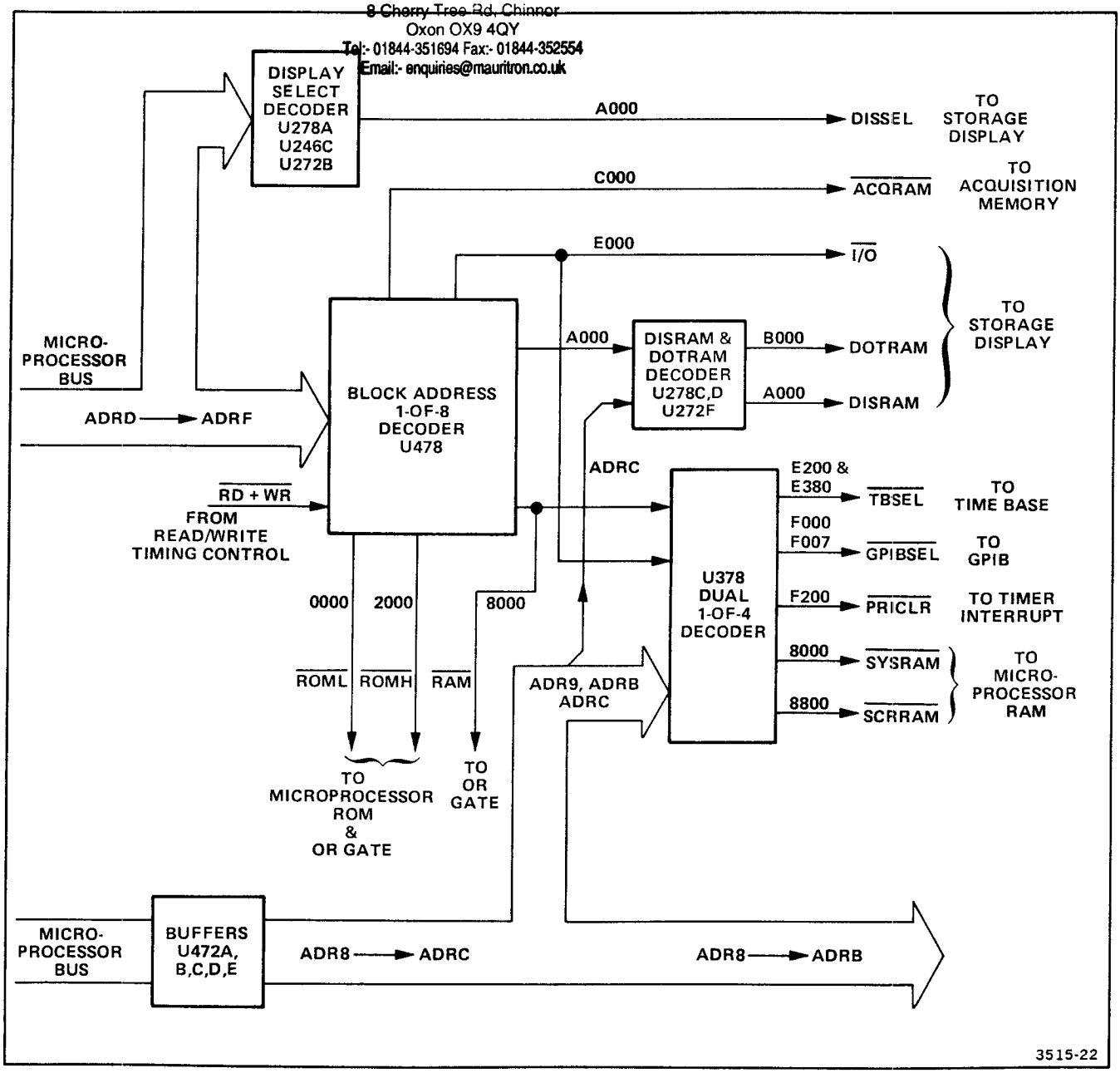

Figure 3-22. Detailed block diagram of the Address Decoding and Strobe Generation circuits.

Address block Y_5 is assigned to select either the Display RAM or the Dot RAM (both located on the Storage Display Board). The decoded block Y_5 addresses from U478 pin 10 are applied to a 1-of-2 decoder circuit composed of U278C, U278D, and U272F. Address line ADRC is also applied to this decoder circuit to control which strobe is produced at the output (DISRAM or DOTRAM). When ADRC is LO at U278 pin 9, block Y_5 will be gated through U278C to become the DISRAM strobe. When ADRC is HI, block Y_5 will be gated through U278D to become the DOTRAM strobe. The DOTRAM strobe selects a 1024 by 1-bit RAM which is used to produce the TIME cursor dots. A DISRAM strobe selects the 1024 by 8-bit Display Memory RAM. Timing of the block Y_5 DISRAM and DOTRAM strobes is controlled by processor $\overline{RD}$ or $\overline{WR}$ signals which occur during clock periods T_2 and T_3 (see Figure 3-21). A select signal is required in clock period T_1 for use on the Storage Display Board, therefore additional block Y_5 decoding is performed by a circuit consisting of U278A, U272B, and U246C. The A13 through A15 Microprocessor lines are applied to this decoding circuitry to produce a DISSEL strobe beginning in clock period T_1. The DISSEL strobe is produced when A13 and A15 are HI and A14 is LO.

Address block Y_6 (U478 pin 9) produces a strobe ($\overline{ACQRAM}$) that selects the acquisition RAM on the Memory Board (diagram 14). Additional discussion of the selection method is included in the "Acquisition Memory" circuit discussion.

An $\overline{ACQRAM}$ strobe is decoded from only the upper three addresses (A13 through A15). The next four lower addresses of the acquisition RAM are unselected ("don't care" to the Microprocessor). The remaining nine acquisition RAM addresses are produced by the Microprocessor and placed on the bus to select each storage address in a 512 byte segment of the acquisition RAM.

I/O REGISTER SELECTION. Address block Y_7 produces strobe I/O at U478 pin 7. This strobe is used when selecting the various registers that must be read from or written into by the Microprocessor. Additional decoding is performed on the Storage Display Board (diagram 17) to select both the register banks (Display 1, Display 2, or Front Panel) and the exact register in a bank. Three other register banks are selected by decoding circuits on the Microprocessor board. See Table 3-5 for the address bit assignments of the block Y_7 addresses.

When the Microprocessor restarts the acquisition of the input waveform, some of the restart signal address bits are used to determine the amount of pretrigger holdoff. This selection is performed by U378 decoding address bits ADRC (on pin 3) and ADR9 (on pin 2) in conjunction with the I/O strobe. When the combination of these two bits equals 01, in either of two address (E200 or E380), the $\overline{TBSEL}$ strobe is produced. This action provides a restart signal ($\overline{RSTACQ}$) for both the pretrigger and post-trigger operation of the Time Base.

Two remaining strobes are selected by different combinations of the ADRC and ADR9 bits. Access to the GPIB register bank is obtained when the combination equals 10. This produces the strobe, $\overline{GPIBSEL}$. When the combination of these bits equals 11, the CURSOR position rate potentiometer digitizing circuit strobe ($\overline{PRICLR}$) is produced at address F200.

When the block Y_7 addresses are not being decoded, $\overline{I/O}$ is HI. This HI is applied to U378 pin 1, and the U378 outputs at pins 5, 6, and 7 are all forced HI. This prevents a decoding of the ADRC and ADR9 address bits, except when the $\overline{I/O}$ strobe is activated.

DATA TRANSFER. At the beginning of clock period T_2 (Figure 3-21), the information on the AD0 through AD7 multiplexed lines becomes undefined, causing either the $\overline{RD}$ or the $\overline{WR}$ signal from U364 to become LO. At this time, the $\overline{RD + WR}$ signal, generated by U278B at pin 4, also goes LO at U478 pin 5 to activate the selected address that was set up in U478 during clock period T_1.

If a memory-read operation is required (RAM read, instruction fetch, or status register read), the selected device will place data on the bus. Address or Data Buffer U452 is gated by the RD signal going LO at its GAB input pin 1 (via buffer U472H) to transfer the data from the bus to the Microprocessor (B-to-A). Approximately 600 ns later, during the middle of clock period T_3, RD goes HI, and U364 latches the data from its AD0 through AD7 lines. The positive transition of RD clocks Address or Data Buffer control flip-flop U255A pin 3, forcing its Q output HI at pin 5. This HI, applied to U452 pin 19, disables the Address or Data Buffer to isolate the AD0 through AD7 lines from the U364. This prevents both the Microprocessor and any devices still driving the bus from conflicting with each other.

Further clock periods (T states) are needed by the Microprocessor to handle certain instructions obtained by a fetch cycle. During these added T states, the information present on lines A8 through A15 also becomes invalid, and the decoder U478 will have all of its outputs forced HI by the $\overline{RD + WR}$ signal going HI at U478 pin 5. Thus, invalid addresses are not decoded.

For memory-write cycles (RAM write and control register write) $\overline{RD}$ remains HI after the address is selected in clock period T_1. The GAB input of U452 pin 1 is HI, and during clock period T_2, data is gated from U364 onto the AD0 through AD7 bus lines via U452. When the $\overline{WR}$ signal goes HI in clock period T_3, it signals the selected device that data is valid. This data will remain valid for approximately 90 ns, during which time it must be either latched or written into the selected device.

The ROM and RAM are connected to the AD0 through AD7 bus lines via bidirectional Memory Buffer U558. The $\overline{RAM}$, $\overline{ROML}$, and $\overline{ROMH}$ strobes are combined in OR gate U264B to enable U558 whenever RAM or ROM is selected. Control of the direction of data transfer through U558 is accomplished by the RD signal at pin 1. During a read cycle, RD is HI and data is gated from A-to-B. In a write cycle, RD is LO and data is gated from B-to-A.

MICROPROCESSOR INTERRUPT OPERATION. There are five handware interrupt inputs to U364. The Microprocessor will first respond to the highest priortiy interrupt before handling other, lower-priority interrupts. Interrupt functions and their priorities are shown in Table 3-6. The interrupts are divided into three types:

1. The INTR interrupt can be enabled or disabled by program instructions (maskable). It causes the Microprocessor to fetch a special instruction placed on the bus. Execution of this instruction calls a subroutine used to handle the interrupt from the ROM.

2. Interrupts RST 7.5, RST 6.5, and RST 5.5 are also maskable depending on the current conditions of U364 as well as the program instructions. The vector addresses for these interrupts are obtained internally from the Microprocessor (Table 3-6).

3. The TRAP interrupt is not maskable and is initiated manually by removing NORM plug P262. With this plug removed, the TRAP input is pulled HI to interrupt the Microprocessor.

Interrupts are used to divert the Microprocessor from the operation in progress so that some other circuit functions can be performed. Each interrupt will cause a different operating sequence to begin.

The TRAP interrupt is used to start a bus-test servicing routine. When P262 is disconnected, the Microprocessor vectors to address 0024, which contains the instruction INX HL. This command increments the contents of the Microprocessor's internal H and L register pair. Continuing, the Microprocessor then reads the contents of address location 0025, which contains the instruction MOV A,M. This command moves the contents of memory, whose address is indicated by the contents of the H and L register pair, into the Microprocessor A register. The content of the address location is not used, so it is only temporarily stored in the A register until it is replaced during the next read cycle of the bus test routine.

Next, U364 reads the contents of address location 0026 which contains the instruction JMP. The address of the jump location is contained in the next two address locations, 0027 and 0028. The entire command is JMP 24, which returns the routine back to address location 0024 to start the increment-move-jump sequence over again.

The routine continues to loop back to address 0024, and as the H and L register pair are incremented each time, a different memory location is read. This looping routine is useful for signature analysis testing of Microprocessor address sequences and of address generated strobes.

Interrupt RST 5.5 is connected through buffer U472F to the GPIBINT line. When the GPIBINT signal is generated, it is held HI until the Microprocessor receives the interrupt. Then U364 vectors to 002C to begin the GPIB routine. When the rountine is finished, the Microprocessor clears the interrupt from the GPIB interface.

Interrupt RST 6.5 is the DISPLAY interrupt connected through inverter U272A. This interrupt vectors the Microprocessor to address 0034. The DISPLAY line going LO signals the Microprocessor that a display cycle was completed. When a display cycle is restarted at the completion of the interrupt service routine, the DISPLAY signal is set HI again.

Interrupt RST 7.5 is an edge-triggered interrupt used to provide a time reference required by the firmware to perform various operations. The reference is derived from a 50-kHz signal generated on the Storage Display Board. Divider U440 receives the 50-kHz signal on pin 1 and divides it by 100 to produce a rectangular pulse 500 μs wide with a period of 2 ms. The rising edge of the pulse sets the internal RST 7.5 flip-flop. This flip-flop remains set until it is cleared by the Microprocessor with an internal reset signal.

When the RST 7.5 interrupt is acknowledged, the Microprocessor vectors to address 003C.

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Table 3-5
Address Block Y7 Control Bit Assignments

Control Signal Address	Control Signal Name	Controlling Strobe	Control Signal Function	Bit Assignments							
				AD7	AD6	AD5	AD4	AD3	AD2	AD1	AD0
E040	$\overline{FPC}$	$\overline{I/O}$	WRITE	$\overline{TIDS}$ LED	TRACK / $\overline{HOLD}$	CH1POS	CH2POS	RESET	LATCH	ADVAN	SRQLED
E041	$\overline{CONTRL}$	$\overline{I/O}$	WRITE	ACTIVEL	$\overline{ZAXON}$	—	$\overline{LINECUR}$	$\overline{TRIGVIEW}$	$\overline{STORDIS}$	BOTH	ODD
E042	$\overline{FP2}$	$\overline{I/O}$	READ	—	—	—	$\overline{XMIT}$	—	$\overline{NO.AVG}$	$\overline{TIME}$	$\overline{VOLTS}$
E043	$\overline{FP1}$	$\overline{I/O}$	READ	PULSE / $\overline{SINE}$	POST-TRIG / $\overline{PRETRIG}$	$\overline{SAVEREF}$	$\overline{SAVE}$	$\overline{AVG}$	$\overline{ENV}$	$\overline{NORM}$	$\overline{OFF}$
E044	$\overline{LEDRO}$	$\overline{I/O}$	WRITE	← $\overline{SCALE\ LED}$ →			DEC.PT	← DIGIT STROBE (LSD)			→ (MSD)
E045	$\overline{SVNSEG}$	$\overline{I/O}$	WRITE	—	—	—	—	← BCD SEGMENT			→
E200	$\overline{RSTACQ}$	$\overline{TBSEL}$	STROBE	← START ACQUISITION →							
E201	WRSR1	$\overline{TBSEL}$	WRITE	LT2	STORON	ENVL	PRETRG	AGTSEL	ADD	CH1	CH2
E202	WRSR2	$\overline{TBSEL}$	WRITE	← SAMPLE RATE WORD TO DIVIDE CHAIN SEE TABLE 3-7 →							
				MSB							LSB
E203	MTRIG	$\overline{TBSEL}$	STROBE	← MANUAL TIME BASE TRIGGER →							
E204	$\overline{RDSTAT}$	$\overline{TBSEL}$	READ	—	—	—	—	—	—	AOM	$\overline{ACQUIRE}$
E205	$\overline{RDMAR}$	$\overline{TBSEL}$	READ	← ADDRESS OF LAST ACQUIRED WAVEFORM DATA POINT →							
				A8							A1
E206	$\overline{RDJC8}$	$\overline{TBSEL}$	READ	← 8-BIT JITTER CORRECTION SIGNAL →							
				MSB							LSB
E207	$\overline{RDJC4}$	$\overline{TBSEL}$	READ	← 4-BIT JITTER CORRECTION SIGNAL →				—	—	—	—
				MSB			LSB				
E400	$\overline{DIPSW}$	$\overline{I/O}$	READ	← SERVICE AND OPTION SWITCH →							
				OPTION							
E401	$\overline{LINER}$	$\overline{I/O}$	WRITE	← 8 MSB OF 10-BIT LINE CURSOR →							
E402	$\overline{DISREG}$	$\overline{I/O}$	WRITE	CSEL	STOP512	STOP256	STOP128	VERT10X	START	V2SB	VLSB
										← LINE CURSOR BITS →	
E403	$\overline{CURSOR}$	$\overline{I/O}$	READ	—	RATE / $\overline{POS}$	SELECT	PRDONE	← POSITION RATE COUNT			→
								MSB			LSB
E404	$\overline{JITTER}$	$\overline{I/O}$	WRITE	← JITTER CORRECTION →							
				MSB							LSB

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Table 3-5 (cont)

Control Signal Address	Control Signal Name	Controlling Strobe	Control Signal Function	Bit Assignments							
				AD7	AD6	AD5	AD4	AD3	AD2	AD1	AD0
E405	$\overline{\text{VGAIN}}$	$\overline{\text{I/O}}$	WRITE	← VERTICAL GAIN WORD →							
E406	$\overline{\text{HGAIN}}$	$\overline{\text{I/O}}$	WRITE	← HORIZONTAL GAIN WORD →							
E407	$\overline{\text{STOPDIS}}$	$\overline{\text{I/O}}$	STROBE	← STOPS DISPLAY →							
E800	CH1	$\overline{\text{I/O}}$	READ	CH1 PROBE CODING	CH1 UNCAL	← CH1 INPUT COUPLING →		← CH1 VOLTS/DIV →			
E801	CH2	$\overline{\text{I/O}}$	READ	CH2 PROBE CODING	CH2 UNCAL	← CH2 INPUT COUPLING →		← CH2 VOLTS/DIV →			
E802	ATIME	$\overline{\text{I/O}}$	READ	—	—	—	← A TIME/DIV →				
E803	BTIME	$\overline{\text{I/O}}$	READ	A / $\overline{\text{B}}$	—	—	← B TIME/DIV →				
E804	MODE	$\overline{\text{I/O}}$	READ	$\overline{\text{CH1}}$	$\overline{\text{TRIG VIEW}}$	$\overline{\text{ADD}}$	$\overline{\text{CHOP}}$	$\overline{\text{CH2}}$	$\overline{\text{XY}}$	EXT TRIG	—
E805	LIGHTS	$\overline{\text{I/O}}$	WRITE	—	—	—	—	$\overline{\text{CH1X10}}$	$\overline{\text{CH1X1}}$	$\overline{\text{CH2X10}}$	$\overline{\text{CH2X1}}$
E806	VSM	$\overline{\text{I/O}}$	WRITE	SWEEP DISABLE	TRIGVIEW ENABLE	ALT / $\overline{\text{CHOP}}$	CH1	$\overline{\text{XY}}$	CH2	ADD	TRIG VIEW
F000	$\overline{\text{TALKREG}}$	GPIBSEL	READ	TALK ONLY	—	—	← TALK ADDRESS → 16	8	4	2	1
F001	$\overline{\text{SNTACK}}$	GPIBSEL	STROBE	← SENT ACKNOWLEDGED →							
F002	$\overline{\text{DATACC}}$	GPIBSEL	STROBE	← DATA ACCEPTED →							
F003	$\overline{\text{ATNFLS}}$	GPIBSEL	STROBE	← ATTENTION FLAG SET →							
F004	$\overline{\text{WIFDO}}$	GPIBSEL	WRITE	DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
F005	$\overline{\text{RIFDI}}$	GPIBSEL	READ	DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
F006	$\overline{\text{WIFCTL}}$	GPIBSEL	WRITE	TP335	TP333	LAT.IFC	—	TEOI	TSRQ	nba	TADS
F007	$\overline{\text{RIFSTAT}}$	GPIBSEL	READ	SENT	TADS	RRFD	NDAC	ATNDAV	ATTEN	RATN	$\overline{\text{IFCL}}$
F200	PRICLR	$\overline{\text{I/O}}$	STROBE	← CLEAR POSITION RATE INTERRUPT F-F →							

3515-100

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Table 3-6

Microprocessor Interrupts

Function	Name	Trigger Required	Priority	Vector Address
Bus Looping Routine	TRAP	Rising edge AND remain HI until sampled.	1	0024
Firmware Timing	RST 7.5	Rising edge (latched).	2	003C
Display	RST 6.5	HI until sampled.	3	0034
GPIB	RST 5.5	HI until sampled.	4	002C
Position Rate Pot	INTR (RST 7)	HI until sampled.	5	0038

An additional divide-by-five is performed by U446 to reduce the 2-ms signal to a pulse (PRDONE) that is HI for 2 ms and LO for 8 ms. During the 8-ms LO time, a counter (on the Storage Display Board) is accumulating counts from a voltage-to-frequency converter that is used to digitize the output of the CURSOR position-rate potentiometer. When PRDONE goes HI, the rising edge clocks PRDONE latch U255B, and its Q output at pin 9 goes HI.

This HI interrupts the Microprocessor, and it responds by performing an instruction fetch to obtain a vector address from the bus. However, the $\overline{RD}$ signal at U364 pin 32, which is present during a normal instruction fetch, is not activated, and Address or Data Buffer U452 is not gated. Therefore, the Microprocessor is not connected to the bus lines. Instead, its AD0 through AD7 lines are all HI due to pull-up resistor pack R450. Thus the instruction obtained from the AD lines is FF (the RST 7 instruction), and the Microprocessor is vectored to address 0038.

Firmware response to this interrupt includes reading and resetting the CURSOR position-rate counter and generating the $\overline{PRICLR}$ strobe used to clear PRDONE latch U255B. The $\overline{PRICLR}$ strobe is generated in the address decoder circuitry when address F200 is accessed by the Microprocessor.

SERVICING OUTPUTS. For servicing, the Microprocessor serial out data (SOD) pin 4 is used with the service ROM to provide the Start/Stop pulse used with signature analysis testing.

Certain system error conditions will cause the Microprocessor to halt. A halt condition can be detected by checking the logic level at pins 29 and 33 (S_0 and S_1). If both pins are LO, the Microprocessor is halted.

Microprocessor clock signal $\overline{MPUCLK}$ is divided-by-two internally and is available for testing at the CLK OUT pin 37.

TIME BASE

A functional block diagram of the Time Base circuitry is located in the "Diagrams" section of Volume II of this manual. The Time Base circuitry (diagram 19), under control of the Microprocessor, controls the sample rate and acquisition mode of the oscilloscope's digital storage circuitry. Continual signal sampling occurs during the time interval between triggers. When a trigger signal occurs, the Record Counter circuit begins counting the samples as they are acquired. After the remaining samples required to obtain 512 samples for either pretrigger or posttrigger operation are obtained, the Record Counter generates the DONE signal. This signal indicates that the acquisition cycle has ended and that a display cycle may be entered.

The time difference between the fixed-rate sample clock and the oscilloscope trigger causes display jitter. This effect is reduced by measuring the time between the occurrence of a trigger signal and the next sample clock (measured by the Time Interval circuit) and then offsetting the display with a jitter-correction signal to compensate for the measured difference in timing.

Strobe Control

The Strobe Control circuit, composed of address latch U140 and 1-of-8 decoder U146, generates the timed strobes used by the Microprocessor to control the Time Base circuitry. Addresses from the Microprocessor AD0 through AD2 bus lines are latched into U140 on the rising edge address latch enable signal $\overline{ALE}$. When the Time Base is selected by the Microprocessor, the TBSEL strobe enables U146 to decode the address and to generate the appropriate strobe to the selected device in the Time Base (Table 3-5).

Two strobes generated by U146 are directed to the Memory Board: $\overline{\text{RSTACQ}}$ starts a new acquisition, and $\overline{\text{RDMAR}}$ strobes the Memory Address Register to allow the Microprocessor to obtain the address of the last waveform sample acquired at the end of an acquisition cycle.

Also generated by U146 are two write strobes: $\overline{\text{WRSR1}}$ strobes register U236 to load the acquisition mode data, and $\overline{\text{WRSR2}}$ strobes register U436 to load the sample-period data.

Two read strobes are directed to the Time Interval Meter. $\overline{\text{RDJC8}}$ strobes register U440 to allow the Microprocessor to read the 8-bit jitter-correction time-interval measurement between the sample clock and the trigger for sweep rates from 10 μs to 20 ns per division. $\overline{\text{RDJC4}}$ strobes register U240 to allow the Microprocessor to read the 4-bit jitter-correction data for sweep speeds from 5 s to 20 μs per division.

Another read strobe, $\overline{\text{RDSTAT}}$, enables a section of register U240 (containing the acquisition status) to be read by the Microprocessor.

The final strobe generated, $\overline{\text{MTRIG}}$, is used to supply a trigger to Trigger flip-flop U110A. Whenever a front-panel control is changed that affects the data being acquired, the Microprocessor supplies a manual reset to Trigger flip-flop U110A. This reset signal starts the Record Counter, and the sample timing is switched to fast sampling so the count is finished rapidly. This feature eliminates a long time delay in beginning a new acquisition when very low sweep speeds are in use. Thus, the next trigger signal received will begin a data acquisition at the new control setting, with no wait to complete a full record count with slow triggers.

Time Base Control Registers

Two write-only registers, Sample Rate register U436 and Acquisition Mode register U236, receive commands from the Microprocessor that control the sample rate and acquisition mode of the instrument. Sampling rate is determined by setting the Sample Period Divide Chain to produce different divide ratios of the 5-MHz clock (C5M). The sampling-period commands are loaded into register U436 as it is strobed with $\overline{\text{WRSR2}}$ from Strobe Control U146.

Acquisition Mode register U236 is loaded with commands that control the instrument operating mode. These commands are loaded in register U236 when the $\overline{\text{WRSR1}}$ strobe from U146 is applied, and they remain unchanged at the register outputs until new commands are clocked in by the next enabling strobe.

Trigger Control

The trigger select circuit (composed of U100A, U100B, U100D, and U434A) forms a gating circuit that allows either the A + Gate or the B + Gate signal to clock Trigger flip-flop U110A. At the beginning of the acquisition cycle, U110A is reset by the $\overline{\text{RSTACQ}}$ strobe. The AGTSEL signal from Acquisition Mode register U236 is applied directly to NAND gate U100A pin 2; this signal is also inverted by U434A and applied to NAND gate U100D. When AGTSEL is HI, the A + Gate causes U100A pin 3 to to go LO. This LO, along with the HI from U100D pin 11, causes U100B pin 6 to go HI for the duration of the A + Gate. The rising edge of the A + Gate sets Trigger flip-flop U100A, indicating that a trigger has been received.

When AGTSEL is LO (A + Gate not selected), NAND gate U100D is enabled to pass the B + Gate for use in clocking the Trigger flip-flop.

Both the A + Gate and the B + Gate continue on to the external A + GATE and B + GATE bnc connectors on the rear panel of the oscilloscope.

50-MHz Master Clock

A 50-MHz, crystal-controlled oscillator-and-dividing circuit composed of Y134, U230B, U230A, U220B, U128B, and U128A provides the clock frequencies that control circuit timing. The 50-MHz frequency is reduced to 25 MHz (C25M) by divide-by-two flip-flop U128A. A divide-by-five circuit composed of U230B, U230A, and U128B produces the 10-MHz clock (C10M), which is further reduced by divide-by-two flip-flop U220B to produce the 5-MHz clock (C5M). The 5-MHz clock is buffered by inverting amplifier U434B to produce the Microprocessor clock signal $\overline{\text{MPUCLK}}$.

Sample Rate Divide Chain

A divide chain comprised of U430, U424, U418, U510, U518, and U218C and D, provides the variable clock rates used to clock the Sample Rate Timing Generator. The Microprocessor, in response to TIME/DIV switch settings, programs the divide ratio of the chain. Sweep rates for A and A INTEN HORIZ DISPLAY are controlled by the A TIME/DIV switch, while ALT and B DLY'D HORIZ DISPLAY are controlled by the B TIME/DIV switch.

The programmed divide ratio reduces the 5-MHz clock (C5M) to the required clock frequency. Each counter in the divide chain is clocked on the rising edge of the clock pulse. Also clocked at the same time is U220A, a flip-flop used to synchronize the divide chain output with the rising edge of the 5-MHz clock.

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Table 3-7 is a listing of the divide ratios and their respective final output clock frequencies from the divide chain, as produced by commands from the Microprocessor.

The data at the input of U436 is gated into the register when the Microprocessor activates the $\overline{\text{WRSR2}}$ strobe.

Located at the beginning of the divide chain is prescaling divider U430. It is programmed by the Microprocessor to divide by 2, 5, or 10 as determined by the data preset into the A, B, C, and D counter inputs. For example, a divide-by-two is accomplished in the following manner. In Table 3-7, the command for the chain to divide by two is FE_{16}. In binary notation, FE_{16} is 11111110, with AD7 being the most significant address bit.

Enabling inputs T (SRA) and P (SRB), arriving at U430 pin 10 and pin 7, will both be HI (address lines AD7 and AD6). Inputs T and P must be HI in order for the divide chain to function. Other logic combinations of the SRA and SRB bits are used in succeeding circuitry to select clock frequencies different from those produced by the divide chain.

The A and C inputs of U430 (pins 3 and 5) are connected together, while the B input (pin 4) is permanently LO and the D input (pin 6) is independently selectable. In the case of a divide-by-two, the inputs to U430 will be as follows: A, B, and C are LO, while D is HI. In binary notation, this corresponds to 1000, or decimal 8. Although the input is preset, the 8 count will not be placed in the counter until it is loaded by a LO on U430 pin 9 (the LOAD input).

When the Prescaler count reaches 9, the CARRY OUT output pin 15 is activated HI. This HI is applied to NAND gate U218D pin 12 along with the fixed HI on pin 13, causing the LOAD input at U430 pin 9 to go LO. The next rising edge of the clock will gate the preset 8 into the counter, and CARRY OUT will go LO. At the next clock rising edge, the counter will go to 9, which will again preset 8 into the counter. The count sequence then continues as 8,9,8,9,8,9,8,..., with each 9 count producing a CARRY OUT output.

To preset the divide chain, all the counters must initially reach a full count to produce a LOAD signal at the output. The counting cycle just prior to a loaded preset count occurs in the following sequence. Each counter in the chain is enabled by the CARRY OUT output from its preceding counter. Thus, each time the CARRY OUT of U430 goes HI, the T and P inputs of U424 are enabled, and U424 will count once. When the count of U424 reaches 9, its CARRY OUT is enabled, and U418 will begin to count. This cascaded operation continues until all the counters reach a full count of 9. At that point, the CARRY OUT of the last counter, U518, is activated HI. This HI is applied to NAND gate U218C pin 10 which, along with the HI from U430's CARRY OUT, is applied to U218C pin 9, causing U218C pin 8 to go LO. This LO is applied to each decade counter's LOAD input (pin 9), and the preset 9 placed on each of the counter's inputs (from register U436) is loaded into the counters.

From this point, in a divide-by-two routine, all the counters except U430 are preset to 9; and each time U430 counts from 8 to 9, the CARRY OUT is generated synchronously through the entire divider chain. This means that Prescaler U430 is performing the divide-by-two, while the rest of the divide chain is merely propagating the CARRY OUT, and the output clock frequency is 2.5 MHz.

The LO CARRY OUT from the last counter, U518, is also applied to synchronizing flip-flop U220A pin 2, and on the next rising edge of the C5M clock, the $\overline{Q}$ output of U220A is clocked HI. The CARRY OUT output from U430 to U218C pin 9 also starts LO on the same clock rising edge that clocked U220A pin 6 HI. The propagation delay involved in loading the preset input into U430 allows U220A pin 6 to complete its transition before the CARRY OUT output goes LO. This LO from U430 disables NAND gate U218C, and pin 2 of U220A goes HI.

Table 3-7

Sample Rate Divide Chain

Input to Sample Rate Register U436	Divide Ratio of Prescaler U430 (÷)	Four Stage Divide Chain (÷)	Output Clock Frequency (Sample Rate)
FE	2	1	2.5 MHz
FD	5	1	1.0 MHz
FC	10	1	500 kHz
FA	2	10	250 kHz
F9	5	10	100 kHz
F8	10	10	50 kHz
F2	2	100	25 kHz
F1	5	100	10 kHz
F0	10	100	5 kHz
E2	2	1,000	2.5 kHz
E1	5	1,000	1 kHz
E0	10	1,000	500 Hz
C2	2	10,000	250 Hz
C1	5	10,000	100 Hz

The next clock rising edge causes U430 to count from 8 to 9. However, before U430 CARRY OUT becomes HI again, the LO on U220A pin 2 is clocked through to become a HI on U220A pin 6. The pulse thus generated is 200 ns wide and is initiated with each LOAD input pulse.

By using different presets to both the Prescaler and the Divide Chain counters, other divide ratios are similarly set up to obtain the desired output sample clock frequency.

For servicing, jumper P420 in the divider chain LOAD line is removed to break the feedback loop, and the four-stage divider will only perform a divide-by-10,000.

Timing Signal Selector

The source of the sample rate clock is selected by multiplexer U120. A choice of 25 MHz (C25M), 10 MHz (C10M), 5 MHz (C5M), or the output of the Sample Rate Divide Chain, is available at the input pins of the multiplexer. The logic combinations of the SRA and SRB bits (AD7 and AD6) on U120 pins 2 and 14 control the switching function to select the clock frequency that was applied to the Sample Rate Timing Generator U436. See Table 3-8 for a listing of the selection combinations.

Table 3-8

Timing Signal Selection at U120

SRB	SRA	Timing Signal
0	0	25 MHz (C25M)
0	1	10 MHz (C10M)
1	0	5 MHz (C5M)
1	1	2.5 MHz to 100 Hz (From Divide Chain Output)

Sample Rate Timing Generator

Multiplexer U118 is switched by two output signals (LT2 and ENVL) from Acquisition Mode Register U236. These two signals select the clock frequencies to be used for the CONVERT and SAVE clocks that control the acquisition of data into the Acquisition Memory (Figure 3-23).

The rising edge of the CONVERT clock starts both data conversion by the A/D Converter and data storage into the Acquisition Memory. The SAVE clock signals the storage of a data byte and also clocks the Record Counter, the Time Interval Meter, and Chop Drive flip-flop U150B.

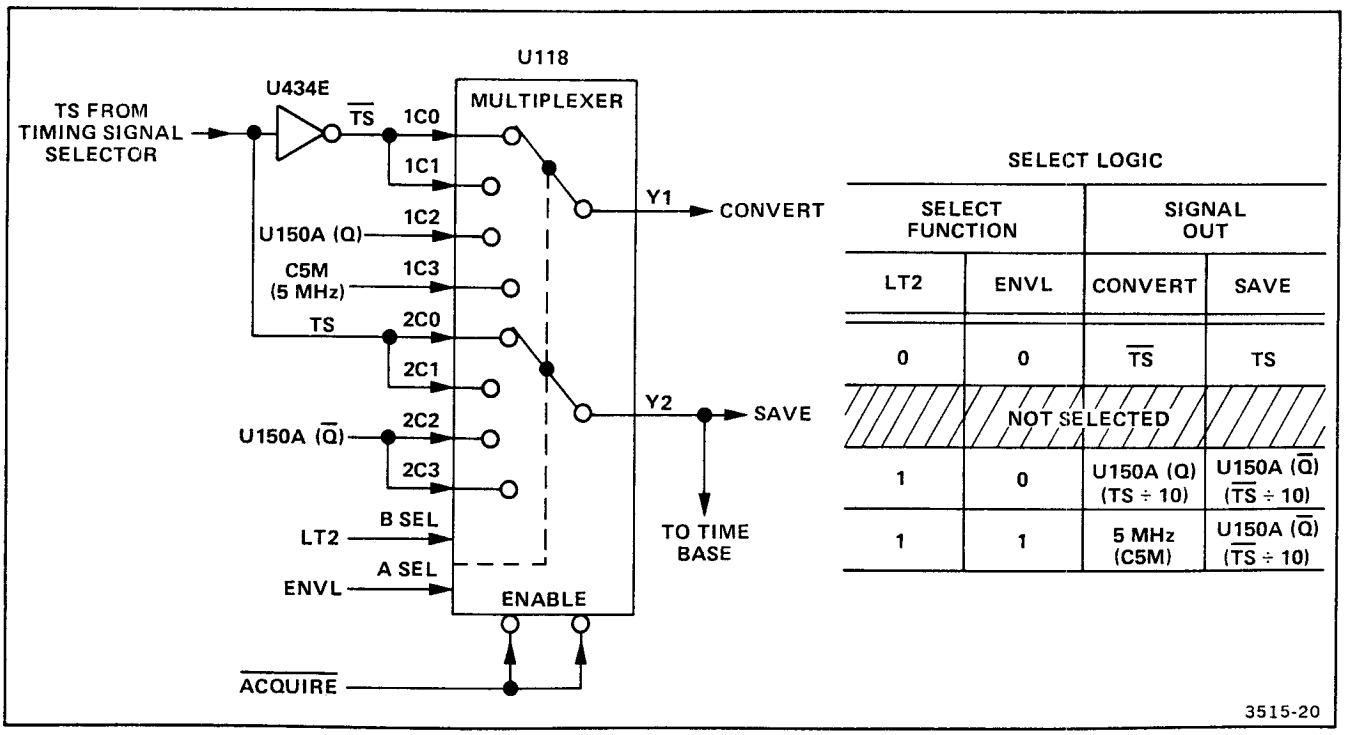

Figure 3-23. Simplified illustration of Multiplexer U118 switching operation.

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For sample periods of 40 ns, 100 ns, and 200 ns, the CONVERT clock is the logical complement of the SAVE clock. Selection of TS and $\overline{TS}$ for the timing occurs when LT2 is LO. The inverted timing signal (inverted by U434E to $\overline{TS}$) is applied to the U118 $1C_0$ and $1C_1$ inputs at pins 6 and 5, while the noninverted timing signal is applied to the $2C_0$ and $2C_1$ inputs at pins 10 and 11. Multiplexer U118 gates the $\overline{TS}$ signal to output Y_1 (pin 7 CONVERT), and the TS signal is gated to the Y_2 output (pin 9 SAVE). See Figure 3-23 for a logic table of the multiplexer switching.

At sample periods slower than 200 ns and when in the NORM and AVG Storage Modes, the CONVERT clock is the Q output of flip-flop U150A, and the SAVE clock is the $\overline{Q}$ output. When ENVELOPE Storage Mode is selected, ENVL will be HI at U118 pin 14. Thus the CONVERT clock will be 5 MHz, while the SAVE clock frequency remains one-tenth of the timing signal TS.

The divide-by-10 circuit composed of U210, U150, and U218B is used to divide the timing signal by 10. The result is a square-wave output having a period equal to one-tenth of the timing signal (TS). The divided signal is synchronized with the rising edge of the 5-MHz clock pulse.

This square wave has a 50 percent duty cycle (symmetrical) rather than a rectangular pulse (Figure 3-24). To establish this condition, U210 is preset to 3 on each load. The A and B inputs (pins 3 and 4) are held HI and the C and D inputs are held LO for a fixed 3 at the four preset inputs. At a TS count of 8, the U210 Q_D line (pin 11) goes HI. This HI is applied to the D input (pin 2) of synchronizing flip-flop U150A. The next 5-MHz clock (C5M) rising edge clocks the HI on pin 2 to the Q output of U150A at pin 5.

When U210 reaches a count of 12, its Q_C and Q_D outputs are both HI. These HIs are NANDed by U218B to place a LO on the U210 LOAD input at pin 9. With LOAD enabled, the next TS clock rising edge at U210 pin 2 clocks the preset 3 into the counter, and Q_C and Q_D both go LO, thus removing the LOAD signal from U210. On the next 5-MHz clock rising edge at U150A pin 3, the LO from U210's Q_D output at pin 11 is clocked to the U150A Q output while the U150A $\overline{Q}$ output goes HI. Thus, the TS timing signal is divided by 10, and the transitions are synchronized to the rising edge of the 5-MHz clock.

The Q and $\overline{Q}$ outputs of U150A are applied to the selecting inputs of multiplexer U118 for use at sample periods longer than 200 ns. For sample periods of 40 ns, 100 ns, and 200 ns, the divide-by-10 counter is not used. For these sample periods, the 50-MHz Master Clock circuit produces the required clock frequencies of 25 MHz, 10 MHz, and 5 MHz.

The TS timing signal is also used to clock the low-speed Time Interval Meter at U100C pin 9 when TS/10 is selected for SAVE.

The $\overline{ACQUIRE}$ signal on U118 enabling inputs pins 1 and 15 is used to turn off the CONVERT and SAVE clocks when a waveform acquisition is not in progress.

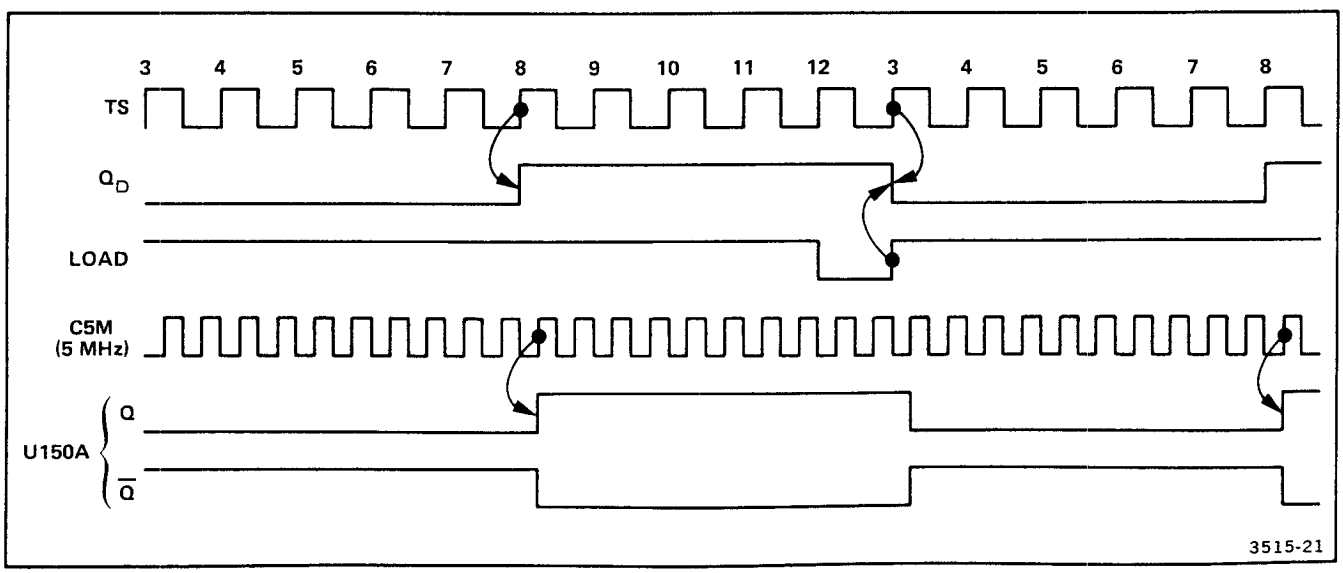

Figure 3-24. Sample Rate Timing Generator divide-by-ten timing diagram.

Record Counter

A circuit composed of U536, U540, U530A, U530B, U530C, and U524 records the number of samples obtained during an acquisition cycle. This circuit is used to determine the correct number of samples required to complete the cycle in progress after the oscilloscope trigger occurs. Post-trigger Storage Display requires 448 samples after the trigger, while Pretrigger operation requires 64 samples after the trigger occurs to complete the full 512-sample record length.

To accomplish the required count, the counter is preset either with 040_{16} (64_{10}) for post-trigger mode or $1C0_{16}$ (448_{10}) for pretrigger mode. The preset is loaded each time an acquisition is finished and when the STOP signal is set LO (before the acquisition is restarted). When STOP is LO, the enabling inputs to U540 pins P and T are also LO, and the counter is disabled.

Upon receiving a trigger signal, Trigger flip-flop U110A is set, and on the first rising edge of the SAVE clock, the STOP signal from flip-flop U110B is set HI. At that point, the counter begins to count up to 512, starting from the preset count previously loaded. Upon completing the count of 512_{10} (200_{16}), the Q_B output of U524 pin 13 is set HI to signal DONE to the Acquisition Memory.

The AND gates U530A, U530B, and U530C are used to produce an enabling signal to U524, the final counter in the chain. Each time U540 and U536 reach a full count (FF_{16}), both the P and T inputs of U524 will be HI to allow U524 to count once. In pretrigger operation, U524 only counts once to produce an output; in post-trigger operation it must count twice. The AND gates generate a faster CARRY OUT from U536 and U540 to U524 than the internal CARRY OUT circuits of the counters can provide.

Chop Drive

Flip-flop U150B is used to drive the digital storage Input Channel Switch U328 (diagram 13). Acquisition Register U236 provides the set and reset signals to the flip-flop (CH 1 and CH 2). Table 3-9 lists the switch logic of the flip-flop for selecting the input signal.

When chopping CH 1 and CH 2, the Acquisition Mode Control provides the SAVE0 signal from U440A pin 6 (diagram 14). The SAVE0 signal, applied to U150B pin 12, ensures that the data acquired from CH 1 and the data acquired from CH 2 will each be directed to the same part of the Acquisition Memory during each acquisition.

Table 3-9

Chop Drive Switching Logic

CH 1	CH 2	$\overline{\text{CHAN1}}$	Function
0	0	1	Not used
1	0	0	Selects CH 1
0	1	1	Selects CH 2
1	1	SAVE0	Chops Between CH 1 and CH 2

Flip-flop U150B is clocked by the SAVE clock (inverted by U434F). Since the SAVE clock is a square-wave signal, it provides symmetrical timing for CH 1 and CH 2 signal acquisition when chopping between the two inputs. When ALT Vertical Mode is selected, the Microprocessor alternately selects CH 1 and CH 2 for application to the Chop flip-flop to produce the switching signal to the Input Channel Switch (diagram 13).

Time Base Status Register

Part of register U240 in the Time Interval Meter circuitry is used as an Acquisition Status register. Status register strobe $\overline{\text{RDSTAT}}$ is provided by the Microprocessor at the end of each acquisition cycle. The Microprocessor polls the $\overline{\text{ACQUIRE}}$ signal, applied to U240 pin 14, to determine when the data acquisition is completed. $\overline{\text{ACQUIRE}}$ is generated in the Acquisition Mode Control circuitry (diagram 14) from U332A pin 5, and it tells the Microprocessor that the new acquired data can be read from the Acquisition Memory.

A second signal read is the A0M bit, also from the Acquisition Mode Control (U332B pin 9). This signal records the location of the trigger with respect to the current address (odd or even) being written into. The location of the trigger with respect to the current address is used to generate the most significant bit of the jitter correction data.

Time Interval Meter

Jitter correction signals are generated in a circuit that measures the time interval between the trigger point and the next rising edge of a SAVE clock. Due to the wide range of sample clocks used for acquiring data, two separate Time Interval Meter circuits are used. One of the two circuits is used for clock frequencies of 2.5 MHz or less and the other for 25 MHz, 10 MHz, and 5 MHz SAVE clocks.

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The low sample rate counter is composed of counter U246 and NAND gate U100C. A clock frequency equal to 10 times the SAVE clock is used to produce a counting sequence from 0 to 9 by U246 during the time interval between trigger occurrence and the next rising edge of the SAVE clock. The actual count reached by the counter is a measure of the time interval between the two points.

When a trigger is received, flip-flop U110A pin 5 goes HI and the counter clear input (U246 pin 13) is released to begin counting from 0. This HI is also applied to U110B pin 13 to release the Reset input of the Stop flip-flop. The $\overline{Q}$ output (pin 8) of the Stop flip-flop is HI, and timing signal TS is gated through NAND gate U100C. Counter U246 counts the TS clocks until the next SAVE clock rising edge clocks U110B to make U110B pin 8 go LO, shutting off the timing signal clocks to U246 through U100C. The count stored in the counter is read by the Microprocessor from register U240 and is scaled to produce the jitter-correction data for the stored display.

The high-sample-rate (25 MHz, 10 MHz, and 5 MHz) Time Interval Meter circuit is composed of U446, U218A, U546, Q552, Q554, Q546, Q547, and Q544. These components, along with associated circuit components, form a counter that uses a dual-slope integrating technique to measure time intervals. The dual-slope technique is required because the TTL logic of the counter cannot handle clocking frequencies of 10 times the SAVE clock frequency for the high sample rates.

Transistor pair Q546 and Q547 forms a switchable 10-mA current source, and transistor pair Q554 and Q552 forms a 100-μA current source, either of which is used to supply a charging current to capacitor C538 during the counting intervals. Between counting intervals, the charge on C538 is held to zero by Q544 conducting the charging current to ground. The transistor pair supplying the capacitor charging current is selected by the state of STOP flip-flop U110B.

Initially, before a trigger is received, $\overline{\text{TRIG'D}}$ from U110A pin 6 is HI and TRIG'D on pin 5 is LO. When $\overline{\text{TRIG'D}}$ is HI, Q544 is conducting the charging current to ground. With TRIG'D LO, STOP flip-flop U110B is reset, and STOP at pin 9 is LO, while $\overline{\text{STOP}}$ at pin 8 is HI. STOP being LO turns on Q552, causing the 100-μA current source Q554 to be shunted to ground. Simultaneously, $\overline{\text{STOP}}$ is HI and Q546 is biased off, and the 10-mA current from Q547 is shunted through Q544.

When a trigger is received, $\overline{\text{TRIG'D}}$ goes LO and Q544 turns off, allowing the 10-mA current from Q547 to flow into C538. The current into C538 causes the voltage across C538 to ramp up.

On the first rising edge of the SAVE clock, after the trigger is received, Stop flip-flop U110B changes state and Q546 conducts, shunting the 10-mA charging current to ground. At the same time, Q552 is turned off, allowing a 100-μA charging current from Q554 to continue charging C538 at a rate reduced by a factor of 100 from the previous charging rate.

Counting begins when the charging rate is switched by simultaneously releasing the U446 clear inputs (pins 2 and 12). Counter U446 begins counting the 10-MHz clock (C10M) being applied through NAND gate U218A.

When the 100-μA charging current causes the voltage across C538 to reach 2 V, comparator U546 output at pin 7 goes LO to stop the 10-MHz clock, through U218A, to the counter.

The 100-μA charging current is capable of charging C538 from 0 to 2 V during the time required for the counter, counting the 10-MHz clock, to reach a count of 200. However, the 10-mA charging current is capable of charging C538 100 times faster. Thus, the actual count reached by the counter measures the time during which the 10-mA current was charging C538. Since the ratio of the 100-μA current to the 10-mA current is 100:1, each count is equal to 1/100 of the 10-MHz clock period, or 1 ns. Therefore, the high-sample-rate Time Interval Meter measures the time between the trigger and the next SAVE clock rising edge to within 1 ns.

Data from the Time Interval Meter is read from either register U440 or register U240, using the appropriate strobe. The Microprocessor then generates a horizontal offset that removes the displayed signal jitter caused by the one-sample-period uncertainty between the oscilloscope trigger and the sample clock.

A Typical Acquisition Sequence in the Time Base

The typical acquisition sequence begins with the Microprocessor loading the selected sample rate and acquisition mode into registers U436 and U236. Then the Microprocessor generates the $\overline{\text{RSTACQ}}$ strobe from U146 to arm Trigger flip-flop U110A and to reset Stop flip-flop U110B. The $\overline{\text{RSTACQ}}$ strobe also sets Acquire flip-flop U332A (diagram 14). The correct sample clock is selected by Timing Signal Selector U120, and CONVERT and SAVE clocks are sent to both the A/D Converter and the Acquisition Memory from Sample Rate Timing Generator U118.

If CH 1 and CH 2 are both selected in the CHOP Vertical Mode, the SAVE0 signal at pin 12 of Chop Drive flip-flop U150B will be clocked through on each falling edge of the SAVE clock and will drive the digital storage Input Channel Switch U328 (diagram 13). Using the SAVE0 signal to drive the Input Channel Switch ensures that the CHOP data for each waveform will be placed into the correct half of the Acquisition Memory (diagram 14).

When ALT Vertical Mode is selected, the Microprocessor controls CHOP Drive flip-flop U150 by alternately selecting CH 1 and CH 2.

When a trigger occurs, Trigger flip-flop U110A is set, and the Time Interval Meter measures the time between the trigger and the SAVE clock rising edge.

The trigger also starts the Record Counter to count from the preset value. When a count of 512_{10} is reached, the DONE signal is sent to the Acquisition Memory to set Acquire flip-flop U332A, thus stopping the CONVERT and SAVE clocks from Sample Rate Timing Generator U118.

When Microprocessor polls Acquisition Status Register U240, the $\overline{\text{ACQUIRE}}$ signal on U240 pin 4 will be HI, and at that time the acquired waveform data is transferred from the Acquisition Memory to the Display Memory. Then the Microprocessor reads the Time Interval Meter and processes it to produce a jitter-correction offset. Now the Microprocessor is free to start another waveform acquisition.

STORAGE DISPLAY CONTROL AND LED READOUT

The Storage Display Control circuitry (diagram 17) is located on the A16 Storage Display circuit board. A functional block diagram of the Storage Display Control and LED Readout circuitry is located in the "Diagrams" section in Volume II of this manual.

In the Storage Display Control circuitry, control strobes are generated that select the Microprocessor-controlled display functions. The digital storage front-panel switch positions are stored in registers located on the Storage Display board. These are scanned at regular intervals by the Microprocessor to check for switch position changes that will alter the present operating state of the oscilloscope. At power-on, the Service Test Switch Register is also read to determine whether the Power-On RAM test switch and the GPIB Option switch are set.

Strobe Control

The low byte of addresses (AD0-AD7) being accessed by the Microprocessor is latched into Display Strobe Control Register U207 on the rising edge of the Address Latch Enable pulse (ALE). From U207 outputs Q_1, Q_8, and Q_2, the latched addresses (LADR0-LADR2) are applied to two 3-to-8 decoders, U213 and U218.

Decoding of the latched addresses occurs as follows. The $\overline{\text{I/O}}$ strobe, produced by decoding the high-order addresses (diagram 18), is applied to pin 5 of both U213 and U218. When the I/O strobe is LO, decoding of the latched addresses occurs. Another enabling strobe determines which of the decoders will produce an output strobe. If address line A (ADRA) is HI on pin 6 of U213 while $\overline{\text{I/O}}$ is LO, U213 will produce a strobe. If latched address line 6 (LADR6) at pin 6 of U218 is HI while $\overline{\text{I/O}}$ is LO, U218 will produce an output strobe. The strobes generated are identified in the description of the circuitry with which they are used.

The LADR0-LADR2 addresses are also fed to the $\overline{\text{I/O}}$ Vertical Mode switch (diagram 4), along with the $\overline{\text{I/O}}$ strobe, for generating the strobes needed in that circuitry.

Display Control Registers

Control data to the Storage Display Board is latched into the Display Control Registers, U223 and U228, from the AD0-AD7 Microprocessor Bus lines. The latching strobes are supplied by Latched Address Decoder, U218. The $\overline{\text{CONTRL}}$ strobe from U218 pin 14 latches control bits into U223, while the $\overline{\text{FPC}}$ strobe from U218 pin 15 latches control bits into U228. See Table 3-5 in the "Microprocessor" part of this section for a listing of the control bit assignments.

Storage Front-Panel Switches

The Microprocessor scans the front-panel switches at 100-ms intervals to determine if a change in a switch position has occurred. Switch positions are buffered by U743 (for VOLTS, TIME, NO. OF AVE, and XMIT) and U717 (for NON STORE, NORM, ENVELOPE, AVG, SAVE, SAVE REF, PRE TRIG/POST TRIG, and SINE/PULSE switches). The Microprocessor reads U717 when $\overline{\text{FP1}}$ is decoded by U218, and U743 is read when $\overline{\text{FP2}}$ is decoded.

A third switch register (Service Test Switch Register U713) is read when the $\overline{\text{DIPSW}}$ strobe is decoded by U213. The Service Test Switch Register is read at power-on to

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determine whether the Option Present Switch (switch 8) is set on and whether the Power-On RAM Test Disable Switch (switch 7) is set for a normal power-on sequence. If the instrument is set up for servicing, the register will contain the binary number of the test routine to be performed by the Microprocessor.

Seven-Segment LED Indicators

The display seen on the four, seven-segment LED indicators is controlled by the Microprocessor using timing strobes to latch data from the Microprocessor bus into both U759 and U748. The segments of the indicators are controlled by U759, a binary-coded-decimal (BCD) to seven-segment decoder driver.

Segment control bits to be written into U759 from the Microprocessor are placed on the AD0 through AD3 bus lines. After the data has settled, the Microprocessor sends the $\overline{\text{SVNSEG}}$ strobe, from U218 pin 10, to latch the data into U759. These control bits are decoded by U759 to select the indicator segments that will be illuminated (Figure 3-25).

Each digit to be displayed is selected by the Microprocessor in a time-multiplexed sequence. Data placed on the AD0 through AD7 bus lines by the Microprocessor is latched into U748 when the $\overline{\text{LEDRO}}$ strobe, from U218 pin 11, is applied to U748 pin 11. The data written into U748 includes the scale-factor LED to be illuminated and the appropriate decimal-point-select bit.

Display multiplexing is done in the following manner. When U748 receives the $\overline{\text{LEDRO}}$ strobe, data present at the input pins of U748 is latched in. The data selects the appropriate scale-factor LED and controls the decimal point. However, at this time all the digits are disabled to blank the display while the seven-segment data is being changed in U759. During this blanking time, BCD information for the next digit to be displayed is latched into U759 by the $\overline{\text{SVNSEG}}$ strobe.

After the digit code is written into U759, new data containing the digit to be enabled is written into U748 (along with the repeated scale-factor information). If the decimal point is to be illuminated for the digit selected, that information is also written into U748 at the same time. See Figure 3-26 for the bit controlling plan for both U759 and U748. At this time, the selected digit will be enabled, and the segments of that digit will be illuminated as determined by the output of U759. A new digit is displayed approximately every 4 ms.

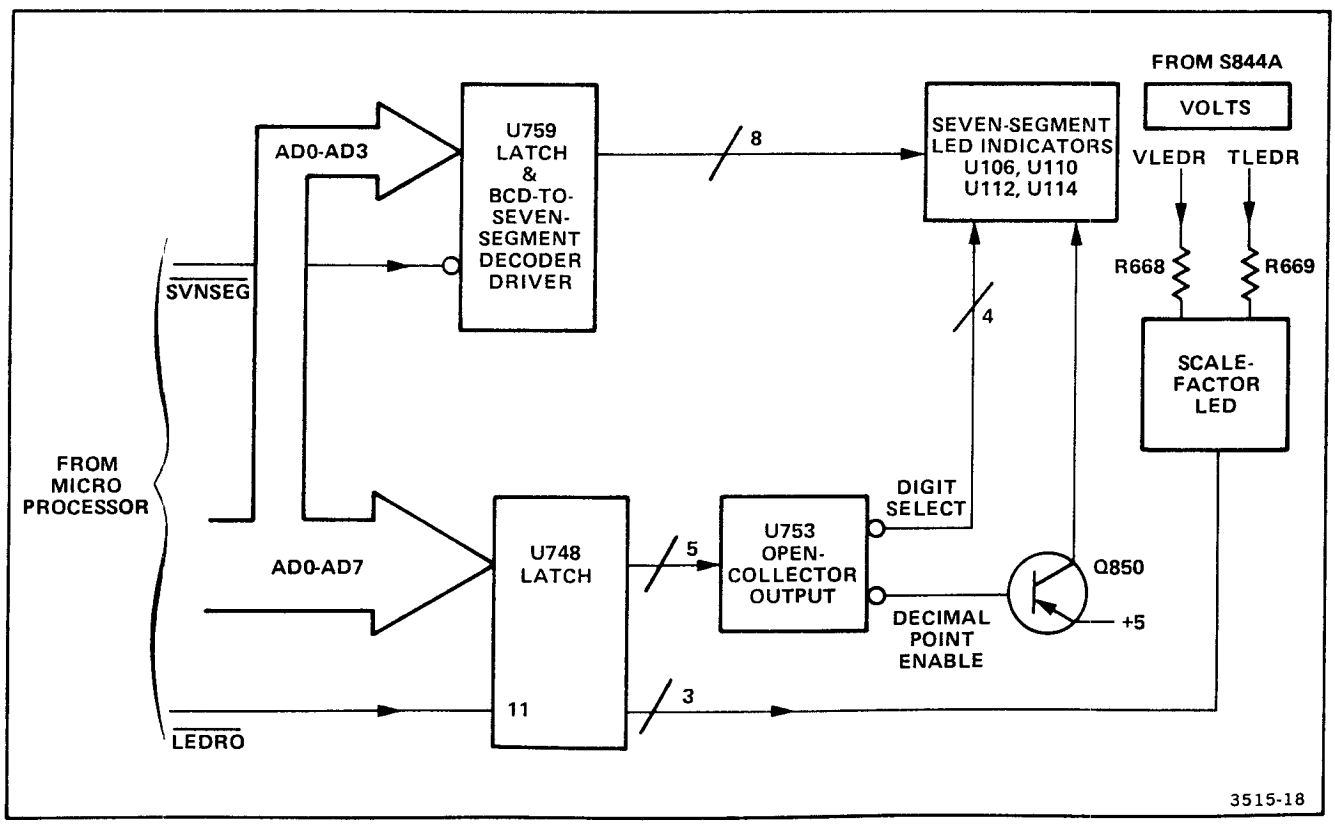

Figure 3-25. Simplified block diagram of the LED Display circuit.

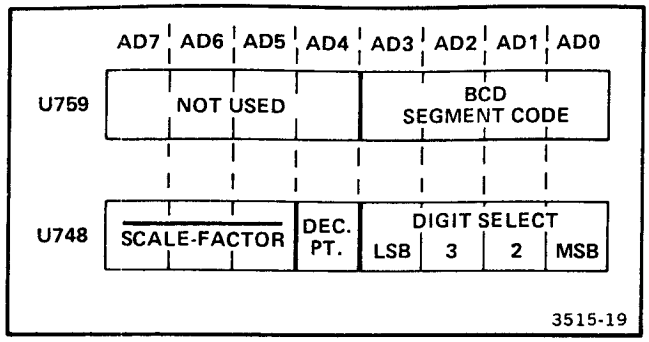

Figure 3-26. Bit controlling plan for U759 and U748.

The path for the driving current from U759 to the seven-segment LED indicators is via U753, which converts the TTL level outputs of U748 into open-collector outputs. Whenever a decimal point bit is written into U748 by the Microprocessor, the current path for the decimal point is provided by Q850.

The selected color of the bicolor, scale-factor LED (either red or green) is determined by the position of S844A, the VOLTS Cursor Function switch. When the switch is pushed in, R668 is connected to the +5-V supply, and the appropriate red LED will be illuminated by the output of U748. The green LED will be connected to the +5-V supply through R669 whenever the VOLTS push-button switch is out; a green LED selected by U748 will be illuminated to indicate the scale factor when a time measurement is being made.

STORAGE DISPLAY RAM AND Z-AXIS

The portion of the A16 Storage Display Board shown on diagram 15 performs several different functions. On this board a signal is produced to provide the drive to the Z-Axis circuitry of the oscilloscope for the display of cursors and stored waveforms. Other circuitry included is the Display Memory (a RAM) which stores the vertical data used to construct the displayed waveform. Additional circuitry produces the clocking and control signals required to time the operation of the display circuitry. A functional block diagram of the Storage Display RAM and Z-Axis circuitry is located in the "Diagrams" section of Volume II of this manual.

Display Control Register

Control bits are latched into U723 from the Microprocessor bus when the $\overline{\text{DISREG}}$ strobe is decoded from Latched Address Decoder U213 (diagram 17). Outputs from U723 are fed to U623 in the Display Control Logic circuitry to control starting and stopping the display. Other outputs are fed to the Storage Display X- and Y-Axis circuitry. The purpose of the output signals is discussed in the descriptions of the circuitry with which they are used.

Display Control Logic

Logic gating contained in the Display Control Logic circuitry combines signals to produce the select and write signals for the Display and Dot Memories. In addition, control bits latched into Display Control Register U723 are used to produce the display-on (DISPLAY) and display-done (DISDN) signals that indicate whether the display is either on or off.

The circuit composed of U623 and U618B provides the gating and output logic for starting and stopping the display. The START level (U723 pin 5) is ANDed with the DISDN signal coming from the $\overline{Q}$ output of U618B pin 8 and a 250-kHz frequency from U245 pin 3. This frequency is derived from the 5-MHz Microprocessor clock frequency ($\overline{\text{MPUCLK}}$) to clock flip-flop U618B.

When the display is off, DISDN from U618B pin 8 is HI. On the first falling edge of the 250-kHz pulse (after the START signal from U723 goes HI), U618B is clocked by the rising edge of the logic pulse from U623 pin 6. With START also applied to the D input of U618B pin 12, a HI is placed on U618B pin 9 to start the display (see Figure 3-27). Then DISDN will go LO, and both the 250-kHz clock frequency and the START level are no longer enabled through the logic gating.

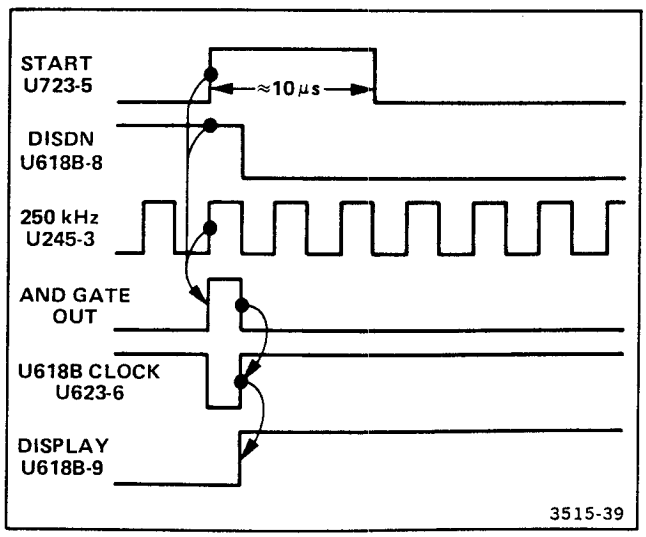

Figure 3-27. Display-start timing diagram.

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The display is stopped by control bits from U723 and address outputs Q_7, Q_8, or Q_9 from Display Address Counters U413 and U418. A choice of 128 counts, 256 counts, or 512 counts is programmable by the Microprocessor. Setting HI any of the STOP control bits from U723 will enable one of the input gates of U623. When the Display Address count bit applied to the enabled gate also goes HI and then LO, the rising edge of the output from U623 pin 6 clocks U618B. The START signal on U618B pin 12 is LO, so U618B pin 9 (DISPLAY) goes LO to stop the display.

The Microprocessor can stop the display at any time by applying the $\overline{\text{STOPDIS}}$ signal (from U213 pin 7, diagram 17) to the reset input of U618B pin 13.

Clock Divider and Display Clock Multiplexer

In this circuitry the Microprocessor 5-MHz clock is divided in U245, a dual-decade counter, to produce 500-kHz, 250-kHz, and 50-kHz clocking signals (Figure 3-28). The 250-kHz clock is used to advance the Display Address Counters for all display except the ENVELOPE display.

For the ENVELOPE display, the minimum and maximum data point values are stored alternately in the Display Memory. The display is swept between the maximum and minimum values to produce the envelope fill, and then a 256-point minimum envelope and 256-point maximum envelope are displayed to complete the ENVELOPE display. Each address advance for the 256-point displays is done at a 500-kHz rate to obtain the same overall display rate for all the displays at the vertical signal output filter (diagram 16).

Both the 500-kHz and the 250-kHz clock signals are fed to one half of U528, a 4-line-to-1-line multiplexer used to select the Display Address Counter clock frequency. The 50-kHz frequency is fed to the Microprocessor circuitry (diagram 18) to be further divided and to provide one of the Microprocessor interrupt signals.

The other half of Multiplexer U528 is used to select the least significant address bit of the Display Memory. This bit comes from either the output of Address Counter U407 at pin 13 (Q_1) or the ODD signal from U223 pin 2 (diagram 17). The ODD signal selects either the odd or even Display Memory addresses during an ENVELOPE display.

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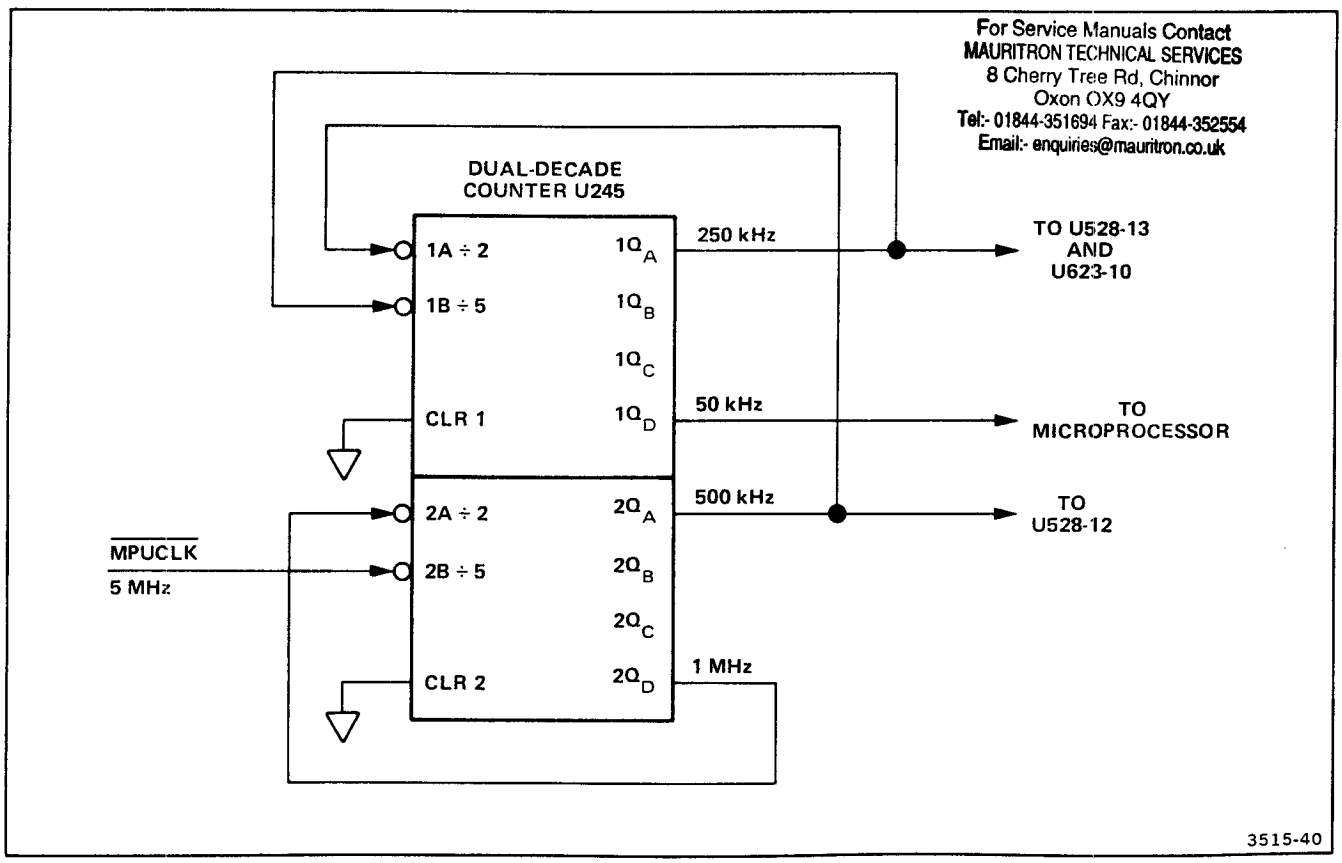

Figure 3-28. Simplified illustration of Clock Divider U245.

The Q_1 counter output controls the least significant bit of the Display Memory during a Microprocessor read or write cycle, and it controls all displays except ENVELOPE. During a read or write cycle, the Q_1 output of U407 follows the Microprocessor AD1 address or data bus line.

Switching of Display Clock Multiplexer U528 is done by the DISPLAY signal from U618B pin 9 and the BOTH signal (set by the Microprocessor from U223 pin 19, diagram 17). Table 3-10 provides a logic table for the Multiplexer switching operation.

Table 3-10

U528 Switching Logic Table

Display (B)	Both (A)	Memory LSB	Counter Clock	Function
0	0	ODD	$\overline{ALE}$	Microprocessor Read/Write
0	1	Q_1	$\overline{ALE}$	Microprocessor Read/Write
1	0	ODD	500 kHz	ENVELOPE Display
1	1	Q_1	250 kHz	All other storage displays

Display Address Counters

The Address Counter circuit, composed of U407, U413, and U418, performs a dual function. During a Microprocessor read or write of Display Memory, these counters latch the address to be accessed by the Microprocessor. Early in the address portion of the Microprocessor AD bus, DISSEL (from the Microprocessor Address Decoder, diagram 18) is gated through U643D to place each counter in the Load mode. Since the DISPLAY signal is LO, address latch enable signal $\overline{ALE}$ is selected by U528 to clock the address levels on bus lines AD0 through ADRA into the counters.

During the display of a stored waveform, the starting address of the display in memory is loaded into the counters by accessing the first data point address. The Q_0 level from U407 pin 14 is a HI (from the AD0 bus line) that is fed to the Track/Hold circuit in the Storage Display vertical circuitry (diagram 16) to place that circuitry in the Track mode.

The START signal from U723 pin 5 is set HI to prevent $\overline{ALE}$ from being selected by U528 to clock the Address Counters. With the DISPLAY signal HI, Display Clock Multiplexer U528 selects either the 500-kHz clocking signal (for ENVELOPE display) or the 250-kHz clocking signal (for all other displays) to increment the Address Counters. A HI DISPLAY signal enables U407, U413, and U418 as counters, and the count begins from the address of the first data point (access by the Microprocessor to set the starting point address). Counting continues until one of the STOP numbers set in U723 (STOP 128, STOP 256, or STOP 512) is reached to produce a DISDN signal from U618B.

Display and Dot Memories

The Display Memory RAM (U328 and U334) is selected by the inverted DISRAM signal from U238D pin 13, and the Display Memory Buffer is enabled (through U238A) to gate data either to or from the Display Memory. For a memory write, DISSEL is gated with WR through U643A to gate data through U731 from B to A into the Display Memory. When the memory is read, WR is LO, and data is gated from A to B in U731.

In a Microprocessor read from or write into Display Memory operation, U328 and U334 behave in the same manner as the Microprocessor System Memory.

Access to Dot Memory U234 is obtained in the same manner as just described for the Display Memory. However, in selecting the write only Dot Memory, the select signal (DOTRAM) is gated through U238C; while the Display Memory select signal (DISRAM) is not present. Thus neither Display Memory Buffer U731 nor the Display Memory is enabled.

To display a waveform, the Microprocessor loads the waveform's Y-Axis data point values into the Display Memory. If TIME Cursor dots are to be displayed, zeros are written into the Dot Memory at the two addresses of the data points to be intensified. The CSEL and $\overline{LINCUR}$ signals both are set to HI, placing a HI enabling level on U238D pin 11 and U238C pin 9. This allows both the Display Memory and the Dot Memory to be selected during the stored waveform display.

The START signal is sent, and the display is started as discussed previously. The Address Counters start counting at a 250-kHz rate, and vertical data is fed from the Display Memory to the Vertical digital-to-analog converter (DAC) in the Storage Display X- and Y-Axis circuitry (diagram16). Data continues out of the Display Memory until one of the STOP levels is reached by the Address Counters.

The Display Memory does not follow the Q_0 output of the Address Counter, so a data word goes to the vertical

DAC every 8 μs (125-kHz rate). However, the Dot Memory, which drives the Z-Axis output, does follow the Q_0 address line. This allows a dot to be placed between two vertical data points of the displayed waveform.

Line Cursors

When a VOLTS cursor is displayed, the value of the cursor's vertical position is latched into Line Cursors Register U737 by the $\overline{\text{LINER}}$ strobe. Then the $\overline{\text{LINCUR}}$ signal is set LO to enable the register output onto the display data bus, DD0-DD7. The $\overline{\text{LINCUR}}$ strobe going LO also prevents the CSEL signal at U523B pin 4 from enabling the Display and Dot Memories.

The Microprocessor then starts a display cycle with the STOP 128 level set (from U723 pin 6), and the cursor level is fed to the Vertical DAC to display a horizontal line.

Overrange/Underrange

A logic gating circuit composed of U631, U637, and U648 provides signals to force the Z-Axis to blank if the Y-Axis value is beyond the range of the digital display system (255-to-0). An all HI output on the vertical data bus is detected by U631, and an all LO output is detected by U637. If either of these conditions becomes true, a LO is gated to the output of U648. This LO is then applied to the D input (pin 2) of flip-flop U618A in the Z-Axis Control circuitry.

Another gating path through U648 is used to generate the dashed cursor display seen before a valid waveform has been stored in the Acquisition Memory. The ACTIVEL signal is generated by the Microprocessor, via U223 (diagram 17), and is then ANDed with the Q_2 output of the Address Counters to produce a square-wave output used to toggle flip-flop U618A.

Z-Axis Control

Control of the Z-Axis signal for the stored waveform display is accomplished by flip-flop U618A. If DASH (Q output, pin 5) is HI, the Z-Axis output will be on; and if LO, the Z-Axis will be off. During a ground reference dot display, the Z-Axis is forced on by setting $\overline{\text{ZAXON}}$ LO on the set input (pin 5) of U618A. If $\overline{\text{ZAXON}}$ is HI while DISPLAY (pin 1) is LO (display not running), the Z-Axis will be held off.

When the display is running, the logic output from U648 is clocked into U618A by the Q_0 bit (LSB) from U407. The Q_0 bit rising edge turns on the Z-Axis output after the new vertical data word has settled on the display data bus.

Z-Axis signal current is controlled by current-switching transistor pairs in five-transistor array U378. When the display is to be on, signal current is supplied to the oscilloscope Z-Axis circuitry (diagram 11) via J486.

When DASH from U618A is HI, the base of U378A becomes biased into conduction, and U378B switches off. If DASH is LO, U378B conducts to shunt the Z-Axis signal current to ground.

A dot is supplied similarly by the $\overline{\text{DOT}}$ signal from Dot Memory U234 controlling the conduction of the U378D and U378E transistor pair. When $\overline{\text{DOT}}$ is LO, Z-Axis signal current is supplied by U378E. No dot appears when $\overline{\text{DOT}}$ is HI.

Cursor Positioning

Positioning of both the VOLTS cursors and the TIME dots is performed by the circuit composed of U788, U776, and U770 in conjunction with the CURSOR control knob and CURSOR SELECT push-button switch. Two cursors are displayed (in either VOLTS or TIME Cursor mode), but only one cursor at a time is controlled by CURSOR control potentiometer R881. The CURSOR SELECT push-button switch S881B is a momentary contact switch. When S881B is closed, the A_6 input of Cursor Register U770 is pulled LO. It is pulled HI again as the switch is released. The pulse produced is the clock input to a control firmware toggle flip-flop that switches the active cursor. The stationary cursor will remain displayed at the position set by the CURSOR control knob.

The CURSOR control knob is an assembly made up of potentiometer R881 and switch pair S881A. While both contacts of S881A are closed, the linear voltage changes, produced at the wiper of R881, produce a linear change in the position of the active cursor. Near either end of the potentiometer rotation, one of the contacts of S881A will open, and the A_4 input of the Cursor Register will be pulled HI. With A_4 HI, the position of the active cursor will change more rapidly at a rate proportional to how far the knob is rotated.

The R881 wiper-arm voltage is applied to U788, a voltage-to-frequency converter. A digital logic output, with a frequency proportional to the voltage input level, is applied to the clock input (pin 12) of U776, a three-digit, BCD counter. At regular intervals, the Microprocessor reads the counter output through Buffer U770. The CURSOR strobe, generated from U213 (diagram 17), enables the counter output onto the Microprocessor bus to be read.

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Timing of the Microprocessor read operation of U770 is as follows:

1. The PRDONE signal has a 10-ms period that is HI for 2 ms and LO for 8 ms. A rising edge of the PRDONE signal interrupts the Microprocessor (discussed in the "Microprocessor" circuit description) and stops the counter so the Microprocessor can read the current count.

2. The LATCH signal (U776 pin 10) is sent by the Microprocessor to latch the BCD digits.

3. The $\overline{\text{CURSOR}}$ strobe is sent to U770 to enable the first digit onto the Microprocessor bus.

4. The second digit is addressed by sending the ADVAN signal to the counter at pin 4.

5. The second digit is read.

6. Steps 4 and 5 are repeated to read the third BCD digit from the counter.

7. The RESET signal is applied to U776 pin 13 to set up the counter for the next counting sequence.

8. The PRDONE signal goes LO and again the counter starts counting the output frequency from U788.

The cursor position on the display moves in proportion to the count change derived from the CURSOR control knob rotation. If the count remains the same each time, the cursor position does not change. Increasing the count causes the active cursor to slew in one direction, and decreasing the count causes the active cursor to slew in the opposite direction from its current position. The linear displacement region of R881 moves the cursor position approximately one division before one of the contacts of S881A opens, causing the cursor position slew rate to increase.

STORAGE DISPLAY X- AND Y-AXIS

The circuitry shown on diagram 16 produces the X-axis and Y-axis signals to the oscilloscope horizontal and vertical amplifiers when a stored waveform is displayed. In addition, the normal trigger to the A and B Trigger Generator is selected from either the digital storage Input Channel Switch or the oscilloscope Vertical Switching Logic circuit. Channel 1 and Channel 2 vertical positioning signals are generated for use in waveform acquisition and during a SAVE Storage Mode display. A functional block diagram of the Storage Display X- and Y-Axis circuitry is located in the "Diagrams" section in Volume II of this manual.

Vertical Signal Path

Digital words representing either the eight-bit stored waveform or the 10-bit voltage cursors are applied to Vertical Signal DAC U435 and are converted to an analog current signal. The +7.5-V reference voltage applied to U435 pin 15 sets the reference current for digital-to-analog conversions.

The least significant bit and second least significant bit inputs (VLSB and V2SB) at pins 13 and 12 are used only during the voltage cursor display. For a stored waveform display, VLSB and V2SB are set LO.

Output current from DAC U435 is converted to a voltage by feedback amplifier U545. A feedback resistor for U545 is provided internally in U435 to allow simple connection of the amplifier. Since U545 is connected as an inverting amplifier, the voltage output ranges from zero, for all LO digital inputs to the DAC, to −7.5 V for all HI digital inputs.

Stabilization of the U435-U545 circuit is provided by C448, and diode CR342 protects the pin 1 output of U435 from reverse biasing that may occur during power-up. High-frequency bypassing of the supply voltages is supplied by capacitors throughout the circuit.

The vertical signal voltage, ranging from 0 to −7.5 V, is changed to signal current by R567 and applied to U571B pin 6, the inverting input of the operational amplifier. An offset current is added to the signal by R569 (from +VREF) to center the vertical signal around ground, and this signal is amplified with unity gain through U571B. The combination of feedback resistor R565 and input resistor R567 sets the gain, and R568 supplies a compensating bias current at pin 5 to balance out any leakage current. High-frequency compensation of the feedback circuit is provided by capacitor C570.

Vertical positioning current for a SAVE Storage Mode display waveform is added to the vertical signal at U571B pin 6. This signal comes from either U466B (the CH 1 Position switch) or U466A (the CH 2 Position switch). The method used to generate the vertical positioning signals is discussed later in this circuit description.

The output voltage from U571B is applied to pin 16 of Vertical Gain DAC U766 where it is converted to a current signal. The DAC is programmable by the Microprocessor to control the vertical expansion of the stored waveform display. Vertical gain data is latched into U766 from the Microprocessor bus by the $\overline{\text{VGAIN}}$ strobe from the Display Control circuitry (diagram 17). The vertical gain digital data is used to control the gain of U571A.

Feedback from the output of U571A pin 1 is applied to the V_{ref} input of U766 at pin 15. Gain of U571A is controlled by changing the amount of attenuation of the negative feedback signal introduced by U766 through programming from the Microprocessor. Increasing the attenuation decreases negative feedback and increases the amplifier gain. Conversely, decreasing the attenuation of the negative feedback signal decreases the gain of U571A. The signal current is added to the feedback current at U766 pin 1 and applied to the inverting input of U571A pin 2.

Voltage excursions from U571A are limited to the range of ±5 V by the network composed of CR664, CR665, CR666, CR667, and R670. The network is shunted by C571, a stabilizing capacitor for U571A. Additional stabilization for analog gains of less than 10X is provided by the circuit composed of Q570 (a p-channel, junction field-effect transistor) and R563.

When the VERTX10 signal is LO, Q570 is biased on, allowing R563 to act as a low impedance on the input pin of U571A, dampening its response. The low impedance of R563 is removed from the input circuit of U571A when Q570 is switched off by VERTX10 going HI. This allows the frequency response to increase for a X10 gain setting. The Vertical Gain DAC is never programmed for gains higher than 10.

From the output of U571A pin 1, the vertical signal is applied to pins 4 and 5 of analog switch U466C via R566. The combination of U466C, U523D, and C348 performs a sample-and-hold function. Large switching transients from the Vertical Signal DAC are rejected by allowing the vertical signal to be applied to U352 only after the signal has settled. New waveform data is being applied to the DAC inputs at a 125-kHz rate.

A 250-kHz signal is applied to AND gate U523D pin 12, and a 125-kHz signal is applied to pin 13. The AND gate is enabled when both input signals are HI, thus allowing U466C to pass the vertical signal to the input of amplifier U352 and charge the hold capacitor C348.

In the short time period that U466C is enabled, hold capacitor C348 must be charged to the new signal level. The RC combination of R566 and C465 aids the output of U541A in supplying the current required to rapidly charge C348. The hold capacitor retains the signal voltage level between each data level change.

Amplifier U352 is a unity-gain, operational amplifier with a high input impedance. The amplifier buffers the hold capacitor voltage level and supplies the signal current to an active filter network composed of U558 and associated components. The filter network has a third-order, low-pass response that approximates an ideal signal averaging filter for the vertical signal. The response of the filter is such that a step input produces a nearly linear vector from initial to final value at the output.

The filter circuit includes the Storage Vertical Centering adjustment (R345) that is used to supply an offset voltage through R348 that centers the stored display on the crt graticule. Output signals from U558 are applied directly to Storage Vertical Gain control R571. This gain control is used to set the attenuation of the signal path composed of R571, R580, R581, and C676 to the base of Q578. Transistors Q578 and Q580 are configured into a differential amplifier that converts the single-ended vertical signal into a balanced, differential output signal.

A diode switching circuit at the output of the differential amplifier selects either the stored signal or the A External Trigger View signal to be passed on to the oscilloscope Vertical Switching circuitry (diagram 3). During NON STORE mode operation, $\overline{\text{STORDIS}}$ at the base of U378C is HI, biasing it on and forward biasing CR584 and CR586. The stored display vertical signal current is shunted to ground through U378C; CR587 and CR585 are reverse biased to prevent any signal current from passing on to the oscilloscope Vertical Switching circuit. During a storage mode display, $\overline{\text{STORDIS}}$ is LO, U378C is biased off, and the stored signal is allowed to pass through CR587 and CR585 to be displayed.

In all modes (Storage and NON STORE), Q680 is biased on except when TRIG VIEW vertical mode is selected in NON STORE. When TRIG VIEW is selected in NON STORE, Q680 is biased off, and the A External Trigger View signal is allowed to pass through CR686 and CR684 to the Vertical Switching circuit to be selected for display.

Vertical Positioning

Both Channel 1 and Channel 2 positioning is accomplished by identical circuits. Channel 1 vertical positioning is discussed for the purpose of describing the circuit operation.

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POSITIONING DURING ACQUISITION. Position voltage from the CH 1 POSITION potentiometer is buffered by unity-gain operational amplifier U374C and is then directly applied to the Acquisition Input Channel Switch (diagram 13) via P138 to offset the dc level of the waveform being acquired.

POSITIONING OF A SAVE STORAGE MODE DISPLAY. After a waveform is acquired and the SAVE mode entered, a positioning signal is produced to offset the dc level of the waveform display. The output voltage of CH 1 Vertical POSITION control buffer U374C is applied to a Track-and-Hold circuit composed of U373B, U377, U385, and U374D. The circuit is arranged as a successive-approximation A/D converter with a digital hold feature. The circuit uses closed-loop feedback to produce a voltage that tracks the output from the POSITION control.

Feedback voltage from U374D and position voltage from U374C are summed at the input of analog voltage comparator U373B pin 5. Output from U373B is applied to successive-approximation register U377 at pin 6.

The digital output of U377 is applied to DAC U385 where it is changed to an analog output current. Output current applied to the inverting input of feedback amplifier U374D is converted to a voltage level and applied to pin 5 of U373B, through R470, to form the complete closed-feedback loop.

At the start of each successive approximation conversion, the Q_0 output of U377 is HI, while all the other outputs are LO. The gain of U374D is set, via the feedback input of U385, to produce an output voltage equal to one-half of the POS REF voltage at U385 pin 15, but of the opposite polarity. The output of U374D is compared to the incoming vertical position voltage by U373B. If the output of U374D is higher than the vertical signal voltage, the output of U373B will go LO, and on the next rising edge of PRDONE, U377 will set its Q_0 output LO and its Q_1 output will go HI. The gain of U374D, as set by U385, will be reduced to lower its output to one-quarter of the POS REF voltage.

The new output voltage level is then compared to the vertical position voltage, and if the output is still higher, U377's Q_1 output will go LO and its Q_2 output will go HI to again lower the gain of U374D. However, if the output of U374D is now lower in magnitude than the vertical position voltage, U373B output will go HI when the comparison is made. On the next rising edge of PRDONE, Q_1 of U377 will remain HI and Q_2 will also switch HI. The gain of U374D is raised to produce an output voltage equal to 0.375 times the POS REF voltage.

With each clock, the output bits of U377 are set and tested until all eight bits have been checked. At the end of nine PRDONE cycles, the output of U377 is an eight-bit digital representation of the vertical position voltage, and the gain of U374D is set to produce a voltage level equal in magnitude but of opposite polarity to the vertical position voltage.

Upon entering the SAVE Storage Mode, TRACK/$\overline{\text{HOLD}}$ at U377 pin 9 goes LO, and the circuit enters the HOLD state. The current conversion in progress by U377 is completed, and then the output ceases to change state. The voltage output of U374D remains equal in magnitude, but of opposite polarity, to the vertical position voltage level that was present when the HOLD state was entered.

After SAVE Storage Mode is entered, and prior to any further vertical positioning, the position voltage at pin 15 of U466B is zero due to the summation of voltages from U374C and U374D through R472 and R473. Adjusting the Vertical POSITION control causes the voltage at U466B pin 15 to vary in proportion to the amount of rotation.

If a Channel 1 waveform has been stored, CH 1 POS at U466B pin 10 goes HI when SAVE Storage Mode is entered. Also the input voltage at pin 15 is connected to the vertical signal path at pin 6 of U571B. Any POSITION control voltage change is applied to the vertical signal dc level to effect positioning of the displayed signal.

Channel 2 SAVE positioning is accomplished in an identical manner by the circuit composed of U374A, U373A, U374B, U365, U359, and U466A.

If more than one channel is displayed, the position voltages are applied to the input of U571B in a time-shared manner to effect positioning of the appropriate trace. When ADD vertical mode is displayed, both U466A and U466B will close to allow both CH 1 and CH 2 POSITION controls to affect the vertical position of the ADD trace.

Horizontal Signal Path (X-Axis)

The voltage ramp that produces the horizontal deflection for the stored display originates in the Ramp Generator, composed of Q441, Q442, and U444. Just before the start of the sweep, DISDN at the gate of Q442 is HI, and Q442 is biased on to hold the collector of Q441 at a fixed level near ground potential. The actual voltage on the collector is determined by the JITTER signal (attenuated by R640 and R439) applied at the source of Q442.

The JITTER signal is produced by DAC U659 under control of the Microprocessor. This signal adds a horizontal offset to the ramp to compensate for the sample-clock-to-trigger jitter encountered in the Time Base (diagram 19). Output level of operational amplifier U553A is controlled by the data latched into U659 from the Microprocessor in the same manner as discussed previously in the "Vertical Signal Path" description. A new JITTER offset voltage is generated for each waveform display produced.

When DISDN (from U618B-8, diagram 15) goes LO, a 70-mV step occurs at the collector of Q441 as Q442 turns off. The step occurs as charging current (that had been flowing through Q442) starts flowing through C437 and R438. After the step, the collector voltage of Q441 continues to rise, but now with a constant slope, as C437 charges from the constant current supplied by Q441. The voltage reaches approximately 6 V in 4 ms, when DISDN goes HI again to reset the Ramp Generator at sweep end. The ramp voltage is buffered by U444, a unity-gain, high-impedance buffer amplifier.

The output ramp from U444 is applied to Horizontal Gain DAC U653, which with operational amplifier U553B, forms a programmable gain amplifier circuit similar in operation to the Vertical Gain DAC and amplifier, U766 and U571A, discussed previously. Under control of the Microprocessor, the stored display is expanded horizontally to the correct scale as determined by the TIME/DIV switch.

Refer to Figure 3-29 during the following circuit description. The ramp from U553 pin 7 is fed to Q569 in the Horizontal Amplifier (diagram 10). Transistor Q569 is a common-base amplifier that provides a low-impedance termination for the ramp output from U553B and a high-impedance output to the Horizontal Amplifier. Ramp current to Q569 is controlled primarily by R350 in series with Storage Horizontal Gain potentiometer R550. Horizontal offset current is added through R351 and the Storage Horizontal Centering potentiometer R346 to center the display horizontally.

High-frequency noise suppression for the horizontal ramp is provided by C570 and R567 (diagram 10). The time constant of C570 and R567 is long enough that, if an ideal ramp were applied, a significant amount of distortion in the ramp start would occur. However, the time constant of C570 and R567 is identical to the time constant of C437 and R438 in the collector circuit of Q441. The ramp has an initial step as a result of the action of C437 and R438 when the Ramp Generator started, and the step is canceled by C570 and R567. The resultant current signal to Q569 is close to an ideal ramp with very little noise present.

When the storage display is not in use, $\overline{\text{STORDIS}}$ at the base of Q345 goes HI to forward bias Q345. The storage horizontal ramp current is then shunted to ground to prevent it from reaching the Horizontal Amplifier.

Reference Voltages

The +7.5-V and −7.5-V reference voltages used by the Storage Display circuitry are generated in a circuit composed of U783, U559A, and U559B. A stable +2.5 V is output from pin 2 of U783, a reference voltage IC. Operational amplifier U559B multiplies the +2.5 V three times to produce a low-impedance +7.5-V source for $+V_{REF}$. The output of U559B is inverted with unity gain by U559A to produce $-V_{REF}$. Pull-up current to aid U559B in driving all of the required loads on the $+V_{REF}$ line is supplied through R287.

MAIN POWER SUPPLY

The Main Power Supply circuit (diagram 20) provides the operating power for this instrument from five regulated supplies. Regulation provides stable, low-ripple output voltages. Three unregulated output voltages are supplied for use in special circuit applications. Figure 3-30 shows a detailed block diagram of the Power Supply circuit.

Power Input

Power is applied to the primary of transformer T14500 through Line Fuse F14500, POWER switch S108, Thermal Cutout S14520, Line Voltage Selector switch S226, and Regulating Range Selector switch R216. Line Voltage Selector switch S226 connects the split primaries of T14500 either in parallel (for 115-V nominal operation) or in series (for 230-V nominal operation). Line Fuse F14500 value is selected to provide the required protection for each nominal line voltage. Refer to "Replaceable Electrical Parts" list in Volume II of this manual for correct fuse values.

Secondary Circuit

The −8-V, +5-V, +15-V, +55-V, and +110-V power supplies are series-regulated supplies. Amplifiers U712A, U712B, U506A, and U506B are two-channel, high-gain cells with differential inputs. These amplifiers monitor variations in the output voltages and supply correction information to the series-regulating transistors (except for the +110-V supply). The +55-V supply is the reference voltage source for the remaining supplies, and its output must be correct to enable the other supplies to operate within their regulating limits.

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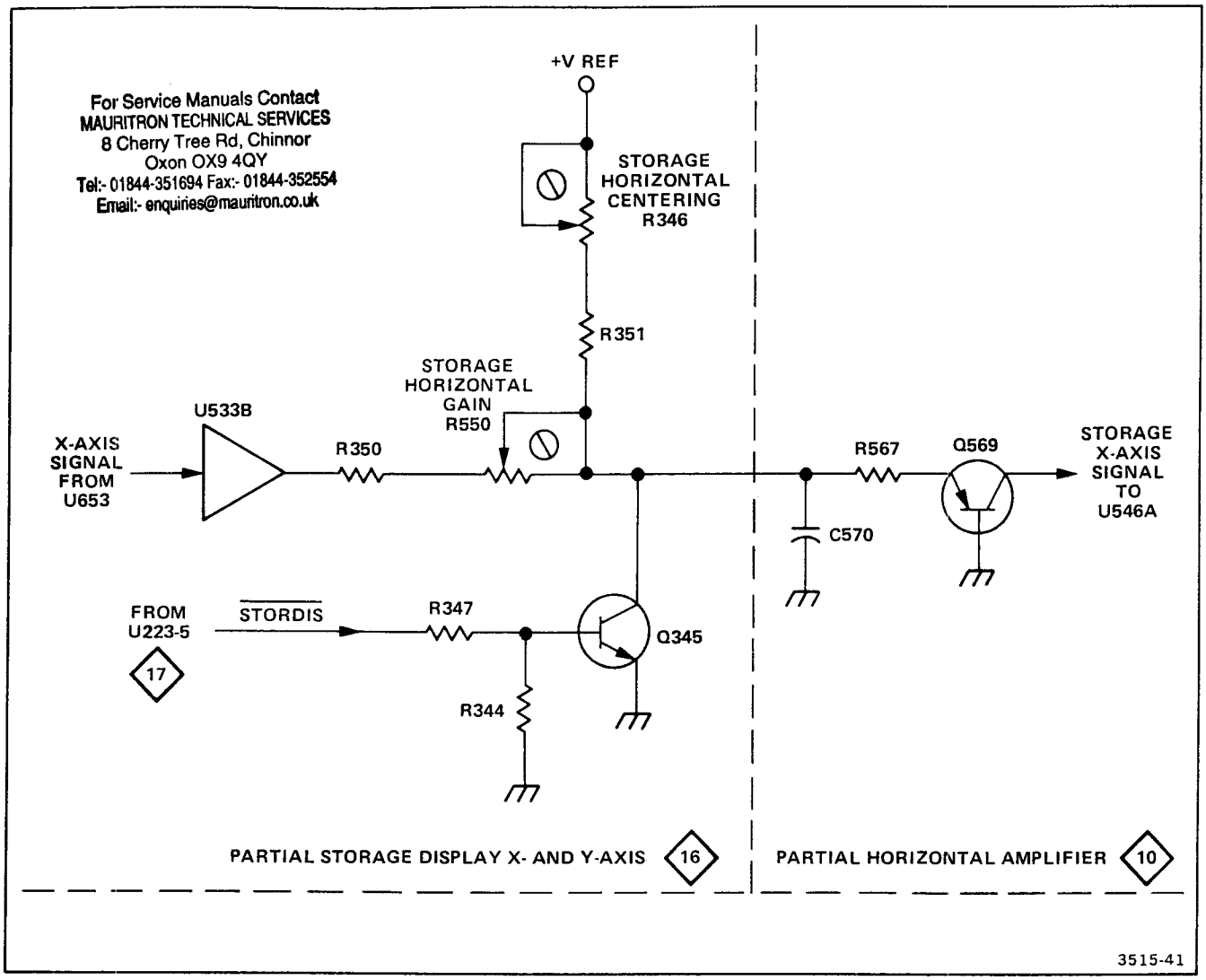

Figure 3-29. Partial circuit diagram of the Storage Display X-Axis signal path.

Current-limiting circuits provide short-circuit protection for each of the regulated supplies. The following description applies only to the +55-V current-limiting circuit; the other current-limiting circuits operate in a similar manner.

In the +55-V supply, Q606 is normally biased off. Under normal conditions, the base voltage of Q606 is about +55 V. Under conditions of power supply loading, when the supply current increases, the voltage drop across R602 (in the emitter circuit of Q501) increases. The increasing emitter voltage level is coupled through the base of Q501 to a voltage divider (composed of R508 and R507) thereby causing the base of Q606 to go more positive. If the +55-V supply is loaded down sufficiently, Q606 will turn on. The collector of Q606 then moves in the negative direction, and Q503 and Q501 begin turning off to limit the output current. Even though the supply is limited, transistor Q501 will continue to conduct current in order to produce enough voltage drop across R602 to keep Q606 biased on. The limited supply output voltage can be any value between its regulated value and zero, depending on the extra load it is trying to supply (Figure 3-31). The limiting transistors for the other supplies are:

+15 V	Q704
+5 V	Q617
−8 V	Q406
+110 V	Q740

Figure 3-31 also shows the action of the current limiting (foldover) circuit. At point A, Q606 begins conducting. At point B the supply is directly shorted to ground through a current meter.

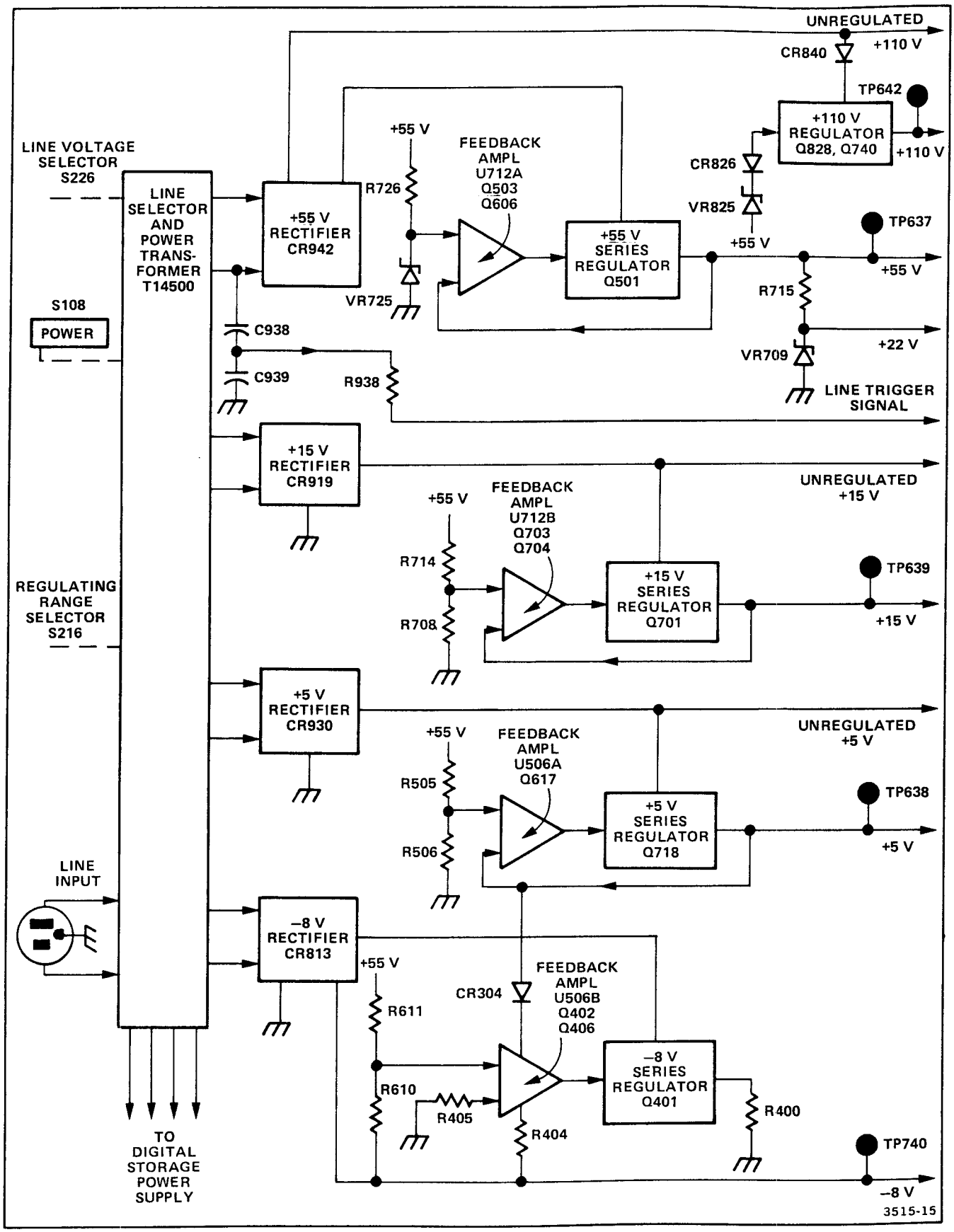

Figure 3-30. Detailed block diagram of the Main Low-Voltage Power Supply circuit.

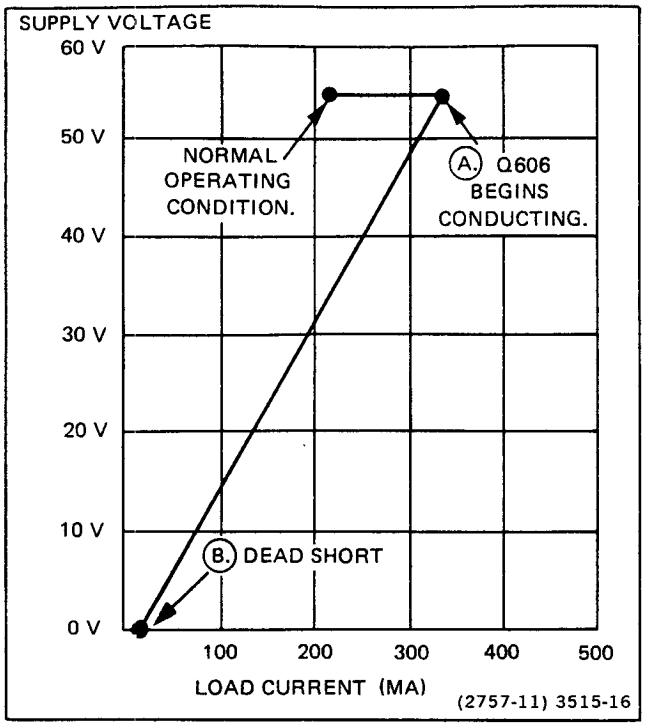

Figure 3-31. Foldover circuit action.

Two of the unregulated output voltages, +110 V and +15 V, supply the HV Oscillator circuitry of the CRT circuit (diagram 11). The third unregulated output, +5 V, supplies power to the Scale Illumination lamps.

A sample of the ac voltage (present in the secondary of T14500) is shaped by the circuit composed of C938, C939, and R932 and applied to the trigger circuitry for use in the LINE position of the A Trigger SOURCE switch.

STORAGE POWER SUPPLY

The Storage Power Supply (diagram 21) produces the low-voltage power required for the digital storage portion of the oscilloscope. A high-efficiency switching converter supplies the +5-VS high-current logic supply. Three-terminal regulators and associated circuitry provide the other stable, low-ripple output voltages. An unregulated source provides the fan supply voltage.

Power Input

Power is obtained from two fused secondaries of main power transformer T14500. The secondary voltage from the tapped secondary is applied to CR190, a full-wave bridge rectifier whose output is applied across filter capacitors C292 and C350. Noise-suppression capacitors C197 and C188 are placed across the secondary windings to reduce conducted interference back into the power source.

Prefiltering for both the +12-VS and +5-VS supplies is provided by C292, and C350 provides filtering for the −12-VS power supply.

Three-terminal regulators U190 (+12 V) and U560 (−12 V) provide all the regulation required for the + and −12-VS supplies. Additional bypassing to increase regulator stability is provided by C190 (from U190 pin 3 to ground) on the +12-VS output and by C558 and C560 on the −12-VS regulator.

In the −12-VS output, CR567 protects both U560 and the components in the output load from damage in the event of a short to a positive supply.

+5-V Switching Regulator

A high-efficiency regulator circuit composed of U470, U566A, Q380, Q280, Q259, and Q269 provides the +5-VS regulated output voltage. Three-terminal reference U470 produces a highly stable +2.5-V reference voltage used for the +5-VS supply and for the −6-VS supply. The reference is multiplied by two in U566A, a high-input-impedance operational amplifier, to supply a +5-V reference from a low-impedance source.

An RC filter composed of R471, R470, and C571 decouples the output of U566A to prevent switching transients at the base of Q380 from affecting the output of U566A.

The reference voltage is applied to the base of Q380, which is one-half of a voltage comparator used to turn switching transistors Q259 and Q269 on and off.

ASTABLE SWITCHING CIRCUIT. An astable switching circuit composed of Q380, Q280, Q259, and Q269 dynamically maintains the dc voltage present at the base of Q280 at the same level as the +5-V reference applied to the base of Q380. Steady-state circuit operation is described in the following discussion.

As an initial starting point, assume that Q259 and Q269 are beginning to conduct. Current through T160 produces a positive voltage step that is coupled through R278 and C279 to the base of Q380. The positive step turns Q380 fully on to drive to saturation Q259 and Q269, functioning as a Darlington pair. Supplying the collector current of Q259 from a tap on T160 allows Q269 to approach full saturation, thus obtaining more efficient switching.

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In the steady-state operation of the circuit, the dc voltage at C162 is approximately +5 V. During the conduction time of Q269 and Q259, the voltage across C162 rises slowly as the current through T160 increases. At the same time, the voltage step at the base of Q380, applied when Q269 turned on, is decreasing rapidly as C279 discharges. When the base voltage of Q380 meets the base voltage of Q280, circuit operation begins to switch, and Q259 and Q269 begin to turn off. As they turn off, the induction of T160 forces a rapid negative step at the collectors of Q259 and Q269 that is coupled to the base of Q380 through R278 and C279. The negative step reinforces the turn-off sequence, which is in progress, to rapidly complete the switching. With Q259 and Q269 off, the current from T160 flows through clamp diode CR169, a Schottky power diode.

As the output load continues to draw current, the voltage across C162 slowly falls, while the base voltage of Q380 rapidly rises as C279 discharges the negative step applied at turn off. Again, when the base voltage of Q380 meets the base voltage of Q280, both Q259 and Q269 will begin to turn on to repeat the switching cycle.

When the circuit is operating at nominal input voltage, the switching frequency is set by the time constant of R278, C279, and R470 to approximately 30 kHz. As the input voltage and output loading vary, the operating frequency of the switching circuit varies to maintain regulation of the output voltage.

TURN-OFF SWITCHING. A circuit composed of C171, CR170, and R170 provides protection to Q269 during the transistor's turn off. When the collector voltage of Q269 starts to fall, CR170 becomes forward biased to allow current from T160 to flow through C171 until CR169 becomes forward biased and turns on. Therefore, Q269 does not have to handle the full current while the full supply voltage is present at turn off.

While Q269 is turning on, CR170 is back biased and C171 is charged up slowly through R170 to the output voltage. With C171 charged to the output voltage, CR170 becomes forward biased to allow current flow as soon as the voltage across T160 reverses in polarity. The current supplied by Q269 at turn on is limited to that current required by T160, and the current to charge C171 is supplied over a longer time period due to the time constant of R170 and C171.

OVERVOLTAGE PROTECTION. Overvoltage protection for the IC components supplied from the +5-VS power source is provided by a "crowbar" circuit composed of Q157, VR258, and associated components. Zener diode VR258 begins conducting if the +5-VS output exceeds about +5.6 V. When the current through VR258 is high enough to cause the voltage drop across R254 to reach the firing point of Q157, Q157 switches on and drops the output voltage to near ground potential, causing secondary supply fuses F4007 and F4009 to open. The current will continue to flow in Q157 until the flow drops below the maintaining current level.

Service jumper W158 may be removed to isolate the load from the power supply in the event it becomes necessary to perform troubleshooting of the +5-VS supply.

–6-VS Regulator

A separate secondary winding provides the source for the –6-VS supply. Secondary voltage is applied to diode bridge rectifier CR471, and the rectified output voltage from the bridge is filtered by C456. An unregulated output from this point is applied to the oscilloscope ventilation fan.

The input to U570, a three-terminal regulator, is bypassed by C572 to prevent the fan load from affecting the regulator input and to stabilize the regulator.

The –6-VS regulator circuit is composed of three-terminal regulator U570 (nominal –5.2-V output), operational amplifier U566B, and associated components. Pin 1 of U570 is not directly grounded but is held below ground potential by the output of U566B. The additional voltage to ground sets the output voltage level from U570 at –6 V. Operational amplifier U566B is a high-input-impedance device that sums the +2.5-V reference input and the –6-VS output from U570. Any rise in the –6 V toward ground will cause the output of U556B to go more negative, and U570 will pass more current to regulate the –6 VS output. Conversely, if the output of U570 should attempt to go more negative, the output of U566B would move in a positive direction to decrease the current output of U570.

Diodes CR472 and CR473 limit the negative output of U566B to less than approximately –1.4 V, protecting U570 and preventing large negative voltage swings when power is initially applied.

Overvoltage protection for the components supplied by the –6-VS output is provided by a "crowbar" circuit composed of Q577, VR479, and associated components.

GENERAL PURPOSE INTERFACE BUS (GPIB)

The GPIB Option (diagram 23) provides a digital output port for stored waveforms acquired by the 468. The GPIB is composed of an eight-bit bidirectional TTL bus for data transfer, acceptor and source handshake circuitry, one register for control of the interface logic, a buffer to report the current status of the interface to the Microprocessor, and a strobe generator under control of the Microprocessor. A functional block diagram of the GPIB circuitry is located in the "Diagrams" section of Volume II of this manual.

NOTE

Section 8 of the internal Service/Options switch must be set to the closed position to enable the GPIB option. Refer to Figure 5-6 in the Maintenance section of this manual for the switch location.

Strobe Generation

Timing of the interface read and write cycles is controlled by the Microprocessor via strobes generated by U450 and U460. Data present on the AD0 through AD2 Microprocessor bus lines is stored in U450 on the rising edge of the $\overline{ALE}$ signal (from the Microprocessor). When the GPIB is selected by the Microprocessor, the $\overline{GPIBSEL}$ signal is sent to U460 to enable it, and the control bits present on the U460 input pins are decoded to generate the appropriate control strobe.

The $\overline{GPIBSEL}$ signal is a decoded combination of the Microprocessor high address bits plus additional timing to ensure that the read and write cycles occur during a data portion of the Microprocessor cycle. At power-on, register U450 is cleared by the initializing signal ($\overline{INIT}$).

Status Buffer

Status Buffer U330 has the current interface status signals present at its input pins. When the $\overline{RIFSTAT}$ strobe is generated, the interface status is placed on the Microprocessor bus. These status signals are read by the Microprocessor to determine the next operation to be performed.

Control Register

Controlling signals from the Microprocessor are sent to the interface via Control Register U340. Data present on the Microprocessor bus is transferred to the U340 output pins on the rising edge of the $\overline{WIFCTL}$ strobe. The controlling signals remain at the output pins until the next $\overline{WIFCTL}$ strobe is received. The initializing power-on pulse ($\overline{INIT}$) clears Control Register U340.

Bidirectional Data Buffer

The Data I/O Buffer and Latch is composed of U350, U342, U168, and U152. These components send data to and receive data from the GPIB data lines. Message bytes to be placed on the bus from the Microprocessor are latched in eight-bit bytes, into U350 when the $\overline{WIFDO}$ strobe is applied to U350 pin 11. When the Source Handshake circuitry generates the $\overline{SHEN}$ signal, Bidirectional Buffers U168 and U152 place the data byte (present at the U350 output pins) onto the bus data lines.

When the $\overline{RIFDI}$ strobe is applied to U342 during the acceptor handshake, data from the GPIB is read by the Microprocessor, via U168 and U152.

Interrupt

The GPIBINT signal is generated by U310E, U442A and B, and U434C when a bus controller asserts the IFC or ATN signal. The interrupt signal is applied to the Microprocessor RST 5.5 pin to cause an interrupt of the routine in progress. Then the Microprocessor switches to the GPIB service routine.

When the LAT.IFC line from Control Register U340 is set HI (talker or serial poll condition), RIFC is latched into U442B. The latched IFC signal ($\overline{IFCL}$) output is supplied to Status Buffer U330 to be read by the Microprocessor. It is also applied to U434C at pin 11. It is inverted through U434C to become the Microprocessor unterrupt. When the interrupt is received, the Microprocessor reads the Status Buffer to determine the cause of the interrupt ($\overline{IFCL}$ or ATTEN). The LAT.IFC line from the Control Register is then cleared by the Microprocessor. At this time, if the IFC signal is unasserted, the interrupt is removed from the Microprocessor.

The Microprocessor will also be interrupted when the ATN signal is asserted by the bus controller. When the $\overline{RATN}$ signal is generated by the Acceptor Handshake circuitry, it is applied to U430A pin 4 (in the Source Handshake circuitry) and latched. The outputs of U430A are the ATTEN signal (applied to Status Buffer U330 at pin 4) and the $\overline{ATTEN}$ signal (applied to U434C at pins 9 and 10). The $\overline{ATTEN}$ signal is inverted by U434C and applied to the Microprocessor as the GPIBINT signal, and the GPIB service routine is started.

When the Microprocessor reads Status Buffer U330, the ATTEN signal indicates that a controller caused the interrupt by asserting the ATN signal. The Microprocessor clears U430A using the $\overline{ATNFLS}$ strobe after the ATN signal becomes unasserted. The $\overline{INIT}$ signal (applied at power-on to the U430A reset input at pin 1) also clears U430A.

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TALK ONLY and Talk Address Switches

The 468 talk address is operator selected by setting switch S210. When the $\overline{\text{TALKREG}}$ strobe is applied to register U320, the Microprocessor reads the address switch setting information (from switch numbers two through six) on the AD0 through AD4 data bus lines. The TALK ONLY switch (number one) setting information is obtained from the AD7 data bus line.

Acceptor Handshake

The Acceptor Handshake circuitry controls the reception of data bytes from the GPIB. It is active when the ATN signal is asserted on the bus control lines. The negative logic ATN signal is received by U110 and is inverted to produce the RATN signal. This signal is again inverted by U310D to produce the $\overline{\text{RATN}}$ signal that is applied to U110 at pin 12. The $\overline{\text{RATN}}$ signal gates the TNDAC signal (from U410B pin 8) and the TNRFD signal (from U421A pin 12) onto the GPIB handshake lines.

Initially, TNDAC is HI and TNRFD is LO. When these levels are gated onto the bus handshake lines, the controller will put a new data byte on the bus and assert DAV, signaling that the new data is valid.

The DAV signal is received by U121 (in the Source Handshake circuitry), inverted to RDAV and applied to U421A pin 2, U410A pin 3, and U410B pin 13. When RDAV is HI, ATNDAV and TNRFD are both HI. During handshake, the Microprocessor polls Status Buffer U330. When the ATNDAV signal goes HI, the Microprocessor reads the data byte from the GPIB.

After the byte has been read, the Microprocessor sends the $\overline{\text{DATACC}}$ strobe to U410A pin 1 and U410B pin 11. Flip-flop U410A is cleared on the falling edge of $\overline{\text{DATACC}}$ thus removing ATNDAV from pin 5, and TNDAC goes LO on the rising edge. This signals the controller that the data byte has been accepted. When all the devices on the bus have signaled that the data byte is accepted, the DAV signal may be unasserted. The RDAV signal goes LO on U421A pin 2 and U410B pin 13, thus causing TNDAC to go HI and TNRFD to go LO. The interface is now ready for the next data byte to be placed on the bus.

Source Handshake

Placing data bytes to be transmitted onto the bus is controlled by the Source Handshake circuitry. This circuitry is active when the interface has been addressed as a talker and a bus controller is not sending IFC or ATN. Under these conditions, the TADS signal (at U434B pin 3 and U421C pin 10), $\overline{\text{ATTEN}}$ (at U434B pin 5 and U421C pin 9), and $\overline{\text{IFCL}}$ (at U442B pin 4) are all HI. The $\overline{\text{SHEN}}$ signal from U434B pin 6 becomes LO and is applied to Bidirectional Buffers U168 and U152 to gate the data latched into U350 onto the GPIB.

The TDAV signal is gated onto the bus handshake lines, and RNDAC and RRFD are inputs from the listeners on the line. Initially RNDAC is HI, RRFD is LO, nba is LO, SENT is LO, and TDAV is LO. When all the devices on the bus are ready for data, RRFD will become HI, and the Microprocessor will see a HI on the RRFD line (U330 pin 14) as it polls Status Buffer U330. The Microprocessor will then put a data byte on the bus and set nba HI (U434A pin 1). The TDAV signal becomes HI when SENT is LO and RRFD and nba are HI, and the GPIB listeners may read the data.

As the listeners on the bus read the data, they set their RNDAC signal lines LO. When all the listeners have accepted the data byte, the RNDAC control line will go LO, TDAV will go LO, and SENT (U440A pin 5) will go HI. This HI level is read from Status Buffer U330 by the Microprocessor and nba is set LO. The $\overline{\text{SNTACK}}$ strobe from U460 pin 14 is applied to U440A pin 1 to reset SENT LO. At this time, the data byte has been sent, and the Microprocessor starts looking for a HI on the Status Buffer RRFD line (pin 14) in preparation for sending the next data byte.

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CALIBRATION

This section is in two parts. It contains a Performance Check and an Adjustment Procedure. The Performance Check is used to verify that the instrument meets the Performance Requirements listed in the Specification, while the Adjustment Procedure is used to restore the instrument to its original Performance Requirements.

The test equipment listed in Table 4-1, or an equivalent piece of test equipment, is required to accomplish a complete Performance Check and Adjustment Procedure. In Table 4-1, the specifications given for the equipment are the minimum necessary to provide accurate results. Therefore, the equipment used must meet or exceed the listed specifications. Detailed operating instructions for the test equipment are not provided in these procedures. Refer to the appropriate test equipment instruction manual if more operating information is required.

Table 4-1

Test Equipment Required

Description	Minimum Specification	Purpose	Examples of Suitable Test Equipment
1. Variable Autotransformer	Capable of supplying 1.5 A over a range of 108 to 132 V.	Power Supply Regulation check.	General Radio W8WT3VM Variac Autotransformer.
2. Digital Voltmeter	Range, 0 to 140 V; dc voltage accuracy, ±0.15%; 4 1/2 digit display.	Low-Voltage Power Supply checks and adjustments. CRT Grid Bias adjustment. Vertical and Horizontal Centering adjustments. Calibrator Output adjustment.	a. TEKTRONIX DM501A Digital Multimeter.[a] b. TEKTRONIX DM44 Digital Multimeter. c. Any digital multimeter that meets minimum specification.
3. DC Voltmeter	Range, 0 to 2500 V, calibrated to 1% accuracy at −2450 V.	High-Voltage Power Supply check.	a. Triplett Model 630-NA. b. Simpson Model 262.
4. Test Oscilloscope with 10X probe and 1X probe (1X probe is optional accessory)	Bandwidth, dc to 100 MHz; minimum deflection factor, 5 mV/div; accuracy, ±3%, dual trace. Probe, 10X scale-factor switching.	Power Supply Ripple check. CRT Z-Axis compensation. Vertical Gain adjustment. A Trigger Holdoff check. A and B + Gate Output Signal check.	a. TEKTRONIX 465B Oscilloscope with 2 (included) 10X probes. b. TEKTRONIX 475 Oscilloscope with 2 (included) 10X probes. c. TEKTRONIX P6101 Probe (1X). Part Number 010-6101-03.

[a] Requires a TM500-Series Power Module.

Table 4-1 (cont)

Description	Minimum Specification	Purpose	Examples of Suitable Test Equipment
5. Calibration Generator	Standard-amplitude accuracy, ±0.25%; signal amplitude, 2 mV to 50 V; output signal, 1 kHz square wave; fast-rise repetition rate, 1 to 100 kHz; rise time, 1 ns or less; signal amplitude, 100 mV to 1 V; aberrations, ±2%; high-amplitude output, 60-V pulse supplying at least 10 mA.	Vertical checks and adjustments. Trigger View checks and adjustments. X-Gain adjustment. Z-Axis check.	a. TEKTRONIX PG 506 Calibration Generator.[a] b. TEKTRONIX 067-0502-01 Standard-Amplitude Calibrator (amplitude calibrator only). c. TEKTRONIX Type 106 Square-Wave Generator (fast-rise and high-amplitude only).
6. Sine-Wave Generator	Frequency, 350 kHz to above 100 MHz; output amplitude variable from 0.5 to 5.5 V p-p; output impedance, 50 Ω; reference frequency, 50 to 350 kHz; amplitude accuracy, constant within 3% of reference frequency as output frequency changes.	Vertical Centering checks and adjustments. Bandwidth and Isolation checks. Trigger checks and adjustments. X-Y Phase Difference check. X Bandwidth check.	a. TEKTRONIX SG 503 Leveled Sine-Wave Generator.[a] b. TEKTRONIX Type 191 Constant-Amplitude Signal Generator.
7. Time-Mark Generator	Marker outputs, 2 ns to 0.5 s; marker accuracy, ±0.1%; trigger output, 1 ms to 0.1 μs, time-coincident with markers.	CRT Y-Axis and Geometry adjustments. Auto Trigger check. Horizontal Timing checks and adjustments.	TEKTRONIX TG 501 Time-Mark Generator.[a]
8. Low-Frequency Generator	Frequency, 60 Hz to 100 kHz; output amplitude, variable from 30 mV to 4 V p-p; positive square-wave output amplitude, 5 V.	Low-Frequency Trigger checks. Vertical compensation.	TEKTRONIX SG 502 Oscillator.[a]
9. Function Generator	Frequency response, less than 1 Hz to 1 kHz; sinusoidal output amplitude, variable up to greater than 5 V p-p.	AC-Coupled Lower −3 dB Point check.	TEKTRONIX FG 501 Function Generator.[a]
10. HV Probe	1 kV to 40 kV dc; input resistance, 1000 MΩ; accuracy, ±1% to 25 kV dc.	HV measurement using DMM in lieu of DC Voltmeter.	TEKTRONIX HV Probe. Part Number 010-0277-00.
11. 50-Ω Signal Pickoff	Frequency response, 50 kHz to 100 MHz; 50-Ω impedance for signal input, signal output, and trigger output.	Trigger checks and adjustments.	TEKTRONIX CT-3 Signal Pickoff. Part Number 017-0061-00.
12. Cable (2 required)	Impedance, 50 Ω; length, 42 in; connectors, bnc.	Signal interconnection.	Tektronix Part Number 012-0057-01.

[a] Requires a TM500-Series Power Module.

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Table 4-1 (cont)

Description	Minimum Specification	Purpose	Examples of Suitable Test Equipment
13. Cable (2 required)	Impedance, 50 Ω; length, 18 in; connectors, bnc.	Signal interconnection.	Tektronix Part Number 012-0076-00.
14. Adapter	Connectors, GR874-to-bnc female.	Signal interconnection.	Tektronix Part Number 017-0063-00.
15. Adapter	Connectors, GR874-to-bnc male.	Signal interconnection.	Tektronix Part Number 017-0064-00.
16. Adapter	Connectors, bnc female-to-bnc female.	Signal interconnection.	Tektronix Part Number 103-0028-00.
17. Adapter	Connectors, bnc female-to-coaxial cable connector.	Signal interconnection.	Tektronix Part Number 131-1315-01.
18. Adapter	Connectors, bnc male-to-miniature probe tip.	Signal interconnection.	Tektronix Part Number 013-0084-01.
19. Dual-Input Coupler (2 required)	Connectors, bnc female-to-dual-bnc male.	Vertical checks. Trigger checks and adjustments. X-Y Phase check.	Tektronix Part Number 067-0525-01.
20. T-Connector	Connectors, bnc.	Signal interconnection.	Tektronix Part Number 103-0030-00.
21. 10X Attenuator (2 required)	Ratio, 10X; impedance, 50 Ω; connectors, bnc.	Vertical compensation. Vertical Bandwidth check. Trigger adjustments.	Tektronix Part Number 011-0059-02.
22. 5X Attenuator	Ratio, 5X; impedance, 50 Ω; connectors, bnc.	Vertical System compensation. Trigger adjustments.	Tektronix Part Number 011-0060-02.
23. 2X Attenuator	Ratio, 2X; impedance, 50 Ω; connectors, bnc.	Vertical System compensation. Trigger adjustments.	Tektronix Part Number 011-0069-02.
24. Termination (2 required)	Impedance, 50 Ω; connectors, bnc.	Signal termination.	Tektronix Part Number 011-0049-01.
25. Screwdriver	Length, 3-in shaft; bit size, 3/32 in.	Adjust variable resistors.	Xcelite R-3323.
26. Low-Capacitance Alignment Tool	Length, 1-in shaft; bit size, 3/32 in.	Adjust all variable capacitors.	J.F.D. Electronics Corp. Adjustment Tool Number 5284.
27. Shorting Strap		Calibrator adjustment.	

[a]Requires a TM500-Series Power Module.

PERFORMANCE CHECK

PURPOSE

The Performance Check is used to verify the Performance Requirements as listed in the Specification (section 1) and to determine the need for recalibration (adjustment) of the product. Removing the instrument's dust cover is not necessary to perform this procedure. All checks are made using the operator-accessible controls and connectors.

LIMITS AND TOLERANCES

The limits and tolerances given in this procedure are valid only if the instrument has been calibrated at an ambient termperature between +20°C and +30°C, the instrument is operating at an ambient temperature between −15°C and +55°C (unless otherwise noted), and the instrument has had a warmup period of about 20 minutes.

TEST EQUIPMENT REQUIRED

The following equipment is required to perform a complete Performance Check. The numbers preceding equipment types correspond to the items listed in Table 4-1.

4. 10X Scale-factor-switching Probe (supplied with 468)

5. Calibration Generator
   a. Square-Wave Generator
   b. Amplitude Calibrator

6. Leveled Sine-Wave Generator

7. Time-mark Generator

8. Low-Frequency Sine-Wave Generator

9. Function Generator

11. 50-Ω Signal Pickoff Unit (Type CT-3)

12. 42-in, 50-Ω Bnc Cable (2 required)

15. GR-to-bnc-male Adapter

16. GR-to-bnc-female Adapter

18. Bnc-to-miniature-probe-tip Adapter

19. Dual-Input Coupler (2 required)

20. Bnc T-Connector

21. 10X Bnc Attenuator

22. 5X Bnc Attenuator

23. 2X Bnc Attenuator

24. 50-Ω Bnc Termination (2 required).

At the beginning of each subsection there is also a list showing only the test equipment necessary for performing the steps in that subsection. In this list, the number that precedes each piece of equipment corresponds to the item number listed in Table 4-1.

SPECIAL FIXTURES

Special fixtures are used only where they simplify the test setup and procedure. These fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

TEST EQUIPMENT ALTERNATIVES

When equipment other than that recommended is used, control settings or the test setup may need to be altered. If the exact item of equipment given as an example in the Test Equipment list (Table 4-1) is not available, first check the Minimum Specification column carefully to see if any other equipment might suffice. Then check the Purpose column to verify use of this item. If it is used for a check that is of little or no importance to your measurement requirements, the item and corresponding steps may be deleted.

PREPARATION

Before performing this procedure, ensure that the Regulating Range Selector and Line Voltage Selector switches are set for the line voltage being used (see "Preparation for Use" in the "Operating Instructions" section of this manual). Connect the test equipment and the instrument to be checked to an appropriate ac-power-input source.

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Power-On Self-Test

When power is applied to the 468, the instrument's Microprocessor performs a self-test to check the operational capability of the digital circuitry. Should an error be detected during the self-test, the seven-segment LED indicators will display an error code to aid in locating specific circuitry that is malfunctioning.

To check the power-on self-test, either select the NON STORE function (push button in) or ensure that both the VOLTS and TIME Cursor Function push buttons are released before applying power to the instrument. When the POWER switch is set to ON (button pressed in), self-test commences immediately. All the segments and decimal points of the display and all of the LED indicators read by the Microprocessor are illuminated (the seven-segment display is 8.8.8.8). Then a series of zeros will begin appearing on the display as checks of the random-access and read-only memories are made. The zeros flash rapidly and continue until all four digits indicate zero (0000). At that point, if the test is passed, the 468 will power up in an operating mode, and the seven-segment indicators will go blank.

Any seven-segment LED display that remains upon completion of the self-test is an error message. Should an error display be generated, cycle the POWER switch off, then on again to restart the self-test. If the error indication remains after the second power-on attempt, refer the instrument to qualified service personnel.

After checking the self-test, turn the INTENSITY control fully counterclockwise and allow a 20-minute warmup period of the 468 and all the test equipment before commencing the Performance Check.

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VERTICAL

Equipment Required (see Table 4-1):

4. 10X Scale-factor-switching Probe
5. Calibration Generator
6. Leveled Sine-Wave Generator
8. Low-Frequency Sine-Wave Generator
9. Function Generator
12. 42-in, 50-Ω Bnc Cable (2 required)
18. Bnc-to-probe-tip Adapter
19. Dual-Input Coupler
20. Bnc T-Connector
21. 10X Bnc Attenuator
22. 5X Bnc Attenuator
23. 2X Bnc Attenuator
24. 50-Ω Bnc Termination (2 required)

468 CONTROL SETTINGS

POWER	ON (button in)

Crt

INTENSITY	As desired
FOCUS	Best focused display
SCALE ILLUM	As desired

Vertical (CH 1 and CH 2 if applicable)

VERT MODE	CH 1
POSITION	Midrange
VOLTS/DIV	5 mV
VOLTS/DIV VAR	Calibrated detent
AC-GND-DC	GND
INVERT	Normal (button out)
20 MHz BW LIMIT	Full bandwidth (button out)

Trigger (A and B if applicable)

COUPLING	AC
LEVEL	Midrange
SLOPE	+
SOURCE	NORM
TRIG MODE	AUTO
A TRIGGER HOLDOFF	NORM

Sweep (A and B if applicable)

HORIZ DISPLAY	A
TIME/DIV	1 ms
TIME/DIV VAR	Calibrated detent
DELAY TIME POSITION	Fully counterclockwise
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange

Digital Storage

NON STORE	On (button in)
SAVE REF	Off (button out)
CURSOR FUNCTION	Both off (buttons out)

1. Check TRACE ROTATION

a. Position trace to the center horizontal graticule line.

b. CHECK—Trace is parallel with the center horizontal graticule line. Readjust TRACE ROTATION (front-panel screwdriver adjustment) if necessary.

2. Check ALT Mode

NOTE

The VERT MODE switches are push-push types that must be pressed to select a particular VERT MODE and pressed again to remove the trace from the crt display. For example, selecting CH 1 VERT MODE does not release any VERT MODE switch previously selected. The CH 1 VERT MODE switch must be pressed again to remove the CH 1 trace from the display.

a. Set:

VERT MODE	CH 1, CH 2, A TRIG VIEW, ADD, and ALT
A TRIGGER SOURCE	EXT

b. Use the CH 1 and CH 2 Vertical POSITION controls to space the CH 1, CH 2, and ADD traces approximately

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2 divisions apart. Use the A TRIGGER LEVEL control to position the A TRIG VIEW trace below the vertical channel traces.

c. CHECK—Sweep alternates in all settings of the A TIME/DIV switch except STOR ONLY (1, 2, and 5 s per division) and X-Y. The order of alternate traces is as follows: CH 1, CH 2, ADD, and A TRIG VIEW.

NOTE

At sweep speeds of 2 ms per division and faster, the trace alternations occur rapidly and cannot be seen.

d. Release ADD and A TRIG VIEW VERT MODE push buttons to remove their traces from the crt display.

3. Check CHOP Mode

a. Set:

A TIME/DIV	1 μs
A TRIGGER SOURCE	NORM
VERT MODE	CH 1, CH 2, and CHOP

b. Use the Channel 1 and Channel 2 Vertical POSITION controls to position the two traces about 4 divisions apart.

c. Adjust the A TRIGGER LEVEL control for a stable display of the CHOP frequency.

d. CHECK—Period of one cycle is approximately 2 μs (2 horizontal divisions).

e. Press in the ADD and A TRIG VIEW VERT MODE switches.

f. CHECK—Chopped mode display has four levels.

g. CHECK—Display for blanking of switching transients.

h. Press ADD, A TRIG VIEW, and CH 2 push buttons to remove their traces from the display.

4. Check CH 1 and CH 2 Balance

a. Set:

VERT MODE	CH 1

b. Position trace to the center horizontal graticule line.

c. CHECK—Trace shift is 1.0 division or less as the CH 1 VAR control is rotated from one extreme of its range to the other. (CH 1 UNCAL LED is illuminated when the VAR control is out of the detent position.)

d. Return CH 1 VAR control to its calibrated detent.

e. Release the CH 1 VERT MODE push button and press in the CH 2 VERT MODE push button.

f. Repeat parts b through c for the CH 2 VAR control.

g. Return the CH 2 VAR control to its calibrated detent.

5. Check CH 2 INVERT Trace Shift

a. Press the CH 2 INVERT push button.

b. CHECK—Trace shift is 2 divisions or less when switching between normal and INVERT.

c. Return the INVERT push button to normal (button out).

6. Check Vertical POSITION Range and Centering

a. Set:

CH 1 VOLTS/DIV	20 mV
CH 2 VOLTS/DIV	0.1 V
AC-GND-DC (both)	DC
A TRIGGER LEVEL	Fully clockwise

b. Connect the leveled sine-wave generator output to the CH 2 or Y input via a 50-Ω bnc cable and a 50-Ω bnc termination. Set the generator frequency to 50 kHz and adjust the output for a vertical display of 4.8 divisions.

c. Set CH 2 VOLTS/DIV to 20 mV.

d. CHECK—Top of display can be positioned down to the center horizontal graticule line, and bottom of display can be positioned up to the center horizontal graticule line.

e. Move the signal from the CH 2 OR Y input to the CH 1 OR X input connector.

f. Set VERT MODE switches for a CH 1 display.

g. CHECK—Repeat step 6, part d, for CH 1.

7. Check BEAM FIND Operation

a. Push in and hold the BEAM FIND push button.

b. CHECK—A compressed display is visible regardless of the setting of the following controls:

CH 1 POSITION

INTENSITY control

Horizontal POSITION control

c. Return both the Horizontal POSITION control and the INTENSITY controls to midrange.

d. Set CH 1 AC-GND-DC switch to GND.

e. While still holding in the BEAM FIND button, vertically position the trace to the center horizontal graticule line.

f. Release the BEAM FIND button.

g. CHECK—Trace remains within the graticule area.

h. Return the CH 1 AC-GND-DC switch to DC and disconnect the test equipment.

8. Check CH 1 and CH 2 DC Accuracy

a. Connect a 20 mV standard-amplitude signal to the CH 1 input connector via a 50-Ω bnc cable. Do not use a termination.

b. CHECK—CH 1 dc accuracy is within the limits given in Table 4-2.

c. Set:

VERT MODE	CH 2
CH 2 VOLTS/DIV	5 V

d. Move the signal from the CH 1 OR X input to the CH 2 OR Y input connector.

e. CHECK—CH 2 dc accuracy is within the limits given in Table 4-2. Reverse the order of checks (from bottom to top) for ease in making the checks.

Table 4-2

DC Accuracy Limits

VOLTS/DIV Switch Setting	Standard Amplitude Signal	Vertical Deflection (Divisions)	3% Tolerance (Divisions)
5 mV	20 mV	4	3.88 to 4.12
10 mV	50 mV	5	4.85 to 5.15
20 mV	0.1 V	5	4.85 to 5.15
50 mV	0.2 V	4	3.88 to 4.12
0.1 V	0.5 V	5	4.85 to 5.15
0.2 V	1.0 V	5	4.85 to 5.15
0.5 V	2.0 V	4	3.88 to 4.12
1.0 V	5.0 V	5	4.85 to 5.15
2.0 V	10.0 V	5	4.85 to 5.15
5.0 V	20.0 V	4	3.88 to 4.12

9. Check CH 1 and CH 2 Storage DC Accuracy

a. Set:

VOLTS/DIV (both)	5 mV
STORAGE MODE	NORM
CURSOR FUNCTION	VOLTS

b. Change the generator to 20 mV.

c. CHECK—CH 2 NORM Storage dc accuracy. The acquired waveform must be 4 divisions, within 3% (3.88 divisions to 4.12 divisions).

d. Move the signal from the CH 2 OR Y input to the CH 1 OR X input connector and set VERT MODE switches to display CH 1.

e. CHECK—Repeat step 9, part c, for CH 1.

10. Check VOLTS CURSOR Readout Accuracy

a. Set:

VOLTS/DIV (both)	0.5 mV
AC-GND-DC (both)	GND

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b. Use VOLTS CURSOR controls to obtain an exact 6-vertical-division difference between the VOLTS cursors.

c. CHECK—VOLTS Readout accuracy is within the limits given in Table 4-3 for each VOLTS/DIV switch setting.

d. Rotate the CH 1 VOLTS/DIV VAR control out of the calibrated detent.

e. CHECK—Readout is 5.88 to 6.12 divisions.

f. Return the VAR control to its calibrated detent.

g. Set VERT MODE switches to display CH 2.

h. CHECK—VOLTS readout changes for each VOLTS/DIV switch setting.

i. CHECK—Repeat step 10, parts d, e, and f using the CH 2 VAR control.

Table 4-3

VOLTS Cursor Readout Accuracy

VOLTS/DIV Switch Setting	2% Readout Tolerance
0.5 mV	2.940 to 3.060 mV
1 mV	5.88 to 6.12 mV
2 mV	11.76 to 12.24 mV
5 mV	29.40 to 30.60 mV
10 mV	58.8 to 61.2 mV
20 mV	117.6 to 122.4 mV
50 mV	294.0 to 306.0 mV
0.1 V	0.588 to 0.612 V
0.2 V	1.176 to 1.224 V
0.5 V	2.940 to 3.060 V
1 V	5.88 to 6.12 V
2 V	11.76 to 12.24 V
5 V	29.40 to 30.60 V

11. Check CH 1 and CH 2 VAR VOLTS/DIV Range

a. Set:

VOLTS/DIV (both)	20 mV
NON STORE	On (button in)
AC-GND-DC	DC

b. Change the generator output to 0.1 V.

c. CHECK—Display reduces to less than 2 divisions when the CH 2 VAR control is rotated to its extreme counterclockwise rotation.

d. Move the signal to the CH 1 OR X input connector and set VERT MODE switches to display CH 1.

e. CHECK—Repeat step 11, part c, using the CH 1 VAR control.

f. Return both VAR controls to their calibrated detent positions and disconnect the signal from the CH 1 input connector.

12. Check ADD Mode

a. Set:

VOLTS/DIV (both)	5 mV
VERT MODE	ADD

b. Connect a 10-mV standard-amplitude signal to both the CH 1 and CH 2 input connectors via a 50-Ω bnc cable and a dual-input coupler.

c. CHECK—Displayed signal is approximately 4 divisions in amplitude.

d. Set:

STORAGE MODE	NORM

e. CHECK—Repeat step 12, part c, for the Stored Display.

f. Press in the NON STORE push button.

13. Check CH 1 and CH 2 Gain Balance

a. Press in CH 2 INVERT push button.

b. CHECK—Displayed vertical amplitude is approximately zero division.

c. Return the CH 2 INVERT push button to normal (button out) and disconnect the test equipment.

14. Check Vertical Low-Frequency Compensation

a. Set:

VERT MODE	CH 1
TIME/DIV (both)	0.2 ms
VOLTS/DIV (both)	5 mV

b. Connect a 1-kHz fast-rise + square-wave signal to the CH 1 input connector via a 50-Ω bnc cable, 10X bnc attenuator, and a 50-Ω bnc termination.

c. Adjust generator output to obtain a 5-division display. Adjust the A TRIGGER LEVEL control for a stable display.

d. CHECK—Rounding or overshoot is within 3% (±0.15 division) at the frequencies listed in Table 4-4.

e. Disconnect the fast-rise + signal from the CH 1 input connector.

Table 4-4

Low-Frequency Compensation Setup

Calibration Generator Frequency	TIME/DIV Switch Setting
1 kHz	0.2 ms
10 kHz	20 μs
100 kHz	2 μs

15. Check CH 1 and CH 2 VOLTS/DIV Compensation

a. Set:

TIME/DIV (both)	0.2 ms

b. Connect a 10X probe with scale-factor switching connector to the CH 1 input (note that the VOLTS/DIV scale-factor switching LED now indicates 50 mV).

c. Connect a 1-kHz high-amplitude square-wave signal through a 2X, 5X, or 10X bnc attenuator (depending on generator output amplitude) to a 50-Ω bnc termination that is connected to a bnc-to-probe-tip adapter. Insert the 10X probe tip into the probe-tip adapter.

d. Adjust the generator output and select attenuators as necessary to obtain a 5-division display.

e. Adjust probe compensation for the best flat-top waveform. Do not readjust the probe compensation during the remainder of this step.

f. CHECK—Rounding or overshoot on the waveform is within 3% (±0.15 division) at all settings of the VOLTS/DIV switch between 50 mV and 5 V. Add or remove attenuators and/or termination as required and adjust generator output amplitude as necessary to maintain a 5-division display at each VOLTS/DIV switch setting.

g. Move the test setup to CH 2 input connector and set the VERT MODE switches to display CH 2.

h. Repeat step 15, part f, for CH 2.

i. Disconnect the test setup.

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16. Check CH 1 and CH 2 Transient Response

a. Set:

TIME/DIV (both)	0.05 μs
VOLTS/DIV (both)	5 mV
A TRIGGER SLOPE	+ (plus)

b. Connect a 100-kHz fast-rise + square-wave signal to the CH 2 input connector via a 50-Ω bnc cable, 10X attenuator, and a 50-Ω bnc termination. Set the generator output for a vertical display of 5 divisions at 100 kHz.

c. CHECK—Flat-top waveform is within 4% (5 divisions ± 0.2 division).

d. Move the test setup to the CH 1 input connector and set the VERT MODE switches to display CH 1.

e. CHECK—Repeat step 16, part c, for CH 1.

17. Check Storage Acquisition Step Response

a. Set:

TIME/DIV (both)	0.1 μs
STORAGE MODE	NORM
DISPLAY RESPONSE	PULSE
STORAGE WINDOW	POST TRIG

b. Adjust the A TRIGGER LEVEL control as necessary to obtain a triggered acquisition of the 5-division fast-rise + waveform.

c. Press in the ENVELOPE Storage Mode push button, then press in the SAVE Storage Mode push button.

d. Allow the ENVELOPE acquisition cycle to complete and enter the SAVE Storage Mode.

e. CHECK—Overshoot on leading edge of the waveform is 3% or less (0.15 division or less).

f. Disconnect the fast-rise + signal from the CH 1 input connector.

18. Check CH 1 and CH 2 Bandwidth

a. Set:

A TIME/DIV	0.2 ms
A TRIGGER LEVEL	Fully clockwise

b. Connect a 50-kHz leveled sine-wave signal to the CH 1 input connector via a 50-Ω bnc cable, 10X bnc attenuator, and 50-Ω bnc termination.

c. Set the generator output for a vertical display of 5 divisions, then change the generator output frequency to 100 MHz.

d. CHECK—Display amplitude is 3.5 divisions or greater.

e. Repeat step 18, parts c and d for all CH 1 VOLTS/DIV switch settings from 5 mV to 0.5 V. Adjust the generator output amplitude and either add or remove attenuators as necessary to maintain a 5-division, 50-kHz reference signal display.

f. Move the sine-wave generator output signal from the CH 1 input to the CH 2 input connector and set VERT MODE switches to display CH 2.

g. Repeat step 18, parts c and d, for all CH 2 VOLTS/DIV switch settings from 5 mV to 0.5 V. Adjust the generator output amplitude and add or remove attenuators as needed to maintain a 5-division, 50-kHz reference signal display.

NOTE

Attempting to check VOLTS/DIV settings beyond 0.5 V will exceed the power-handling capability of the 50-Ω terminations and output power of standard calibration equipment.

19. Check Useful Storage Bandwidth

a. Set:

VOLTS/DIV (both)	5 mV
STORAGE MODE	NORM
A TIME/DIV	10 μs
CURSOR FUNCTION	VOLTS

b. Remove any attenuators between the leveled sine-wave generator and the CH 2 input connector and reconnect the cable, with a 50-Ω bnc termination, to the CH 2 input connector.

c. Set the generator to obtain a 50-kHz, 6-division display. Adjust the A TRIGGER LEVEL control as necessary to obtain a triggered acquisition of the 50-kHz reference signal.

d. Change the A TIME/DIV switch to 0.2 μs and change the sine-wave generator output frequency to 10 MHz.

e. Press in the SAVE Storage Mode push button to hold a stable display for measurement.

f. CHECK—Any single-cycle p-p signal amplitude is not greater than 33.65 mV or less than 21.20 mV. Use the VOLTS cursors to make the measurements.

g. Set the VERT MODE switches for a CHOP display of CH 1 and CH 2 and change the sine-wave generator output frequency to 5 MHz.

h. Press in the NORM Storage Mode push button. Then, after a new display has been acquired, press in the SAVE Storage Mode push button.

i. CHECK—Any single cycle p-p signal amplitude is not greater than 31.80 mV or less than 25.25 mV. Again, use the VOLTS cursors to make the measurements.

20. Check Storage Analog Bandwidth

a. Set:

STORAGE MODE	ENVELOPE
A TIME/DIV	1 ms

b. Set the sine-wave generator output frequency to 50 kHz and verify that a 6-division vertical signal display is being acquired.

c. Change the sine-wave generator output frequency to 10 MHz.

NOTE

At exactly 10 MHz input signal frequency, it is possible for an alias display to be seen. If an ENVELOPE display with variable amplitude appears, shift the test frequency slightly off 10 MHz to obtain an envelope with flat amplitude.

d. Press in the SAVE Storage Mode push button. The 468 will enter the SAVE Storage Mode at the end of the ENVELOPE acquisition cycle.

e. CHECK—The ENVELOPE display signal amplitude is 30 mV p-p within ±3.65 mV (33.65 mV to 26.35 mV). Use the VOLTS cursors to make the measurement.

f. Disconnect the test setup.

21. Check Cascaded Gain and Bandwidth

a. Set:

VERT MODE	CH 2
A TIME/DIV	2 ms
NON STORE	On (button in)

b. Connect the CH 1 VERT SIGNAL OUT connector (on the 468 rear panel) to the CH 2 input connector via a 50-Ω cable and a 50-Ω bnc termination.

c. Connect a 5-mV standard-amplitude signal to the CH 1 input connector via a 50-Ω bnc cable.

d. CHECK—Display vertical amplitude is 5 divisions or greater.

e. Remove the standard-amplitude signal from the CH 1 input connector.

f. Connect a 50-MHz, leveled sine-wave signal to the CH 1 input connector via a 50-Ω bnc cable, a 10X bnc attenuator, and a 50-Ω bnc termination. Adjust the generator output to obtain a 5-division signal display.

g. Adjust the generator output frequency to 50 MHz.

h. CHECK—Displayed signal amplitude is now 3.5 divisions or greater.

i. Disconnect the test setup.

22. Check Trigger View Gain

a. Set:

VERT MODE	A TRIG VIEW
A TIME/DIV	0.2 ms
A TRIGGER COUPLING	DC
A TRIGGER SOURCE	EXT
A TRIGGER LEVEL	Midrange

b. Connect a 0.5-V standard-amplitude signal to the EXT A TRIGGER input connector via a 50-Ω bnc cable. Use no termination.

c. Use the A TRIGGER LEVEL control to vertically center the signal display.

d. CHECK—Display signal amplitude is 5 divisions ±5% (4.75 divisions to 5.25 divisions).

e. Set the A TRIGGER SOURCE to EXT/10 and change the output of the calibration generator to 5 V. Use

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the A TRIGGER LEVEL control to vertically center the display.

f. CHECK—Display signal amplitude is 5 divisions ±5% (4.75 divisions to 5.25 divisions).

g. Disconnect the test signal from the EXT A TRIGGER input connector.

23. Check Trigger View Centering

a. Set:

A TRIGGER SOURCE	EXT

b. Connect a 1-kHz, sine-wave signal to the EXT A TRIGGER input connector via a 50-Ω bnc cable. Use no termination.

c. Set the generator to obtain a 5-division signal display.

d. CHECK—Sweep symmetrically triggers within ±1 graticule division of the center horizontal graticule line when the A TRIGGER SLOPE is switched between + (plus) and – (minus).

e. Disconnect the sine-wave generator from the EXT A TRIGGER input connector.

24. Check Trigger View Low-Frequency Compensation

a. Set:

A TIME/DIV	0.1 ms
A TRIGGER SLOPE	+ (plus)

b. Connect a 1-kHz, high-amplitude square-wave signal to the EXT A TRIGGER input connector via a 50-Ω bnc cable and a 50-Ω bnc termination. Set the generator output for a 5-division signal display.

c. Use the A TRIGGER LEVEL control to vertically center the display.

d. CHECK—Square-wave leading edge has less than 10% overshoot or rounding (±0.5 division).

e. Set the A TRIGGER SOURCE to EXT/10 and adjust the generator output for a signal display of 5 vertical divisions. Use the A TRIGGER LEVEL control to vertically center the displayed signal.

f. CHECK—Square-wave leading edge has less than 10% overshoot or rounding (±0.5 division).

g. Disconnect the generator output from the EXT A TRIGGER input connector.

25. Check Trigger View High-Frequency Compensation

a. Set:

A TRIGGER SOURCE	EXT
A TIME/DIV	0.2 μs

b. Connect a 100-kHz fast-rise + square-wave signal to the EXT A TRIGGER input connector via a 50-Ω bnc cable and a 50-Ω bnc termination.

c. Adjust the generator output amplitude for a signal display of 5 vertical divisions. Use the A TRIGGER LEVEL control to vertically center the display.

d. CHECK—Square-wave front-corner aberration is less than ±10% (±0.5 division).

e. Disconnect the test setup.

26. Check A and B Zero Trigger View Delay

a. Set:

VERT MODE	CH 1 and A TRIG VIEW
A TIME/DIV	0.02 μs
X10 MAG	On (button in)
A TRIGGER COUPLING	AC
CH 1 VOLTS/DIV	0.1 V

b. Connect a 40-MHz leveled sine-wave signal via a bnc T-connector, two 42-inch (equal length) 50-Ω bnc cables, and two 50-Ω bnc terminations; one leading to the CH 1 input connector, and the other to the EXT A TRIGGER input connector. Set the sine-wave generator output amplitude for a 6-vertical-division display of the A TRIG VIEW signal.

c. Adjust CH 1 VAR and VOLTS/DIV controls to match the amplitude of the CH 1 displayed signal to the amplitude of the A TRIG VIEW signal. Use the A TRIGGER LEVEL control to vertically center the A TRIG VIEW display and use the CH 1 Vertical POSITION control to vertically center the CH 1 display.

d. CHECK—Time difference between the CH 1 and A TRIG VIEW signals (with displays superimposed) is 0.2 horizontal graticule division or less.

e. Set:

HORIZ DISPLAY	B DLY'D
A TIME/DIV	0.2 μs
B TIME/DIV	0.02 μs

f. Repeat step 26, part c.

g. CHECK—Time difference between the CH 1 and A TRIG VIEW signals with displays superimposed is 0.2 horizontal graticule division or less.

h. Disconnect test setup.

27. Check AC-Coupled Lower −3 dB Point

a. Set:

A TIME/DIV	0.5 ms
VERT MODE	CH 1
CH 1 VOLTS/DIV	1 V
A TRIGGER SOURCE	CH 1
AC-GND-DC	AC

b. Connect a 1-kHz sine-wave signal from the function generator via a 50-Ω bnc cable and a 50-Ω bnc termination, to the CH 1 input connector.

c. Set the generator amplitude for a 5-vertical-division signal display.

d. Set the A TRIG MODE to NORM and adjust the A TRIGGER LEVEL control for a stable, triggered display.

e. Press in the NORM Storage Mode push button.

f. Use the Channel 1 Vertical POSITION control to vertically center the display.

g. Press in the VOLTS Cursor Function push button. Use the VOLTS cursors in conjunction with the generator amplitude control to obtain a 5-V p-p reference signal display.

h. Set the generator output frequency to 10 Hz. Do not change the generator output amplitude control.

i. Set the A TIME/DIV switch to 50 ms and adjust the A TRIGGER LEVEL control as necessary for a stable, triggered siplay.

j. Use the VOLTS cursors to measure the p-p amplitude of the display.

k. CHECK—Display p-p amplitude is 3.54 V or greater.

l. Disconnect the bnc cable and termination from the CH 1 input connector.

m. Connect a 10X probe (preferably one supplied with the instrument) to the CH 1 input connector. Use a bnc-to-probe-tip adapter at the output of the function generator and apply the generator sine-wave output to the CH 1 input connector via the 10X probe tip.

n. Press in the NON STORE push button and repeat step 27, parts c through g.

o. Set the generator output frequency to 1 Hz. Do not adjust the generator output amplitude.

p. Set the A TIME/DIV switch to 0.5 s and adjust the A TRIGGER LEVEL control as necessary for a stable, triggered display.

q. Use the VOLTS cursors to measure the p-p amplitude of the 1-Hz signal.

r. CHECK—Display amplitude is 3.54 V or greater.

s. Disconnect the test setup.

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TRIGGERING

Equipment Required (see Table 4-1):

5. Calibration Generator
6. Leveled Sine-Wave Generator
11. 50-Ω Signal Pickoff Unit (Type CT-3)
12. 42-in, 50-Ω Bnc Cable (2 required)
14. GR-to-bnc-female Adapter
15. GR-to-bnc-male Adapter
19. Dual-Input Coupler (2 required)
21. 10X Bnc Attenuator
23. 2X Bnc Attenuator
24. 50-Ω Bnc Termination (2 required)

468 CONTROL SETTINGS

POWER	ON (button in)

Crt

INTENSITY	As desired
FOCUS	Best focused display
SCALE ILLUM	As desired

Vertical (CH 1 and CH 2)

VERT MODE	CH 1
POSITION	Midrange
VOLTS/DIV	5 mV
VOLTS/DIV VAR	Calibrated detent
AC-GND-DC	DC
INVERT	Normal (button out)
20 MHz BW LIMIT	Full bandwidth (button out)

Triggers (A and B)

COUPLING	AC
LEVEL	Midrange
SLOPE	+
SOURCE	NORM
TRIG MODE	AUTO
A TRIGGER HOLDOFF	NORM

Sweep (A and B)

HORIZ DISPLAY	A
TIME/DIV	5 μs
TIME/DIV VAR	Calibrated detent
DELAY TIME POSITION	Fully counterclockwise
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange

Digital Storage

NON STORE	On (button in)
SAVE REF	Off (button out)
CURSOR FUNCTION	Both off (buttons out)

1. Check A and B Internal Triggering

a. Connect the test equipment to the 468 as illustrated in Figure 4-1.

b. Adjust the leveled sine-wave generator for a 3-division, 50-kHz signal display and set both VOLTS/DIV switches to 50 mV (0.3-division vertical display) for AC and DC TRIGGER COUPLING.

c. CHECK—Stable display can be obtained by adjusting the A TRIGGER LEVEL control in the following A TRIGGER COUPLING and A TRIGGER SOURCE switch positions:

TRIGGER COUPLING	TRIGGER SOURCE	Display Amplitude
AC	NORM	0.3 div
	CH 1	0.3 div
	CH 2	0.3 div
DC	NORM	0.3 div
	CH 1	0.3 div
	CH 2	0.3 div

d. Set CH 1 VOLTS/DIV switch to 5 mV and adjust the sine-wave generator output for a 5-division vertical signal display. Then, set the CH 1 VOLTS/DIV switch to 50 mV to obtain a 0.5-division vertical display.

e. CHECK—Stable display can be obtained by adjusting the A TRIGGER LEVEL control in the following A TRIGGER COUPLING and A TRIGGER SOURCE switch positions:

TRIGGER COUPLING	TRIGGER SOURCE	Display Amplitude
LF REJ	NORM	0.5 div
	CH 1	0.5 div
	CH 2	0.5 div
HF REJ	NORM	0.5 div
	CH 1	0.5 div
	CH 2	0.5 div

f. Set:

HORIZ DISPLAY	B DLY'D
A TRIGGER LEVEL	Fully clockwise
CH 1 VOLTS/DIV	5 mV

g. CHECK—Repeat step 1, parts b through e, using the B TRIGGER COUPLING and B TRIGGER SOURCE switch positions and adjusting the B TRIGGER LEVEL control.

2. Check A and B External Triggering

a. Set:

CH 1 VOLTS/DIV	20 mV
TRIGGER SOURCE (both)	Ext
TRIGGER COUPLING (both)	AC

b. Adjust the leveled sine-wave generator output for a display amplitude of 5 vertical divisions.

c. CHECK—Stable display can be obtained by adjusting the B TRIGGER LEVEL control with B TRIGGER COUPLING in the following switch positions:

AC and DC

d. Remove the 2X bnc attenuator from the test setup.

e. CHECK—Stable display can be obtained by adjusting the B TRIGGER LEVEL control with B TRIGGER COUPLING in the following switch positions:

LF REJ and HF REJ

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f. Set:

HORIZ DISPLAY A

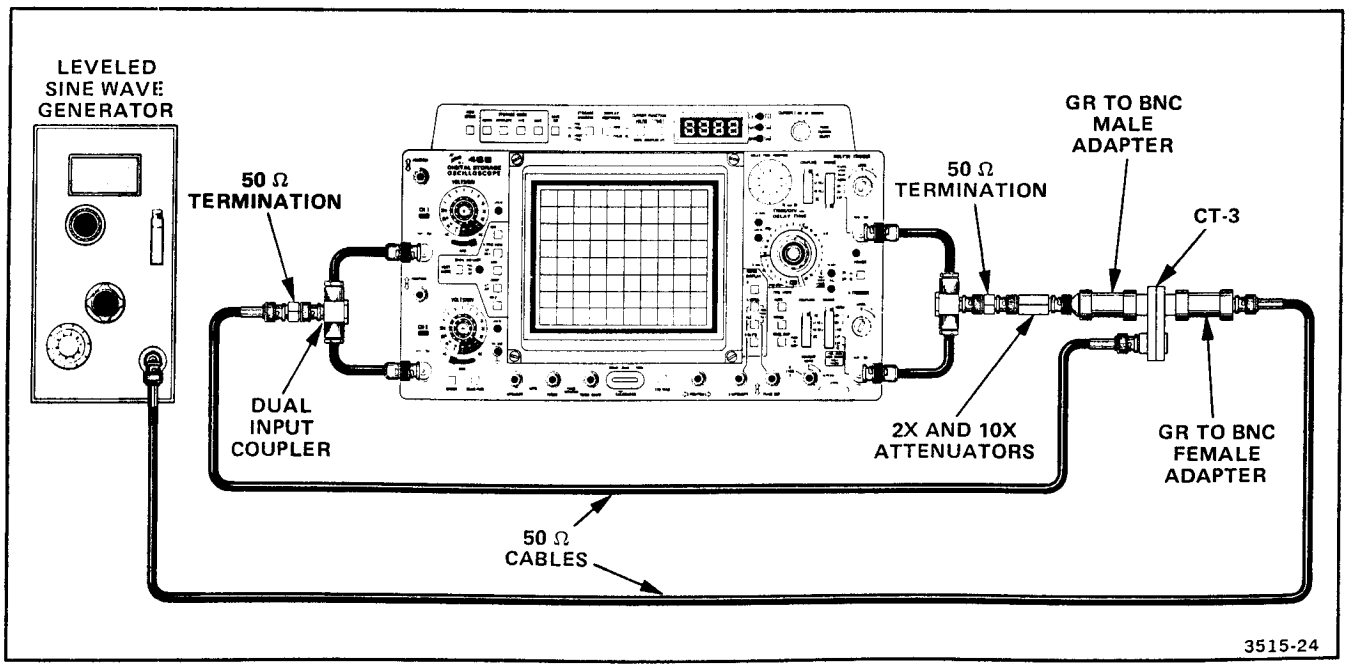

Figure 4-1. Test setup for A and B triggering checks.

g. CHECK–Stable display can be obtained by adjusting the A TRIGGER LEVEL control with A TRIGGER COUPLING in the following switch positions:

LF REJ and HF REJ

h. Reinstall the 2X attenuator in series with the 10X attenuator.

i. CHECK–Stable display can be obtained by adjusting the A TRIGGER LEVEL control with the A TRIGGER COUPLING in the following switch positions:

AC and DC

j. Remove the 10X attenuator from the test setup and set A TRIGGER SOURCE to EXT/10.

k. CHECK–Stable display can be obtained by adjusting the A TRIGGER LEVEL control with the A TRIGGER COUPLING in the following switch positions:

AC and DC

l. Remove the 2X attenuator from the test setup.

m. CHECK–Stable display can be obtained by adjusting the A TRIGGER LEVEL control with the A TRIGGER COUPLING in the following switch positions:

LF REJ and HF REJ

3. Check NORM TRIG Mode

a. Set:

A TRIGGER COUPLING	A
A TRIGGER SOURCE	NORM

b. Adjust the A TRIGGER LEVEL control for a stable display.

c. Set TRIG MODE to NORM.

d. CHECK–Stable display is visible.

e. Set CH 1 AC-GND-DC switch to GND.

f. CHECK–No visible display in the absence of an adequate trigger signal.

g. Press in the NORM Storage Mode push button and return the CH 1 AC-GND-DC switch to AC.

h. Repeat step 3, parts b through e, for the Storage NORM trigger operation.

i. CHECK–TRIG LED is extinguished in the absence of an adequate trigger signal.

4. Check SINGL SWP Mode

a. Set:

NON STORE	On (button in)
CH 1 AC-GND-DC	DC

b. Adjust the A TRIGGER LEVEL control until display just triggers.

c. Set CH 1 AC-GND-DC switch to GND.

d. Press SINGL SWP push button (READY LED should illuminate and remain on).

e. Set CH 1 AC-GND-DC switch to DC.

f. CHECK–READY LED goes out and a single sweep occurs.

NOTE

The INTENSITY control may require adjustment to observe the single-sweep trace.

g. Press in SINGL SWP push button several times.

h. CHECK–Single sweep occurs every time SINGL SWP push button is pressed in.

i. Disconnect test setup.

HORIZONTAL

Equipment Required (see Table 4-1):

5. Calibration Generator
6. Leveled Sine-Wave Generator
7. Time-Mark Generator
12. 42-in, 50-Ω Bnc Cable
24. 50-Ω Bnc Termination

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468 CONTROL SETTINGS

POWER	ON

Crt

INTENSITY	As desired
FOCUS	Best focused display
SCALE ILLUM	As desired

Vertical (CH 1 and CH 2)

VERT MODE	CH 1
POSITION	Midrange
VOLTS/DIV	0.5 V
VOLTS/DIV VAR	Calibrated detent
AC-GND-DC	DC
INVERT	Normal (button out)
20 MHz BW LIMIT	Full bandwidth (button out)

Trigger (A and B)

COUPLING	AC
LEVEL	Midrange
SLOPE	+
SOURCE (both)	NORM
TRIG MODE	AUTO
A TRIGGER HOLDOFF	NORM

Sweep (A and B)

HORIZ DISPLAY	A
TIME/DIV	1 ms
TIME/DIV VAR	Calibrated detent
DELAY TIME POSITION	Fully counterclockwise
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange

Digital Storage

NON STORE	On (button in)
SAVE REF	Off (button out)
CURSOR FUNCTION	Both off (buttons out)

1. Check A and B Timing Accuracy

a. Connect 1-ms time markers to the CH 1 input connector via a 50-Ω bnc cable and a 50-Ω bnc termination.

b. Use the CH 1 Vertical POSITION control to center the trace vertically and adjust the A TRIGGER LEVEL control for a stable, triggered display.

c. Switch the A TIME/DIV switch to 0.02 μs and select the 20-ns time markers. Use the Horizontal POSITION control to align the first time marker with the first vertical graticule line (extreme left edge of the graticule area).

d. CHECK—The A timing accuracy. Timing must be accurate within 2% (0.2 division at the 11th time marker).

e. Using the TIME/DIV switch and time-mark generator settings given in Table 4-5, check timing accuracy for the remaining A TIME/DIV switch settings. Readjust the A TRIGGER LEVEL control and Horizontal POSITION control as necessary.

NOTE

For the A TIME/DIV switch settings from 50 ms to 0.5 s per division, watch the time-marker tips only at the 1st and 11th graticule lines while adjusting the horizontal position and checking the timing accuracy.

f. Press in the X10 MAG push button.

g. CHECK—The A Magnified timing accuracy using the TIME/DIV switch and time-mark generator settings given in Table 4-5 under the X10 MAG column. Timing must be accurate within 3% (0.3 division at the 11th time marker).

Table 4-5

A and B Timing Accuracy

A and B TIME/DIV Switch Setting	Time-Mark Generator Output	
	NORM	X10 MAG
0.02 μs	20 ns	Not checked
0.05 μs	50 ns	5 ns
0.1 μs	0.1 μs	10 ns
0.2 μs	0.2 μs	20 ns
0.5 μs	0.5 μs	50 ns
1 μs	1 μs	0.1 μs
2 μs	2 μs	0.2 μs
5 μs	5 μs	0.5 μs
10 μs	10 μs	1 μs
20 μs	20 μs	2 μs
50 μs	50 μs	5 μs
0.1 ms	0.1 ms	10 μs
0.2 ms	0.2 ms	20 μs
0.5 ms	0.5 ms	50 μs
1 ms	1 ms	0.1 ms
2 ms	2 ms	0.2 ms
5 ms	5 ms	0.5 ms
10 ms[a]	10 ms	1 ms
20 ms[a]	20 ms	2 ms
50 ms[a]	50 ms	5 ms
A Sweep Only		
0.1 s[a]	0.1 s	10 ms
0.2 s[a]	0.2 s	20 ms
0.5 s[a]	0.5 s	50 ms

[a]For A TIME/DIV switch settings slower than 5 ms/division, set TRIG MODE to NORM.

h. Set:

HORIZ DISPLAY	B DLY'D
B TIME/DIV	0.02 μs
A TIME/DIV	0.05 μs
A TRIGGER LEVEL	Triggered A Sweep
B TRIGGER LEVEL	Stable display
X10 MAG	Off (button out)

i. Set the time-mark generator to 20 ns.

j. CHECK—Repeat the accuracy checks of step 1, parts c and d, for the B Sweep using the TIME/DIV switch and time-mark generator settings given in Table 4-5.

k. Press in the X10 MAG push button.

l. CHECK—Repeat step 1, part g, for the B Magnified timing-accuracy check.

2. Check Storage Timing Accuracy

a. Set:

HORIZ DISPLAY	A
STORAGE MODE	NORM
STORAGE WINDOW	POST TRIG (button out)
A TRIGGER MODE	AUTO
A TRIGGER LEVEL	Triggered display
A TIME/DIV	2 μs
CURSOR FUNCTION	TIME

b. Set the time-mark generator to obtain 2-μs time markers. Obtain a NORM Storage Mode time-marker display. For POST TRIG Storage Window, only 10 time markers will be displayed. Use the CH 1 Vertical POSITION control to center the display vertically.

NOTE

Amplitude variations occurring in the time markers as they are being acquired is due to the sample clock and time marker frequency difference. Sampling of the narrow time markers does not always occur either at peak amplitude of the markers or at the same amplitude point on the markers between sampling intervals.

c. Use the Horizontal POSITION control to align the 2nd time marker rising edge with the 2nd vertical graticule line.

NOTE

If display amplitude variation becomes a problem, pressing in the SAVE Storage Mode push button when an acquisition is completed will hold the waveform display stable for making the accuracy check. The SAVE Storage Mode display may also be positioned vertically, if required, to move any portion of the waveform to the graticule markings on the center horizontal graticule line.

d. Set the CH 1 AC-GND-DC switch to GND and adjust the INTENSITY control for a visible display of the trace and the TIME dots.

e. Use the CURSOR control knob to set the active TIME cursor to the second vertical graticule line. Press the CURSOR SELECT push button to activate the 2nd TIME cursor. Position the cursor to the 10th vertical graticule line (8-division spacing between TIME cursors).

f. CHECK—LED readout accuracy is within 2% (16.00 μs ± 0.32 μs).

g. Set the CH 1 AC-GND-DC switch to DC and adjust the INTENSITY control as necessary for viewing the time markers.

h. CHECK—Readout accuracy and A timing using the TIME/DIV settings, time-mark generator outputs, and LED readouts given in Table 4-6. Timing must be accurate within 2% (±0.16 division) over the center 8 divisions (between the 2nd and 10th time markers). Use the Horizontal POSITION control as necessary to maintain cursor alignment of the 2nd time marker on the graticule as the TIME/DIV switch setting is changed.

NOTE

To obtain a valid display on the first trigger accepted at a new TIME/DIV switch setting, change the time-mark generator output to the next required time markers before changing the 468 TIME/DIV switch setting. This procedure is especially useful for TIME/DIV switch settings from 0.1 s to 5 s per division. Watch for a display update (display flickers and TIME LED readout changes to the scale of the newly acquired waveform) prior to making the accuracy check at the new TIME/DIV switch setting. As TIME/DIV switch setting increases, the time required for the update to occur increases. At 5 s per division, it takes at least 50 s to acquire a complete waveform.

i. Set:

A TRIG MODE	AUTO
HORIZ DISPLAY	B DLY'D
TIME/DIV (both)	2 μs
B TRIGGER LEVEL	Triggered display

j. Set the time-mark generator for 2-μs markers.

k. CHECK—Repeat step 2, part h, to check the B timing.

Table 4-6

Storage Timing Accuracy

A and B TIME/DIV Switch Setting	Time-Mark Generator Output	LED Readout Accuracy Over Center 8 Divisions
2 μs	2 μs	15.68 μs to 16.32 μs
5 μs	5 μs	39.20 μs to 40.80 μs
10 μs	10 μs	78.40 μs to 81.60 μs
20 μs	20 μs	157.8 μs to 163.2 μs
50 μs	50 μs	392.0 μs to 408.0 μs
0.1 ms	0.1 ms	0.784 ms to 0.816 ms
0.2 ms	0.2 ms	1.568 ms to 1.632 ms
0.5 ms	0.5 ms	3.920 ms to 4.080 ms
1.0 ms	1.0 ms	7.84 ms to 8.16 ms
2.0 ms	2.0 ms	15.68 ms to 16.32 ms
5.0 ms	5.0 ms	39.20 ms to 40.80 ms
10.0 ms	10.0 ms	78.40 ms to 81.60 ms
20.0 ms	20.0 ms	156.8 ms to 163.2 ms
50.0 ms	50.0 ms	392.0 ms to 408.0 ms
0.1 s[a]	0.1 s	0.784 s to 0.816 s
0.2 s[a]	0.2 s	1.568 s to 1.632 s
0.5 s[a]	0.5 s	3.920 s to 4.080 s
1.0 s[a]	1.0 s	7.84 s to 8.16 s
2.0 s[a]	2.0 s	15.68 s to 16.32 s
5.0 s[a]	5.0 s	39.20 s to 40.80 s

[a]For TIME/DIV switch settings slower than 50 ms/division, set TRIG MODE to NORM.

3. Check Storage 0.02-μs to 2.0-μs Timing Accuracy

a. Set:

A TRIGGER MODE	AUTO
HORIZ DISPLAY	A
TIME/DIV (both)	0.02 μs
CH 1 AC-GND-DC	GND
DISPLAY RESPONSE	PULSE (button out)
B TRIGGER SOURCE	STARTS AFTER DELAY

b. Obtain a NORM Storage display of the baseline trace. Then press in the SAVE Storage Mode push button.

c. Adjust the INTENSITY control for a visible display of the trace and TIME cursor dots. Use the CH 1 Vertical POSITION control to center the trace vertically.

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d. Use the CURSOR control knob to set the active time cursor on the 2nd vertical graticule line. Press in the CURSOR SELECT push button to activate the 2nd TIME cursor. Use the CURSOR control knob to adjust the 2nd TIME cursor to the 10th vertical graticule line (8 divisions between the dots).

e. CHECK—LED Readout accuracy using the TIME/DIV switch settings and LED readouts given in Table 4-7. Accuracy must be within 2%.

f. Set HORIZ DISPLAY to B DLY'D.

g. CHECK—Repeat step 3, parts b through e, to check the B-timing LED readout accuracy.

Table 4-7

0.02 μs to 2.0 μs Timing Accuracy

TIME/DIV Switch Setting	LED Readout Accuracy
0.02 μs	0.157 μs to 0.163 μs
0.05 μs	0.392 μs to 0.408 μs
0.1 μs	0.784 μs to 0.816 μs
0.2 μs	1.568 μs to 1.632 μs
0.5 μs	3.920 μs to 4.080 μs
1.0 μs	7.84 μs to 8.16 μs
2.0 μs	15.68 μs to 16.32 μs

4. Check A TIME/DIV VAR Range

a. Set:

HORIZ DISPLAY	A
TIME/DIV	2 ms
NON STORE	On (button in)
CH 1 AC-GND-DC	DC

b. Select the 5-ms time markers from the time-mark generator.

c. Adjust the INTENSITY control for best viewing level. Use Horizontal POSITION control to align the first time marker with the left edge of the graticule area.

d. CHECK—One time marker per division can be displayed by rotating the TIME/DIV VAR control.

e. Return the TIME/DIV VAR control to its calibrated detent.

5. Check Delay or Differential Time Linearity

a. Set:

A TIME/DIV	1 ms
B TIME/DIV	5 μs
HORIZ DISPLAY	B DLY'D
B TRIGGER SOURCE	STARTS AFTER DELAY
DELAY TIME POSITION	1.00

b. Select 1-ms time markers from the time-mark generator.

c. Rotate the DELAY TIME POSITION dial to set the rising edge of the time marker that appears nearest to the center of the trace on the center graticule line. Note the dial setting.

d. Rotate the DELAY TIME POSITION dial to 2.00 and then set the time marker that appears nearest to the center of the trace on the center graticule line. Note the dial setting.

e. CHECK—Difference in setting between part c and part d is 1.00 ±0.01 division (0.99 to 1.01 division difference), with ambient temperature within the range of +15°C to +35°C. If the ambient temperature is outside this range, but between −15°C and +55°C, the difference should not exceed 1.00 ±0.03 division (0.97 to 1.03 division difference).

6. Check Delay or Differential Time Accuracy

a. Set:

A TIME/DIV	0.2 μs
B TIME/DIV	0.02 μs

b. Select the 0.1-μs time markers from the time-mark generator.

c. Set the DELAY TIME POSITION dial to 1.00. Adjust the Horizontal POSITION control so that the top of one displayed time marker crosses the center vertical graticule line. (If the top of the time marker at the beginning of the sweep isn't visible, then use the second time marker.)

d. Without changing the Horizontal POSITION control setting, set the DELAY TIME POSITION dial to 9.00. Slightly readjust the DELAY TIME POSITION dial to align the top of the displayed time marker with the center vertical graticule line.

e. CHECK—The DELAY TIME POSITION dial setting is 9.00 ±0.08 (8.92 to 9.08).

f. CHECK—Repeat step 6, parts c through e, for each setting listed in Table 4-8.

Table 4-8

Delay or Differential Time Accuracy

A TIME/DIV Switch Setting	B TIME/DIV Switch Setting	Time-Mark Generator Output
0.2 μs	0.02 μs	0.1 μs
0.2 μs	0.05 μs	0.1 μs
0.5 μs	0.05 μs	0.5 μs
1 μs	0.1 μs	1 μs
2 μs	0.1 μs	1 μs
5 μs	0.5 μs	5 μs
10 μs	1 μs	10 μs
20 μs	1 μs	10 μs
50 μs	5 μs	50 μs
0.1 ms	10 μs	0.1 ms
0.2 ms	10 μs	0.1 ms
0.5 ms	50 μs	0.5 ms
1 ms	0.1 ms	1 ms
2 ms	0.1 ms	1 ms
5 ms	0.5 ms	5 ms
10 ms[a]	1 ms	10 ms
20 ms[a]	1 ms	10 ms
50 ms[a]	5 ms	50 ms
0.1 s[a]	10 ms	0.1 s
0.2 s[a]	10 ms	0.1 s
0.5 s[a]	50 ms	0.5 s

[a]For sweep times greater than 5 ms/division set TRIG MODE to NORM.

7. Check Delay or Differential Jitter

a. Set:

DELAY TIME POSITION Dial	9.00
A TIME/DIV	1 ms
B TIME/DIV	0.2 μs

b. Select the 1-ms time markers from the time-mark generator.

c. Verify that the A TRIGGER SLOPE is set to + (plus). Slightly readjust the DELAY TIME POSITION dial to position a time marker within the graticule area.

d. CHECK—Jitter on the leading edge of the time marker does not exceed 1 division (2.5 divisions if operating from a 50 Hz or less ac power source). Disregard slow drift.

e. Set the DELAY TIME POSITION dial to 1.00.

f. CHECK—Repeat step 7, parts c and d.

g. Disconnect the time-mark generator from the 468.

8. Check ALT HORIZ DISPLAY Trace Separation

a. Set:

A TRIG MODE	AUTO
HORIZ DISPLAY	A INTEN
A TIME/DIV	1 ms
B TIME/DIV	0.1 ms
B INTENSITY	As required for visible display

b. Use the CH 1 Vertical POSITION control to align the trace with the center horizontal graticule line.

c. Select ALT HORIZ DISPLAY.

d. CHECK—TRACE SEP control will move the B trace at least ±4 vertical divisions from the center graticule line, with the A trace centered.

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9. Check A INTEN and B ENDS A Operation

a. Set:

DELAY TIME	
POSITION Dial	5.00
HORIZ DISPLAY	A INTEN

b. CHECK—B portion of trace is intensified (approximately 1 division).

c. Rotate the A TRIGGER HOLDOFF control clockwise to the B ENDS A position (detent position).

d. CHECK—Trace ends at the end of the intensified portion.

e. Rotate the A TRIGGER HOLDOFF control counterclockwise to the NORM position.

10. Check X Gain

a. Set:

TIME/DIV (both)	X-Y
VOLTS/DIV (both)	5 mV
CH 1 AC-GND-DC	AC
CH 2 AC-GND-DC	GND
HORIZ DISPLAY	A

NOTE

For instruments with firmware version 1.0 installed, both the CH 1 and CH 2 VERT MODE buttons must be pushed in to illuminate the scale-factor probe-coding LED. It is not necessary to select any VERT MODE push buttons to obtain the X-Y function display.

b. Connect a 20-mV standard-amplitude signal from the calibration generator to the CH 1 input via a 50-Ω bnc cable.

c. CHECK—Display shows a difference of 4 divisions ±0.16 division between the two dots (3.84 to 4.16 divisions).

d. Disconnect the test setup from the 468.

11. Check X Bandwidth

a. Connect a 50-kHz leveled sine-wave signal to the CH 1 input via a 50-Ω bnc cable and a 50-Ω termination.

b. Set the generator to obtain a 10-division horizontal display.

c. Without changing the generator amplitude, adjust generator output frequency to 4 MHz.

d. CHECK—Display is at least 7 divisions in length.

e. Disconnect the test equipment from the 468.

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GATE OUTPUTS, EXTERNAL Z-AXIS, AND CALIBRATOR

Equipment Required (see Table 4-1):

4. 10X Probe (supplied with 468)
5. Calibration Generator
12. 42-in, 50-Ω Bnc Cable (2 required)
24. 50-Ω Bnc Termination

468 CONTROL SETTINGS

POWER	ON

Crt

INTENSITY	Midrange
FOCUS	Best defined display
SCALE ILLUM	As desired

Vertical (CH 1 and CH 2)

VERT MODE	CH 1
POSITION	Midrange
VOLTS/DIV	2 V
VOLTS/DIV VAR	Calibrated detent
AC-GND-DC	DC
INVERT	Normal (button out)
20 MHz BW LIMIT	Full bandwidth (button out)

Trigger (A and B)

COUPLING	AC
LEVEL	Fully clockwise
SLOPE	+ (plus)
A TRIGGER SOURCE	NORM
B TRIGGER SOURCE	STARTS AFTER DELAY
TRIG MODE	AUTO
A TRIGGER HOLDOFF	NORM

Sweep (A and B)

TIME/DIV (both)	10 μs
TIME/DIV VAR	Calibrated detent
DELAY TIME POSITION	Fully counterclockwise
HORIZ DISPLAY	A INTEN
X10 MAG	Normal (button out)
POSITION (Horizontal)	Midrange

Digital Storage

NON STORE	On (button in)
SAVE REF	Off (button out)
CURSOR FUNCTION	Both off (buttons out)

1. Check A and B + GATE Outputs

a. Connect the A + GATE output (connector on the 468 rear panel) to the CH 1 input of the test oscilloscope via a 42-inch, 50-Ω bnc cable.

b. CHECK—For a positive pulse display (amplitude of 5.5 V, starting within approximately 500 mV of 0 V).

c. Move the bnc cable from the A + GATE connector to the B + GATE connector.

d. CHECK—Repeat part b for the B + GATE signal.

e. Disconnect the test setup from the 468.

2. Check EXT Z-AXIS Operation

a. Set:

HORIZ DISPLAY	A
TIME/DIV	0.5 ms

b. Connect a 5-V, standard-amplitude square-wave signal to the EXT Z-AXIS connector (located on the 468 rear panel) via a 50-Ω bnc cable.

c. CHECK—For noticeable intensity modulation of the trace when the INTENSITY control is set for normal viewing brightness. Adjust the TIME/DIV VAR control,

if necessary, to observe the modulation. Return the VAR control to the calibrated detent.

d. Disconnect the test setup from the 468.

3. Check CALIBRATOR Operation

a. Set:

CH 1 VOLTS/DIV	10 mV
TIME/DIV	1 ms

b. Connect the CALIBRATOR current-loop signal to the CH 1 input via a 10X scale-factor switching probe (preferably one supplied with the oscilloscope).

c. CHECK—For a 3-division vertical display of the CALIBRATOR square-wave signal (square-wave period is typically 1 ms, within 20%).

d. Disconnect all test equipment.

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ADJUSTMENT PROCEDURE

IMPORTANT—PLEASE READ BEFORE USING THIS PROCEDURE

PURPOSE

The Adjustment Procedure is used to return the instrument to conformation with its Performance Requirements as listed in the "Specification" (Section 1).

LIMITS AND TOLERANCES

The limits and tolerances listed in this Adjustment Procedure are instrument specifications only if they are listed in the "Performance Requirements" column of the "Specification" (Section 1). Tolerances given are for the instrument undergoing calibration and do not include test equipment error. Calibration (adjustment) of the instrument must be accomplished at an ambient temperature between +20°C and +30°C, and the instrument must have had a warmup period of at least 20 minutes.

TEST EQUIPMENT REQUIRED

Table 4-1 at the beginning of this section describes the test equipment required to accomplish the entire Adjustment Procedure. The Adjustment Procedure is based on using the first item of equipment listed in the "Examples of Suitable Test Equipment" column of Table 4-1. When other equipment is substituted, the control settings or calibration setups might need to be altered. If the exact equipment listed is not available, check the "Minimum Specification" column carefully to see if any other equipment might suffice. Then check the "Purpose" column to see where this equipment is used. If it is used for a check or adjustment that is of little or no importance to your requirement(s), the item and corresponding step(s) may be omitted.

At the beginning of each subsection there is also a list showing only the test equipment necessary for performing the steps in that subsection. In this list, the number that precedes each piece of equipment corresponds to the item number listed in Table 4-1.

ADJUSTMENT SEQUENCE

The Adjustment Procedure is written such that complete calibration of the conventional oscilloscope portion of the 468 is accomplished prior to performing Digital Storage Circuit adjustments. This ensures that the level of the signals applied to the Digital Storage circuitry for processing is correct and that the Vertical Output and Horizontal Output Amplifiers are correctly adjusted, since they affect Digital Storage calibration.

PARTIAL PROCEDURES

This procedure is structured in subsections to permit adjustment of individual sections of the instrument (except the Power Supply) whenever a complete recalibration is not required. For example, if only the Vertical section fails to meet Performance Requirements (or has had repairs made and 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 recalibration of the instrument will usually be required. In this case the entire Adjustment Procedure must be accomplished.

At the beginning of each subsection is a list of all the front-panel control settings required to prepare the instrument for performing Step 1 in that subsection. Each succeeding step within a subsection should then be performed both in sequence and in its entirety to ensure that control-setting changes will be correct for ensuing steps.

INTERNAL ADJUSTMENTS AND ADJUSTMENT INTERACTION

Do not preset any internal controls or change the +55-V power supply adjustment, since this will typically necessitate a complete recalibration of the instrument when only a partial recalibration might otherwise be required. To avoid unnecessary recalibration, change an internal control setting only when a Performance Characteristic is not met with the original setting. When it is necessary to change the setting of any internal control, always check Table 4-9 for any possible interacting adjustments that might require recalibration.

The use of Table 4-9 is particularly important if only a partial procedure is performed or if a circuit requires

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Table 4-9
Adjustment Interactions

Adjustments Made	Interacting Adjustments
	+55 V SUPPLY
	TRACE ROTATION
	Y-AXIS ALIGNMENT
	GEOMETRY
	CH 1 VAR BAL
	CH 2 VAR BAL
	INVERT BAL
	CH 1 POSITION CENTERING
	CH 2 POSITION CENTERING
	CH 1 GAIN
	CH 2 GAIN
	VERT OUT GAIN
	SWP START AND A SWP CAL
	X1 HORIZONTAL GAIN
	X10 HORIZONTAL GAIN
	B SWP CAL
	HIGH SPEED MAG TIMING (A AND B)
	TRIGGERING SENSITIVITY (A AND B)
	SLOPE CENTERING (A AND B)
	TRIG LEVEL CENTERING (A AND B)
	NORM TRIG DC BALANCE
	CH 1 TRIG DC BAL
	CH 2 TRIG DC BAL
	TRIGGER VIEW CENTERING
	TRIGGER VIEW GAIN
	X GAIN
	CRT GRID BIAS
	CRT
	CH 1 ACQUISITION CENTERING
	CH 2 ACQUISITION CENTERING
	CH 1 ACQUISITION GAIN
	CH 2 ACQUISITION GAIN
	STORAGE VERTICAL CENTERING
	STORAGE VERTICAL GAIN
	STORAGE HORIZONTAL GAIN
+55 V SUPPLY	■
TRACE ROTATION	■
Y-AXIS ALIGNMENT	■
GEOMETRY	■
CH 1 VAR BAL	■
CH 2 VAR BAL	■
INVERT BAL	■
CH 1 POSITION CENTERING	■
CH 2 POSITION CENTERING	■
CH 1 GAIN	■
CH 2 GAIN	■
VERT OUT GAIN	■
SWP START AND A SWP CAL	■
X1 HORIZONTAL GAIN	■
X10 HORIZONTAL GAIN	■
B SWP CAL	■
HIGH SPEED MAG TIMING (A AND B)	■
TRIGGERING SENSITIVITY (A AND B)	■
SLOPE CENTERING (A AND B)	■
TRIG LEVEL CENTERING (A AND B)	■
NORM TRIG DC BALANCE	■
CH 1 TRIG DC BAL	■
CH 2 TRIG DC BAL	■
TRIGGER VIEW CENTERING	■
TRIGGER VIEW GAIN	■
X GAIN	■
CRT GRID BIAS	■
CRT	■
CH 1 ACQUISITION CENTERING	■
CH 2 ACQUISITION CENTERING	■
CH 1 ACQUISITION GAIN	■
CH 2 ACQUISITION GAIN	■
STORAGE VERTICAL CENTERING	■
STORAGE VERTICAL GAIN	■
STORAGE HORIZONTAL GAIN	■

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recalibration due to a component replacement. To use this table, first find, in the leftmost column, the adjustment that was made. Then move to the right, across that row, until you come to a darkened square. From the darkened square, move up the column and check the accuracy of the adjustment found at the heading of that column. Readjust if necessary.

Certain interactions are called out in the Adjustment steps to indicate that the adjustments affected must be repeated until no further improvement is noted.

DISPLAY

The most accurate display adjustments are made with a stable, well-focused, low-intensity display. Unless otherwise noted, adjust the INTENSITY, ASTIG, FOCUS, and TRIGGER LEVEL controls as needed.

STEP TITLES

Where possible, instrument performance is checked before an adjustment is made. Steps containing checks and adjustments are titled "Check/Adjust." Those steps with checks only are titled "Check."

SPECIAL CALIBRATION FIXTURES

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

PREPARATION FOR ADJUSTMENT

It is necessary to remove the equipment cabinet to perform the Adjustment Procedure. See the "Cabinet Removal" instructions located in the Maintenance section of this Volume. Connect the test equipment to be used to an appropriate power source. Connect the 468 to an autotransformer set for 115 V ac. Apply power and allow a 20-minute warmup period before commencing the Adjustment Procedure. This procedure is written for the instrument to be operated from a 115-V power source. Operating from other power-source voltages will require setting the Line Voltage Selector and Regulating Range Selector to the appropriate settings for the available power source.

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MAIN POWER SUPPLY

Equipment Required (see Table 4-1)

1. Autotransformer
2. Digital Voltmeter
3. DC Voltmeter
4. Test Oscilloscope
25. 3-in. Flat-Bit Screwdriver

See ADJUSTMENT LOCATIONS 1 *in this Volume for test point and adjustment locations.*

NOTE

Prior to applying power to the 468, make the initial control settings. Connect the 468 to an appropriate power source through a variable autotransformer. Set the autotransformer to 115 V, apply power to the instrument and test equipment, and allow a 20-minute warmup period before commencing the adjustments and checks.

468 CONTROL SETTINGS

Power

Regulating Range Selector	High
Line Voltage Selector	115 V
POWER	See preceding NOTE

Crt

INTENSITY	As desired
FOCUS	Best focused display
SCALE ILLUM	As desired

Vertical (CH 1 and CH 2)

VERT MODE	CH 1
POSITION	Midrange
VOLTS/DIV	5 mV
VOLTS/DIV VAR	Calibrated detent
AC-GND-DC	GND
INVERT	Normal (button out)
20 MHz BW LIMIT	Full bandwidth (button out)

Trigger (A and B)

COUPLING	AC
SLOPE	+
LEVEL	As needed for a stable display
SOURCE	NORM
TRIG MODE	AUTO
A TRIGGER HOLDOFF	NORM

Sweep (A and B if applicable)

HORIZ DISPLAY	A
TIME/DIV	1 ms
TIME/DIV VAR	Calibrated detent
DELAY TIME POSITION	Fully counterclockwise
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange

Digital Storage

NON STORE	On (button in)
SAVE REF	Off (button out)
CURSOR FUNCTION	Both off (buttons out)

1. Check/Adjust Power Supply DC Levels, Regulation, and Ripple (R614)

NOTE

Review the information at the beginning of the Adjustment Procedure before starting this step.

a. Connect the digital voltmeter low lead to chassis ground and connect the volts lead to the first test point listed in Table 4-10.

b. CHECK—Voltage level is within the range given in Table 4-10.

c. Repeat parts a and b for each test point in Table 4-10.

d. If voltages are within tolerance, skip to part g. If not, continue with part e.

NOTE

Adjustment of the +55-V power supply will make it necessary to perform a complete recalibration of the instrument. Do not adjust the +55-V level if it is within tolerance unless a complete Adjustment Procedure is being performed.

e. Connect the digital voltmeter low lead to chassis ground and connect the volts lead to TP637.

f. ADJUST—+55-V supply (R614) for +55 V. Recheck all power supply dc levels according to Table 4-10.

g. Connect the test oscilloscope to the first test point indicated in Table 4-11.

h. CHECK—Ripple amplitude of the dc supply while varying the source voltage between 108 V and 132 V. To obtain the necessary vertical resolution for measuring ripple amplitude, use a 1X probe and cascaded gain on the test oscilloscope. Ripple amplitude should be within the typical value given in Table 4-11.

i. Repeat parts g and h for each test point in Table 4-11.

j. Return the source voltage to 115 V.

Table 4-10

Main Power Supply Limits

Power Supply	Test Point (+ Lead)	Reading	Tolerance
+55 V	TP637	+54.62 to +55.39	±0.7%
+15 V	TP639	+14.75 to +15.26	±1.7%
+5 V	PT638	+4.92 to +5.09	±1.7%
−8 V	TP740	−7.86 to −8.14	±1.7%
+110 V	TP642	+106.7 to +113.3	±3.0%

Table 4-11

Typical Main Power Supply Ripple

Power Supply	Test Point	Typical p-p Ripple
+55 V	TP637	4 mV
+15 V	TP639	2 mV
+5 V	TP638	2 mV
−8 V	TP740	2 mV
+110 V	TP642	20 mV

2. Check High Voltage Supply

a. Connect the low lead of a dc voltmeter capable of measuring at least 3000 V dc to chassis ground and the volts lead to TP328 on the Interface board. (TP328 is accessible through a hole in the high-voltage power-supply shield.)

NOTE

The digital voltmeter with HV probe may be used in lieu of the dc voltmeter to perform this check.

b. CHECK—High Voltage Supply dc level is −2450 V ±54 V (−2396 V to −2504 V).

c. Disconnect the dc voltmeter.

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DISPLAY AND Z-AXIS

Equipment Required (see Table 4-1)

3. DC Voltmeter
4. Test Oscilloscope
4. 10X Probe
7. Time-Mark Generator
12. 50-Ω Bnc Cable
24. 50-Ω Bnc Termination
25. 3-in., Flat-Bit Screwdriver
26. Low-Capacitance Alignment Tool

See ADJUSTMENT LOCATIONS *in this Volume for test point and adjustment locations.*

468 CONTROL SETTINGS

Power

Regulating Range Selector	High
Line Voltage Selector	115 V
POWER Switch	ON (button in)

Crt

INTENSITY	Fully counterclockwise
FOCUS	Best focused display
SCALE ILLUMINATION	Fully counterclockwise

Vertical (CH 1 and CH 2)

VERT MODE	CH 1
VOLTS/DIV	5 mV
VOLTS/DIV VAR	Calibrated detent
POSITION	Midrange
AC-GND-DC	GND
INVERT	Normal (button out)
20 MHz BW LIMIT	Full bandwidth (button out)

Triggering (A and B if applicable)

TRIG MODE	AUTO
SOURCE	NORM
COUPLING	AC
SLOPE	+
LEVEL	As needed for a stable display
A TRIGGER HOLDOFF	NORM

Sweep (A and B if applicable)

HORIZ DISPLAY	A
A TIME/DIV	X-Y
TIME/DIV VAR	Calibrated detent
DELAY TIME POSITION	Fully counterclockwise
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange

Digital Storage

NON STORE	On (button in)
SAVE REF	Off (button out)
CURSOR FUNCTION	Both off (buttons out)

1. Check/Adjust CRT Grid Bias (R409)

a. Connect the digital voltmeter low lead to chassis ground and the volts lead to TP418 on the Interface circuit board. (TP418 is accessible through a hole in the high-voltage power-supply shield.

b. Set the INTENSITY control for a digital voltmeter reading of +20 V.

c. CHECK–Display for a well-defined, low-intensity dot. Use FOCUS and ASTIG controls as needed.

d. ADJUST–CRT Grid Bias (R409) for a visible dot, then back off the control until the dot is just visible.

e. Disconnect the voltmeter from the 468.

2. Check/Adjust Trace Alignment (TRACE ROTATION)

a. Set:

A TIME/DIV	0.5 ms
INTENSITY	As desired
SCALE ILLUM	As desired

b. Position the trace to the center horizontal graticule line.

c. CHECK—Trace is parallel with the center horizontal graticule line.

d. ADJUST—TRACE ROTATION control (front-panel screwdriver adjustment) to align the trace parallel with the center horizontal graticule line.

3. Check/Adjust Y-Axis Alignment (R270)

a. Set:

CH 1 AC-GND-DC	DC
CH 1 VOLTS/DIV	0.1 V
CH 1 POSITION	Fully counterclockwise

b. Connect 0.2-ms time markers from the time-mark generator to the CH 1 input via a 50-Ω bnc cable and 50-Ω bnc termination. (Time markers should fill the graticule area vertically. If not, reduce the VOLTS/DIV switch setting until they do.)

c. CHECK—Display for 0.1 division of tilt or less, when compared to the center vertical graticule line.

d. ADJUST—Y-Axis Alignment (R270) to align a time marker parallel with the center vertical graticule line.

e. CHECK—TRACE ROTATION adjustment. Repeat steps 2 and 3 for best display alignment.

4. Check/Adjust Geometry (R267)

a. CHECK—Display for 0.1 division or less of bowing of the time markers across the graticule area from top to bottom.

b. ADJUST—Geometry (R267) for minimum bowing of the time markers across the graticule area (especially at the left and right graticule edges).

c. CHECK—Y-Axis Alignment adjustment (step 3, part c).

d. Disconnect the test setup and vertically center the trace.

5. Check/Adjust Z-Axis Compensation (C518)

a. Set:

A TIME/DIV	0.05 μs
A TRIGGER LEVEL	Fully clockwise

b. Set test oscilloscope controls as follows:

VOLTS/DIV	5 V (with 10X probe)
TIME/DIV	0.1 μs
AC-GND-DC	DC
Trigger controls	As required for a stable display

c. Connect the 10X probe from the test oscilloscope to TP418 (accessible through hole in high-voltage shield, Z-Axis TP).

d. Adjust the 468 INTENSITY control for a 15-V (3-division) unblanking-gate-signal display on the test oscilloscope.

e. ADJUST—Z-Axis Compensation (C518), using a low-capacitance alignment tool, for the best square corner on the unblanking pulse displayed on the test oscilloscope.

f. Disconnect the test setup.

g. CHECK—Display for uniform trace intensity in the first two divisions of the trace.

h. READJUST—Z-Axis Compensation (C518), if necessary, for a trace of uniform intensity. (Compromise best square corner for uniform intensity.)

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VERTICAL

Equipment Required (see Table 4-1)

4. Test Oscilloscope (only if gain requires complete recalibration)

4. Two 10X Probes (one should have scale-factor switching, however an 11-kΩ resistor may be substituted in step 1, part a)

5. Calibration Generator
   a. Standard Amplitude Calibrator
   b. Square-Wave Generator

6. Leveled Sine-Wave Generator

8. Low-Frequency Sine-Wave Generator

12. 50-Ω Bnc Cable (2 required)

17. Bnc-female-to-coaxial-cable-connector Adapter

18. Bnc-to-probe-tip Adapter

19. Dual-Input Coupler

21. 10X Bnc Attenuator (2 required)

23. 2X or 5X Bnc Attenuator

24. 50-Ω Bnc Termination (2 required)

25. 3-in., Flat-Bit Screwdriver

26. Low-Capacitance Alignment Tool

See ADJUSTMENT LOCATIONS 2 *and* ADJUSTMENT LOCATIONS 3 *in this Volume for test point and adjustment locations.*

468 CONTROL SETTINGS

Power

Regulating Range Selector	High
Line Voltage Selector	115 V
POWER Switch	ON (button in)

Vertical (CH 1 and CH 2)

VERT MODE	CH 1
VOLTS/DIV	5 mV
VOLTS/DIV VAR	Calibrated detent
AC-GND-DC	DC
POSITION	Midrange
INVERT	Normal (button out)
20 MHz BW LIMIT	Full bandwidth (button out)

Triggering (A and B if applicable)

A TRIGGER SOURCE	NORM
B TRIGGER SOURCE	STARTS AFTER DELAY
TRIG MODE	AUTO
COUPLING	AC
SLOPE	+
LEVEL	For a stable display
A TRIGGER HOLDOFF	NORM

Sweep (A and B)

HORIZ DISPLAY	A
TIME/DIV (both)	1 ms
TIME/DIV VAR	Calibrated detent
DELAY TIME POSITION	Fully counterclockwise
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange

Digital Storage

NON STORE	ON (button in)
SAVE REF	Off (button out)
CURSOR FUNCTION	Both off (buttons out)

1. Check Probe Coding Indicator LED

a. Connect a 10X probe with a scale-factor switching connector to the CH 1 input (if no scale-factor switching probe is available, an 11-kΩ resistor may be used. Connect the resistor between ground and the metal coding ring on the input connector).

b. CHECK— 5 mV LED is extinguished and 50 mV LED is illuminated.

c. Set VERT MODE switches to display CH 2 and move the probe to the CH 2 input connector.

d. CHECK—5 mV LED is extinguished and 50 mV LED is illuminated.

e. Remove 10X probe from the 468.

2. Check Input Coupling (AC-GND-DC) Switches

a. Connect a 20-mV, standard-amplitude square-wave signal to the CH 2 input via a 50-Ω cable.

b. Position the bottom of the display to the center horizontal graticule line and set CH 2 AC-GND-DC switch to GND.

c. CHECK—Trace is at center horizontal graticule line with no vertical deflection.

d. Set CH 2 AC-GND-DC switch to AC.

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

f. Set VERT MODE switches to display CH 1 and move test signal to CH 1 input connector.

g. Position bottom of the display to the center horizontal graticule line.

h. Set CH 1 AC-GND-DC switch to GND.

i. CHECK—Trace is at center horizontal graticule line with no vertical deflection.

j. Set CH 1 AC-GND-DC switch to AC.

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

l. Disconnect test equipment from the 468.

3. Check ALT Mode

a. Set:

VERT MODE	CH 1 (in), CH 2 (in), and ALT (button out)
A TRIGGER LEVEL	Fully clockwise

b. Position CH 1 and CH 2 traces about 2 divisions apart.

c. CHECK—Sweeps alternate for all A TIME/DIV settings except STOR ONLY and X-Y.

4. Check CHOP Mode

a. Set:

A TIME/DIV	0.5 μs
VERT MODE	CH 1, CH 2, and CHOP (all buttons in)
AC-GND-DC (both)	GND
A TRIGGER COUPLING	HF REJ

b. Position the CH 1 and CH 2 traces about 4 divisions apart and adjust the A TRIGGER LEVEL control for a stable display.

c. CHECK—Vertical switching transients are completely blanked between horizontal chopped segments for normal viewing intensity.

d. CHECK—Duration of each cycle is approximately 4 divisions.

5. Check BEAM FIND

a. Push in BEAM FIND push button and hold.

b. CHECK—Display remains entirely within the graticule area regardless of setting of Vertical or Horizontal POSITION controls.

c. CHECK—Trace intensity remains constant and visible regardless of setting of INTENSITY control.

d. Set VERT MODE to CH 1 and center the CH 1 trace both vertically and horizontally while holding the BEAM FIND button in.

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e. Release BEAM FIND button.

f. CHECK–Trace remains within the graticule area.

6. Check/Adjust CH 1 VOLTS/DIV VAR Balance (R273) and CH 1 UNCAL LED

a. Position trace to the center horizontal graticule line.

b. Rotate CH 1 VOLTS/DIV VAR control counterclockwise out of calibrated detent.

c. CHECK–CH 1 UNCAL LED is illuminated.

d. CHECK–Trace shift of 1 division or less when rotating VAR control from fully counterclockwise to fully clockwise.

e. ADJUST–CH 1 Var Bal (R273) for minimum trace shift while rotating the CH 1 VAR control from one extreme to the other.

f. Return CH 1 VAR control to the detent position (fully clockwise).

7. Check/Adjust CH 1 Position Centering (R238)

a. Set:

CH 1 VOLTS/DIV	0.2 V
CH 1 AC-GND-DC	AC
A TIME/DIV	1 ms
A TRIGGER LEVEL	Fully clockwise

b. Connect a 50-kHz, leveled sine-wave signal to the CH 1 input via a 50-Ω bnc cable and a 50-Ω termination. Set the generator for a 2.4-division signal display.

c. Set CH 1 VOLTS/DIV switch to 20 mV.

d. CHECK–Top of display positions down to (or below) the center horizontal graticule line, and bottom of display positions up to center (or above) horizontal graticule line.

e. ADJUST–CH 1 Position Center (R238) so that display positions the same distance above and below the center horizontal graticule line.

f. Disconnect the test signal from the 468.

8. Check/Adjust CH 2 VOLTS/DIV VAR Balance (R573) and CH 2 UNCAL LED

a. Set:

VERT MODE	CH 2

b. Position trace to the center horizontal graticule line.

c. Rotate CH 2 VOLTS/DIV VAR control out of calibrated detent.

d. CHECK–CH 2 UNCAL LED is illuminated.

e. CHECK–Trace shift of 1 division or less when rotating VAR control from fully counterclockwise to fully clockwise.

f. ADJUST–CH 2 Var Bal (R573) for minimum trace shift while rotating the CH 2 VAR control from one extreme to the other.

g. Return CH 2 VAR control to the detent position (fully clockwise).

9. Check/Adjust CH 2 INVERT Balance (R566)

a. Set:

CH 2 AC-GND-DC	GND

b. Position trace to the center horizontal graticule line and push in the INVERT button.

c. CHECK–Trace shift is 2 divisions or less when switching from normal to inverted.

d. ADJUST–Invert Bal (R566) for minimum trace shift when switching between normal and inverted.

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10. Check/Adjust CH 2 Position Centering (R434)

a. Set:

INVERT	Normal (button out)
CH 2 VOLTS/DIV	0.2 V
CH 2 AC-GND-DC	AC
A TRIGGER LEVEL	Fully clockwise

b. Connect a 50-kHz, leveled sine-wave signal to the CH 2 input via a 50-Ω bnc cable and a 50-Ω termination. Set the generator for a 2.4-division signal display.

c. Set CH 2 VOLTS/DIV switch to 20 mV without changing the VAR control.

d. CHECK—Top of display positions down to the center horizontal graticule line or below, and bottom of display positions up to center horizontal graticule or above.

e. ADJUST—CH 2 Position Center (R434) so that display positions the same distance above and below the center horizontal graticule line.

f. Disconnect test signal from the 468.

11. Check CH 1 and CH 2 Input FET Gate Current

a. Set:

AC-GND-DC (both)	GND
VOLTS/DIV (both)	5 mV

b. Position the CH 2 trace to graticule center and set the CH 2 AC-GND-DC switch to DC.

c. CHECK—Trace shift is 0.1 division or less when switching between GND and DC.

d. Set VERT MODE switches to display CH 1. Position the CH 1 trace to graticule center and change the CH 1 AC-GND-DC switch to DC.

e. CHECK—Trace shift is 0.1 division or less when switching between GND and DC.

f. Set both AC-GND-DC switches to DC.

12. Check/Adjust Gain (R269, R117, and R569)

NOTE

It is not always necessary to perform a complete readjustment to meet instrument gain specifications. Use the following procedure to determine adjustments required.

a. Set:

VERT MODE	CH 2
CH 2 VOLTS/DIV	5 mV
CH 2 AC-GND-DC	DC

b. Connect a 20-mV, standard-amplitude square-wave signal to CH 2 input connector via a 50-Ω bnc cable.

c. CHECK—Display amplitude is 4 divisions within 3% (4 divisions ±0.12 division).

d. Change CH 2 VOLTS/DIV switch settings and standard-amplitude signals as shown in Table 4-12 and CHECK that dc accuracies are within the display limits listed in the table.

e. Set VERT MODE switches to display CH 1 and set the CH 1 AC-GND-DC switch to DC.

f. Move the input signal from the CH 2 input connector to the CH 1 input.

g. CHECK—Display amplitude is 4 divisions within 3% (4 divisions ±0.12 division).

h. Change CH 1 VOLTS/DIV switch settings and standard-amplitude signals as shown in Table 4-12 and CHECK that deflection accuracies are within the display limits listed in the table.

i. If all checks for both channels are within 3%, no further vertical gain calibration is required; skip to step 13. If any single check falls outside the 3% accuracy limits, a complete gain recalibration is required. Continue with part j of this step.

j. Set CH 1 VOLTS/DIV switch to 5 mV and set the standard-amplitude signal output to 20 mV.

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Table 4-12

Vertical DC Accuracy

VOLTS/DIV Switch Setting	Standard Amplitude Signal	Deflection for 3% Accuracy		Display Limits (divisions)
		Divisions	Accuracy	
10 mV	50 mV	5	±0.15 div	4.85 to 5.15
20 mV	0.1 V	5	±0.15 div	4.85 to 5.15
50 mV	0.2 V	4	±0.12 div	3.88 to 4.12
.1 V	0.5 V	5	±0.15 div	4.85 to 5.15
.2 V	1 V	5	±0.15 div	4.85 to 5.15
.5 V	2 V	4	±0.12 div	3.88 to 4.12
1 V	5 V	5	±0.15 div	4.85 to 5.15
2 V	10 V	5	±0.15 div	4.85 to 5.15
5 V	20 V	4	±0.12 div	3.88 to 4.12

k. Set test oscilloscope controls as follows:

Vertical Mode	Add
Invert	On
Volts/Div (both)	0.1 V (with 10X probe)
Triggering	Auto (free-running sweep)
A Trigger Source	Ext (with no triggering signal applied)

l. Connect two 10X probes from the test oscilloscope; one to TP217 and the other to TP314 on the 468 Vertical Preamplifier board. Connect the probe ground leads to chassis ground.

m. CHECK—Signal between TP217 and TP314 is 400 mV p-p (4 divisions).

n. ADJUST—CH 1 Gain Adjust (R269) for 400 mV p-p.

NOTE

This is a nominal value for this adjustment. Readjustment may be required to obtain correct CH 1 overall gain.

o. Disconnect the probes from the 468 test points.

p. CHECK—Display is 4 divisions within 3% (4 divisions ±0.12 division).

q. ADJUST—Output Gain Adjust (R117) on the Vertical Output Amplifier board for a 4-division display.

r. Set CH 2 VOLTS/DIV switch to 5 mV and move the input signal from the CH 1 input to the CH 2 input. Set VERT MODE switches to display CH 2 only.

s. CHECK—Display is 4 divisions within 3% (4 divisions ±0.12 division).

t. ADJUST—CH 2 Gain Adjust (R569) for a 4-division display.

u. Repeat parts e through i of this step to recheck Vertical DC Accuracy for correct overall gain.

13. Check CH 1 and CH 2 VOLTS/DIV VAR Range

a. Set:

VERT MODE	CH 2
VOLTS/DIV (both)	10 mV

b. Connect a 50-mV, standard-amplitude square-wave signal to CH 2 input.

c. Rotate CH 2 VOLTS/DIV VAR control fully counterclockwise.

d. CHECK—Display reduces to 2 divisions or less in amplitude.

e. Move the test signal to CH 1 input and set the VERT MODE switches to display CH 1 input.

f. Rotate CH 1 VOLTS/DIV VAR control fully counterclockwise.

g. CHECK—Display reduces to 2 divisions or less in amplitude.

h. Return both VAR controls to their calibrated detent.

14. Check ADD Mode

a. Set:

VOLTS/DIV (both)	5 mV
VERT MODE	ADD
INVERT	Normal (button out)

b. Connect a 10-mV, standard-amplitude square-wave signal to both CH 1 and CH 2 inputs via a 50-Ω cable and dual-input coupler.

c. CHECK—Display amplitude is 4 divisions within 3% (4 divisions ±0.12 division).

15. Check Compression and Expansion

a. Set:

CH 2 AC-GND-DC	GND
VERT MODE	CH 1 only

b. Adjust CH 1 VAR control for an exact 2-division display, centered about the center horizontal graticule line.

c. Position top of display to top graticule line.

d. CHECK—For typical display compression or expansion of 0.1 division or less.

e. Position bottom of display to bottom graticule line.

f. CHECK—For typical display compression or expansion of 0.1 division or less.

g. Set CH 1 VAR control to the calibrated detent.

h. Disconnect the test equipment from the 468.

16. Check/Adjust TRACE SEP Centering (R112)

a. Set:

A TIME/DIV	2 μs
HORIZ DISPLAY	ALT
B TIME/DIV	0.2 μs

b. Use the CH 1 Vertical POSITION control to center the A trace and use the TRACE SEP control to superimpose the B trace at the center horizontal graticule line.

c. CHECK—TRACE SEP control will separate the B trace from the A trace equally (at least 4 divisions) in both the upward and downward direction as the control is rotated between fully clockwise and fully counterclockwise.

d. ADJUST—Trace Sep Centering (R112) for a vertically centered trace separation range when rotating the TRACE SEP control between the fully clockwise and fully counterclockwise positions.

17. Check/Adjust Low-Frequency Compensation

a. Set:

A TIME/DIV	0.2 ms
VERT MODE	CH 1
AC-GND-DC (both)	DC
VOLTS/DIV (both)	5 mV
A TRIGGER LEVEL	For a stable display
HORIZ DISPLAY	A

b. Connect the square-wave generator fast-rise + output through a 50-Ω bnc cable, a 10X attenuator, and a 50-Ω bnc termination to the CH 1 input.

c. Adjust the generator as necessary to maintain a 5-division display throughout the step.

d. CHECK—Display overshoot or rounding is within 3% (4.85 to 5.15 division) for each A TIME/DIV switch setting and generator setting given in Table 4-13.

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Table 4-13

Maximum Overshoot or Rounding

Fast-Rise + Frequency	A TIME/DIV Switch Setting	Rounding or Overshoot Tolerance (divisions)
1 kHz	0.2 ms	4.85 to 5.15
10 kHz	20 μs	4.85 to 5.15
100 kHz	2 μs	4.85 to 5.15

e. If all checks are within tolerance, skip to step 18. If not, continue with part f of this step.

f. Set:

A TIME/DIV	0.2 ms
VERT MODE	CH 1, CH 2, and ALT
A TRIGGER SLOPE	– (minus)
A TRIGGER LEVEL	For a stable display

g. Unplug the cable connector from J686 (Vert Alt Sync output from the Interface board) and insert the P686 plug into a bnc-female-to-coaxial-cable-connector adapter. Connect the square-wave output of the low-frequency sine-wave generator to the bnc-to-cable-connector adapter via a 50-Ω bnc cable. Set the generator output frequency to 1 kHz and adjust CH 1 and CH 2 Vertical POSITION controls for a 6-division display. Adjust the A TRIGGER LEVEL control for a stable display. Presentation will be a square wave when the CH 1 and CH 2 traces alternate at the generator frequency.

NOTE

As an alternate signal source, use the fast-rise – (minus) output of the calibration generator. Do not terminate the cable and adjust the output amplitude to maximum. Any other signal source used must be TTL compatible to supply the proper logic voltage levels to drive the Vertical Switching Logic circuit.

h. ADJUST—Vertical Output LF Compensation for the best flat top on the display, using the settings and adjustments given in Table 4-14. Rounding or overshoot must be 3% or less.

i. INTERACTION—Repeat 1-kHz, 10-kHz, and 100-kHz adjustments until no further improvement is obtained.

Table 4-14

Vertical Output Low-Frequency Compensation

Square-Wave Frequency	TIME/DIV Switch Setting	Adjustment Circuit Number
1 kHz	0.2 ms	R335
10 kHz	20 μs	R329, R325
100 kHz	2 μs	R321, R319

j. Unplug the P686 cable connector from the bnc-to-cable-connector adapter and plug the connector back into J686.

k. Set:

A TIME/DIV	0.2 ms
VERT MODE	CH 1
A TRIGGER SLOPE	+ (plus)

l. Connect a 1-kHz, fast-rise + signal to the CH 1 input connector via a 50-Ω bnc cable, a 10X attenuator, and a 50-Ω bnc termination. Set the generator for a 6-division display and adjust the A TRIGGER LEVEL control for a stable display.

m. ADJUST—CH 1 LF Compensation for the best flat top on the display, using the settings and adjustments given in Table 4-15. Rounding or overshoot must be 3% or less.

Table 4-15

CH 1 Low-Frequency Compensation

Square-Wave Frequency	TIME/DIV Switch Setting	Adjustment Circuit Number
1 kHz	0.2 ms	R165
10 kHz	20 μs	R172
100 kHz	2 μs	R321 and R319 on the Vertical Output board if needed (see Table 4-16).

n. Move the test signal from the CH 1 input to the CH 2 input and set the VERT MODE switches to display CH 2 only.

Table 4-16

CH 2 Low-Frequency Compensation

Square-Wave Frequency	TIME/DIV Switch Setting	Adjustment Circuit Number
1 kHz	0.2 ms	R371
10 kHz	20 μs	R373
100 kHz	2 μs	R321 and R319 for best compromise between CH 1 and CH 2.

o. ADJUST—CH 2 LF Compensation for the best flat top on the display, using the settings and adjustments given in Table 4-16. Rounding or overshoot must be 3% or less.

p. Disconnect the fast-rise + signal from the 468.

NOTE

In steps 18 and 19, all VOLTS/DIV Checks and Adjustments require the use of a 10X probe with scale-factor switching (preferably the probe supplied with the oscilloscope being calibrated).

18. Check/Adjust CH 1 VOLTS/DIV Compensation

NOTE

Input capacitor C13010, in the CH 1 Attenuator, is set at the factory to give C13010 in the CH 2 Attenuator enough range to match CH 2 input capacitance with CH 1 input capacitance. Unless there is a circuit malfunction, the CH 1 C13010 should not require readjustment.

Make any adjustments required in the attenuator and preamplifier using a low-capacitance screwdriver only. If the screwdriver has a metal bit, the adjustment may be affected. Check adjustment after the screwdriver is removed from the adjustment screw, and readjust if necessary.

a. Set:

VOLTS/DIV (both)	5 mV (see NOTE preceeding step 18)
VERT MODE	CH 1
A TIME/DIV	0.2 ms (see NOTE after part h)
20 MHz BW LIMIT	Limited bandwidth (button in)

b. Connect a 10X probe to the CH 1 input (note that the VOLTS/DIV Scale-Factor LED now indicates 50 mV).

NOTE

If the oscilloscope is to be used primarily with a 50-Ω signal source, more accurate reproduction of the waveform front corner may be achieved by calibrating with a 50-Ω system. To accomplish this, substitute a properly terminated 50-Ω bnc cable for the 10X probe while making the front-corner adjustments listed in Table 4-17.

c. Connect the square-wave high-amplitude test signal to the tip of the 10X probe via a 2X, 5X, or 10X attenuator (depending on the generator output signal amplitude) and bnc-to-probe-tip adapter. Check generator output impedance to determine if a 50-Ω termination is required.

d. Set the generator for a 1-kHz, 5-division display. During the remainder of procedure steps 18 and 19, add or remove attenuators and/or termination as needed to maintain a 5-division display of the test signal.

e. Adjust the probe compensation for the best flat top on the displayed waveform. Do not readjust the probe compensation during the remainder of this step.

f. Set CH 1 VOLTS/DIV switch to 0.1 V (with 10X probe).

g. CHECK—Compensation for all VOLTS/DIV settings listed in Table 4-17 is adjusted to produce a displayed waveform that has 2% or less overshoot or rounding and has a flat top within 2% (4.9 to 5.1 divisions). If compensation is within 2%, skip part h. If not, perform part h.

h. ADJUST—Any adjustment pair (as given in Table 4-17) required to compensate all settings of the VOLTS/DIV switch to within 2%.

NOTE

When adjusting compensation, one adjustment will affect the waveform front corner and another will affect the flat top. Ignore the front corner when making the flat-top adjustment and vice versa. The A TIME/DIV switch should be set to 1 ms for the flat-top and to 0.2 ms for front-corner checks and adjustments.

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Table 4-17

VOLTS/DIV Compensation

VOLTS/DIV Setting (10X Scale-Factor)	Adjust	
	TIME/DIV Set to 1 ms FLAT	TIME/DIV Set to 0.2 ms CORNER
0.1 V	C37	C36
0.2 V	C35	C34
0.5 V	C33	C32
1.0 V	Check	Check
2.0 V	Check	Check
5.0 V	C31	C30

19. Adjust CH 2 VOLTS/DIV Compensation

a. Set:

VERT MODE CH 2

b. Move the 10X probe connector from the CH 1 input to the CH 2 input. Do not readjust probe compensation.

c. Adjust the generator for a 1-kHz, 5-division display. Add or remove attenuators and/or termination as needed to maintain a 5-division signal display throughout the remainder of this step.

d. CHECK—Display for a flat-top waveform, within 2% (±0.1 division).

e. ADJUST—C13010 in the CH 2 Preamplifier input for best flat-top waveform, using a low-capacitance alignment tool.

f. Set:

CH 2 VOLTS/DIV 0.1 V

g. Repeat step 18, parts g and h, for CH 2.

h. Disconnect the test setup from the 468.

NOTE

Adjustments contained in steps 20 through 26 interact. Before attempting to make any adjustment, first perform these seven steps in sequence and make all the checks. If all checks are within the given limits, proceed to step 27.

If any of the checks are not within the given limits, perform steps 20 through 26, making adjustments as required with a low-capacitance alignment tool.

If all checks are still not within the given limits after making adjustments, perform all of steps 6 through 26.

If calibration is being performed after repair or replacement of vertical system components, adjustments may be made as they occur in each step.

20. Check/Adjust CH 2 and Output High-Frequency Compensation

a. Set:

VOLTS/DIV (both) 5 mV
20 MHz BW LIMIT Full bandwidth (button out)

b. Connect a 100-kHz, fast-rise + (positive-going) square-wave signal via a 50-Ω bnc cable, a 10X attenuator, and a 50-Ω bnc termination to the CH 2 input.

c. Adjust the generator for a 5-division signal display.

d. Set:

A TIME/DIV 0.2 μs

e. CHECK—Flat-top display aberrations are within 4% (±0.2 division). See Figure 4-2 for a typical display.

f. ADJUST—R477, C480, R438, C444 (CH 2), and C213, R218, R229, and C234 (Vertical Output Amplifier) for best front corner.

g. Apply a fast-rise − (negative-going) signal to the CH 2 input. Maintain the 5-division signal amplitude.

h. Set A TRIGGER SLOPE switch to − (minus).

i. CHECK—Flat-bottom display aberrations are within 6% (±0.3 division).

21. Check CH 2 Position Effect

a. Use the CH 2 Vertical POSITION control to position the bottom of the display to the top graticule line.

b. CHECK—Display aberrations are within 8% (±0.4 division).

c. Set A TRIGGER SLOPE switch to + (plus).

d. Apply a fast-rise + signal (5 divisions in amplitude) to the CH 2 input.

e. Position the top of the display to the bottom graticule line.

f. CHECK—Display aberrations are within 6% (±0.3 division).

22. Check/Adjust CH 1 High-Frequency Compensation

a. Set VERT MODE switches to display CH 1 only.

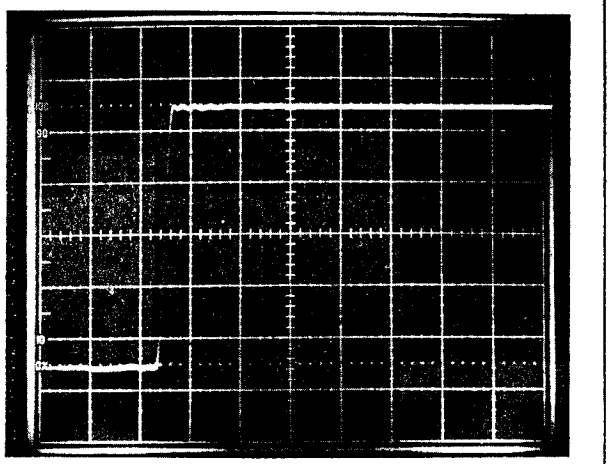
b. Move the fast-rise + signal from the CH 2 input to the CH 1 input.

c. CHECK—Flat-top display aberrations are within 4% (±0.2 division). See Figure 4-2 for a typical display.

d. ADJUST—R176, C181, R240, and C244 (CH 1) for best flat-top display.

INTERACTION—It may be necessary to compromise the Vertical Output Amplifier adjustments and the CH 2 adjustments made in step 20, part f, to obtain the best high-frequency match between CH 1 and CH 2.

e. Apply the fast-rise — (negative-going) signal to the CH 1 input.



3515-52

Figure 4-2. Typical display when high-frequency compensation is correctly adjusted.

f. Set A TRIGGER SLOPE switch to — (minus).

g. CHECK—Flat-bottom aberrations are within 6% (±0.3 division).

23. Check CH 1 Position Effect

a. Position bottom of the display to the top graticule line.

b. CHECK—Display aberrations are within 8% (±0.4 division).

c. Set A TRIGGER SLOPE switch to + (plus).

d. Apply the fast-rise + signal to the CH 1 input.

e. Position top of the display to the bottom graticule line.

f. CHECK—Display aberrations are within 6% (±0.3 division).

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24. Check CH 1 Transient Response

a. Verify that A TRIGGER SLOPE switch is set to + and that the fast-rise + signal is connected to the CH 1 input via a 50-Ω bnc cable, a 10X attenuator, and a 50-Ω bnc termination.

b. Set the generator and add or remove attenuators as required to maintain a 5-division display throughout part c of this step.

c. CHECK—Display flat-top aberrations are within 4% (±0.2 division) for each of the following VOLTS/DIV switch settings: 5 mV, 10 mV, 20 mV, and 50 mV. (Maintain the 5-division display in each position checked.)

25. Check CH 2 Transient Response

a. Set VERT MODE switches to display CH 2 only.

b. Move the fast-rise + signal from the CH 1 input to the CH 2 input.

c. Adjust the generator and add or remove attenuators as required to maintain a 5-division display throughout part d of this step.

d. CHECK—Display flat-top aberrations are within 4% (±0.2 division) for each of the following VOLTS/DIV switch settings: 5 mV, 10 mV, 20 mV, and 50 mV. (Maintain the 5-division display in each position checked.)

e. Disconnect the test equipment from the 468.

26. Check Bandwidth

a. Set:

A TIME/DIV	0.2 ms
CH 2 VOLTS/DIV	5 mV

b. Connect the leveled sine-wave generator reference signal (reference signal frequency is typically 50 kHz) via a 50-Ω bnc cable, a 10X attenuator, and a 50-Ω bnc termination to the CH 2 input.

c. Adjust the generator for a 5-division reference-signal display.

d. Set the generator frequency to 100 MHz.

e. CHECK—Display amplitude is 3.5 divisions or more.

f. Repeat parts c, d, and e of this step for the 10-mV through 1-V positions of the CH 2 VOLTS/DIV switch.

g. Change VERT MODE switches to display CH 1 only and move the signal from the CH 2 input to the CH 1 input.

h. Repeat parts c, d, and e of this step for the 5-mV through 1-V positions of the CH 1 VOLTS/DIV switch.

i. Disconnect the test setup from the 468.

27. Check Cascaded Gain and Bandwidth

a. Set:

VOLTS/DIV (both)	5 mV
AC-GND-DC (both)	AC
VERT MODE	CH 2
A TIME/DIV	1 ms

b. Connect the CH 1 VERT SIGNAL OUT (located on the 468 rear panel) via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 2 input connector.

c. Connect a 5-mV, standard-amplitude square-wave signal to the CH 1 input via a 50-Ω bnc cable.

d. CHECK—Display amplitude is 5 divisions or more.

e. Remove the standard-amplitude signal from the CH 1 input.

f. Connect a leveled sine-wave reference signal via a 50-Ω bnc cable, a 10X attenuator, and a 50-Ω bnc termination to the CH 1 input.

g. Adjust generator for a reference signal display of 5 divisions. (Reference-signal frequency is typically 50 kHz.)

h. Change the generator output frequency to 50 MHz.

i. CHECK—Display amplitude is 3.5 divisions or more.

j. Disconnect the test signal from the 468.

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28. Check Channel Isolation

a. Set:

CH 2 VOLTS/DIV	0.2 V
VERT MODE	CH 2
CH 1 AC-GND-DC	GND
CH 2 AC-GND-DC	DC

b. Connect a 25-MHz, leveled sine-wave signal via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 2 input.

c. Adjust the generator for a 2-division display.

d. Set:

VOLTS/DIV (both)	20 mV
VERT MODE	CH 1
A TRIGGER SOURCE	CH 2
A TRIGGER LEVEL	As needed for a stable display

e. CHECK—Display amplitude is 0.2 division or less.

f. Move the test signal from the CH 2 input to the CH 1 input.

g. Set:

CH 1 AC-GND-DC	DC
CH 2 AC-GND-DC	GND
VERT MODE	CH 2
A TRIGGER SOURCE	CH 1
A TRIGGER LEVEL	As needed for a stable display

h. CHECK—Display amplitude is 0.2 division or less.

i. Disconnect the test setup from the 468.

29. Check/Adjust Common-Mode Rejection Ratio (R569)

a. Set:

VOLTS/DIV (both)	20 mV
AC-GND-DC (both)	DC
A TRIGGER SOURCE	NORM
VERT MODE	CH 1
CH 2 INVERT	Inverted (button in)

b. Connect a 20-MHz, leveled sine-wave signal via a 50-Ω bnc cable, a 10X attenuator, a 50-Ω bnc termination, and a dual-input coupler to the CH 1 and CH 2 inputs.

c. Set the generator amplitude for a 6-division display.

d. Set VERT MODE switches to display ADD only (press CH 1 push button to release it, removing the CH 1 trace from the display).

e. CHECK—Display amplitude is 0.6 division or less. This indicates that the common-mode rejection ratio is at least 10:1 at 20 MHz.

f. If the check in part e meets the requirement, skip to part m. If it does not, continue with part g.

g. Set VERT MODE switches to display CH 1 only.

h. Change the generator frequency to 50 kHz and adjust the amplitude to obtain a 6-division display.

i. Set VERT MODE switches to display ADD only.

j. ADJUST—CH 2 Gain Adjust (R569) for minimum display amplitude (best CMRR).

k. Change the generator frequency to 20 MHz.

l. CHECK—Display amplitude is 0.6 division or less.

m. Press CH 2 INVERT push button to release it; disconnect the test setup.

30. Check Bandwidth Limit Operation

a. Set:

20 MHz BW LIMIT	Limited bandwidth (button in)
CH 1 AC-GND-DC	DC
VERT MODE	CH 1

b. Connect the leveled sine-wave reference frequency signal via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 1 input.

c. Set the generator output amplitude to obtain a 6-division display.

d. Increase the generator frequency until the display amplitude is 4.2 divisions.

e. CHECK—Generator frequency is within the range of 16 MHz to 24 MHz.

f. Disconnect the test setup from the 468.

31. Check/Adjust Trigger View Centering and Gain (R534 and R443)

a. Set:

A TRIGGER COUPLING	AC
A TRIGGER SOURCE	EXT
A TRIGGER LEVEL	0
A TIME/DIV	0.2 ms
VERT MODE	A TRIG VIEW

b. Connect a 0.5-V, standard-amplitude square-wave signal to the EXT A TRIGGER input via a 50-Ω bnc cable.

c. CHECK—Display will trigger symmetrically within 1 division of the center horizontal graticule line when A TRIGGER SLOPE is switched between + and —.

d. ADJUST—Trig View Centering (R534) to center the display about the center horizontal graticule line (verify that the A TRIGGER LEVEL is set to 0).

e. CHECK—Display amplitude is 5 divisions ±5% (4.75 to 5.25 divisions).

f. ADJUST—Trig View Gain (R443) to obtain a 5-division display.

g. INTERACTION—Between Trig View Centering and Trig View Gain adjustments. Repeat parts d through f until no visible interaction is observed.

h. Disconnect the signal from the EXT A TRIGGER input.

32. Check/Adjust Trigger View Low-Frequency Compensation (C509 and C510)

a. Connect a 1-kHz high-amplitude square-wave signal to the EXT A TRIGGER input via a 50-Ω bnc cable (check generator used to determine if a 50-Ω bnc termination is required).

b. Set generator output amplitude to obtain a 5-division display.

c. CHECK—Square wave has 10% or less overshoot or rounding (±0.5 division).

d. ADJUST—C509 for the best flat top on the square-wave display.

e. Set A TRIGGER SOURCE switch to EXT/10 and adjust the generator to obtain a 5-division display.

f. ADJUST—C510 for the best flat top on the square-wave display.

g. Disconnect the bnc cable from the 468.

33. Check/Adjust Trigger View High-Frequency Compensation (C438, C538, and R435).

a. Set:

A TIME/DIV	0.2 μs
A TRIGGER SOURCE	EXT

b. Connect a 100-kHz, fast-rise + square-wave signal via a 50-Ω bnc cable and a 50-Ω bnc termination to the EXT A TRIGGER input.

c. Adjust the generator output amplitude to obtain a 5-division display.

d. CHECK—Square-wave front corner has less than 10% aberration (±0.5 division).

e. ADJUST—C438, C538, and R435 for the best front corner to obtain a square-wave rise time of 5 ns or less.

f. Disconnect test signal from the 468.

34. Check/Adjust Zero Trigger View Delay (R124 and R270)

a. Set:

VERT MODE	CH 1 and A TRIG VIEW
HORIZ DISPLAY	A
A TIME/DIV	0.02 μs
A TRIGGER SOURCE	EXT
A TRIGGER COUPLING	AC
CH 1 VOLTS/DIV	0.1 V

b. Connect a 40-MHz, leveled sine-wave signal via a bnc T-connector, two 42-inch (equal-length) 50-Ω bnc cables, and two 50-Ω bnc terminations; one connected to the CH 1 input and the other to the EXT A TRIGGER input. Set the generator output signal amplitude to obtain a 6-division A TRIG VIEW signal display.

c. Set the CH 1 VOLTS/DIV switch and VAR control to match the CH 1 display-signal amplitude to the A TRIG VIEW display-signal amplitude.

d. Use the CH 1 Vertical POSITION control and the A TRIGGER LEVEL control to superimpose the two displayed signals.

e. Set:

X10 MAG	On (button in)

f. CHECK—Phase difference between the CH 1 signal and the A TRIG VIEW signal is 0.2 horizontal graticule division or less.

NOTE

See Figure 4-3 for location of access holes through the Storage Display circuit board to reach adjustments located on the Timing circuit board.

g. ADJUST—R124 for zero phase difference between the CH 1 signal and the A TRIG VIEW signal.

h. Set:

HORIZ DISPLAY	B DLY'D
A TIME/DIV	0.2 μs
B TIME/DIV	0.02 μs
X10 MAG	Off (button out)

i. Repeat part c of this step to verify the two signals are superimposed.

j. Set:

X10 MAG	On (button in)

k. CHECK—Phase difference between the CH 1 signal and the A TRIG VIEW signal is 0.2 horizontal graticule division or less.

l. ADJUST—R270 for zero phase difference between the CH 1 signal and the A TRIG VIEW signal.

m. Disconnect the test setup from the 468.

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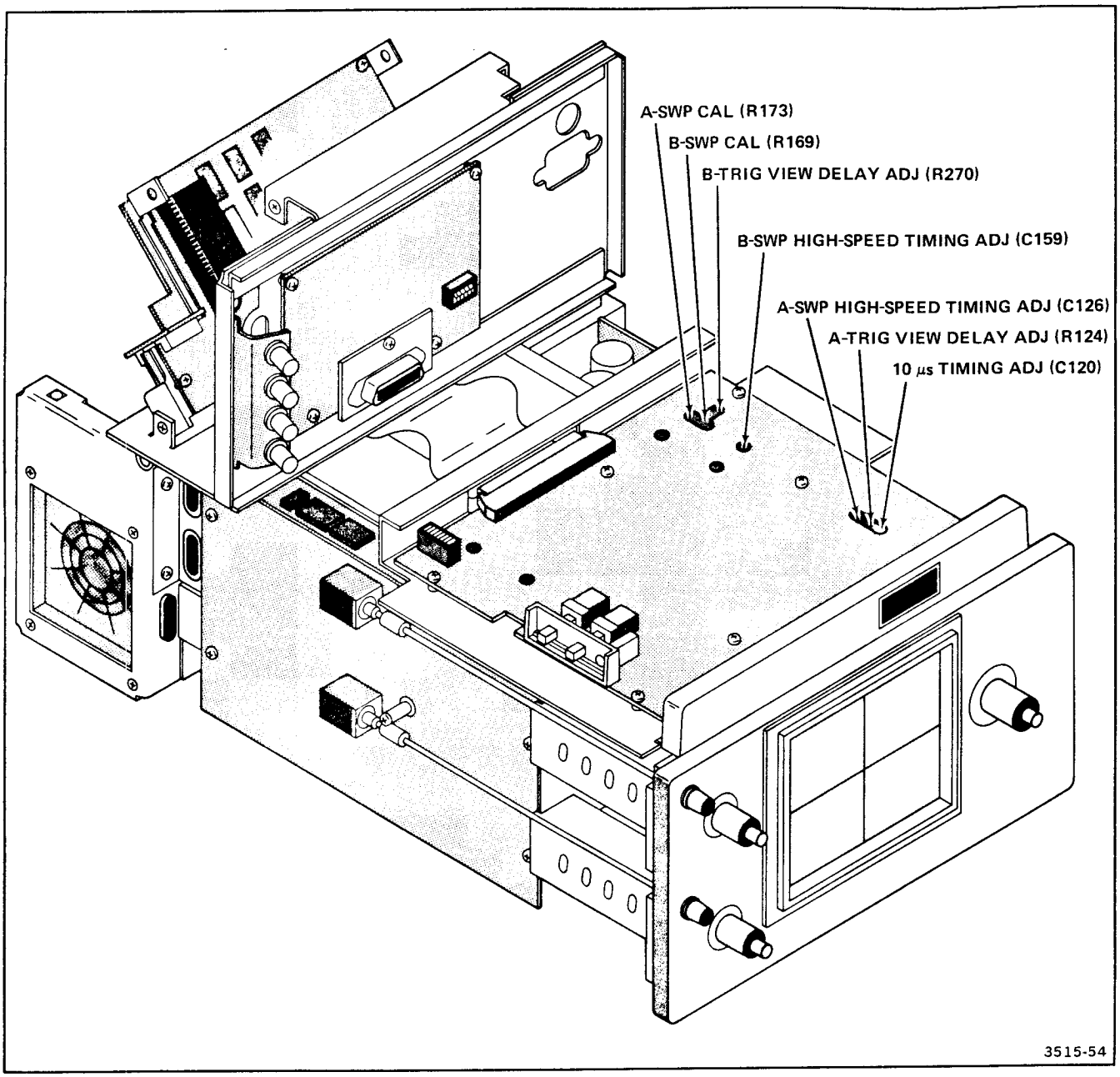

Figure 4-3. Location of timing adjustments accessed through the Storage Display circuit board.

TRIGGERING

Equipment Required (see Table 4-1)

4. 10X Probe (supplied with the 468)
6. Leveled Sine-Wave Generator
7. Time-Mark Generator
8. Low-Frequency Sine-Wave Generator
11. 50-Ω Signal Pickoff Unit (Type CT-3)
12. 42-in., 50-Ω Bnc Cable (2 required)
14. Gr-to-bnc-female Adapter
15. Gr-to-bnc-male Adapter
19. Dual-Input Coupler (2 required)
20. Bnc T-Connector
21. 10X Bnc Attenuator
24. 50-Ω Bnc Termination
25. 3-in., Flat-Bit Screwdriver

See ADJUSTMENT LOCATIONS 2 *and* ADJUSTMENT LOCATIONS 3 *in this Volume for test point and adjustment locations.*

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468 CONTROL SETTINGS

Power

Regulating Range Selector	High
Line Voltage Selector	115 V
POWER	ON (button in)

Crt

INTENSITY	As desired
FOCUS	Best focused display
SCALE ILLUM	As desired

Vertical (CH 1 and CH 2)

VOLTS/DIV	10 mV
VOLTS/DIV VAR	Calibrated detent
VERT MODE	CH 1
POSITION	Midrange
AC-GND-DC	DC
INVERT	Off (button out)
20 MHz BW LIMIT	Full bandwidth (button out)

Triggering (A and B if applicable)

A TRIGGER SOURCE	NORM
A TRIG MODE	AUTO
SLOPE	+
COUPLING	AC
LEVEL	For a stable display
A TRIGGER HOLDOFF	NORM

Sweep (A and B)

HORIZ DISPLAY	A
DELAY TIME POSITION	Fully counterclockwise
TIME/DIV (both)	0.05 μs
TIME/DIV VAR	Calibrated detent
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange

Digital Storage

NON STORE	On (button in)
SAVE REF	Off (button out)
CURSOR FUNCTION	Both off (buttons out)

1. Check/Adjust A Trigger Sensitivity and TRIG LED (R351)

a. Connect a 10-MHz, leveled sine-wave signal to both the A and B EXT TRIGGER inputs and the CH 1 and CH 2 inputs as shown in Figure 4-4.

b. Adjust the generator output amplitude for a 3-division signal display.

c. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.3 division display).

d. CHECK—Stable display can be obtained by rotating the A TRIGGER LEVEL control with SLOPE switch in both + and —.

e. CHECK—TRIG LED is illuminated when the display is stable.

f. Set:

CH 1 AC-GND-DC GND

g. CHECK—Stable display cannot be obtained for any position of the A TRIGGER LEVEL control with SLOPE switch in either + or — (TRIG LED does not remain illuminated). Return the A TRIGGER SLOPE to +.

h. If the checks in parts b through g meet the requirements, skip to step 2. If not, continue with the following parts.

i. Set:

CH 1 AC-GND-DC AC

j. ADJUST—A Trigger Sensitivity (R351) so display can just be triggered by rotating the A TRIGGER LEVEL control (A TRIGGER SLOPE in +).

k. Set:

CH 1 AC-GND-DC GND

l. CHECK—Stable baseline display cannot be obtained for any position of the A TRIGGER LEVEL with SLOPE in + (negative slope is generally slightly more sensitive).

m. If a stable display can be obtained, then the trigger sensitivity is too high. Adjust A Trigger Sensitivity (R351) slightly so display just fails to trigger for any position of the A TRIGGER LEVEL control (with the A TRIGGER SLOPE in + only).

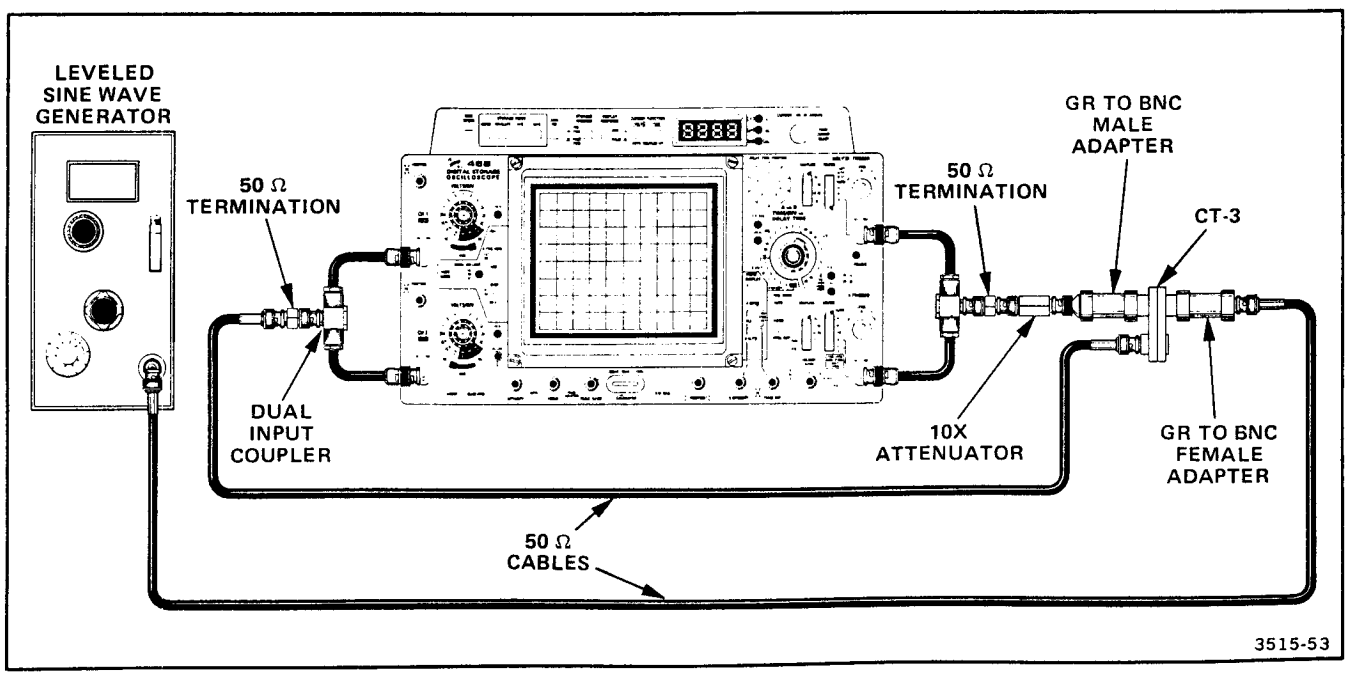

Figure 4-4. Test setup for A and B triggering checks and adjustments.

n. Repeat step 1, parts i through m, until a stable display can be obtained on a 0.3-division display, but not on a baseline trace (+ SLOPE only).

o. Repeat checks in step 1, parts b through g.

2. Check/Adjust B Trigger Sensitivity (R154)

a. Set:

HORIZ DISPLAY	B DLY'D
CH 1 VOLTS/DIV	10 mV
CH 1 AC-GND-DC	DC
A TRIGGER LEVEL	Fully clockwise
B TRIGGER LEVEL	For a stable display

b. Adjust the generator for a 3-division signal display.

c. Set:

CH 1 VOLTS/DIV	0.1 V (0.3-division display)

d. CHECK—Stable display can be obtained by rotating the B TRIGGER LEVEL control with the B TRIGGER SLOPE in either + or —.

e. Set:

CH 1 AC-GND-DC	GND

f. CHECK—Stable display cannot be obtained by rotating the B TRIGGER LEVEL control with the B TRIGGER SLOPE in either + or —.

g. If the checks in preceding parts b through f meet the requirements, skip to step 3. If they do not, continue with the following parts.

h. Set:

CH 1 AC-GND-DC	AC

i. ADJUST—B Trigger Sensitivity (R154) so display can just be triggered by rotating the B TRIGGER LEVEL control (B TRIGGER SLOPE in + only).

j. Set:

CH 1 AC-GND-DC	GND

k. CHECK—Stable display cannot be obtained by rotating the B TRIGGER LEVEL control (with B TRIGGER SLOPE in + only).

l. If a stable display can be obtained, then the trigger sensitivity is too high. Adjust B Trigger Sensitivity (R154) slightly so display will just fail to trigger in any position of the B TRIGGER LEVEL control (with SLOPE in + only).

m. Repeat step 2, parts h through l, until a stable display can be obtained on a 0.3-division display, but not on a baseline trace.

n. Repeat checks in parts c through f.

3. Check/Adjust B Trigger Slope Center and Level (R148 and R134)

a. Set:

B TRIGGER SOURCE	STARTS AFTER DELAY
TIME/DIV (both)	10 μs
B TRIGGER LEVEL	0
CH 1 VOLTS/DIV	10 mV
CH 1 AC-GND-DC	GND

NOTE

The B TRIGGER LEVEL control must remain set to 0 throughout this step.

b. Use the CH 1 Vertical POSITION control to align the trace with the center horizontal graticule line.

c. Set:

CH 1 AC-GND-DC	DC
B TRIGGER SOURCE	NORM

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d. Adjust the generator for a 50-kHz, 4-vertical-division signal display.

e. CHECK—Display begins at about the same vertical point, within 1 division of graticule center, when B TRIGGER SLOPE is switched between + and —.

f. ADJUST—B Slope Center (R148) so that the display starts at the same vertical point on the sine wave with SLOPE switch in both + and — (not necessarily the center horizontal graticule line). Return the B TRIGGER SLOPE switch to +.

g. ADJUST—B Trig Level (R134) to move the starting point of the display to the center horizontal graticule line.

INTERACTION—B Trig Level (R134), B Slope Center (R148), and B Trigger Sensitivity (R154) will interact. Repeat parts f and g of this step and step 2, parts i through o, until no improvement is noted.

4. Check/Adjust A Trigger Slope Center and Level (R349 and R330)

a. Set:

HORIZ DISPLAY	A
A TRIGGER LEVEL	0

NOTE

The A TRIGGER LEVEL control must remain set to 0 throughout this step.

b. CHECK—Display begins at about the same vertical point (within 1 division of graticule center) when A TRIGGER SLOPE is switched between + and —.

c. ADJUST—A Slope Center (R349) so that the display starts at the same vertical point on the sine wave with the SLOPE in both + and — (not necessarily the center horizontal graticule line). Return the A TRIGGER SLOPE switch to +.

d. ADJUST—A Trig Level (R330) to move the starting point of the display to the center horizontal graticule line.

INTERACTION—A Trig Level (R330), A Trigger Sensitivity (R351), and A Slope Center (R349) will interact. Repeat parts c and d of this step and step 1, parts i through p, until no improvement is noted.

5. Check/Adjust A Trigger DC Levels (R205, R122, and R431)

a. Set:

A TRIGGER COUPLING	DC

NOTE

The A TRIGGER LEVEL control must remain set to 0 throughout this step.

b. CHECK—Vertical position of the start of the display is within 1 division of the center horizontal graticule line when A TRIGGER SLOPE is switched between + and —. Return the A TRIGGER SLOPE to +.

c. ADJUST—Norm Trig DC Balance (R205) to move the starting point of the display to the center horizontal graticule line.

INTERACTION—A and B Trig Level (R330 and R134) interact with Norm Trig DC Balance (R205). Repeat part c of this step, step 4 part d, and step 3 part g until no improvement is noted.

d. Set:

A TRIGGER SOURCE	CH 1

e. CHECK—Vertical position of the start of the display is within 1 division of the center horizontal graticule line when A TRIGGER SLOPE is switched between + and —. Return the A TRIGGER SLOPE to +.

f. ADJUST—CH 1 Trig DC Balance (R122) to move the starting point of the display to the center horizontal graticule line.

g. Set:

A TRIGGER SOURCE	CH 2

h. CHECK—Vertical position of the start of the display is within 1 division of the center horizontal graticule line when the A TRIGGER SLOPE is switched between + and —. Return the A TRIGGER SLOPE to +.

i. ADJUST—CH 2 Trig DC Balance (R431) to move the starting point of the displayed signal to the center horizontal graticule line.

6. Check B Trigger DC Levels

a. Set:

HORIZ DISPLAY	B DLY'D
A TRIGGER LEVEL	Fully clockwise
B TRIGGER LEVEL	0
B TRIGGER COUPLING	DC
B TRIGGER SOURCE	NORM

NOTE

The B TRIGGER LEVEL control must remain set to 0 throughout this step.

b. CHECK—Vertical position of start of the display is within 1 division of the center horizontal graticule line when B TRIGGER SOURCE is switched to the following positions: NORM, CH 1, and CH 2.

7. Check B Internal 10-MHz Triggering

a. Set:

TRIGGER COUPLING (both)	AC
CH 1 VOLTS/DIV	10 mV
CH 2 VOLTS/DIV	0.1 V
A TIME/DIV	0.2 μs
B TIME/DIV	0.05 μs
TRIGGER SOURCE (both)	NORM

b. Adjust the generator for a 10-MHz, 3-division signal display amplitude (30 mV).

c. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.3-division display).

d. Adjust the B TRIGGER LEVEL control as needed for a stable display.

e. CHECK—For a stable display, with B TRIGGER SLOPE switched to both + and — in the following B TRIGGER switch settings:

B TRIGGER

SOURCE	COUPLING
NORM	AC, DC
CH 1	DC, AC
CH 2	AC, DC

f. Set:

CH 1 VOLTS/DIV	10 mV
B TRIGGER COUPLING	LF REJ

g. Adjust the generator for a 10-MHz, 5-division signal display (50 mV).

h. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.5-division display).

i. Adjust the B TRIGGER LEVEL control as needed to obtain a stable display.

j. CHECK—For a stable display, with B TRIGGER SLOPE switched to both + and — in each of the following B TRIGGER SOURCE switch positions: CH 2, CH 1, and NORM.

k. Set:

B TRIGGER COUPLING	HF REJ

l. CHECK—A stable display cannot be obtained in any of the following B TRIGGER SOURCE switch positions: NORM, CH 1, and CH 2.

8. Check A Internal 10-MHz Triggering

a. Set:

HORIZ DISPLAY	A
A TIME/DIV	0.05 μs
A TRIGGER LEVEL	For a stable display
CH 1 VOLTS/DIV	10 mV

b. Adjust the generator for a 10-MHz, 3-division signal display (30 mV).

c. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.3-division display).

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d. Adjust the A TRIGGER LEVEL control to obtain a stable display.

e. CHECK—For a stable display, with the A TRIGGER SLOPE switched to both + and — for the following A TRIGGER switch settings:

A TRIGGER	
SOURCE	COUPLING
NORM	AC, DC
CH 1	DC, AC
CH 2	AC, DC

f. Set:

CH 1 VOLTS/DIV	10 mV
A TRIGGER COUPLING	LF REJ

g. Adjust the generator for a 10-MHz, 5-division signal display (50 mV).

h. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.5-division display).

i. Adjust the A TRIGGER LEVEL control as needed to obtain a stable display.

j. CHECK—For a stable display, with the A TRIGGER SLOPE switched to both + and — in each of the following A TRIGGER SOURCE switch positions: CH 2, CH 1, and NORM.

k. Set:

A TRIGGER COUPLING	HF REJ

l. CHECK—No stable display can be obtained in the following A TRIGGER SOURCE switch positions: NORM, CH 1, and CH 2.

9. Check A External 10-MHz Triggering

a. Set:

VOLTS/DIV (both)	10 mV
TRIGGER COUPLING (both)	AC
TRIGGER SOURCE (both)	EXT

b. Set the generator for a 10-MHz, 5-division signal display and adjust the A TRIGGER LEVEL control to obtain a stable display.

NOTE

The generator must be adjusted as necessary to maintain a 5-division signal display throughout this step.

c. CHECK—For a stable display, with the A TRIGGER SLOPE switched to both + and — in each of the following A TRIGGER COUPLING switch positions: AC and DC.

d. Set:

CH 1 VOLTS/DIV	20 mV
A TRIGGER COUPLING	LF REJ

e. Adjust the generator for a 10-MHz, 5-division signal display (100 mV).

f. Adjust the A TRIGGER LEVEL control as needed to obtain a stable display.

g. CHECK—For a stable display, with the A TRIGGER SLOPE switched to both + and —.

h. Set:

A TRIGGER COUPLING	HF REJ

i. CHECK—No stable display can be obtained.

j. Remove the 10X attenuator from the external trigger test setup and set the A TRIGGER SOURCE switch to EXT/10.

k. CHECK—No stable display can be obtained at any TRIGGER SLOPE or TRIGGER LEVEL setting.

l. Set:

A TRIGGER COUPLING	LF REJ

m. CHECK—For a stable display, with the A TRIGGER SLOPE switched to both + and —.

n. Set:

CH 1 VOLTS/DIV	10 mV
A TRIGGER COUPLING	AC

o. Adjust the generator for a 10-MHz, 5-division signal display (50 mV display with 0.5 V at the EXT TRIGGER input connector).

p. CHECK—For a stable display, with the A TRIGGER SLOPE switched to both + and − in each of the following A TRIGGER COUPLING switch positions: AC and DC.

10. Check B External 10-MHz Triggering

a. Set:

HORIZ DISPLAY	B DLY'D
A TIME/DIV	0.2 μs
B TIME/DIV	0.05 μs

b. Reconnect the 10X attenuator into the external trigger test setup.

NOTE

The generator must be adjusted as necessary to maintain a 5-division signal display throughout this step.

c. CHECK—For a stable display, with the B TRIGGER SLOPE switched to both + and − in each of the following B TRIGGER COUPLING switch positions: AC and DC.

d. Set the CH 1 VOLTS/DIV switch to 20 mV.

e. Adjust the generator for a 10-MHz, 5-division signal display (100 mV).

f. Set:

B TRIGGER COUPLING	LF REJ
B TRIGGER LEVEL	For a stable display

g. CHECK—For a stable display, with the B TRIGGER SLOPE switched to both + and −.

h. Set:

B TRIGGER COUPLING	HF REJ

i. CHECK—No stable display can be obtained.

11. Check B and A External 100-MHz Triggering

a. Set:

TRIGGER COUPLING (both)	AC
TRIGGER SOURCE (both)	EXT
CH 1 VOLTS/DIV	50 mV

b. Adjust the generator for a 10-MHz, 5-division signal display (150 mV); then change the generator frequency to 100 MHz. Do not readjust signal amplitude.

c. Press in the X10 MAG push button.

d. Adjust both the A and B TRIGGER LEVEL controls as needed in the remainder of this step to obtain a stable display.

e. CHECK—For a stable display, with 0.1 division or less jitter, when the B TRIGGER SLOPE is switched to both + and − in each of the following B TRIGGER COUPLING switch positions: AC and DC.

f. Adjust the generator for a 10-MHz, 6-division signal display (300 mV); then change the generator frequency to 100 MHz. Do not readjust the signal amplitude.

g. Set:

B TRIGGER COUPLING	LF REJ

h. CHECK—For a stable display, with 0.1 division or less jitter, when the B SLOPE is switched to both + and −.

i. Set:

B TRIGGER COUPLING	HF REJ

j. CHECK—No stable display can be obtained.

k. Set:

A TIME/DIV	A
A TRIGGER COUPLING	LF REJ
A TRIGGER LEVEL	For a stable display

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l. CHECK—For a stable display, with 0.1 division or less jitter, when the A TRIGGER SLOPE is switched to both + and —.

m. Set:

A TRIGGER COUPLING HF REJ

n. CHECK—No stable display can be obtained at any TRIGGER SLOPE or TRIGGER LEVEL setting.

o. Set:

A TRIGGER COUPLING AC

p. Adjust the generator for a 10-MHz, 5-division signal display (150 mV); then change the generator frequency to 100 MHz. Do not readjust the signal amplitude.

q. Adjust the A TRIGGER LEVEL control as needed to obtain a stable display.

r. CHECK—For a stable display, with 0.1 division or less jitter, when the A TRIGGER SLOPE is switched to both + and — in each of the following A TRIGGER COUPLING switch positions: AC and DC.

s. Remove the 10X attenuator from the external trigger test setup and set the A TRIGGER SOURCE switch to EXT/10.

t. Adjust the A TRIGGER LEVEL control as needed to obtain a stable display.

u. CHECK—For a stable display, with 0.1 division or less jitter, when the A TRIGGER SLOPE is switched to both + and — in each of the following A TRIGGER COUPLING switch positions: DC and AC.

v. Adjust the generator for a 10-MHz, 6-division signal display (300 mV); then change the generator frequency to 100 MHz. Do not readjust the signal amplitude.

w. Set:

A TRIGGER COUPLING	LF REJ
A TRIGGER LEVEL	For a stable display

x. CHECK—For a stable display, with 0.1 division or less jitter, when the A TRIGGER SLOPE is switched to both + and —.

y. Set:

A TRIGGER COUPLING HF REJ

z. CHECK—No stable display can be obtained at any TRIGGER SLOPE or TRIGGER LEVEL setting.

12. Check A Internal 100-MHz Triggering

a. Set:

VOLTS/DIV (both)	50 mV
TRIGGER SOURCE (both)	NORM
TRIGGER COUPLING (both)	AC

b. Reconnect the 10X attenuator into the external trigger test setup. Adjust the generator for a 100-MHz, 1.5-division signal display.

c. CHECK—For a stable display, with 0.1 division or less jitter, when the A TRIGGER SLOPE is switched to both + and — for each of the following A TRIGGER switch settings.

A TRIGGER	
SOURCE	COUPLING
NORM	AC, LF REJ, DC
CH 1	DC, LF REJ, AC
CH 2	AC, LF REJ, DC

d. Set:

A TRIGGER COUPLING HF REJ

e. CHECK—No stable display can be obtained at any TRIGGER SLOPE or TRIGGER LEVEL setting.

13. Check B Internal 100-MHz Triggering

a. Set:

HORIZ DISPLAY	B DLY'D
A TIME/DIV	0.2 μs
B TIME/DIV	0.05 μs
A TRIGGER COUPLING	DC
A TRIGGER SOURCE	NORM

b. CHECK—For a stable display, with 0.1 division or less jitter, when the B TRIGGER SLOPE is switched to both + and — for each of the following B TRIGGER switch settings.

B TRIGGER	
SOURCE	COUPLING
NORM	AC, LF REJ, DC
CH 1	DC, LF REJ, AC
CH 2	AC, LF REJ, DC

NOTE

It may be necessary to adjust both A and B TRIGGER LEVEL controls to obtain the most stable display at higher frequencies when B Sweep is displayed.

c. Set:

B TRIGGER COUPLING	HF REJ

d. CHECK—No stable display can be obtained at any TRIGGER LEVEL or TRIGGER SLOPE setting.

14. Check A and B HF REJ Triggering

a. Set:

HORIZ DISPLAY	A
TIME/DIV (both)	10 μs
X10 MAG	Off (button in)
TRIGGER COUPLING (both)	HF REJ
TRIGGER SOURCE (both)	NORM
CH 1 VOLTS/DIV	0.1 V
CH 2 VOLTS/DIV	10 mV
VERT MODE	CH 2

b. Adjust the generator for a 50-kHz, 5-division signal display (50 mV).

c. Set the CH 2 VOLTS/DIV switch to 0.1 V.

d. Adjust the A TRIGGER LEVEL control as needed to obtain a stable display.

e. Change the generator frequency to 1 MHz and press in the X10 MAG push button.

f. CHECK—A stable display cannot be obtained with the A TRIGGER SOURCE switch in any of the following positions: NORM, CH 1, and CH 2.

g. Set:

A TRIGGER LEVEL	Fully clockwise
HORIZ DISPLAY	B DLY'D

h. CHECK—A stable display cannot be obtained with the B TRIGGER SOURCE switch in any of the following positions: NORM, CH 1, and CH 2.

15. Check Single Sweep

a. Set:

HORIZ DISPLAY	A
CH 1 VOLTS/DIV	50 mV
VERT MODE	CH 1
X10 MAG	Off (button out)
A TRIGGER COUPLING	AC
A TRIGGER SOURCE	NORM
A TRIGGER SLOPE	+
A TRIGGER LEVEL	0

b. Adjust the generator for a 50-kHz, 1-division signal display.

c. Adjust the A TRIGGER LEVEL control so the display is just triggered.

d. Set:

TIME/DIV (both)	10 ms
CH 1 AC-GND-DC	GND
A TRIG MODE	SINGL SWP (push in)

e. CHECK—READY LED illuminates.

f. Set:

CH 1 AC-GND-DC	DC

g. CHECK—A single sweep occurs, and the READY LED goes out.

h. Press in the SINGL SWP push button.

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i. CHECK—A single sweep occurs each time the SINGL SWP push button is pressed.

j. Disconnect the test setup from the 468.

16. Check 60-Hz Internal Triggering

a. Set:

TIME/DIV (both)	5 ms
A TRIG MODE	NORM
CH 1 VOLTS/DIV	10 mV

b. Connect a 60-Hz, low-frequency sine-wave signal via a 50-Ω bnc cable, a bnc T-connector, and a 50-Ω bnc termination to the CH 1 input. From the other output of the T-connector, connect a 50-Ω bnc cable and a 50-Ω bnc termination to the EXT B TRIGGER input.

c. Adjust the generator for a 3-division signal display (30 mV).

d. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.3-division display).

e. CHECK—For a stable display, with the A TRIGGER SLOPE switched to both + and — in each of the following A TRIGGER COUPLING switch positions: AC and DC.

f. Set:

CH 1 VOLTS/DIV	10 mV
A TRIGGER COUPLING	HF REJ

g. Adjust the generator for a 60-Hz, 5-division signal display (50 mV).

h. Set the CH 1 VOLTS/DIV switch to 0.1 V (0.5-division display).

i. CHECK—For a stable display, with the A TRIGGER SLOPE switched to both + and —.

j. Set:

A TRIGGER COUPLING	LF REJ

k. CHECK—No stable display can be obtained at any TRIGGER SLOPE or TRIGGER LEVEL setting.

l. Set:

A TRIG MODE	AUTO
A TRIGGER LEVEL	Fully clockwise
A TIME/DIV	10 ms
B TIME/DIV	5 ms
B TRIGGER SOURCE	NORM
B TRIGGER COUPLING	HF REJ
HORIZ DISPLAY	B DLY'D
CH 1 VOLTS/DIV	0.1 V

m. CHECK—For a stable display, with the B TRIGGER SLOPE switched to both + and —.

n. Set:

B TRIGGER COUPLING	LF REJ

o. CHECK—No stable display can be obtained at any TRIGGER LEVEL or TRIGGER SLOPE setting.

p. Set:

CH 1 VOLTS/DIV	10 mV
B TRIGGER COUPLING	AC

q. Adjust the generator for a 60-Hz, 3-division signal display (30 mV).

r. Set the CH 1 VOLTS/DIV switch to 0.1 V.

s. Adjust the B TRIGGER LEVEL control as needed to obtain a stable display.

t. CHECK—For a stable display, with the B TRIGGER SLOPE switched to both + and — in each of the following B TRIGGER COUPLING switch positions: AC and DC.

17. Check 60-Hz External Triggering

a. Set:

B TRIGGER COUPLING	AC
CH 1 VOLTS/DIV	10 mV

b. Adjust the generator for a 60-Hz, 5-division signal display (50 mV).

c. Set:

B TRIGGER SOURCE	EXT

d. CHECK—For a stable display, with the B TRIGGER SLOPE switched to both + and — in each of the following B TRIGGER COUPLING switch positions: AC and DC.

e. Set:

CH 1 VOLTS/DIV	20 mV
B TRIGGER COUPLING	HF REJ

f. Adjust the generator for a 60-Hz, 5-division signal display (100 mV).

g. CHECK—For a stable display, with the B TRIGGER SLOPE switched to both + and —.

h. Set:

B TRIGGER COUPLING	LF REJ

i. CHECK—No stable display can be obtained at any TRIGGER LEVEL or TRIGGER SLOPE setting.

j. Move the test signal from the EXT B TRIGGER input to the EXT A TRIGGER input.

k. Set:

HORIZ DISPLAY	A
A TIME/DIV	5 ms
A TRIGGER COUPLING	HF REJ
A TRIG MODE	NORM
A TRIGGER SOURCE	EXT
A TRIGGER LEVEL	For a stable display

l. CHECK—For a stable display, with the A TRIGGER SLOPE switched to both + and —.

m. Set:

A TRIGGER COUPLING	LF REJ

n. CHECK—No stable display can be obtained at any TRIGGER LEVEL or TRIGGER SLOPE setting.

o. Set:

A TRIGGER COUPLING	AC
CH 1 VOLTS/DIV	10 mV

p. Adjust the generator for a 60-Hz, 5-division signal display (50 mV).

q. CHECK—For a stable display, with the A TRIGGER SLOPE switched to both + and — in each of the following A TRIGGER COUPLING switch positions: AC and DC.

18. Check A and B External Trigger Level Ranges

a. Set:

TRIGGER COUPLING (both)	AC
TRIGGER SLOPE (both)	+
CH 1 VOLTS/DIV	1 V
HORIZ DISPLAY	A
A TRIG MODE	AUTO
A TIME/DIV	1 ms
TRIGGER SOURCE (both)	EXT

b. Remove the 50-Ω termination from the external trigger input cable and adjust the generator for a 1-kHz, 4-division signal display (4 V).

c. CHECK—Display is triggered along the positive slope of the waveform as the A TRIGGER LEVEL control is rotated.

d. CHECK—Display is not triggered (free runs) at either extreme of the A TRIGGER LEVEL control's rotation.

e. Set:

A TRIGGER SLOPE	— (minus)

f. CHECK—Display is triggered along the negative slope of the waveform as the A TRIGGER LEVEL control is rotated.

g. CHECK—Display is not triggered (free runs) at either extreme of the A TRIGGER LEVEL control's rotation.

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h. Move the test signal from the EXT A TRIGGER input to the EXT B TRIGGER input.

i. Set:

A TRIGGER LEVEL	Fully counterclockwise
HORIZ DISPLAY	B DLY'D

j. CHECK—Display is triggered along the positive slope of the waveform as the B TRIGGER LEVEL control is rotated.

k. CHECK—Display is not triggered (not visible) at either extreme of the B TRIGGER LEVEL control's rotation.

l. Set:

B TRIGGER SLOPE	– (minus)

m. CHECK—Display is triggered along the negative slope of the waveform as the B TRIGGER LEVEL control is rotated.

n. CHECK—Display is not triggered (not visible) at either extreme of the B TRIGGER LEVEL control's rotation.

o. Disconnect the test setup from the 468.

p. Set:

HORIZ DISPLAY	A
A TRIGGER SOURCE	EXT/10
CH 1 VOLTS/DIV	5 V
CH 1 VAR	Fully counterclockwise
A TRIGGER COUPLING	AC

q. Connect a 50-V, standard-amplitude calibrator square-wave signal via a 50-Ω bnc cable and a bnc T-connector to the CH 1 input. Connect the other T-connector output via a 50-Ω bnc cable to the EXT A TRIGGER input.

NOTE

The range of the A TRIGGER LEVEL control, with the A TRIGGER SOURCE switch set to EXT/10, is ±20 V (40 V p-p) or greater. The applied test signal is 50 V p-p. Therefore, untriggered operation at either rotation extreme of the A TRIGGER LEVEL control is not required.

r. CHECK—Display is triggered along the negative slope of the waveform as the A TRIGGER LEVEL control is rotated.

s. Set:

A TRIGGER SLOPE	+ (plus)

t. CHECK—Display is triggered along the positive slope of the waveform as the A TRIGGER LEVEL control is rotated.

u. Disconnect the test setup from the 468.

19. Check Line Triggers

a. Set:

CH 1 VOLTS/DIV	50 mV (with 10X probe)
A TRIGGER SOURCE	LINE
A TRIGGER LEVEL	0

b. Connect a 10X probe to the CH 1 input connector.

c. Place the 10X probe tip next to the ac-power cord.

d. Adjust the spacing and/or orientation of the probe with respect to the ac-power cord to obtain approximately 4 to 5 divisions of display amplitude.

e. CHECK—For a stable display, starting on the positive peak of the waveform.

f. Set:

A TRIGGER SLOPE	– (minus)

g. CHECK—For a stable display, starting on the negative peak of the waveform. Return the A TRIGGER SLOPE to +.

h. Disconnect the 10X probe from the 468.

20. Check NORM A Triggering Mode

a. Set:

A TIME/DIV	1 ms
CH 1 VOLTS/DIV	0.5 V
CH 1 VOLTS/DIV VAR	Calibrated detent
A TRIGGER SOURCE	NORM

b. Connect 0.1-s time markers via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 1 input.

c. CHECK—Display can be triggered by adjusting the A TRIGGER LEVEL control.

d. Set:

A TRIG MODE	NORM

e. CHECK—Display is triggered.

f. Set:

CH 1 AC-GND-DC	GND

g. CHECK—No display or trace is visible.

21. Check AUTO Recovery Time

a. Set:

CH 1 AC-GND-DC	DC
A TRIG MODE	AUTO

b. CHECK—Display is triggered.

c. Set the generator for 0.5-s time markers.

d. CHECK—Display cannot be triggered (free runs).

e. Disconnect the test equipment from the 468.

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HORIZONTAL

Equipment Required (see Table 4-1)

4. Test Oscilloscope
5. Calibration Generator
   a. Stanrdard-Amplitude Calibrator
6. Leveled Sine-Wave Generator
7. Time-Mark Generator
12. 50-Ω Bnc Cable
19. Dual-Input Coupler
24. 50-Ω Bnc Termination
25. 3-in., Flat-Bit Screwdriver
26. Low-Capacitance Alignment Tool

See ADJUSTMENT LOCATIONS 1 *and* [illegible] *in this Volume for test point and adjustment locations.*

468 CONTROL SETTINGS

Power

Regulating Range Selector	High
Line Voltage Selector	115 V
POWER Switch	ON (button in)

CRT

INTENSITY	As desired
FOCUS	Best focused display
SCALE	As desired
B INTENSITY	Midrange

Vertical (CH 1 and CH 2)

VOLTS/DIV	0.5 V
VOLTS/DIV VAR	Calibrated detent
POSITION	Midrange
AC-GND-DC	DC
VERT MODE	CH 1
INVERT	Off (button out)
20 MHz BW LIMIT	Full bandwidth (button out)

Triggering (A and B if applicable)

A TRIG MODE	Auto
TRIGGER LEVEL	For a stable display
TRIGGER SLOPE	+ (plus)
TRIGGER COUPLING	AC
A TRIGGER SOURCE	EXT
B TRIGGER SOURCE	STARTS AFTER DELAY
A TRIGGER HOLDOFF	NORM

Sweep (A and B)

HORIZ DISPLAY	ALT
DELAY TIME POSITION	1.00
A TIME/DIV	1 ms
B TIME/DIV	5 μs
TIME/DIV VAR	Calibrated detent
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange
TRACE SEP	As needed for ALT HORIZ DISPLAY trace separation

Digital Storage

NON STORE	On (button in)
SAVE REF	Off (button out)
CURSOR FUNCTION	Both off (buttons out)

1. Check/Adjust Sweep Start and A-Sweep Calibration (R970 and R173)

a. Connect 1-ms time markers via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 1 input. Connect the generator trigger output via a 50-Ω bnc cable and a 50-Ω bnc termination to the EXT A TRIGGER input.

b. CHECK—Intensified portion of the A sweep begins at the 2nd time marker. It may be necessary to readjust the INTENSITY and B INTENSITY controls so that the intensified portion of the sweep is visible.

c. ADJUST—Sweep Start (R970) so that intensified portion of the A sweep begins at the start of the 2nd time marker, and the pulse displayed on the B DLY'D sweep starts at the beginning of the sweep.

d. Set:

DELAY TIME POSITION 9.00

e. CHECK—Intensified portion of the sweep begins at the 10th time marker.

f. ADJUST—A SWP Cal (R173) so that intensified portion of the A sweep begins at the start of the 10th time marker, and the pulse displayed on the B DLY'D trace starts at the beginning of the sweep. See preceding Figure 4-3 for location of adjustment access holes through the Storage Display circuit board.

g. INTERACTION—Set the DELAY TIME POSITION dial to 1.00 and repeat parts c through f of this step until no further improvement is observed.

2. Check Delay or Differential Time Linearity

a. Set the DELAY TIME POSITION dial to position the B sweep display of the 10th time marker to the beginning of the sweep.

b. Note the reading on the DELAY TIME POSITION dial.

c. Adjust the DELAY TIME POSITION dial so that the B sweep display of the 9th time marker is positioned to the beginning of the sweep. Note the dial reading.

d. CHECK—DELAY TIME POSITION dial for a difference in reading of 1.00 ±0.01 (0.99 to 1.01), for ambient temperatures from +15°C to +35°C. For ambient temperatures outside the range of +15°C to +35°C, but within the range of −15°C to +55°C, the dial-reading difference must be within 1.00 ±0.03 (0.97 to 1.03).

NOTE

One division on the DELAY TIME POSITION dial is equal to one complete revolution of the inner knob. One minor division on the inner knob is equal to 0.01 division on the DELAY TIME POSITION dial.

e. Rotate the DELAY TIME POSITION dial to position each successive time marker to the beginning of the sweep. Note the dial reading at each marker.

f. CHECK—DELAY TIME POSITION dial for a difference in reading between each successive time marker of 1.00 ±0.01 (0.99 to 1.01), for ambient temperatures from +15°C to +35°C. For ambient temperatures outside the range of +15°C to +35°C, but within the range of −15°C to +55°C, the dial-reading difference must be within 1.00 ±0.03 (0.97 to 1.03).

3. Check/Adjust Horizontal Amplifier Gain (R571 and R572)

a. Set:

HORIZ DISPLAY	A
TIME/DIV (both)	1 ms
DELAY TIME POSITION	Fully counterclockwise

b. Set the generator for 1-ms time markers.

c. Align the 1st time marker with the 1st vertical graticule line.

d. CHECK—Display for 1 marker per division ±2% (±0.2 division at the 11th time marker).

e. ADJUST—X1 Gain (R572) for exactly 1 marker per division.

f. Set the generator for 0.1-ms time markers.

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g. Press in the X10 MAG push button (X10 MAG LED should light).

h. Align a time marker with the 1st vertical graticule line.

i. CHECK–For 1 marker per division ±3% (±0.3 division at the 11th time marker).

j. ADJUST–X10 Gain (R571) for exactly 1 time marker per division.

4. Check Sweep Linearity

a. CHECK–Linearity over any 2 divisions of the magnified sweep is within ±0.1 division.

b. Release the X10 MAG push button.

c. Set the generator for 1-ms time markers.

d. CHECK–Linearity over any 2 divisions of the sweep is within ±0.1 division.

5. Check/Adjust Magnifier Centering and Registration (R551 and R578)

a. Press in the X10 MAG push button.

b. Press and hold in the BEAM FIND push button.

c. CHECK–Display is centered horizontally.

d. ADJUST–Horizontal DC Centering (R551) to horizontally center the display with the BEAM FIND push button held in.

e. Release the BEAM FIND push button.

f. Release the X10 MAG push button.

g. Set the generator for 5-ms time markers.

h. Position the middle time marker to the center vertical graticule line.

i. Press in the X10 MAG push button.

j. Position the displayed time marker to the center vertical graticule line.

k. Release the X10 MAG push button.

l. CHECK–Middle time marker is within 0.2 division of the center vertical graticule line.

m. ADJUST–Magnifier Registration (R578) to position the middle time marker to the center vertical graticule line.

n. Repeat parts i through m of this step until no horizontal shift is observed between X10 MAG on and X10 MAG off.

6. Check/Adjust B-Sweep Calibration (R169)

a. Set:

DELAY TIME POSITION	Fully counterclockwise
HORIZ DISPLAY	B DLY'D
A TIME/DIV	2 ms
B TIME/DIV	1 ms
X10 MAG	Off (button out)

b. Set the generator for 1-ms time markers.

c. CHECK–Display for 1 time marker per division ±2% (±0.2 division at the 11th time marker).

d. ADJUST–B SWP Cal (R169) for exactly 1 time marker per division. See preceding Figure 4-3 for location of adjustment access holes through the Storage Display circuit board.

7. Check A-Sweep Length

a. Set:

HORIZ DISPLAY	A
TIME/DIV (both)	1 ms

b. Set the generator for 5-ms time markers.

c. Position the 3rd time marker horizontally to the center vertical graticule line.

d. CHECK—Trace extends to the right of the center vertical graticule line by 1 division ±0.5 division.

8. Check Variable Time/Division

a. Set:

A TIME/DIV	2 ms

b. Set the generator for 5-ms time markers.

c. Rotate the TIME/DIV VAR control fully counterclockwise (UNCAL LED should light).

d. CHECK—Display for 1 or more time markers per division.

e. Return the VAR control to the calibrated detent.

9. Check Horizontal POSITION Range

a. Rotate the Horizontal POSITION control fully clockwise.

b. CHECK—Start of sweep is to the right of the center vertical graticule line.

c. Rotate the Horizontal POSITION control fully counterclockwise.

d. CHECK—End of sweep is to the left of the center vertical graticule line.

NOTE

Horizontal POSITION control is a combined Coarse and Fine position control mounted on the same shaft in a mechanical arrangement that allows the Fine position potentiometer to rotate approximately 1/4 turn (1/8 turn in either direction from midrange) before the Coarse position control potentiometer is engaged.

e. Return the Horizontal POSITION control to midrange.

f. Rotate the Horizontal POSITION control through its Fine range.

g. CHECK—Horizontal POSITION control Fine range will move the display position approximately 1 horizontal division.

10. Check/Adjust the A-Sweep 10-μs Timing (C120)

a. Set:

DELAY TIME POSITION	1.00
A TIME/DIV	10 μs
B TIME/DIV	1 μs

b. Set the generator for 10-μs time markers.

c. Align the 1st time marker with the 1st vertical graticule line.

d. CHECK—Display for 1 time marker per division ±2% (±0.2 division at the 11th time marker).

e. ADJUST—10-μs Timing (C120), with a low-capacitance alignment tool, for exactly 1 time marker per division. See preceding Figure 4-3 for location of adjustment access holes through the Storage Display circuit board.

f. Set:

HORIZ DISPLAY	B DLY'D
B TRIGGER SOURCE	STARTS AFTER DELAY

g. Horizontally position the displayed marker to align it with a vertical graticule line. The selected line is then used as a reference point in part i.

h. Set:

DELAY TIME POSITION	9.00

i. ADJUST—10-μs Timing (C120), with a low-capacitance alignment tool, to align the displayed marker with the same vertical graticule line selected in part g.

j. Set the DELAY TIME POSITION dial to 1.00 and repeat parts g through i until no error exists between a DELAY TIME POSITION dial setting of 1.00 and 9.00.

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11. Check/Adjust A-Sweep High-Speed Timing (C126)

a. Set:

DELAY TIME POSITION	1.50
A TIME/DIV	0.5 μs
B TIME/DIV	0.05 μs
HORIZ DISPLAY	A

b. Set the generator for 0.5-μs time markers.

c. Align the 1st time marker with the 1st vertical graticule line.

d. CHECK—Display for 1 time marker per division ±2% (±0.2 division at the 11th time marker).

e. ADJUST—A-SWP High-Speed Timing (C126), with a low-capacitance alignment tool, for exactly 1 time marker per division. See preceding Figure 4-3 for adjustment access holes.

f. Set:

HORIZ DISPLAY	B DLY'D

g. Use the Horizontal POSITION control to align the displayed marker with the center vertical graticule line.

h. Set:

DELAY TIME POSITION	8.50

i. CHECK—Displayed time marker aligns with the center vertical graticule line.

j. ADJUST—The A-SWP High-Speed Timing (C126), with a low-capacitance alignment tool, to align the displayed marker with the center vertical graticule line.

k. INTERACTION—Readjust C126 as necessary to obtain the correct timing between the 1.50 and 8.50 settings of the DELAY TIME POSITION dial (within 2%). A compromise in the adjustment may be necessary. Set HORIZ DISPLAY to A and DELAY TIME POSITION to 1.50, then repeat parts c through j until no improvement in timing accuracy is obtained.

12. Check/Adjust B-Sweep High-Speed Timing (C159)

a. Set:

DELAY TIME POSITION	Fully counterclockwise
HORIZ DISPLAY	B DLY'D
B TRIGGER SOURCE	NORM
A TIME/DIV	1 μs
B TIME/DIV	0.5 μs

b. Adjust both the A and B TRIGGER LEVEL controls for a stable display.

c. Align the 1st time marker with the 1st vertical graticule line.

d. CHECK—Display for 1 time marker per division ±2% (±0.2 division at the 11th time marker).

e. ADJUST—B-SWP High-Speed Timing (C159), with a low-capacitance alignment tool, for exactly 1 time marker per division. See preceding Figure 4-3 for adjustment access holes.

13. Check A and B TIME/DIV Accuracy

a. CHECK—B-Sweep timing is within 0.2 division, over the full 10 divisions of the display, for each of the B TIME/DIV switch settings and time-mark generator settings listed in Table 4-18. Align the 1st time marker with the 1st vertical graticule line at each setting.

b. Set:

HORIZ DISPLAY	A
A TRIG MODE	Auto

c. CHECK—The A-Sweep timing is within 0.2 division over the full 10 divisions of the display, for each of the A TIME/DIV switch settings and time-mark generator settings listed in Table 4-18. Align the 1st time marker with the 1st vertical graticule line at each setting.

Table 4-18

A and B Timing Accuracy

A and B TIME/DIV Switch Setting	Time-Mark Generator Setting
0.02 μs	20 ns
0.05 μs	50 ns
0.1 μs	0.1 μs
0.2 μs	0.2 μs
0.5 μs	0.5 μs
1 μs	1 μs
2 μs	2 μs
5 μs	5 μs
10 μs	10 μs
20 μs	20 μs
50 μs	50 μs
0.1 ms	0.1 ms
0.2 ms	0.2 ms
0.5 ms	0.5 ms
1 ms	1 ms
2 ms	2 ms
5 ms	5 ms
10 ms[a]	10 ms
20 ms[a]	20 ms
50 ms[a]	50 ms
A Sweep Only	
0.1 s[a]	0.1 s
0.2 s[a]	0.1 s
0.5 s[a]	0.5 s

[a]Switch A TRIG MODE to NORM below 5 ms/division.

14. Check/Adjust High-Speed Magnified Timing (C548 and C549)

a. Set:

HORIZ DISPLAY	A
X10 MAG	On (button in)
Horizontal POSITION	Midrange (as required)
TIME/DIV (both)	0.05 μs
A TRIG MODE	AUTO

b. Set the generator for 5-ns time markers.

c. Set CH 1 VOLTS/DIV switch for at least a 4-division display amplitude.

d. Align the 1st time marker with the 1st vertical graticule line.

e. CHECK—Display for 1 time marker per division ±3% (±0.3 division at the 11th time marker).

f. ADJUST—C548 and C549 equally to obtain 1 time marker per division over the entire 10 divisions.

g. Set:

TIME/DIV (both) 0.02 μs

h. Press and hold in BEAM FIND push button.

i. CHECK—Display is centered horizontally.

j. ADJUST—Horizontal DC Centering (R551), if necessary, to horizontally center the compressed display. Release the BEAM FIND push button.

k. INTERACTION—If R551 is adjusted, recheck Magnifier Registration (step 5, parts g through n).

l. ADJUST—C548 for 2 time markers per 5 divisions over the entire 10 divisions. Adjust Horizontal POSITION control as necessary to align markers.

m. Set:

TIME/DIV (both) 0.05 μs

n. ADJUST—C549 for 1 time marker per division over the entire 10 divisions.

o. Repeat part g and parts l through n for best timing for both the 0.05-μs and the 0.02-μs TIME/DIV switch settings until no further improvement is noted.

15. Check A and B Magnified Timing Accuracy

a. CHECK—The A magnified sweep timing is within 0.3 division over the center 10 divisions of the magnified display for each A TIME/DIV switch setting and time-mark generator setting listed in Table 4-19. Note the portions of the total magnified sweep length to be excluded from the measurement.

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Table 4-19

A and B Magnified Accuracy

A and B TIME/DIV Switch Setting	Time-Mark Generator Setting	Magnified Sweep Portions to Exclude
0.02 μs	2 ns	First and last 25 divisions
0.05 μs	5 ns	First and last 10 divisions
0.1 μs	10 ns	First and last 5 divisions
0.2 μs	20 ns	First and last 2.5 divisions
0.5 μs	50ns	First 2 divisions
1 μs 2 μs 5 μs	0.1 μs 0.2 μs 0.5 μs	
10 μs 20 μs 50 μs	1 μs 2 μs 5 μs	
0.1 ms 0.2 ms 0.5 ms	10 μs 20 μs 50 μs	
1 ms 2 ms 5 ms	0.1 ms 0.2 ms 0.5 ms	
10 ms[a] 20 ms[a] 50 ms[a]	1 ms 2 ms 5 ms	
A Sweep Only		
0.1 s[a] 0.2 s[a] 0.5 s[a]	10 ms 20 ms 50 ms	

[a]Switch TRIG MODE to NORM below 5 ms/division.

b. Set:

HORIZ DISPLAY	B DLY'D

c. CHECK—The B magnified sweep timing is within 0.3 division over the center 10 divisions of the magnified sweep for each B TIME/DIV switch setting and time-mark generator setting listed in Table 4-19. Note the portions of the total magnified sweep length to be excluded from the measurement.

d. Release the X10 MAG push button.

16. Check Delay or Differential Time Accuracy

a. Set:

B TRIGGER SOURCE	STARTS AFTER DELAY
A TRIG MODE	AUTO
TIME/DIV (both)	According to Table 4-20
HORIZ DISPLAY	ALT

b. CHECK—Differential time accuracy is within ±8 minor dial divisions of the DELAY TIME POSITION control for each A TIME/DIV switch setting, B TIME/DIV switch setting, and time-mark generator setting listed in Table 4-20. Use the following procedure to make this check.

Rotate the DELAY TIME POSITION dial to 1.00 and readjust it slightly until the sweep starts at the top of the 2nd time marker. Note the dial reading. Then, rotate the dial to 9.00 and readjust it slightly until the sweep starts at the top of the 10th time marker. The DELAY TIME POSITION dial setting must be 8.00 divisions ±0.08 division higher than the dial reading noted previously.

NOTE

Below 5 ms/division the ALT HORIZ DISPLAY traces switch too slowly to observe the display with ease; therefore, set HORIZ DISPLAY to B DLY'D. If in doubt as to the correct setting of the DELAY TIME POSITION dial, set the HORIZ DISPLAY switch to A INTEN and check which marker is intensified.

17. Check Delay or Differential Time Jitter

a. Set:

DELAY TIME POSITION	1.00
HORIZ DISPLAY	B DLY'D
A TIME/DIV	1 ms
B TIME/DIV	0.2 μs
A TRIG MODE	AUTO

b. Set the generator for 1-ms time markers.

Table 4-20

Differential Time Accuracy

A TIME/DIV Switch Setting	B TIME/DIV Switch Setting	Time-Mark Generator Setting
0.1 μs	0.02 μs	0.1 μs
0.2 μs	0.05 μs	0.2 μs
0.5 μs	0.05 μs	0.5 μs
1 μs	0.1 μs	1 μs
2 μs	0.2 μs	2 μs
5 μs	0.5 μs	5 μs
10 μs	1 μs	10 μs
20 μs	2 μs	20 μs
50 μs	5 μs	50 μs
0.1 ms	10 μs	0.1 ms
0.2 ms	20 μs	0.2 ms
0.5 ms	50 μs	0.5 ms
1 ms	0.1 ms	1 ms
2 ms	0.2 ms	2 ms
5 ms	0.5 ms	5 ms
10 ms[a]	1 ms	10 ms
20 ms[a]	2 ms	20 ms
50 ms[a]	5 ms	50 ms
0.1 s[a]	10 ms	0.1 s
0.2 s[a]	20 ms	0.2 s
0.5 s[a]	50 ms	0.5 s

[a]Below 5 ms/division, set **HORIZ DISPLAY** to **B DLY'D** and **A TRIG MODE** to **NORM**.

c. Position the time marker to a point near the center vertical graticule line, using the DELAY TIME POSITION dial.

d. CHECK—Jitter on the leading edge of the time marker should not exceed 1 division (2.5 divisions if the instrument is being operated on a 50-Hz or below line frequency). Disregard the slow drift.

e. Rotate the DELAY TIME POSITION dial to 9.00 and readjust it slightly so the time marker is displayed near the center vertical graticule line.

f. CHECK—Jitter on the leading edge of the time marker should not exceed 1 division (2.5 divisions if the instrument is being operated on a 50-Hz or below line frequency). Disregard the slow drift.

g. Disconnect test equipment from the 468.

18. Check/Adjust X-Gain (R681)

a. Set:

TIME/DIV (both)	X-Y
VOLTS/DIV (both)	5 mV
CH 1 AC-GND-DC	AC
CH 2 AC-GND-DC	GND
HORIZ DISPLAY	A
A TRIGGER SOURCE	NORM

NOTE

Setting the A TIME/DIV switch to X-Y disables all VERT MODE switch selections and automatically selects the CH 1 input for the X-Axis signal and the CH 2 input for the Y-Axis signal. However, for firmware version 1.0, the CH 1 and CH 2 VERT MODE push buttons must be pressed in to illuminate the scale-factor LED behind the VOLTS/DIV knob skirts.

b. Connect a 20-mV, standard-amplitude square-wave signal via a 50-Ω, unterminated bnc cable to the CH 1 input.

c. CHECK—Display for 4 divisions of horizontal deflection ±4% (3.84 to 4.16 divisions).

d. Set:

CH 1 AC-GND-DC	DC

e. CHECK—Display for 4 divisions of horizontal deflection ±4% (3.84 to 4.16 divisions).

f. Set:

CH 1 AC-GND-DC	AC

g. ADJUST—X-Gain (R681) for exactly 4 divisions of horizontal deflection.

h. Disconnect test equipment from the 468.

19. Check X-Y Phasing and Bandwidth

a. Connect a 50-kHz, leveled sine-wave signal via a 50-Ω bnc cable, a 50-Ω termination, and a dual-input coupler to the CH 1 and CH 2 inputs.

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b. Adjust the generator to obtain an 8-division horizontal display.

c. Set:

CH 2 AC-GND-DC	AC

d. Center the display both vertically and horizontally using the Horizontal POSITION and CH 2 Vertical POSITION controls.

e. CHECK—Display for an X-Axis elipse dimension at the center horizontal graticule line of 0.4 division or less.

f. Set:

CH 2 AC-GND-DC	GND

g. Adjust the generator to obtain a 10-division horizontal display.

h. Increase the sine-wave frequency until the display reduces to 7 divisions.

i. CHECK—Output frequency of the leveled sine-wave generator is at least 4 MHz.

j. Disconnect test equipment from the 468.

20. Check B Ends A

a. Set:

HORIZ DISPLAY	A INTEN
A TIME/DIV	1 ms
B TIME/DIV	0.1 ms
A TRIGGER HOLDOFF	B ENDS A (in detent)

b. Adjust both the INTENSITY and B INTENSITY controls for a visible intensified portion of the trace.

c. Rotate the DELAY TIME POSITION dial through its entire range.

d. CHECK—The A sweep ends after the intensified portion at all settings of the DELAY TIME POSITION dial.

21. Check A Trigger Holdoff

a. Set:

HORIZ DISPLAY	A
A TRIGGER HOLDOFF	NORM
A TRIGGER LEVEL	Fully clockwise

b. Connect the A + GATE output signal (from the 468 rear panel) via a 50-Ω, unterminated bnc cable to the input of the test oscilloscope.

c. Set the test oscilloscope Time/Div switch and Var control so that the bottom portion of the waveform (holdoff time of the A + GATE is exactly 1 horizontal division.

d. Rotate the A TRIGGER HOLDOFF control clockwise.

e. CHECK—For at least a 10-times increase in the holdoff time of the A + GATE.

f. Disconnect test equipment from the 468.

GATES, CALIBRATOR, AND EXT Z-AXIS

Equipment Required (see Table 4-1)

2. Digital Voltmeter
4. Test Oscilloscope
5. Calibration Generator
   a. Standard-Amplitude Calibrator
12. 42-in., 50-Ω Bnc Cable (2 required)
20. Bnc T-Connector
24. 50-Ω Bnc Termination
25. 3-in., Flat-Bit Screwdriver
27. Shorting Strap

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See ADJUSTMENT LOCATIONS 1 *in this Volume for test point and adjustment locations.*

468 CONTROL SETTINGS

Power

Regulating Range Selector	High
Line Voltage Selector	115 V
POWER Switch	ON (button in)

Crt

INTENSITY	As desired
FOCUS	Best focused display
SCALE ILLUM	As desired
B INTENSITY	As desired

Vertical (CH 1 and CH 2)

VOLTS/DIV	5 mV
VOLTS/DIV VAR	Calibrated detent
POSITION	Midrange
VERT MODE	CH 1
INVERT	Off (button out)
20 MHz BW LIMIT	Full bandwidth (button out)

Triggering (A and B if applicable)

TRIGGER LEVEL	Fully clockwise
TRIGGER SLOPE	+
TRIGGER COUPLING	AC
A TRIGGER SOURCE	NORM
B TRIGGER SOURCE	STARTS AFTER DELAY
A TRIG MODE	AUTO
A TRIGGER HOLDOFF	NORM

Sweep (A and B)

HORIZ DISPLAY	B DLY'D
DELAY TIME POSITION	Fully counterclockwise
TIME/DIV (both)	50 μs
TIME/DIV VAR	Calibrated detent
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange

Digital Storage

NON STORE	On (button in)
SAVE REF	Off (button out)
CURSOR FUNCTION	Both off (buttons out)

1. Check A and B + GATES

a. Connect the B + GATE output (from the 468 rear panel) via a 50-Ω, unterminated bnc cable to the test oscilloscope input.

b. Set test oscilloscope controls:

Vert Mode	CH 1
Ch 1 Volts/Div	1 V
A Time/Div	50 μs
A Trigger Slope	– (minus)
Horiz Display	A
Ac-Gnd-Dc	Dc

c. CHECK—Test oscilloscope display for a positive-going square wave of approximately +5.5 V in amplitude (starting within 500 mV of 0 V).

d. Move the bnc cable from the B + GATE connector to the A + GATE connector.

e. CHECK—Test oscilloscope display for a positive-going square wave of approximately +5.5 V in amplitude (starting within 500 mV of 0 V).

f. Disconnect test equipment from the 468.

2. Check/Adjust Calibrator DC Level (R599)

a. Connect a shorting strap between TP474 and TP475 on the Interface circuit board (A15).

b. Connect the digital voltmeter Low lead to chassis ground and connect the Volts lead to the CALIBRATOR current loop.

c. CHECK—CALIBRATOR dc level is 300 mV ±1% (297 to 303 mV).

d. ADJUST—Amplitude Cal (R599) for a digital voltmeter reading of exactly 300 mV.

e. Remove the shorting strap and digital voltmeter connections.

f. Connect a 10X probe from the test oscilloscope to the CALIBRATOR current loop.

g. Set test oscilloscope controls:

Ch 1 Volts/Div	0.1 V
Time/Div	0.5 μs
A Trigger Slope	+ (plus)

h. CHECK—Test oscilloscope display for a 0.3-V, positive-going square-wave signal (typical square-wave period is approximately 1 ms).

i. Disconnect the test setup.

3. Check External Z-Axis

a. Set:

HORIZ DISPLAY	A
A TIME/DIV	0.2 ms
A TRIGGER SOURCE	EXT

b. Set the INTENSITY control for a normal viewing level.

c. Connect a 5-V, standard-amplitude calibration signal via a 50-Ω bnc cable and T-connector to the EXT A TRIGGER input. Connect the other output of the T-connector via a 50-Ω cable to the EXT Z-AXIS input (on the 468 rear panel).

d. Adjust the A TRIGGER LEVEL control to obtain a stable display (TRIG LED illuminated).

e. CHECK—Trace has noticeable intensity modulation.

f. Disconnect the amplitude calibration signal from the T-connector.

g. Set:

A TIME/DIV	0.02 μs

h. Connect a 5-V, 50-MHz leveled sine-wave signal via a 50-Ω bnc cable and a 50-Ω termination to the T-connector.

i. CHECK—Trace has noticeable intensity modulation.

j. Disconnect the test equipment from the 468.

STORAGE POWER SUPPLY

Equipment Required (see Table 4-1)

2. Digital Voltmeter

4. Test Oscilloscope

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See ADJUSTMENT LOCATIONS *in this Volume for test point and adjustment locations.*

NOTE

If commencing the Adjustment Procedure at this point, prior to applying power to the 468 make the initial control settings. Then, connect the 468 to an appropriate ac-power source. Apply power to the instrument and test equipment and allow a 20-minute warmup period before commencing the adjustments and checks.

468 CONTROL SETTINGS

Power

Regulating Range Selector	High
Line Voltage Selector	115 V
POWER	See preceding NOTE

Crt

INTENSITY	As desired
FOCUS	Best focused display
SCALE ILLUM	As desired

Vertical (CH 1 and CH 2)

VOLTS/DIV	5 mV
VOLTS/DIV VAR	Calibrated detent
VERT MODE	CH 1
POSITION	Midrange
AC-GND-DC	GND
INVERT	Normal (button out)
20 MHz BW LIMIT	Full Bandwidth (button out)

Trigger (A and B)

COUPLING	AC
SLOPE	+
LEVEL	For a stable display
SOURCE	NORM
A TRIG MODE	AUTO
A TRIGGER HOLDOFF	NORM

Sweep (A and B if applicable)

HORIZ DISPLAY	A
TIME/DIV	1 ms
TIME/DIV VAR	Calibrated detent
DELAY TIME POSITION	Fully counterclockwise
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange

Digital Storage

STORAGE MODE	NORM
SAVE REF	Off (button out)
CURSOR FUNCTION	Both off (buttons out)

1. Check Power Supply DC Level and Ripple

a. Connect the Low lead of the digital voltmeter to chassis ground and connect the Volts lead to the first test point listed in Table 4-21.

b. CHECK—Voltage level is within the range given in Table 4-21.

c. Repeat parts a and b for each test point in Table 4-21.

d. Disconnect the digital voltmeter Volts lead from the 468, then disconnect the Low lead from chassis ground.

e. Connect a test oscilloscope 10X probe ground lead to chassis ground and connect the probe tip to TP315.

f. Set the test oscilloscope controls as follows:

Vert Mode	Ch 1
Ch 1 Ac-Gnd-Dc	Ac
Volts/Div	50 mV (with 10X probe attached)

g. Obtain a stable display on the test oscilloscope.

h. CHECK—For a display of 3 divisions or less of p-p amplitude.

i. Disconnect the probe tip from TP315, then disconnect the probe ground lead from the 468.

Table 4-21

Digital Storage Power Supply Limits

Power Supply	Test Point	Reading	Tolerance
+12 VS	TP148	+11.4 to +12.6 V	±5%
+5 VS	TP315	+4.8 to +5.2 V	±4%
−12 VS	TP520	−11.4 to −12.6 V	±5%
−6 VS	TP518	−5.76 to −6.24 V	±4%

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STORAGE VERTICAL

Equipment Required (see Table 4-1)

5. Calibration Generator
   a. Standard-Amplitude Calibrator
   b. Fast-Rise Square-Wave Generator
6. Leveled Sine-Wave Generator
7. Time-Mark Generator
12. 42-in., 50-Ω Bnc Cable (2 required)
19. Dual-Input Coupler
23. 2X, 50-Ω Bnc Attenuator
24. 50-Ω Bnc Termination
25. 3-in., Flat-Bit Screwdriver
26. Low-Capacitance Alignment Tool

See ADJUSTMENT LOCATIONS 2, ADJUSTMENT LOCATIONS 6, ADJUSTMENT LOCATIONS 7, *and* ADJUSTMENT LOCATIONS 8 *in this Volume for test point and adjustment locations.*

468 CONTROL SETTINGS

Power

Regulating Range Selector	High
Line Voltage Selector	115 V
POWER	ON

Crt

INTENSITY	As desired
FOCUS	Best focused display
SCALE ILLUM	As desired

Vertical (CH 1 and CH 2)

VERT MODE	CH 1
VOLTS/DIV	5 mV
VOLTS/DIV VAR	Calibrated detent
AC-GND-DC	GND
POSITION	Midrange
INVERT	Off (button out)

Trigger (A and B)

COUPLING	AC
SLOPE	+
LEVEL	For a stable, triggered display
SOURCE	NORM
A TRIG MODE	AUTO
A TRIGGER HOLDOFF	NORM

Sweep (A and B if applicable)

HORIZ DISPLAY	A
TIME/DIV	5 μs
TIME/DIV VAR	Calibrated detent
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange

Digital Storage

STORAGE MODE	NORM
CURSOR FUNCTION	Both off (buttons out)
STORAGE WINDOW	POST TRIG (button out)
DISPLAY RESPONSE	SINE (button in)
SAVE REF	Off (button out)

1. Check VOLTS Cursor Operation

a. Set:

CURSOR FUNCTION	VOLTS

b. Use the CH 1 Vertical POSITION control to move the baseline trace out of the graticule area.

c. Press in the POWER push button to turn off the 468 then press it in again to reapply power. Power-on self-test will operate.

d. CHECK—Two horizontal VOLTS cursors appear within the graticule area. One is a solid line, and the other is a dashed line.

NOTE

The CURSOR control knob has two operating modes. In its linear region, the knob rotates freely about 1/4 turn. At either end of its free rotation range, spring-stop switches increase resistance to movement of the knob, and cursor displacement becomes a function of how long the spring stop is held open. As the control knob is rotated further into the rate region, cursor displacement rate within the graticule area increases.

e. CHECK—Rotating the CURSOR control knob through its linear region positions the dashed cursor vertically about 1 division.

f. Rotate the CURSOR control knob counterclockwise into the rate region (against the spring tension).

g. CHECK—Dashed cursor moves downward past the bottom of the graticule area.

h. Rotate the CURSOR control knob clockwise into its rate region.

i. CHECK—Dashed cursor moves upward past the top of the graticule area.

j. Rotate the CURSOR control knob counterclockwise into its rate region.

k. CHECK—Dashed cursor is positioned more rapidly as the CURSOR control knob is rotated further into the rate region. Position the dashed cursor near the solid cursor.

l. Press in the CURSOR SELECT push button.

m. CHECK—Previous solid cursor becomes the dashed cursor, and the dashed cursor becomes the solid cursor.

n. Use the CURSOR control knob and CURSOR SELECT push button to position the VOLTS cursors 6 divisions apart on the graticule.

2. Check COUPLED V/T Cursor Operation

a. Set:

CURSOR FUNCTION	TIME only
VERT MODE	CH 2
CH 2 AC-GND-DC	AC

b. Connect a 50-kHz, leveled sine wave via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 2 input.

c. Set the generator output for a 4-division display amplitude. Adjust the A TRIGGER LEVEL control as necessary for a stable display.

d. Set:

STORAGE MODE	SAVE

e. Adjust the INTENSITY control for a visible display of the TIME dots on the waveform.

f. Press in the VOLTS CURSOR FUNCTION push button (both VOLTS and TIME push buttons are in for the COUPLED V/T CURSOR FUNCTION).

g. CHECK—Dashed VOLTS cursor becomes coupled to the active TIME dot, and the solid cursor is coupled to the fixed TIME dot.

h. Rotate the CURSOR control knob to position the active TIME dot to both ends of the display.

i. CHECK—Dashed VOLTS cursor remains coupled to the active TIME dot as the TIME dot is positioned to both ends of the display.

j. Press in the CURSOR SELECT push button.

k. CHECK—Previously active coupled cursors become fixed, and fixed cursors become the active cursors.

l. Press in the TIME CURSOR FUNCTION push button to release the COUPLED V/T CURSOR FUNCTION.

m. CHECK—VOLTS cursors return to the positions to which they were set in part n of step 1 (6 divisions apart).

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n. Disconnect the test equipment from the 468.

3. Check/Adjust Storage Vertical Centering (R345)

a. Set:

STORAGE MODE	SAVE
CURSOR FUNCTION	Both off (buttons out)

b. Press in POWER switch twice. Power-on self-test will run.

c. CHECK—Horizontal dashed line that appears is vertically centered within 0.2 division of the center horizontal graticule line.

d. ADJUST—Vertical Display Centering (R345, ADJUSTMENT LOCATIONS 6) to align the dashed line with the center horizontal graticule line.

4. Check/Adjust Storage Vertical Gain (R571)

a. Set:

VERT MODE	CH 1
VOLTS/DIV (both)	0.5 mV
CURSOR FUNCTION	VOLTS
STORAGE MODE	NORM
AC-GND-DC (both)	GND

b. Use the CURSOR control to position the active cursor (dashed line) 3 divisions below the center horizontal graticule line.

c. Press in the CURSOR SELECT push button and use the CURSOR control to position the 2nd cursor 3 divisions above the center horizontal graticule line for an exact 6-division difference between the two VOLTS cursors.

d. CHECK—Volts readout accuracy is within the limits listed in Table 4-22 for each VOLTS/DIV switch setting. The red scaling LED should be illuminated.

e. Rotate the VOLTS/DIV VAR control out of the calibrated detent. The seven-segment display readout should be within 5.88 to 6.12, and the DIV scaling LED should illuminate.

f. Return the VAR control to the calibrated detent.

Table 4-22

VOLTS Cursor Readout Accuracy

VOLTS/DIV Switch Setting	2% Readout Tolerance
0.5 mV	2.940 to 3.060 mV
1 mV	5.88 to 6.12 mV
2 mV	11.76 to 12.24 mV
5 mV	29.40 to 30.60 mV
10 mV	58.8 to 61.2 mV
20 mV	117.6 to 122.4 mV
50 mV	294.0 to 306.0 mV
0.1 V	0.588 to 0.612 V
0.2 V	1.176 to 1.224 V
0.5 V	2.940 to 3.060 V
1 V	5.88 to 6.12 V
2 V	11.76 to 12.24 V
5 V	29.40 to 30.60 V

g. Set:

VERT MODE	CH 2

h. Repeat parts d through f for CH 2. If checks are within tolerance, skip to step 5. If they are not, continue with parts i through m of this step.

i. Set:

VOLTS/DIV	5 mV
VERT MODE	CH 1 only

j. Verify that the bottom cursor is positioned exactly 3 divisions below the center horizontal graticule line.

k. Press in the CURSOR SELECT push button.

l. Set the active cursor for a seven-segment LED display readout of 30.00 mV.

m. ADJUST—Vertical Display Gain (R571, ADJUSTMENT LOCATIONS 6) for exactly 6 vertical divisions of spacing between the VOLTS cursors.

n. INTERACTION—Vertical Display Centering and Vertical Display Gain interact slightly. Adjust R345 to align the VOLTS cursors with the horizontal graticule lines as you adjust R571 to obtain a 6-division difference between the VOLTS cursors. Repeat steps 3 and 4 until no improvement is noted.

5. Check/Adjust CH 1 and CH 2 Acquisition Gain (R335 and R420)

a. Set:

VOLTS/DIV	5 mV
VERT MODE	CH 1 only
AC-GND-DC (both)	DC
TIME/DIV	1 ms
CURSOR FUNCTION	Both off (buttons out)

b. Connect a 20-mV, standard-amplitude square-wave signal via a 50-Ω bnc cable to the CH 1 input connector.

c. CHECK—DC accuracy is within 3% for each of the VOLTS/DIV switch settings and standard-amplitude generator settings listed in Table 4-23. If the CH 1 DC accuracy is within tolerance, skip to part f. If it is not, continue with part d of this step.

d. Set the generator output for 20 mV and switch the CH 1 VOLTS/DIV switch to 5 mV per division.

Table 4-23

Storage DC Accuracy

CH 1 and CH 2 VOLTS/DIV Switch Setting	Standard-Amplitude Generator Setting	Vertical Deflection (Divisions)
5 mV	20 mV	3.88 to 4.12
10 mV	50 mV	4.85 to 5.15
20 mV	0.1 V	4.85 to 5.15
50 mV	0.2 V	3.88 to 4.12
0.1 V	0.5 V	4.85 to 5.15
0.2 V	1 V	4.85 to 5.15
0.5 V	2 V	3.88 to 4.12
1 V	5 V	4.85 to 5.15
2 V	10 V	4.85 to 5.15
5 V	20 V	3.88 to 4.12

NOTE

CH 1 and CH 2 Acquisition Gain adjustments (R335 and R420) are accessible through the gap between the bottom of the rear frame assembly and the bottom of the main frame. Use an insulated-shaft screwdriver or alignment tool to make the adjustments.

e. ADJUST—CH 1 Acquisition Gain (R335, ADJUSTMENT LOCATIONS 8) for exactly 4 divisions of display amplitude.

f. Set the generator output for 20 mV (if skipping from part c) and move the signal from the CH 1 input connector to the CH 2 input connector.

g. Set:

VERT MODE	CH 2 only

h. CHECK—DC accuracy is within 3% for each of the VOLTS/DIV switch settings and standard-amplitude generator settings listed in Table 4-23. If the CH 2 DC accuracy is within tolerance, skip to step 6. If it is not, continue with parts i and j of this step.

i. Set the generator output for 20 mV and switch the CH 2 VOLTS/DIV switch to 5 mV per division.

j. ADJUST—CH 2 Acquisition Gain (R420, ADJUSTMENT LOCATIONS 8) for exactly 4 divisions of display amplitude.

6. Check/Adjust CH 1 and CH 2 Acquisition Centering (R232 and R436)

a. Set:

VERT MODE	CH 1 and CH 2
AC-GND-DC	GND
VOLTS/DIV (both)	5 mV
NON STORE	On (button in)

b. Use the Channel Vertical POSITION controls to vertically center both the CH 1 and CH 2 baseline traces to the center horizontal graticule line.

c. Set:

STORAGE MODE	NORM

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d. CHECK—Both CH 1 and CH 2 traces are within 0.5 division of the center horizontal graticule line. If the traces are within tolerance, skip to step 7. If they are not within tolerance, continue with the remainder of this step.

NOTE

CH 1 and CH 2 Trig DC Balance controls (R122 and R431) must be correctly adjusted before attempting to adjust CH 1 and CH 2 Acquisition Centering. Refer to "TRIGGERING" adjustments, step 5, given previously in this section of the manual. If the complete Adjustment Procedure is being performed, R122 and R431 are correctly adjusted. If only the Digital Storage Adjustment Procedure is being performed, the Trig DC Balance Adjustments must be checked and adjusted if necessary.

e. ADJUST—CH 1 Acquisition Centering (R232, ADJUSTMENT LOCATIONS 2) to align the CH 1 baseline trace with the center horizontal graticule line.

f. ADJUST—CH 2 Acquisition Centering (R436, ADJUSTMENT LOCATIONS 2) to align the CH 2 trace with the center horizontal graticule line (superimpose the CH 1 and CH 2 traces).

g. INTERACTION—CH 1 and CH 2 Acquisition Centering adjustments interact slightly with the CH 1 and CH 2 Acquisition Gain adjustments. Switch both AC-GND-DC switches to DC and repeat steps 5 and 6 until no improvement is noted.

h. Disconnect the test equipment from the 468.

7. Check 0.5 mV to 2.0 mV VOLTS Readout Accuracy

a. Set:

CURSOR FUNCTION	VOLTS (button in)
VOLTS/DIV (both)	2 mV
STORAGE MODE	NORM
AC-GND-DC (both)	DC
VERT MODE	CH 1

b. Use the CURSOR/NO. of SWEEPS control to position the dashed VOLTS cursor 3 divisions above the center horizontal graticule line. Press in the CURSOR SELECT push button to activate the other VOLTS cursor and position it 3 divisions below the center horizontal graticule line (exact 6-division difference between the cursors).

c. CHECK—Readout accuracy is within 3% for each of the VOLTS/DIV switch settings listed in Table 4-24.

d. Set:

VERT MODE	CH 2

e. Repeat part c using the CH 2 VOLTS/DIV switch.

Table 4-24

0.5 to 2.0 mV VOLTS Readout Accuracy

CH 1 and CH 2 VOLTS/DIV Switch Setting	LED Readout Accuracy
2 mV	11.64 to 12.36 mV
1 mV	5.82 to 6.18 mV
0.5 mV	2.910 to 3.090 mV

8. Check ADD Mode

a. Set:

VERT MODE	ADD
VOLTS/DIV (both)	5 mV

b. Connect a 10-mV, standard-amplitude square-wave signal via a 50-Ω bnc cable and a dual-input coupler to both the CH 1 and CH 2 input connectors.

c. Adjust the A TRIGGER LEVEL control for a stable display.

d. CHECK—Display amplitude is 4 divisions ±0.12 division (3.88 to 4.12 divisions). If the VOLTS cursors are used to make the measurement, the seven-segment LED readout should be within 19.4 to 20.6 mV.

e. Disconnect the test equipment from the 468.

9. Check NORM to SAVE Registration

a. Set:

VERT MODE	CH 1 only
AC-GND-DC (both)	GND

b. Use the Vertical POSITION control to align the trace with the center horizontal graticule line.

c. Press in the SAVE Storage Mode push button.

d. CHECK—Trace remains within 0.2 division of the center horizontal graticule line.

e. Set:

VERT MODE	CH 2 only
STORAGE MODE	NORM

f. Repeat parts b through d for CH 2.

10. Check/Adjust A/D Converter Compensation (R271)

a. Set:

VERT MODE	CH 1, CH 2, and CHOP
AC-GND-DC (both)	DC
A TRIGGER SOURCE	CH 1
STORAGE MODE	NORM
DISPLAY RESPONSE	PULSE
TIME/DIV (both)	2 μs

b. Connect a 1-MHz, fast-rise + square-wave signal via a 50-Ω bnc cable, 2X attenuator, and a 50-Ω bnc termination to the CH 1 input connector.

c. Set the generator output for a 6-division display amplitude.

d. Use the Vertical POSITION controls to vertically center both the CH 2 baseline trace and the CH 1 square-wave display.

e. CHECK—No vertical deflection appears on the CH 2 trace and overshoot on the CH 1 square-wave display is 3% or less (0.2 division or less).

NOTE

R271 is accessible through the gap between the bottom of the rear frame assembly and the bottom of the main frame.

f. ADJUST—A/D Converter Compensation (R271, ADJUSTMENT LOCATIONS 7) for minimum vertical deflection of the CH 2 baseline trace (typically zero deflection) using the following procedure:

1. Using an insulated-shaft screwdriver, adjust R271 fully clockwise.
2. Slowly adjust R271 counterclockwise until the CH 2 baseline trace is flat (no square-wave deflection).

NOTE

Excessive counterclockwise rotation of the adjustment will cause the CH 1 square-wave display to overshoot on the leading edge.

g. CHECK—Overshoot on CH 1 square-wave leading edge is 3% or less (0.2 division or less). If the overshoot exceeds 3%, repeat parts f and g until no further improvement is noted.

11. Check Display Response

a. Set:

VERT MODE	CH 1 only
A TRIGGER SOURCE	NORM
TIME/DIV	1 ms
A TRIGGER LEVEL	For a stable display

b. Set the generator output for a 1-kHz, 5-vertical-division display.

c. Set:

STORAGE MODE	SAVE
X10 MAG	On (button in)

d. Use the Horizontal POSITION control to position a square-wave rising edge to the center vertical graticule line.

NOTE

A rise time of 0.3 division or less is obtainable only on a pulse leading edge with no samples. If a sample is obtained on a pulse leading edge, the rise time will be at least 1.5 sample periods. To make the rise time and aberration measurements, use the Horizontal POSITION control to position a pulse having no samples on the leading edge to the center vertical graticule line.

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e. CHECK—Front corner aberrations are ±0.3 division or less.

f. Use the CH 1 Vertical POSITION control to align the top and bottom of the waveform with the 0% and 100% dotted graticule lines.

g. CHECK—Rise time between 10% and 90% on the waveform rising edge is 0.3 horizontal division or less.

12. Check Storage Acquisition Step Response

a. Set:

TIME/DIV (both)	0.1 μs
STORAGE MODE	NORM
DISPLAY RESPONSE	PULSE (button out)
X10 MAG	Off (button out)

b. Change the generator to 1 MHz and set the output for a 5-division display amplitude.

c. Adjust the A TRIGGER LEVEL control for a triggered acquisition of the signal.

d. Press in the ENVELOPE Storage Mode push button, then press in the SAVE Storage Mode push button.

e. Allow the ENVELOPE acquisition cycle to end (468 then enters the SAVE Storage Mode).

f. CHECK—Overshoot on leading edge of the waveform is 3% or less (0.15 division or less).

13. Check SAVE Storage Mode

a. Set:

VOLTS/DIV (both)	5 mV
TIME/DIV (both)	0.5 ms
STORAGE MODE	NORM

b. Change the generator frequency to 1 kHz and set the generator output to obtain a 5-division display amplitude.

c. Adjust the A TRIGGER LEVEL control for a stable display.

d. Set:

STORAGE MODE	SAVE

e. CHECK—Waveform acquisition stops (trace stops flickering), and the last acquired waveform remains displayed.

NOTE

Waveforms can be expanded up to 100 times horizontally in the steps of the TIME/DIV switch. They can be expanded up to 10 times vertically in the steps of the VOLTS/DIV switch of the channel used to acquire the display.

f. Set:

A TIME/DIV	0.2 ms

g. CHECK—Displayed square-wave period is approximately 5 horizontal divisions wide.

h. CHECK—Waveform continues to expand as the A TIME/DIV switch is stepped to each position clockwise up to and including 5 μs per division.

i. CHECK—Switching the A TIME/DIV switch clockwise past 5 μs per division has no further expansion effect on the waveform.

j. Set:

A TIME/DIV	0.5 ms

k. CHECK—Waveform display is the same as the original waveform saved (5 divisions of amplitude and 1 cycle per 2 divisions).

l. Set:

STORAGE MODE	NORM
CH 1 VOLTS/DIV	50 mV

m. Set:

STORAGE MODE	SAVE

n. CHECK—Display amplitude is approximately 0.5 division.

o. Set:

CH 1 VOLTS/DIV	20 mV

p. CHECK—Display amplitude is approximately 1.25 divisions.

q. CHECK—Waveform continues to expand vertically as the CH 1 VOLTS/DIV switch is stepped clockwise to the 10 mV and 5 mV switch positions. At the 5 mV per division switch position the display amplitude is approximately 5 divisions.

NOTE

When the waveform is fully expanded (10 times), noise present on the acquired signal will cause a least-significant-bit level change on either peak of the displayed waveform. This level change is approximately 0.4 division in amplitude.

r. CHECK—Switching the CH 1 VOLTS/DIV switch clockwise past 5 mV per division has no further expansion effect on the waveform.

s. Return the CH 1 VOLTS/DIV switch to 50 mV.

t. CHECK—Display amplitude is the same as the original waveform saved (approximately 0.5 division).

14. Check SAVE Position Range

a. Set:

STORAGE MODE	NORM
CH 1 VOLTS/DIV	5 mV

b. Set the generator output to obtain an 8-division display amplitude.

c. Set:

STORAGE MODE	SAVE

d. Set:

VOLTS/DIV (CH 1 or CH 2 as appropriate)	0.5 mV

e. CHECK—Top of waveform can be positioned past the bottom graticule line and bottom of waveform can be positioned past the top graticule line using the Vertical POSITION control.

f. Move the signal from the CH 1 input connector to the CH 2 input connector.

g. Set:

VERT MODE	CH 2 only
STORAGE MODE	NORM

h. Repeat parts b through e for CH 2.

i. Disconnect the test equipment from the 468.

15. Check NORM Storage Mode Position Range

a. Set:

STORAGE MODE	NORM
VERT MODE	CH 1
CH 1 VOLTS/DIV	0.1 V
CH 2 VOLTS/DIV	10 mV
AC-GND-DC (both)	DC
TIME/DIV	50 μs

b. Connect a 50-kHz, leveled sine-wave signal via a 50-Ω bnc cable, a 50-Ω bnc termination, and a dual-input coupler to both the CH 1 and CH 2 input connectors.

c. Set the generator output to obtain a 2.4-division display amplitude.

d. Set:

CH 1 VOLTS/DIV	10 mV

e. CHECK—Full counterclockwise rotation of the Vertical POSITION control positions the top of the waveform to at least the 2nd graticule division above the center horizontal graticule line, and full clockwise rotation of the

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Vertical POSITION control positions the bottom of the waveform to at least the 2nd graticule division below the center horizontal graticule line.

f. Set:

VERT MODE	CH 2 only

g. Repeat part e using the CH 2 Vertical POSITION control.

h. Disconnect the test equipment from the 468.

16. Check SAVE REFERENCE Operation

a. Set:

VERT MODE	CH 1
TIME/DIV (both)	5 μs
VOLTS/DIV (both)	5 mV

b. Connect a 50-kHz, leveled sine-wave signal via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 1 input connector.

c. Set the generator output to obtain a 5-division display amplitude. Adjust the A TRIGGER LEVEL control as necessary for a stable display.

d. Set:

SAVE REF	On (button in)

e. Rotate the CH 1 Vertical POSITION control to move the waveform about 1 division vertically.

f. CHECK—A reference waveform was acquired at the original position of the displayed waveform.

g. Change the setting of both the CH 1 VOLTS/DIV switch and the A TIME/DIV switch.

h. CHECK—Reference waveform remains unchanged.

i. Press the SAVE REF push button to release it (reference waveform will be removed from the display).

17. Check Useful Storage Bandwidth

a. Set:

DISPLAY RESPONSE	SINE
STORAGE MODE	NORM
VOLTS/DIV (both)	5 mV
A TIME/DIV	10 μs
CURSOR FUNCTION	VOLTS

b. Set the generator output to obtain a 6-division display amplitude.

c. Change the A TIME/DIV switch to 0.2 μs and change the generator output frequency to 10 MHz.

d. Press in the SAVE Storage Mode push button to hold a stable display for measurement.

e. CHECK—Amplitude of any two adjacent peaks is not greater than 33.65 mV nor less than 21.20 mV. Use the VOLTS cursors to make the required measurements.

f. Set:

VERT MODE	CH 1, CH 2, and CHOP

g. Change the generator output frequency to 5 MHz.

h. Press in the NORM Storage Mode push button. Then, after a new display has been acquired, press in the SAVE Storage Mode push button.

i. CHECK—Amplitude of any two adjacent peaks is not greater than 31.80 mV nor less than 25.25 mV. Again, use the VOLTS cursors to make the required measurements.

18. Check Storage Analog Bandwidth

a. Set:

CURSOR FUNCTION	Both off (buttons out)
STORAGE MODE	ENVELOPE
A TIME/DIV	1 ms
VERT MODE	CH 1

b. Change the generator output frequency to 50 kHz and verify that a 6-division vertical signal display is being acquired.

c. Change the generator output frequency to 10 MHz.

NOTE

At exactly 10 MHz input signal frequency, it is possible to produce a beat-signal display. If an ENVELOPE display with variable amplitude appears, shift the test frequency slightly off 10 MHz to obtain an envelope with flat amplitude.

d. Press in the SAVE Storage Mode push button. The 468 will enter the SAVE Storage Mode at the end of the ENVELOPE acquisition cycle.

e. CHECK—The ENVELOPE display signal amplitude is 30 mV peak-to-peak within ±3.65 mV (33.65 mV to 26.35 mV). (Press in the VOLTS CURSOR FUNCTION push button and use the VOLTS cursors to make the required measurement.)

f. Disconnect the test equipment from the 468.

19. Check Storage ALT/CHOP Function

a. Set:

STORAGE MODE	NORM
TIME/DIV (both)	1 ms
CURSOR FUNCTION	Both off (buttons out)
VOLTS/DIV (both)	0.1 V
VERT MODE	CH 1, CH 2, and ALT

b. Connect a 50-kHz, leveled sine-wave signal via a 50-Ω bnc cable, a 50-Ω bnc termination, and a dual-input coupler to both the CH 1 and CH 2 input connectors.

c. Set the generator output to obtain about a 1-division display amplitude of each waveform.

d. Vertically position the waveforms near the middle of the graticule area, about 1 division apart.

e. Set:

TIME/DIV	50 ms

NOTE

Waveforms are aliased and will not appear as a normal sine wave signal.

f. CHECK—Waveforms are acquired and updated alternately (first one and then the other).

g. Set:

VERT MODE	CH 1, CH 2, and CHOP

h. CHECK—Waveforms are acquired and updated simultaneously.

i. Disconnect the test equipment from the 468.

20. Check Channel Isolation

a. Set:

CH 2 VOLTS/DIV	0.2 V
CH 1 VOLTS/DIV	20 mV
VERT MODE	CH 2
AC-GND-DC (both)	DC
A TIME/DIV	0.1 μs
STORAGE MODE	ENVELOPE

b. Connect a 10-MHz, leveled sine-wave signal via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 2 input connector.

c. Set the generator output for a 2-division display amplitude.

d. Set:

VERT MODE	CH 1 only
CH 2 VOLTS/DIV	20 mV

e. CHECK—CH 1 baseline trace amplitude is 0.2 division or less.

f. Set:

VERT MODE	CH 2 only

g. Move the signal from the CH 2 input connector to the CH 1 input connector.

h. CHECK—CH 2 baseline trace amplitude is 0.2 division or less.

i. Disconnect the test equipment from the 468.

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21. Check/Adjust Common-Mode Rejection Ratio (R420)

a. Set:

TIME/DIV	50 μs
INVERT	On (button in)
VOLTS/DIV (both)	5 mV
AC-GND-DC (both)	DC
VERT MODE	CH 1
STORAGE MODE	NORM

b. Connect a 50-kHz, leveled sine-wave signal via a 50-Ω bnc cable, a 50-Ω bnc termination, and a dual-input coupler to both the CH 1 and CH 2 input connectors.

c. Set the generator output for a 6-division display amplitude.

d. Set:

STORAGE MODE	ENVELOPE
VERT MODE	ADD only

e. Change the generator frequency to 10 MHz.

f. CHECK—Display amplitude is 0.6 division or less. If it is not, continue with the remainder of this step.

g. Change the generator frequency to 50 kHz.

NOTE

R420 is accessible through the gap between the bottom of the rear frame assembly and the bottom of the main frame. Use an insulated-shaft screwdriver or alignment tool to make the adjustment.

h. ADJUST—CH 2 Acquisition Gain (R420, ADJUSTMENT LOCATIONS 8) for minimum amplitude of the ADD display.

i. Disconnect the test equipment from the 468.

22. Check Ground Dot Display

a. Set:

STORAGE MODE	NORM
VERT MODE	CH 1
AC-GND-DC (both)	GND

b. Use the Vertical POSITION control to align the trace with the center horizontal graticule line. Use the Horizontal POSITION control to align the start of the trace with the left graticule edge.

c. Set:

CH 1 AC-GND-DC	DC

d. Use the Vertical POSITION control to position the trace to both the top and bottom of the graticule area.

e. CHECK—Bright ground dot remains displayed at the center horizontal graticule line as the trace is positioned.

f. Position the trace 2 divisions above the center horizontal graticule line.

g. Set the AC-GND-DC switch to GND momentarily; then, to AC.

h. Position the trace 2 divisions below the center horizontal graticule line.

i. CHECK—Ground dot remains displayed at 2 divisions above the center horizontal graticule line.

j. Set:

VERT MODE	CH 2

k. Repeat parts b through i for CH 2.

23. Check ENVELOPE Storage Mode

a. Set:

TIME/DIV (both)	5 μs
NON STORE	On (button in)
VERT MODE	CH 1
VOLTS/DIV (both)	5 mV

b. Connect a 50-kHz, leveled sine-wave signal via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 1 input.

c. Set the generator for a 4-division display amplitude.

d. Set:

STORAGE MODE	ENVELOPE
NO. OF SWEEPS	On (button in)

e. The seven-segment LED readout should be 32 unless previously changed by the operator. This number is the default value (number automatically set at power-on) for the number of sweeps to be acquired in each envelope waveform. If necessary, use the CURSOR/NO. OF SWEEPS control knob to set the number to 32. Clockwise rotation increases the display number, while counterclockwise rotation of the control knob decreases the number.

f. Use the CH 1 Vertical POSITION control to move the display vertically about 2 divisions. A 2-trace envelope waveform should appear until the display is automatically reset at the end of 32 sweeps.

g. Rotate the CURSOR/NO. OF SWEEPS control knob to the counterclockwise stop. The seven-segment LED display should count down by powers of two to 1.

h. Use the CH 1 Vertical POSITION control to position the waveform vertically. Only a single waveform should appear (display reset with each sweep).

i. Rotate the CURSOR/NO. OF SWEEPS control knob to its clockwise end stop.

j. CHECK—The seven-segment LED display counts up to 256 by powers of two, then displays 9999.

k. Position the display vertically on the graticule.

l. CHECK—An envelope waveform is created, and it does not reset.

m. Rotate the CH 1 VOLTS/DIV VAR control momentarily out of, then back into, its calibrated detent position.

n. CHECK—Envelope display is reset both when the VAR contol is rotated out of its detent position and when it is returned to its detent position.

o. Set:

CH 1 AC-GND-DC	GND
TIME/DIV (both)	20 μs

p. Use the CH 1 Vertical POSITION control to create a 6-division envelope display amplitude. (Rotate the POSITION control clockwise until the maximum envelope amplitude is up 3 divisions from the center graticule line. Then, rotate the control counterclockwise until the minimum envelope amplitude is 3 divisions down from the center graticule line.)

q. CHECK—Space between the maximum and minimum envelope amplitudes is filled at least 90% (5.4 divisions or more).

r. Disconnect the test equipment from the 468.

24. Check Option 12, AVG Operation

a. Set:

VERT MODE	CH 1
VOLTS/DIV (both)	0.5 V
TIME/DIV (both)	5 μs
A TRIGGER SOURCE	CH 1
STORAGE MODE	NORM
AC-GND-DC (both)	DC

b. Connect a 50-kHz, leveled sine-wave signal via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 1 input connector.

c. Set the generator output for about a 5-division display amplitude.

d. Adjust the A TRIGGER LEVEL control for a stable display.

e. Connect 5-μs time markers via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 2 input connector.

f. Set:

VERT MODE	ADD
STORAGE MODE	AVG

g. Press in the NO. OF SWEEPS push button (located on the left side panel). The number 32 should appear in the seven-segment LED display, unless previously changed by the operator. This number is the power-on default value and is automatically set when power is applied to the 468.

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h. Note the approximate time marker amplitude seen on the ADD waveform.

i. Rotate the CURSOR/NO. OF SWEEPS control knob clockwise to increase the displayed number to 4, then 8, 16, 32, 64, 128, and finally 256. Allow the display to update at each of the NO. OF SWEEPS selections.

j. CHECK—Time marker amplitude on the sine wave decreases with each completed average cycle as the number of sweeps selected increases. At 256 sweeps, time markers are not visible on the ADD waveform.

k. Return the number of sweeps selected to 32 and press the NO. OF SWEEPS push button (on the left side panel) to release it.

l. Disconnect the test equipment from the 468.

25. Check Option 02, GPIB Operation

Refer to the 468 Digital Storage Oscilloscope Operators Manual for the driver program that enables a Tektronix 4050-series terminal to act as a bus controller for checking operation of the GPIB. Either that program or an operator-developed program must be used with a bus controller to handle the 468 service request that is issued when the 468 is powered on. The program listed in the Operators manual will handle the service request, copy the waveform message, and display the waveform (with graticule lines) and certain 468 control settings that affect the displayed waveform.

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STORAGE TRIGGERING

Equipment Required (see Table 4-1)

6. Leveled Sine-Wave Generator
7. Time-Mark Generator
12. 42-in., 50-Ω Bnc Cable
24. 50-Ω, Bnc Termination
25. 3-in., Flat-Bit Screwdriver

See ADJUSTMENT LOCATIONS 8 *in this Volume for test point and adjustment locations.*

468 CONTROL SETTINGS

Power

Regulating Range Selector	High
Line Voltage Selector	115 V
POWER	ON (button in)

Crt

INTENSITY	As desired
FOCUS	Best focused display
SCALE ILLUM	As desired

Vertical (CH 1 and CH 2)

VOLTS/DIV	0.5 V
VOLTS/DIV VAR	Calibrated detent
VERT MODE	CH 1
POSITION	Midrange
AC-GND-DC	DC
INVERT	Off (button out)
20 MHz BW LIMIT	Full bandwidth (button out)

Trigger (A and B if applicable)

LEVEL	Midrange
SLOPE	+
COUPLING	AC
SOURCE (both)	NORM
A TRIG MODE	AUTO
A TRIGGER HOLDOFF	NORM

Sweep (A and B)

HORIZ DISPLAY	A
TIME/DIV (both)	5 μs
TIME/DIV VAR	Calibrated detent
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange

Digital Storage

STORAGE MODE	NORM
STORAGE WINDOW	POST TRIG (button out)
CURSOR FUNCTION	Both off (buttons out)
SAVE REF	Off (button out)
DISPLAY RESPONSE	SINE (button in)

1. Check STORAGE WINDOW Operation

a. Connect 0.1 ms time markers via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 1 input connector.

b. Use the CH 1 Vertical POSITION control to align the display's baseline with the center horizontal graticule line and use the Horizontal POSITION control to align the sweep start with the left graticule edge.

c. CHECK—Rising edge of the time marker occurs at approximately 1.3 divisions from the left graticule edge.

d. Set:

STORAGE WINDOW	PRE TRIG

e. CHECK—Rising edge of the time marker occurs at approximately 9 divisions from the left graticule edge.

2. Check A and B + GATES

a. Set:

NON STORE	On (button in)
A TIME/DIV	0.1 ms
B TIME/DIV	20 μs
TRIGGER LEVEL (both)	For a stable display

b. Note—Display has 1 time marker per division.

c. Set:

STORAGE MODE	NORM

d. CHECK—Display continues to have 1 time marker per division.

e. Set:

HORIZ DISPLAY	A INTEN

f. CHECK—Display remains unchanged.

g. Set:

NON STORE	On (button in)
HORIZ DISPLAY	B DLY'D

h. Note—Display has 1 time marker per 5 divisions.

i. Set:

STORAGE MODE	NORM

j. CHECK—Display continues to have 1 time marker per 5 divisions.

k. Set:

HORIZ DISPLAY	ALT

l. CHECK—Display remains unchanged.

m. Disconnect the test equipment from the 468.

3. Check/Adjust Storage NORM Trigger DC Balance (R126)

a. Set:

CH 1 VOLTS/DIV	5 mV
HORIZ DISPLAY	A

b. Connect a 50-kHz, leveled sine-wave signal via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 1 input connector.

c. Set the generator output for a 6-division display amplitude.

d. Use the CH 1 Vertical POSITION control to center the display vertically.

e. Use the A TRIGGER LEVEL control to align the point where the sine wave's leading edge intersects the center horizontal graticule line with the 2nd vertical graticule line (1 division from the left graticule line).

f. Set:

A TRIGGER COUPLING	DC

g. CHECK—Intersection point of the sine wave and the center horizontal graticule line remains at the 2nd vertical graticule line within ±0.2 division.

h. ADJUST—Storage NORM DC TRIG Balance (R126) to align the intersection point of the sine wave's leading edge and the center horizontal graticule line with the 2nd vertical graticule line. The adjustment is accessible through a hole in the top of the rear frame assembly next to the 50-conductor ribbon cable connector.

i. Disconnect the test equipment from the 468.

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STORAGE HORIZONTAL

Equipment Required (see Table 4-1)

6. Leveled Sine-Wave Generator
7. Time-Mark Generator
12. 42-in., 50-Ω Bnc Cable
24. 50-Ω Bnc Termination
25. 3-in., Flat-Bit Screwdriver

See ADJUSTMENT LOCATION *in this Volume for test point and adjustment locations.*

468 CONTROL SETTINGS

Power

Regulating Range Selector	High
Line Voltage Selector	115 V
POWER	ON

Crt

INTENSITY	As desired
FOCUS	Best focused display
SCALE ILLUM	As desired

Vertical (CH 1 and CH 2)

VERT MODE	CH 1
VOLTS/DIV	0.5 V
VOLTS/DIV VAR	Calibrated detent
AC-GND-DC	DC
POSITION	Midrange
INVERT	Off (button out)

Trigger (A and B)

COUPLING	AC
SLOPE	+
LEVEL	For a stable, triggered display
SOURCE	NORM
A TRIG MODE	AUTO
A TRIGGER HOLDOFF	NORM
B TRIGGER SOURCE	STARTS AFTER DELAY
DELAY TIME POSITION	Fully counterclockwise

Sweep (A and B if applicable)

HORIZ DISPLAY	A
TIME/DIV	1 ms
TIME/DIV VAR	Calibrated detent
X10 MAG	Off (button out)
POSITION (Horizontal)	Midrange

Digital Storage

STORAGE MODE	NORM
STORAGE WINDOW	POST TRIG (button out)
DISPLAY RESPONSE	PULSE (button out)
CURSOR FUNCTION	Both off (buttons out)
SAVE REF	Off (button out)

1. Check/Adjust Storage Horizontal Gain (R550) and Storage Horizontal Centering (R346)

a. Connect 1-ms time markers via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 1 input connector.

b. Use the Horizontal POSITION control to align the 2nd time marker with the 2nd vertical graticule line.

c. CHECK—Timing at the 10th time marker is within ±0.16 division (2% over the center 8 divisions). If timing is within tolerance, skip to part j. If it is not, continue with the remainder of this procedure.

d. Set:

CURSOR FUNCTION	TIME
AC-GND-DC	GND

e. Use the Vertical POSITION control to center the trace vertically and use the Horizontal POSITION control to align the start of the trace with the left graticule edge. Trace must extend approximately 0.24 division beyond the right graticule edge.

f. Adjust the INTENSITY control so that only the TIME dots are visible.

g. Use the CURSOR control knob to position the active TIME dot to the 2nd vertical graticule line.

h. Press in the CURSOR SELECT push button to activate the 2nd TIME dot and position it to obtain a seven-segment LED readout of exactly 8.00 ms.

i. ADJUST—Horizontal Display Gain (R550) to obtain exactly 8 divisions between the two TIME dots. Use the Horizontal POSITION control to keep the 1st TIME dot aligned with the 2nd graticule line while adjusting R550.

j. Set:

VERT MODE	None (all buttons out)
NON STORE	On (button in)

k. Position the start of the trace to the left graticule edge.

l. Set:

STORAGE MODE	NORM
INTENSITY	For a visible trace

m. CHECK—Start of trace is at the left graticule edge within ±0.2 division.

n. ADJUST—Horizontal Display Centering (R346) to position the start of the trace at exactly the left graticule edge.

o. INTERACTION—Horizontal Display Centering slightly affects Horizontal Display Gain. Press in the CH 1 VERT MODE push button and repeat parts b and c to check the Horizontal Display Gain. If the gain is not within tolerance, repeat parts d through o of this step until no further improvement is noted.

2. Check Storage Timing Accuracy

a. Set:

VERT MODE	CH 1
STORAGE MODE	NORM
A TIME/DIV	2 μs
CH 1 AC-GND-DC	DC

b. Set the time-mark generator for 2-μs time markers. Obtain a NORM Storage Mode time-marker display. For POST TRIG Storage Window, only 10 time markers will be displayed. Use the CH 1 Vertical POSITION control to center the display vertically.

NOTE

Amplitude variations occurring in the time markers as they are being acquired is due to the sample-clock and time-marker frequency differences. Sampling of the narrow time markers does not always occur either at peak amplitude of the markers or at the same amplitude point on the markers between sampling intervals.

c. Use the Horizontal POSITION control to align the 2nd time marker rising edge with the 2nd vertical graticule line.

NOTE

If display amplitude variation becomes a problem, press in the SAVE Storage Mode push button (when an acquisition is completed) to hold the waveform display stable for making the accuracy check. The SAVE Storage Mode display may also be positioned vertically, if required, to move any portion of the waveform to the graticule markings on the center horizontal graticule line.

d. Set the CH 1 AC-GND-DC switch to GND and adjust the INTENSITY control for a visible display of the trace and the TIME dots.

e. Use the CURSOR/NO. OF SWEEPS control knob to set the active TIME dot to the 2nd vertical graticule line. Press the CURSOR SELECT push button to activate the other TIME dot. Position the TIME dot to the 10th vertical graticule line (8-division spacing between the TIME dots).

f. CHECK—LED readout accuracy is within 2% (16.00 μs ± 0.32μs).

g. Set the CH 1 AC-GND-DC switch to DC and adjust the INTENSITY control as necessary for viewing the time markers.

h. CHECK—Readout and timing accuracy at each TIME/DIV switch setting listed in Table 4-25. The time marker spacing must be accurate within 2% (8 divisions ± 0.16 division) over the center 8 divisions. The LED readout limits at each TIME/DIV switch setting are listed in Table 4-25. Use the Horizontal POSITION control as necessary to maintain alignment of the 2nd time marker on the 2nd vertical graticule line as the TIME/DIV switch setting is changed.

NOTE

To obtain a valid display on the 1st trigger accepted at a new TIME/DIV switch setting, change the time-mark generator output to the next required time markers before changing the 468 TIME/DIV switch setting. This procedure is especially useful for TIME/DIV switch settings from 0.1 s to 5 s per division. Watch for a display update (display flickers and TIME LED readout changes to the scale of the newly acquired waveform) prior to making the accuracy check at the new TIME/DIV switch setting. As TIME/DIV switch setting increases, the time required for the update to occur increases. At 5 s per division, it takes at least 50 s to acquire a complete waveform.

i. Set:

A TRIG MODE	AUTO
HORIZ DISPLAY	B DLY'D
TIME/DIV (both)	2 μs
A TRIGGER LEVEL	For a stable display

j. Set the time-mark generator for 2-μs markers.

k. CHECK—Repeat part h of this step to check the B timing accuracy.

l. Disconnect the test equipment from the 468.

3. Check Storage 0.02-μs to 1.0-μs Timing Accuracy

a. Set:

A TRIGGER MODE	AUTO
HORIZ DISPLAY	A
TIME/DIV (both)	0.02 μs
CH 1 AC-GND-DC	GND

Table 4-25

Storage Timing Accuracy

A and B TIME/DIV Switch Setting	Time-Mark Generator Output	LED Readout Accuracy Over Center 8 Divisions
2 μs	2 μs	15.68 μs to 16.32 μs
5 μs	5 μs	39.20 μs to 40.80 μs
10 μs	10 μs	78.40 μs to 81.60 μs
20 μs	20 μs	157.8 μs to 163.2 μs
50 μs	50 μs	392.0 μs to 408.0 μs
0.1 ms	0.1 ms	0.784 ms to 0.816 ms
0.2 ms	0.2 ms	1.568 ms to 1.632 ms
0.5 ms	0.5 ms	3.920 ms to 4.080 ms
1.0 ms	1.0 ms	7.84 ms to 8.16 ms
2.0 ms	2.0 ms	15.68 ms to 16.32 ms
5.0 ms	5.0 ms	39.20 ms to 40.80 ms
10.0 ms	10.0 ms	78.40 ms to 81.60 ms
20.0 ms	20.0 ms	156.8 ms to 163.2 ms
50.0 ms	50.0 ms	392.0 ms to 408.0 ms
0.1 s[a]	0.1 s	0.784 s to 0.816 s
0.2 s[a]	0.2 s	1.568 s to 1.632 s
0.5 s[a]	0.5 s	3.920 s to 4.080 s
1.0 s[a]	1.0 s	7.84 s to 8.16 s
2.0 s[a]	2.0 s	15.68 s to 16.32 s
5.0 s[a]	5.0 s	39.20 s to 40.80 s

[a]For TIME/DIV switch settings slower than 50 ms/division, set TRIG MODE to NORM.

b. Obtain a NORM Storage Mode display of the baseline trace. Then, press in the SAVE Storage Mode push button.

c. Adjust the INTENSITY control for a visible display of the trace and the TIME dots. Use the CH 1 Vertical POSITION control to center the trace vertically.

d. Use the CURSOR/NO. OF SWEEPS control knob to set the active TIME dot on the 2nd vertical graticule line. Press in the CURSOR SELECT push button to activate the other TIME dot. Use the CURSOR/NO. OF SWEEPS control knob to position the 2nd TIME dot to the 10th vertical graticule line (8 divisions between the TIME dots).

e. CHECK—LED readout accuracy at each TIME/DIV switch setting listed in Table 4-26. The seven-segment read-

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out must be accurate within 2%. The green scaling LED should be illuminated for TIME measurements.

f. Set:

HORIZ DISPLAY	B DLY'D

g. CHECK—Repeat parts b through e of this step to check the B-timing LED readout accuracy.

h. Disconnect the test equipment from the 468.

Table 4-26

0.02-μs to 1.0-μs Timing Accuracy

TIME/DIV Switch Setting	LED Readout Accuracy
0.02 μs	0.157 μs to 0.163 μs
0.05 μs	0.392 μs to 0.408 μs
0.1 μs	0.784 μs to 0.816 μs
0.2 μs	1.568 μs to 1.632 μs
0.5 μs	3.920 μs to 4.080 μs
1.0 μs	7.84 μs to 8.16 μs

4. Check Jitter Correction

a. Set:

VERT MODE	CH 1
VOLTS/DIV	5 mV
HORIZ DISPLAY	A
TIME/DIV	0.02 μs
DISPLAY RESPONSE	SINE (button in)
STORAGE MODE	NORM
CURSOR FUNCTION	Both off (buttons out)

b. Connect a 10-MHz, leveled sine-wave signal via a 50-Ω bnc cable and a 50-Ω bnc termination to the CH 1 input connector.

c. Set the generator output for about a 5-division display amplitude.

d. Adjust the A TRIGGER LEVEL control for a stable display.

e. CHECK—Horizontal display jitter is 0.3 division or less.

NOTE

Due to an inherent uncertainty in jitter correction, the jitter will occasionally, at random intervals, exceed 0.3 division. Abnormal jitter correction circuit operation is indicated by a constant horizontal jitter in the display.

f. Set:

TIME/DIV (both)	20 μs
CH 1 VOLTS/DIV	2 mV
X10 MAG	On (button in)

g. Change the generator frequency to 50 kHz.

h. CHECK—Horizontal display jitter is 0.2 division or less.

i. Disconnect the test equipment from the 468.

MAINTENANCE

This section of the manual contains information for use in preventive maintenance, troubleshooting, and corrective maintenance. Signature tables for use in signature analysis testing of the digital storage circuitry are contained at the end of this section. These table are used in conjunction with the troubleshooting charts located at the back of this volume.

PREVENTIVE MAINTENANCE

INTRODUCTION

Preventive maintenance consists primarily of cleaning and visual inspection. When performed on a regular basis, it can enhance instrument reliability. A convenient time to perform preventive maintenance is just prior to recalibration of the instrument. Operating the 468 under severe environmental conditions will necessitate a more frequent preventive maintenance schedule.

CLEANING

The cabinet minimizes accumulation of dust inside the instrument and should normally be in place when operating the instrument. The front cover provides dust protection for the front panel and crt face and should be installed whenever the instrument is stored or is being transported.

Exterior

Loose dust accumulated on the outside of the oscilloscope can be removed with a soft cloth or small camel-hair brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt that remains can be removed with a soft cloth dampened in a mild detergent and water solution. Do not use abrasive cleaners.

Interior

Dust and dirt inside the instrument should be removed as often as operating conditions require. Accumulation of dirt can cause overheating and component breakdown. Dirt on components acts as an insulating blanket, preventing efficient heat dissipation. It also provides an electrical conducting path that can result in instrument failure, especially under high humidity conditions.

CAUTION

Avoid the use of chemical cleaning agents that might damage the plastics used in this instrument. Do not use chemicals that contain acetone, benzene, toluene, xylene, petroleum ether, white kerosene, carbon tetrachloride, methylene chloride, trichloroethane, trichlorotrifluoroethane (Freon 113, -tf, -ta, -te, -tmc) and trichlorethylene. Recommended cleaning agents are isopropyl alcohol, kelite (1 part kelite, 20 parts water), and a solution of 1% mild detergent and 99% water.

Before performing interior cleaning, refer to the "Cabinet Removal" instructions in the Corrective Maintenance part of this section. The best way to clean the interior is to blow out the accumulated dust with dry, low-pressure air (approximately 9 pounds per square inch). Remove any remaining dirt with a soft brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning ceramic terminal strips and circuit boards. Do not use an applicator on switch contacts since they tend to snag, possibly causing damage. Strands of cotton caught by the contacts can also cause intermittent electrical contact.

CAUTION

To prevent damage from electrical arcing, ensure that circuit boards and components are dry before applying power to the instrument.

The high-voltage circuits should receive special attention. Excessive accumulations of dirt in these areas may cause high-voltage arcing that can result in circuit component damage.

Switch Contacts

Many of the switches in the 468 are circuit-board mounted, cam-activated contacts. Exercise care to preserve the high-frequency characteristics of these switches. Switch maintenance is seldom necessary, but if it is required, observe the following precautions:

1. Use only isopropyl alcohol as a cleaning solution, especially in the area of the vertical attenuator boards. Carbon-based solvents will damage the board material used for these boards.

2. Apply the alcohol with a small, camel-hair brush. Do not use cotton-tipped applicators on the contacts.

CAUTION

Most spray-type circuit coolants contain Freon 12 as a propellant. Because many Freons adversely affect switch contacts, check the contents and brand name before using a spray-type coolant. The following brand names are acceptable: Artic Freeze, Quik-Freeze, and Can-O-Gas. Do not use Zero Mist brand. The only recommended circuit coolant for the volts/division attenuators is either dry ice (CO_2) or isopropyl alcohol.

Crt

Two plastic light filters, one blue and one clear, are provided with the oscilloscope. Clean the light filters and the crt face with a soft lint-free cloth dampened with denatured alcohol or a mild detergent and water solution. The optional crt mesh filter can be cleaned in the following manner:

1. Hold the filter in a vertical position and brush lightly with a Number 7 soft watercolor brush to remove light coatings of dust and lint.

2. Greasy residues or dried-on dirt can be removed with a solution of warm water and a neutral-pH liquid detergent. Use the brush to lightly scrub the filter.

3. Rinse the filter thoroughly in clean water and allow to air dry.

4. If any lint or dirt remains, use clean low-pressure air (approximately 9 pounds per square inch) to remove it. Do not use tweezers or other hard cleaning tools on the filter, as the special finish may be damaged.

5. When not in use, store the mesh filter in a lint-free dust-proof container such as a plastic bag.

Air Filter

The air filter should be visually checked every few weeks and cleaned or replaced if dirty. More frequent inspections are required under severe operating conditions. The following procedure is suggested for cleaning the filter:

1. Remove the filter from the side panel. Be careful not to drop any accumulated dirt into the instrument.

2. Flush the loose dirt from the filter with a stream of hot water.

3. Place the filter in a solution of mild detergent and hot water and let it soak for several minutes.

4. Squeeze the filter to force out any remaining dirt.

5. Rinse the filter in clear water and allow it to dry.

6. Coat the dry filter with an air-filter adhesive (available from an air-conditioner supplier, or see Table 5-3 "Maintenance Aids" under "Corrective Maintenance").

7. Let the adhesive dry thoroughly.

8. Reinstall the filter in the side panel.

If the filter is to be replaced, order new air filters from your local Tektronix Field Office or representative. Refer to the Replaceable Mechanical Parts List in Volume II for ordering information.

VISUAL INSPECTION

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

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

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LUBRICATION

The fan motor and most of the potentiometers used in the 468 are permanently sealed and generally do not require periodic lubrication. The switches used in the 468, both cam- and lever-type, are installed with proper lubrication applied where necessary and will rarely require any additional lubrication. A regular periodic lubrication program for the 468 is not recommended.

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 adjustment of this instrument after each 1000 hours of operation or, if used infrequently, every six months. In addition, replacement of components may necessitate readjustment of the affected circuits.

Complete adjustment instructions are given in the "Calibration" section. The adjustment procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed and/or corrected by readjustment. If only a partial adjustment is performed, see the interaction chart, Table 4-9 in the "Calibration" section, for possible interactions with circuits not adjusted.

TROUBLESHOOTING

The following information is provided to facilitate troubleshooting the 468. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component(s). An understanding of the circuit operation is helpful in locating troubles, particularly where integrated circuitry is used. See the "Theory of Operation," Section 3.

POWER-ON SELF-TEST

Each time the POWER push-button switch is pressed in to apply power to the instrument, a power-on self-test will be initiated by the 468. The various tests are performed in the sequence in which they are presented in the following discussion. The test sequence may be restarted by cycling the POWER switch OFF, then ON again.

ROM Checksum Test

A checksum will be calculated and checked for each ROM in the instrument. If an incorrect checksum is found, the Microprocessor will halt, and the oscilloscope will neither respond to the front-panel switches nor will it operate.

Front-panel indication of a ROM failure is that the Lamp test is never started. All LED displays may either be off or on in a random pattern. A definite indication of a ROM problem is failure to execute the RAM Verification test. A failure of an individual LED indicates that the LED or its controlling circuitry has become inoperative.

Lamp Test

All LED displays on the front panel that are under control of the Microprocessor, including all the segments and decimal points of the seven-segment display, will be illuminated at power-on. Failure of the LED to come on indicates occurrence of a problem that prevents the ROM program from reaching that particular point in the power-on sequence.

RAM Verification Test

NOTE

The RAM Verification portion of the power-on self-test can be internally disabled. To do so, set section 7 of the Service/Options switch to the "OPEN" position. Refer to Figure 5-6 in this section of the manual for the Service/Options switch location.

If the ROM Checksum test result is correct, the self-test will proceed to the RAM Verification test. When the RAM Verification test starts, the seven-segment display will first be blanked and then will start displaying the RAM Verification test error codes. The RAM are checked in the following order:

1. System RAM
2. Scratch RAM
3. Display RAM
4. Acquisition RAM

If all tests are passed, the seven-segment display will be blank, and then the oscilloscope will begin operating immediately. Total time required for completion of the power-on self-test is approximately six seconds. Any RAM failure will prevent oscilloscope operation. In addition, a failure in the System RAM will cause the self-test to halt, and a single error code will appear in the seven-segment display (see Figure 5-1 for the display location assigned to each RAM). Any other RAM failure will not stop self testing.

At the end of the RAM Verification test, the seven-segment display will indicate the results of the test.

RAM Verification Test Description

Two tests will be performed on each RAM section: MARCH and DIAPAT. Each RAM section will be tested separately by both tests. Error codes displayed on the seven-segment LED display indicate either that a RAM section has passed the test or that it has failed. A zero is displayed in each segment if all the tests are passed. Error codes appear in any segment assigned to a RAM section that fails a test. See Figure 5-1 for error code definition. In general, failure of a MARCH test indicates a problem in writing or reading data, while failure of a DIAPAT test indicates an addressing problem.

MARCH TEST. This test determines whether each RAM address can be accessed and written into with both a zero and a one. Testing sequence for each RAM section under test is as follows:

1. Writes a background pattern of all zeros into each address.

2. Reads, tests, and writes complements to all addresses.

3. Repeats step 2, reversing the address order.

4. Writes a background pattern of all ones and repeats steps 2 and 3.

DIAPAT TEST. This test is a shifting diagonal pattern used to detect internal multiple-address selection, destruction of stored data due to noise coupling, faulty sense amplifiers, and slow sense amplifier recovery. The testing sequence for each RAM section under test is as follows:

1. Writes a background pattern of all zeros into each address.

2. Starting with a pattern of 00000001 as the original data stored, the Microprocessor performs a left shift.

3. Stores the shifted data and shifts it left again.

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SEVEN-SEGMENT LED DISPLAY

ACQUISITION RAM	DISPLAY RAM	SCRATCH RAM	SYSTEM RAM

ERROR CODE	MEANING
0	NO ERROR
1	MARCH TEST ERROR
2	DIAPAT TEST ERROR
3	BOTH TEST ERROR

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Figure 5-1. RAM error code display.

4. Repeats step 3 until all the address locations are filled.

5. Tests all locations and writes a zero at each location.

6. Shifts original pattern left one position and saves the shifted pattern.

7. Repeats steps 3 through 5.

8. Repeats step 6 until the pattern is back to 00000001.

9. Writes a background pattern of all ones.

10. With an original pattern of 11111110, the Microprocessor performs a left shift.

11. Repeats steps 3 through 6 until the pattern is back to 11111110.

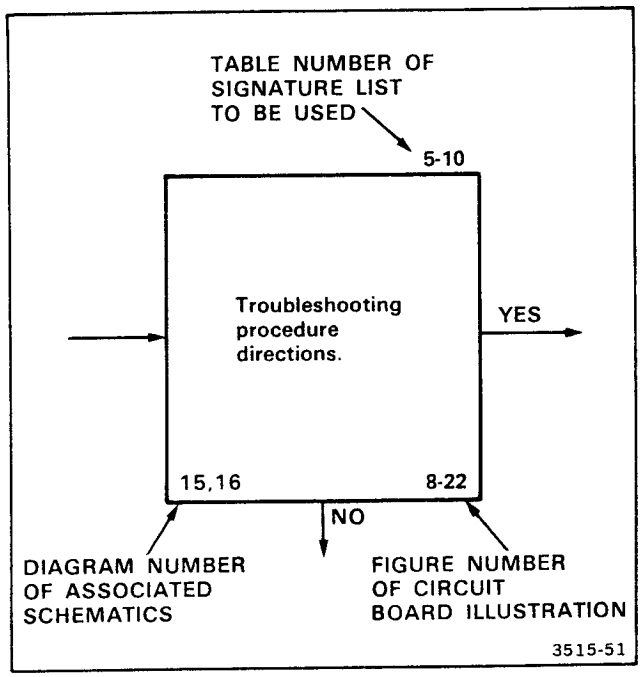

Figure 5-2. Explanation of troubleshooting chart procedure block notations.

TROUBLESHOOTING AIDS

Troubleshooting Charts

The troubleshooting charts, located on tabbed foldout pages at the back of this volume, are to be used as an aid in locating malfunctioning circuitry. They cover both conventional and digital-storage circuitry, with special emphasis placed on the digital-storage portion.

Begin troubleshooting with the Troubleshooting Index chart. The Index chart will help identify a particular problem area and will indicate which other chart can be used for further troubleshooting of that area.

Note that some troubleshooting-procedure boxes on each chart contain numbers in their bottom corners. These are the numbers of the applicable circuit diagram(s) and circuit board illustration(s) (see Figure 5-2). Numbers shown at the start of a troubleshooting path remain applicable to downstream procedure boxes in the path until the procedure specifies a different diagram and/or illustration.

Many of the procedures call for signature-analysis testing. The applicable signature table number is shown outside the upper right corner of the procedure box (see Figure 5-2). The table number is not repeated beyond the first box for which it is used in a troubleshooting path. Any change of the table to be used will be indicated at the box where the change occurs.

Signature tables are located at the end of this section to facilitate their use with the troubleshooting charts contained at the back of this volume. Schematic diagrams and circuit board illustrations are located in Volume II so that they may be referred to without disturbing the pages selected in Volume I.

General and specific notes called out in the troubleshooting-procedure boxes are located on the inner panels of the foldout pages. These notes are usually specific procedures, or amplifying information, to be used in performing the troubleshooting step called for in that box. General notes contain information that pertains to the overall troubleshooting procedure.

Some malfunctions, especially those involving multiple simultaneous failures, may require more elaborate approaches with frequent reference to circuit descriptions in the "Theory of Operation" section of this manual.

Signature Lists

Many of the troubleshooting procedures will refer you to one of the signature list tables at the end of this section. Identified at the top of each table are the circuit boards

on which signatures are to be taken or on which the signature analyzer setup points are to be connected. Signatures contained on a specific circuit board are preceded by the assembly number for that board. Before attempting to take signatures, connect the signature analyzer setup and perform the 468 setup as specified in the appropriate table; then verify the +5 V Check signature.

Service ROM and Test Counter IC

Many of the troubleshooting procedures also require the use of an optional servicing package that includes a Service ROM and a Test Counter IC. The ROM contains the service routines, and the Test Counter IC simulates operation of the vertical signal A/D Converter. Refer to "Maintenance Aids," Table 5-3 in this section of the manual, or contact your local Tektronix Field Office or representative for more information concerning procurement of these accessories.

Diagrams

Complete schematic diagrams are contained on tabbed foldout pages in the Diagrams section of Volume II. The portions of circuitry mounted on each circuit board are enclosed with a heavy black line. Also within the black line, near either the top or bottom edge, is the assembly number and name of the circuit board.

The component number and electrical value of each component in this instrument are shown on the diagrams. See the first page of the Diagrams section for definition of the reference designators and symbols used to identify components in this instrument. Important voltages and waveform numbers are also shown on the schematic diagrams. The physical location of each waveform test point is shown on the appropriate circuit board illustration, and the waveform illustrations are located adjacent to the respective schematic diagram.

Circuit Board Illustrations

A circuit board illustration is provided in conjunction with each schematic diagram. These illustrations are found on the back side of a pullout page which precedes the schematic diagram to which it relates. If more than one diagram is associated with a particular circuit board illustration, the board illustration is located just before its first appearance in a schematic diagram.

Each component shown on a diagram is identified on the circuit board illustration by its component number. In general, component numbers on the circuit boards increase from the left side of the circuit board to the right side and from the top to the bottom. The lowest component numbers will be at the top-left corner, and the highest at the bottom-right corner of the circuit board.

Waveform test points are identified by hexagonal outlined numbers that correspond to the points indicated on the schematic diagrams.

Adjustment Location Illustrations

To aid in locating test points and adjustable components, the ADJUSTMENT LOCATION foldout pages (normally used with the "Adjustment Procedure" are located at the back of this volume.

Grid Coordinate System

Each circuit diagram and circuit board illustration has a grid border. A table located adjacent to each schematic diagram lists the grid coordinates of each component shown on that diagram. The component grid location is shown for both the schematic diagram and the circuit board illustration to aid in cross referencing component location.

Adjacent to each board illustration are alpha-numeric listings of all components mounted on that board. The components are separated by the schematic diagram number in which each component can be found. These grid tables are especially useful when more than one diagram is associated with a particular circuit board.

Power Distribution Diagram

As an aid in troubleshooting power supply problems, Diagram 22 in the foldout pages of Volume II shows the distribution of each voltage from the Main Power Supply. The service jumpers used to remove power from the various circuit boards are also indicated. Excessive loading on the Main Power Supply by a circuit board can be rapidly isolated to the faulty board with the aid of these service jumpers. The power distribution diagram should be used in conjunction with the power supply isolation procedures adjacent to the power supply troubleshooting charts.

Circuit Board Interconnection Diagram

Circuit board interconnections are provided to aid in tracing a signal path or power source between boards. The entire oscilloscope is illustrated, with plug and jack numbers shown along with associated pin numbers. The off-board components are also shown, and the schematic diagram number on which the component is located is identified.

Block Diagrams

Detailed block diagrams of the conventional portion of the oscilloscope and of each major circuit in the digital storage portion of the oscilloscope are included to aid in understanding circuit function and interconnection. Circuit descriptions located in the "Theory of Operation" section

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of this manual are based on both the schematic diagrams and the block diagrams.

Component Color Coding

Information regarding color codes and markings of resistors and capacitors is located in the color-coding illustration (Figure 8-1) at the beginning of the Diagrams section in Volume II.

DIODE COLOR CODE. The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes, or a dot. For most silicon or germanium diodes marked with a series of stripes, the color combination of the stripes identifies the three significant digits of the Tektronix Part Number, using the resistor color-code system. For example, a diode having either pink or blue at the cathode end, then brown-gray-green, is Tektronix Part Number 152-0185-00. The cathode and anode ends of metal-encased diodes can be identified by the diode symbol stamped on the diode body.

Semiconductor Lead Configurations

Typical semiconductor lead configurations are illustrated at the beginning of the Diagrams section (Figure 8-2) in Volume II.

Multi-Connector Holders

Multi-connector holders are keyed with two index triangles: one on the holder and one on the circuit board. Slot numbers are usually stamped on the holder. When a connection is made perpendicular to a circuit board surface, ensure that the triangle on the holder and the triangle on the circuit board are aligned pointing toward each other (see Figure 5-3).

TROUBLESHOOTING EQUIPMENT

A list of suggested test equipment for servicing this instrument is contained in Table 5-1.

CAUTION

Before using any test equipment to make measurements on static-sensitive components or assemblies, be sure that any voltage or current supplied by the test equipment does not exceed the limits of the component to be tested.

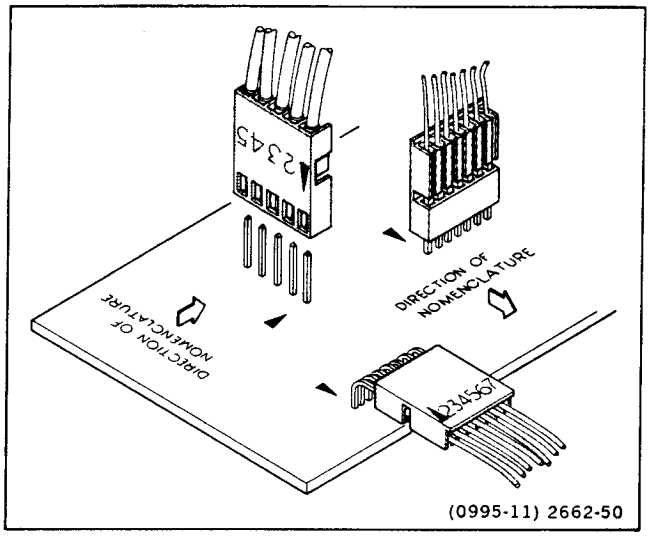

Figure 5-3. Multi-connector holder orientation.

TROUBLESHOOTING TECHNIQUES

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks ensure proper connection, operation, and calibration. 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, it should be replaced following the replacement procedure given under "Corrective Maintenance" in this section.

Check Control Settings

Incorrect control settings can give a false indication of an instrument malfunction. If there is any question about the correct function or operation of any control, refer to either the "Operating Information" section of this manual or the 468 Operators Manual.

Check Associated Equipment

Before proceeding with troubleshooting, check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source for correct voltage.

Check Instrument Calibration

Check the calibration of either the entire instrument, or of the affected circuit, if the trouble exists in one circuit. The apparent trouble may only be a result of misadjustment and may be corrected by adjustment. Complete adjustment instructions are given in the "Calibration" section of this manual.

Table 5-1

Suggested Troubleshooting Equipment

Equipment	Minimum Specification	Usage	Examples
1. Signature Analyzer	Capable of analyzing signatures and displaying a four-digit standard signature.	Check signatures in troubleshooting procedures.	SONY/TEKTRONIX 308 Data Analyzer.
2. Test Oscilloscope with 10X Voltage Probe	Frequency response, dc to at least 100 MHz; deflection factor, 5 mV to 5 V/div; input impedance, 1 MΩ, 20 pf; sweep rate, 0.5 s to 0.02 μs/div.	Check operating waveforms.	TEKTRONIX 465B Oscilloscope with included 10X probe.
3. Semiconductor Tester	Dynamic type tester. Measure reverse breakdown voltages up to at least 400 V.	Test semiconductors.	a. TEKTRONIX 576 Curve Tracer. b. TEKTRONIX 577 (D1 or D2) Curve Tracer with 177 Test Fixture.
4. Multimeter	Digital multimeter. Voltmeter input impedance, 10 MΩ range 0 to 150 volts; voltage accuracy, within 0.15%, display 4 1/2 digits. Ohmmeter, 0 to 20 MΩ.	Check voltages and general troubleshooting.	a. TEKTRONIX DM 501A Digital Multimeter.[a] b. TEKTRONIX 465B44 Oscilloscope DMM.
5. Variable Autotransformer	Variable from 0 to 140 V, 1.2 A. Equipped with 3-wire power cord, plug, and receptacle.	Vary input line voltage when troubleshooting power supply.	General Radio W8MT3VM or W10MT3W Metered Variac Autotransformer.

[a]Requires a TM 500-Series power module.

Visual Check

Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visible indications such as unsoldered connections, broken wires, loose plugs, damaged circuit boards, and damaged components.

Isolate Trouble to a Circuit

To isolate trouble to a particular circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. Use the troubleshooting charts found at the back of this volume as an aid in locating a faulty circuit.

When trouble symptoms appear in more than one circuit, first check the power supplies, then check the affected circuits. If the trouble has been isolated to a power supply, follow the troubleshooting chart for that supply. The Main Power Supply voltage levels are interdependent. All the Main low-voltage supplies depend on the +55-V supply for a reference. If more than one of the Main Power Supply voltages appears defective, repair them in the following order: +55 V, +110 V, +15 V, −8 V, +5 V, then −2450 V.

The Digital Storage Power Supply is independent of the Main Power Supply.

Check Circuit Board Interconnections

After the trouble has been isolated to a particular circuit, check for loose or broken connections, improperly seated transistors, and heat-damaged components.

Check Voltages and Waveforms

Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages are listed on the diagrams. Waveforms are shown adjacent to the circuit diagram, and waveform test points are indicated by a hexagonal outlined number.

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NOTE

Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the voltage and waveform setup procedures at the beginning of the Diagrams section for the preliminary equipment setup. Note the recommended test equipment, front-panel control settings, voltage and waveform conditions, and test equipment cable connection instructions. The 468 Oscilloscope control settings required to obtain the given waveforms and voltages are located adjacent to the waveform diagrams. Changes to the control settings from the preliminary setup, other than those given, are usually not required.

Check Individual Components

The following procedures describe methods of checking individual components. Components that are soldered in place are most accurately checked by disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

WARNING

Turn off POWER switch and unplug the line cord from the ac-power source before removing or replacing components.

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

When troubleshooting transistors in the circuit with a voltmeter, measure both the emitter-to-base and emitter-to-collector voltages to determine if the voltages are consistent with normal circuit voltage. Voltages across a transistor vary with the type of device and its circuit function. Some of these voltages are predictable. The emitter-to-base voltage of a conducting silicon transistor will normally be 0.6 to 0.8 V. The emitter-to-collector voltage of saturated transistors is approximately 0.2 V.

Because these values are small, the best way to check them is by connecting the voltmeter across the junction and using a sensitive voltmeter setting. This method is preferable to comparing two voltages taken with respect to ground (both leads of the voltmeter must be isolated from ground, if this method is used). If values less than those in the preceding paragraph are obtained, either the device is short-circuited or no current is flowing in the circuit. If values are in excess of the base-emitter voltages given, either the junction is back-biased or the device is defective. Values in excess of those given for emitter-collector voltages could indicate either a non-saturated device operating normally or a defective (open-circuited) transistor. If the device is conducting, voltage will be developed across resistors in series with it; if it is open, no voltage will be developed across resistors in series with it unless current is being supplied by a parallel path.

When troubleshooting a field-effect transistor, the voltage across its elements can be checked in the same manner as for a transistor. 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 (IC) can be checked either with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of circuit operation is essential to troubleshooting circuits having IC. Use care when checking voltages and waveforms around the IC so that adjacent leads are not shorted together. Typical semiconductor lead configurations are shown at the beginning of the Diagrams section in Volume II.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High current may damage the diode. Do not measure tunnel diodes with an ohmmeter; use a dynamic tester (such as a TEKTRONIX Type 576 Transistor-Curve Tracer). Checks on diodes can be performed in much the same manner as on transistor emitter-to-base junctions. Silicon diodes should have 0.6 to 0.8 V across the junction when conducting. Higher readings indicate that they are either back biased or defective, depending on polarity.

DIODES. A diode can be checked for an open or a short circuit by measuring the resistance between terminals with an ohmmeter set to the R X 1k scale. The diode resistance should be very high in one direction and very low when the meter leads are reversed. Do not check tunnel diodes or back diodes with an ohmmeter.

RESISTORS. Check resistors with an ohmmeter. Refer to the Replaceable Electrical Parts List in Volume II for tolerance of resistors used in this instrument. Resistors normally do not require replacement unless the measured value varies widely from the specified value.

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.

NOTE

Some coils are wound on high ohmic value resistors. If one of these coils is checked, an open is indicated by a high measured-resistance value.

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

ATTENUATORS. The thick film attenuators are best checked by substitution. If only one channel of the 468 is not operating properly and there is reason to believe an attenuator is defective, replace the suspected attenuator with the same attenuator from the other channel; then recheck instrument operation. If proper operation results, replace the defective attenuator.

Repair and Readjust the Circuit

If any defective parts are located, follow the replacement procedures given in this section. Be sure to check the performance of any circuit that was repaired or that had any electrical components replaced. Readjustment of the affected circuit may be necessary. Refer to Table 4-9 in the "Adjustment Procedure" of this manual for possible adjustment interaction.

CORRECTIVE MAINTENANCE

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

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. Use care not to interconnect instrument grounds which may be at different potentials (cross grounding).

3. Do not use excessive heat when soldering, since circuit boards and semiconductors can be damaged.

STATIC-SENSITIVE COMPONENTS

CAUTION

Static discharge can damage any semiconductor component in this instrument.

This instrument contains electrical components that are susceptible to damage from static discharge. See Table 5-2 for various classes of semiconductors and relative susceptibilities to damage. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Observe the following precautions to avoid damage.

1. Minimize handling of static-sensitive components.

2. Transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components.

3. Discharge the static voltage from your body by wearing a wrist strap while handling these components. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.

4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.

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5. Keep the component leads shorted together whenever possible.

6. Pick up components by the body, never by the 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 to resolder components.

10. Use only approved anti-static vacuum-type desoldering tools for component removal from multilayered boards.

Table 5-2

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:**

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

(Voltage discharged from a 100-pF capacitor through a resistance of 100 ohms.)

OBTAINING REPLACEMENT PARTS

Standard Parts

Most electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, you should be able to obtain many of the standard electronic components from a local commercial source in your area. Before you purchase or order a part from a source other than Tektronix, Inc., please check the Replaceable Electrical Parts List for the proper value, rating, tolerance, and description.

NOTE

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.

Special Parts

In addition to the standard electronic components, some special components are used in the 468. 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 (see Cross Index—Manufacturers Code Number to Manufacturer in Replaceable Electrical Parts List for code numbers). Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., it is imperative that all of the following information be included in order to ensure receiving the proper parts.

1. Instrument type (include modification or option numbers).

2. Instrument serial number.

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

4. Tektronix part number.

SOLDERING TECHNIQUES

WARNING

To avoid an electric-shock hazard, disconnect the instrument from the ac-power source before attempting to solder in the instrument.

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used to remove or replace parts.

Desoldering and removing parts from multilayer circuit boards is especially critical and should be done only with a vacuum-type solder extractor. Many of the integrated circuits are static sensitive and can be damaged by a static charge that may be generated by some types of solder extractors. Use only an anti-static type of solder extractor approved by a Tektronix, Inc. Service Center for work involving static-sensitive devices.

Use rosin-core wire solder containing 63% tin and 37% lead. Contact your local Tektronix, Inc. Field Office or representative to obtain the names of approved solder types.

Circuit boards in this instrument have as many as six conductive layers. Conductive paths between the top and bottom board layers may connect one or more of the inner layers. If any inner-layer conductive path becomes broken due to poor soldering practices, the board becomes unusable and must be replaced. Damage of this nature can void the instrument warranty.

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. The following multilayer board assemblies are particularly susceptible to heat damage: A16, A17, A18, A19, and A21.

When soldering on circuit boards or small insulated wires, use only a 15-watt, pencil-type soldering iron. A higher wattage soldering iron can 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 iron tip to the solder joint. Apply only enough heat to make a good solder joint. To protect heat-sensitive components, either hold the component lead with a pair of long-nose pliers or place a heat block between the component body and the solder joint.

CAUTION

Attempts to unsolder, remove, and resolder leads from the component side of the circuit board may cause damage to the reverse side of the circuit board.

The following technique should be used to replace a component on any of the circuit boards:

1. Touch the vacuum desoldering tool to the lead at the solder connection. Never place the iron directly on the board; doing this may damage the board.

NOTE

Some components are difficult to remove from the circuit board due to a bend placed in each lead during machine insertion of the component. The purpose of the bent leads is to hold the component in position during a flow-solder manufacturing process that solders all the components at once. To make removal of machine-inserted components easier, straighten the component leads on the reverse side of the circuit board with a small screwdriver or pliers. It may be necessary to remove the circuit board to gain access to the component leads on the reverse side of the circuit boards. Circuit-board removal and reinstallation procedures are discussed later in this section.

2. When removing multipin components, especially IC, 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.

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. Solder wick, spring-actuated or squeeze-bulb solder suckers, and heat blocks (for desoldering multipin components) must not be used. Damage caused by poor soldering techniques can void the instrument warranty.

3. Bend the leads of replacement components 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 only just protrude through the reverse side of the circuit board. Excess lead length may cause shorting to other conductive parts.

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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.

CAUTION

Do not allow solder or solder flux to flow beneath etched circuit board switches. The etched switch contacts on the circuit board are an integral part of the switch, and intermittent operation can occur if the contacts become contaminated.

5. Touch the soldering iron 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 leads protruding through the circuit board (if not clipped to size 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.

When soldering to the ceramic strips in the instrument, a slightly larger soldering iron can be used. It is recommended that a solder containing about 3% silver be used when soldering to these strips to avoid destroying the bond to the ceramic material. This bond can be broken by repeated use of ordinary tin-lead solder or by the application of too much heat; however, occasional use of ordinary solder will not break the bond, if excessive heat is not applied.

If it becomes necessary to solder in the general area of any of the high-frequency contacts in the instrument, clean the contacts immediately upon completion of the soldering. Refer to the "Switch Contacts" paragraph in the "Preventive Maintenance" part of this section for recommended cleaners and procedures.

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 drawing associated with the Replaceable Mechanical Parts list in Volume II may be helpful in the removal or disassembly of individual components or subassemblies. Component locations are shown in the Diagrams section. The maintenance aids listed in Table 5-3 include items required for some of the maintenance procedures in this instrument. Equivalent products may be substituted for the examples given, provided the characteristics are similar.

CABINET REMOVAL

The instrument cabinet can be removed and reinstalled in the following manner:

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

2. Install the front-panel cover, place the cabinet handle against the bottom of the cabinet, and set the instrument face down on a flat surface.

3. Unwrap the power cord from the instrument feet and detach it from the instrument.

4. Remove six screws (indicated in Figure 5-4) holding the rear cabinet frame and remove the frame with feet and screws from the instrument as an assembly.

5. Slide the cabinet up over the main chassis assembly until it is separated from the instrument.

WARNING

Dangerous potentials exist at several points throughout this instrument. If it is operated with the cabinet removed, do not touch exposed connections or components. Some transistors may have elevated cases. Disconnect the ac-power-input source from the instrument before cleaning the instrument or replacing parts.

Table 5-3

Maintenance Aids

Description	Specifications	Usage	Example
1. Soldering Iron	15 to 25 W.	General soldering.	Antex Precision Model C.
2. Screwdriver	Phillips #1 tip.	Assembly and disassembly.	Xcelite Model X108.
3. Screwdriver	Phillips #2 tip.	Assembly and disassembly.	Xcelite Model X102.
4. Screwdriver	Three-inch shaft; 3/32-inch flat bit.	Assembly and disassembly.	Xcelite Model R3323.
5. Service ROM and Test Counter IC	Servicing accessory package.	Signature analysis and troubleshooting.	Tektronix Part Number 067-0989-00.
6. Nutdrivers	1/4 inch, 5/16 inch, 3/8 inch, 7/16 inch.	Assembly and disassembly.	Xcelite #8, #10, #12, and #14.
7. Open-end Wrenches	1/4 inch, 5/16 inch, 9/16 inch.	Assembly and disassembly.	
8. Allen Wrenches	1/16 inch, 5/64 inch, 0.050 inch.	Assembly and disassembly.	
9. Vacuum Solder Extractor	No static charge retention.	Unsoldering static-sensitive devices and components on multilayer boards.	Pace Model PC 10.
10. Lubricant	Versilube.	Switch lubrication.	Tektronix Part Number 006-1353-00.
11. Spray Clearner	No Noise.	Switch pad cleaning.	Tektronix Part Number 006-0442-02.
12. Air Filter Adhesive		Coating air filter after cleaning.	Tektronix Part Number 006-0580-00.
13. IC-Removal Tool		Removing DIP IC packages.	Augat T114-1.
14. IC Test Clip	14/16-, 20-, 24-, and 40-lead testers.	Testing DIP IC packages.	Tektronix Part Number 015-0330-00; Pomona DIP Clip Adapter Models 4124-A, 4140; AP Products Model TC16.

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CABINET INSTALLATION

The instrument cabinet can be reinstalled in the following manner:

1. Disconnect the instrument power cord from the ac-power-input source and detach the cord from the instrument.

2. If parts were removed or replaced, check all sections of the instrument for proper assembly. It may be helpful to refer to the exploded view in the "Replaceable Mechanical Parts" section of Volume II of this manual to aid in verifying the complete assembly of the instrument.

3. Install the front cover and set the instrument face down on a flat surface.

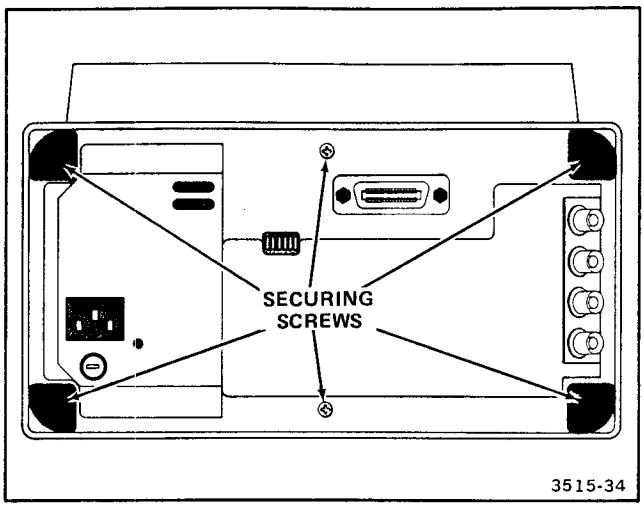

Figure 5-4. Removing the wrap-around cabinet.

4. Place the cabinet handle against the bottom of the cabinet.

5. Carefully slide the cabinet over the instrument. Avoid pinching cables or damaging components that protrude from the circuit boards.

6. Using both hands, press lightly on the top, bottom, and sides of the cabinet until the cabinet front edge is inserted into the groove around the front cabinet frame.

7. Set the feet and screws into place and with one hand exert a light downward pressure on the rear cabinet panel. Press lightly on the top and bottom of the cabinet with the other hand, while checking that the cabinet edge is properly seated in the gasket groove of both the front and rear frames. Continue to exert a downward pressure and tighten the six screws of the rear frame to a snug fit. Do not overtighten these screws.

8. Reattach the instrument power cord.

CIRCUIT BOARDS

Occasionally it may be necessary to gain access to the reverse side of a circuit board or to remove one circuit board to gain access to another. The following procedures outline the necessary steps to facilitate instrument disassembly and reassembly. Most of the connections to the circuit boards in the instrument are made with pin connectors. However, some connections are soldered to the board. Observe the soldering precautions given under "Soldering Techniques" in this section.

Storage Display Circuit Board, Assembly A16

The Storage Display circuit board can be removed and reinstalled as follows:

1. Disconnect nine miniature coaxial connectors from the Storage Display circuit board. Note the cable color codes and locations to aid in proper installation during reassembly. The cable color code numbers are printed on the circuit board adjacent to each connector. Verify the color and location from the following list:

a. J158, white with yellow and black stripes.

b. J172, white with an orange stripe.

c. J262, white with orange and black stripes.

d. J449, white with blue and black stripes.

e. J486, white with green and black stripes.

f. J583, white with orange and black stripes.

g. J586, white with yellow and black stripes.

h. J683, white with brown and black stripes.

i. J686, white with red and black stripes.

2. Disconnect P204 and P404 (connected to the Vertical Mode Switch and Attenuator circuit board).

3. Disconnect P262 (connected to CH 1 and CH 2 POSITION controls).

4. Disconnect the 50-conductor ribbon cable by pulling it straight out from connector P138. Note the location of the edge stripe for later reinstallation.

5. Remove four Phillips-head screws retaining the mounting bracket to the main frame and lift the Storage Display circuit board, with bracket, from the instrument.

Reinstall the Storage Display circuit board into the instrument using the following steps:

6. Align the holes for the four retaining screws and install the screws.

7. Reconnect the ribbon cable. Align the edge stripe, as noted in step 4, and insert it into connector P138.

8. Reconnect P204 and P404 (from the Vertical Mode Switch circuit board).

9. Reconnect nine miniature coaxial connectors (disconnected in step 1).

10. Reconnect P262 (from the CH 1 and CH 2 POSITION controls).

Vertical Preamplifier Circuit Board, Assembly A11

The Vertical Preamplifier circuit board must be removed to gain access to the High-Voltage Multiplier, the High-Voltage Transformer, and the High-Voltage Oscillator power transistor. Removal and reinstallation of the Vertical Preamplifier circuit board is accomplished as follows:

1. Use a 0.050-inch Allen wrenth to loosen the front set screws of the Vertical VOLTS/DIV VAR shaft coupler and slide the shafts out of the instrument.

2. Disconnect the INVERT and 20 MHz BW LIMIT push-button extension shafts from the switch shafts. Insert a scribe or a similar tool in the notch between the end of the white plastic shaft and the end of the black plastic extension shaft. Then, gently pry the shaft and extension apart.

3. Disconnect 14 miniature coaxial cables from the Preamplifier circuit board. Note the cable color codes and locations to aid in proper connection during reassembly. The cable color code number is printed on the circuit board next to each connector. Verify the wire color and cable number from the following list:

a. J103, white with a purple stripe.

b. J104, white with a brown stripe.

c. J105, white with yellow and black stripes.

d. J107, white with red and black stripes.

e. J123, white with orange and black stripes.

f. J133, white with green and black stripes.

g. J204, white with blue and black stripes.

h. J218, white with yellow and black stripes (located approximately two inches from the rear edge of the board).

i. J500, white with an orange stripe.

j. J501, white with a red stripe (located at the rear edge of the board near the bottom).

k. J502, white with a gray stripe.

l. J523, white with a red stripe (located near the bottom of the board approximately two inches from the rear).

m. J535, white with gray and black stripes.

n. J536, white with purple and black stripes.

4. Disconnect the following wires and connectors from the Preamplifier circuit board (note location of each for reassembly reference):

a. Unplug the delay line from the end of the Preamplifier circuit board (located toward the rear of the circuit board).

b. Unsolder the ground braid (located near the High-Voltage Power-Supply shield) connection between the Preamplifier circuit board and the Interface board. (Unsolder the end of the braid attached to the Preamplifier circuit board.)

c. P356, a three-wire connector near the middle of the Preamplifier circuit board (connected to the Interface circuit board).

d. P306, an eight-wire connector near the rear of the Preamplifier circuit board (from the Vertical Mode Switch circuit board).

e. P138 and P343, both three-wire connectors near the CH 1 and CH 2 POSITION potentiometers (connected to the Storage Display circuit board).

5. Unsolder two 30-Ω resistors (R3045) that connect the CH 1 and CH 2 Attenuator Assemblies to the Preamplifier circuit board.

6. Remove five circuit board securing screws from the circuit board (two at the rear, two closest to the middle at the front, and the first one back from the front on the top) and a standoff with grounding clip attached (near P356). (The remaining screws retain the shield on the reverse side of the circuit board).

7. Separate the board from the instrument by carefully pulling out on the rear of the board to clear the front. Then remove the circuit board from the instrument.

Reinstall the Vertical Preamplifier circuit board into the instrument using the following steps:

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8. Place the circuit board into position and reinstall five Phillips-head screws and one standoff post, with grounding clip (removed in step 6).

9. Resolder the two resistors that connect the CH 1 and CH 2 Attenuator assemblies to the Preamplifier circuit board.

10. Reconnect the 14 miniature cables disconnected in step 3.

11. Reconnect the following wires and connectors:

a. The delay-line connector at the end of the Preamplifier circuit board.

b. Ground braid connecting the Preamplifier to the Interface circuit board.

c. P356, a three-wire connector near the middle of the Preamplifier circuit board.

d. P306, an eight-wire connector near the rear of the Preamplifier circuit board.

e. P138 and P343, both three-wire connectors near the CH 1 and CH 2 POSITION potentiometers (from the Storarage Display circuit board).

12. Align the extension shafts of both the INVERT and 20 MHz BW LIMIT switch shafts and gently press them together until they snap into position.

13. Insert the VOLTS/DIV VAR control shafts into the couplers and use a 0.050-inch Allen wrench to tighten the front set screws.

Vertical Mode Switch Circuit Board, Assembly A14

The Vertical Mode Switch circuit board and the Attenuator circuit boards can be removed and reinstalled using the following procedure:

1. Remove the Vertical Preamplifier circuit board using the previously described procedure in this section.

2. Use a 1/16-inch Allen wrench to loosen the set screws in both VOLTS/DIV switch knobs and remove the knobs. Note their positions for reinstallation reference.

3. Remove the AC-GND-DC lever switch knobs by grasping them and pulling straight out from the instrument.

4. Remove the 10 Phillips-head screws retaining the Attenuator covers (five in each) and remove the covers.

5. Unplug both input coupling capacitors from the board and gently bend the capacitors out of the way, leaving the lead soldered to the input connector attached.

6. Use a 1/4-inch nut driver to remove the four nuts securing the Attenuator chassis to the front casting of the instrument.

7. Disconnect the following wires and connectors from the Vertical Mode Switch circuit board:

a. P160 (from the Interface circuit board).

b. P196 (from the VOLTS/DIV VAR controls).

c. P1100 (from the CH 1 and CH 2 VOLTS/DIV UNCAL LED).

d. P307 (from the Preamplifier circuit board).

e. P1118 and P1440 (from the Probe Coding circuit boards).

f. P356 (from the Storage Display circuit board).

g. P142 (from the Storage Display circuit board).

h. P190 (from the 20 MHz BW LIMIT LED).

i. P111 (from the Trigger circuit board).

j. P120 and P130 (from the Timing circuit board).

8. Remove four Phillips-head screws and two 1/4-inch standoff posts securing the Vertical Mode Switch circuit board.

9. Lift the Vertical Mode Switch circuit board from the instrument.

Reinstall the Vertical Mode Switch circuit board into the instrument using the following steps:

10. Position the Vertical Mode Switch circuit into place.

11. Reinstall four Phillips-head screws and two 1/4-inch standoff posts (removed in step 8).

12. Reconnect the wires and connectors that were disconnected in step 7.

13. Reinstall four nuts used to secure the Attenuator chassis to the front casting (removed in step 6).

14. Plug in the input coupling capacitors (unplugged in step 5).

15. Replace the attenuator covers, ensuring that the edge-grounding fingers are correctly placed. Exercise care not to bend or break the fingers.

16. Reinstall 10 Phillips-head screws in the Attenuator covers (five in each, small one in front).

17. Reinstall the knobs on the AC-GND-DC lever switches by pushing the knobs onto the levers (removed in step 3).

18. Reinstall the knobs on the VOLTS/DIV controls at the position noted in step 2 and use a 1/16-inch Allen wrench to tighten the set screws.

19. Reinstall the Vertical Preamplifier circuit board using the previously described procedure in this section.

Vertical Output Amplifier Circuit Board, Assembly A23

Remove the Storage Display circuit board using the previously described procedure in this section. Then, the Vertical Output Amplifier circuit board can be removed and reinstalled using the following procedure:

1. Remove the two screws securing the Vertical Output Amplifier shield and lift the shield from the instrument.

2. Disconnect P2495 (near the front edge of the circuit board).

3. Disconnect delay line DL208 (located near the rear edge of the circuit board).

4. Disconnect the two Y-Axis (vertical) deflection lead connectors (close to resistors R156 and R256 near the front of the circuit board) using a pair of long-nose pliers. Pull straight out on these connectors to prevent strain on the metal-to-glass seal on the crt neck. Note the wire color and location for correct reinstallation.

5. Lay the instrument on its Trigger circuit board side and use a 1/4-inch open-end wrench to remove the nut and washer (located on the outside of the crt compartment) used to secure U239 to the main frame.

6. Lay the instrument down on its Interface board side again and remove the two Phillips-head screws securing the Vertical Output Amplifier circuit board to the main chassis.

7. Slide the U239 mounting stud out of the main chassis and lift the circuit board out of the instrument.

Reinstall the Vertical Output Amplifier circuit board into the instrument using the following steps:

8. Position the circuit board into the main chassis crt compartment (insert the U239 mounting stud through the mounting hole in the main chassis) and reinstall two Phillips-head screws (removed in step 6).

9. Lay the instrument on its Trigger board side and reinstall the nut and washer used to secure U239 to the main chassis (removed in step 5).

10. Reconnect the two Y-Axis lead connectors on the neck of the crt at the location noted in step 4.

11. Reconnect delay line DL208 (disconnected in step 3).

12. Lay the instrument back down on its Interface board side and reconnect P2495 (disconnected in step 2).

13. Reinstall the Vertical Output Amplifier shield using two Phillips-head self-tapping screws (removed in step 1).

14. Reinstall the Storage Display circuit board using the previously described procedure in this section.

Trigger Circuit Board, Assembly A12

The Trigger circuit board can be removed and reinstalled using the following procedure:

1. Insert a scribe, or similar tool, in the notch between the POWER-switch-extension shaft and the switch shaft and gently pry them apart. The shaft extension remains in place until the circuit board is separated from the instrument.

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2. Disconnect the following connectors from the Trigger circuit board:

a. P110 (from the POWER LED).

b. P112 (from the B DLY'D TRIGGER SLOPE and LEVEL control).

c. P160 (from the main wiring harness).

d. P310 (from the READY and TRIG LED).

e. P410 (from the A TRIGGER SLOPE and LEVEL control).

f. P483 (from the Memory circuit board).

g. P493 (from the Vertical Mode Switch circuit board).

h. P3008 (from the power transformer secondary windings).

i. P4008 (from the Storage Power Supply).

3. Unsolder the wire from both the EXT A TRIGGER input connector and the EXT B TRIGGER input connector.

4. Disconnect eight miniature coaxial connectors. Note their circuit numbers and verify their wire colors and locations for correct reinstallation.

a. J183, white with a blue stripe.

b. J188, white with a yellow stripe.

c. J190, white with a green stripe.

d. J210, white with a brown stripe.

e. J219, white with a red stripe.

f. J227, white with an orange stripe.

g. J533, white with brown and black stripes.

h. J540, white with red and black stripes.

5. Set both SOURCE (A and B) and both COUPLING (A and B) switch levers to approximately midrange.

6. Remove four Phillips-head screws and one standoff post (near P160) that secure the Trigger circuit board to the main chassis.

7. Use a flat-bit screwdriver to gently pry the Trigger circuit board away from the Interface circuit board until the pins of J560 and J580 are disengaged from P944 and P970 on the Interface board.

8. Slide the Trigger circuit board toward the rear of the instrument until the SLOPE and COUPLING switch lever and the POWER-switch-extension shaft clear the front panel; then lift the board from the instrument.

Reinstall the Trigger circuit board into the instrument using the following steps:

9. Align the SOURCE and COUPLING switch levers and the POWER-switch-extension shaft with the corresponding holes in the front panel and position the circuit board in place.

10. Carefully mate the pins of J560 and J580 with the connectors on the Interface board and press them together until they are fully engaged.

11. Reinstall four Phillips-head retaining screws and one 1/4-inch standoff post (removed in step 6).

12. Reconnect the eight miniature coaxial connectors that were disconnected in step 4.

13. Resolder the wires to both the EXT A TRIGGER and the EXT B TRIGGER input connectors.

14. Reconnect the connectors that were disconnected in step 2.

15. Use a flat-bit screwdriver to fully hold in the POWER switch while aligning the POWER-switch-extension shaft with the switch shaft. Gently press them together until they snap into position.

Timing Circuit Board, Assembly A13

To access the Timing circuit board, both the Trigger circuit board and the Storage Display circuit board must first be removed using the previously described procedures in this section. Then remove and reinstall the Timing circuit board using the following procedure:

1. Disconnect the following connectors from the Timing circuit board:

a. P111 (from the X10 MAG and UNCAL LED).

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b. P117 (from the DELAY TIME POSITION potentiometer).

c. P129 (from the main wiring harness).

d. P135 and P146 (from the Vertical Mode Switch circuit board).

2. Use a 1/16-inch Allen wrench to loosen the set screw of the TIME/DIV VAR knob and remove the knob.

3. Rotate the A and B TIME/DIV switch knobs until the shaft-coupling set screws are accessible (inside the instrument). Note the position of the A and B TIME/DIV control knobs for reinstallation reference (this is important to obtain the correct alignment during reinstallation).

4. Use a 1/16-inch Allen wrench to loosen the two set screws holding the A TIME/DIV knob and remove the knob from the shaft.

5. Use a 5/64-inch Allen wrench to loosen the two shaft-coupling set screws on the B TIME/DIV control shaft. Then use a flat-bit screwdriver between the coupling and switch housing to gently pry the control knob (clear plastic) from the instrument. Retain the black front-panel spacer for reinstallation.

6. Remove the Phillips-head screw located towards the front of the board.

7. Use a 3/16-inch nutdriver to remove the standoff post located near the rear of the board.

8. Gently lift the Timing circuit board up, separating the pins of P524 and P555 from J885 and J887 on the Interface board.

9. Pull the Timing circuit board to the rear until the push buttons of the HORIZ DISPLAY and TRIG MODE switches clear the front panel and lift the circuit board from the instrument.

Reinstall the Timing circuit board into the instrument using the following steps:

10. Insert the push buttons of the HORIZ DISPLAY and TRIG MODE switches through the corresponding holes in the front panel.

11. Carefully mate the pins of P524 and P555 with J885 and J887 on the Interface board and press them together until fully engaged.

12. Reinstall the 3/16-inch standoff post (removed in step 7).

13. Reinstall the Phillips-head screw (removed in step 6).

14. Reinstall the B TIME/DIV knob at the position noted in step 3 and use a 5/64-inch Allen wrench to tighten the set screws in the shaft coupling.

15. Reinstall the A TIME/DIV knob at the position noted in step 3 and use a 1/16-inch Allen wrench to tighten the set screws in the knob.

NOTE

Check the alignment of the knobs over their full rotation and reposition them slightly, if necessary, to obtain the correct alignment with the front-panel numbers.

16. Reinstall the TIME/DIV VAR knob and use a 1/16-inch Allen wrench to tighten the set screw.

17. Reconnect the connectors disconnected in step 1.

18. Reinstall the Trigger circuit board and the Storage circuit board using the previously described procedures in this section.

Microprocessor Circuit Board, Assembly A21

The Microprocessor circuit board may be removed and reinstalled using the following procedure:

1. Detach the power cord (if not previously removed) and remove two Phillips-head screws securing the rear panel of the instrument.

2. Disconnect the 50-conductor ribbon cable from P152 and P130 (located on the Memory circuit board and Microprocessor circuit board, respectively, in the rear frame assembly). Note the location of the edge stripe on the cable for correct reinstallation.

3. Remove four large Phillips, flat-head screws from the top of the rear chassis assembly.

4. Slide the rear chassis assembly to the rear until all of the components are clear of the main chassis.

5. Lift the rear chassis assembly and rotate it 180 degrees. Place it on top of the main chassis and align the two innermost mounting holes with the corresponding threaded inserts on the main chassis. Then reinstall two of the screws removed in step 3 into the threaded inserts to hold the rear chassis assembly in place.

6. Lift the Interconnect board straight up to disconnect it from P278 (on the Memory circuit board) and from P206 (on the Microprocessor circuit board).

7. Disconnect the following five miniature coaxial connectors located at the lower-right corner of the Microprocessor circuit board. Verify the cable color code and location of each cable for reinstallation reference.

a. J107, white with green and black stripes.

b. J110, white with blue and black stripes.

c. J112, white with purple and black stripes.

d. J118, white with gray and black stripes.

e. J120, white with orange and black stripes.

8. Remove five Phillips-head screws securing the Microprocessor circuit board and lift the board from the instrument.

Reinstall the Microprocessor circuit board into the instrument using the following steps:

9. Position the board in place and reinstall five Phillips-head securing screws (removed in step 8).

10. Reconnect five miniature coaxial cables (disconnected in step 7).

11. Reconnect the Interconnect board into the pins of P278 (located on the Memory circuit board) and P206 (located on the Microprocessor circuit board).

12. Remove two Phillips-head screws securing the rear chassis to the main chassis.

13. Lift the rear chassis assembly, rotate it 180 degrees downward, and slide it into the main chassis until the mounting-screw holes are aligned.

14. Reinstall four Phillips-head screws (removed in step 3) into the top of the rear chassis assembly.

15. Reconnect the 50-conductor ribbon cable to P130 (on the Microprocessor circuit board) and to P152 (on the Memory circuit board).

16. Reinstall two Phillips-head screws in the rear panel (removed in step 1).

Memory Circuit Board, Assembly A18

The Memory circuit board can be removed and reinstalled using the following procedure:

1. Detach the power cord (if not previously removed) and remove two Phillips-head screws securing the rear panel to the instrument.

2. Disconnect the 50-conductor ribbon cable from P152 (on the Microprocessor circuit board) and from P130 (on the Memory circuit board). Note the location of the edge stripe for reinstallation.

3. Remove four Phillips, flat-head screws from the top of the rear chassis assembly.

4. Slide the rear chassis assembly to the rear until all of the components are clear of the main chassis.

5. Lift the rear chassis assembly and rotate it 180 degrees. Place it on top of the main chassis and align the two innermost mounting holes with the corresponding threaded inserts on the main chassis. Then reinstall two of the screws removed in step 3 to hold the rear chassis assembly in place.

6. Lift the Interconnect board straight up to disconnect it from P278 (on the Memory circuit board) and from P206 (on the Microprocessor circuit board).

7. Remove two Phillips-head screws (one from each side) holding the hinged bracket in place and rotate the bracket down approximately 90 degrees.

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8. Disconnect five 10-wire connectors located across the bottom of the circuit board. Exercise care to maintain the lead spacing and dress of the wiring and pins on the circuit board.

9. Disconnect P160, a two-wire connector at the bottom of the board.

10. Remove five Phillips-head securing screws and remove the Memory circuit board from the instrument.

Reinstall the Memory circuit board into the instrument using the following steps:

11. Position the circuit board into place and reinstall five securing screws (removed in step 10).

12. Reconnect P160, a two-wire connector (disconnected in step 9).

13. Reconnect the five 10-wire connectors (disconnected in step 8). Retain the original lead spacing and arrangement of the wiring harnesses and circuit-board pins.

14. Rotate the hinged bracket up approximately 90 degrees until the securing-screw holes are aligned and reinstall two Phillips-head screws (removed in step 7).

15. Reinstall the Interconnect circuit board into the pins of P278 (on the Memory circuit board) and P206 (on the Microprocessor circuit board).

16. Remove two Phillips-head screws holding the rear chassis to the main chassis.

17. Lift the rear chassis assembly, rotate it 180 degrees downward, and slide it into the main chassis until the mounting-screw holes are aligned.

18. Reinstall four Phillips-head screws into the rear chassis assembly mounting holes.

19. Reconnect the 50-conductor ribbon cable to P130 and P152, with the edge stripe positioned as noted in step 2.

20. Position the rear panel into place and reinstall two Phillips-head screws (removed in step 1).

Time Base/Power Supply Circuit Board, Assembly A19

The Time Base/Power Supply circuit board can be removed and reinstalled using the following procedure:

1. Detach the power cord (if not previously removed) and remove two Phillips-head screws securing the rear panel.

2. Disconnect the 50-conductor ribbon cable from P152 (on the Memory circuit board) and from P130 (on the Microprocessor circuit board). Note the location of the edge stripe for reinstallation reference.

3. Remove four Phillips-head screws from the top of the rear chassis assembly.

4. Slide the rear chassis assembly to the rear until all of the components are clear of the main chassis.

5. Lift the rear chassis assembly and rotate it upward 180 degrees. Place it on top of the main chassis and align the two innermost mounting holes with the corresponding threaded inserts on the main instrument chassis. Then reinstall two of the screws removed in step 3 to hold the rear chassis assembly in place.

6. Remove two Phillips-head screws (one on each side) holding the hinged bracket in position and rotate the bracket down approximately 90 degrees.

7. Disconnect the five 10-wire connectors located across the bottom of the Time Base/Power Supply circuit board. Exercise care to retain the original lead dress and spacing of the wiring harness and pin connectors.

8. Disconnect the following four miniature coaxial connectors located at the lower right side of the circuit board. Note the cable color code and location of each connector for reinstallation reference.

a. J101, white with a yellow stripe (from the main wiring harness).

b. J105, white with a green stripe (from the main wiring harness).

c. J110, white with a yellow stripe (from the A + GATE bnc connector on the rear chassis assembly).

d. J115, white with a green stripe (from the B + GATE bnc connector on the rear chassis assembly).

9. Disconnect P140 (a 16-wire connector from P265 of the GPIB Option circuit board, if installed).

10. Disconnect P380 (a two-wire connector from the Fan motor).

11. Disconnect P199 (a five-wire connector from the Trigger circuit board).

12. Use a 3/16-inch wrench and a Phillips-tip screwdriver to remove the nut and screw retaining the three-terminal regulator on each of the power supplies. U190 is located near the power-supply shield, and both U560 and U570 are mounted on the top of the rear chassis assembly (as viewed in the servicing position).

13. Pull straight out on the three-terminal regulators to remove them from their sockets. Note their type and location for reinstallation reference.

14. Remove 10 Phillips-head securing screws from the circuit board. The hinged bracket must be pushed into its fully up position to reach the bottom-middle securing screw (in the edge of the power-supply shield).

15. Slide the Time Base/Power Supply circuit board out of the right side of the rear chassis assembly (as viewed from the front of the instrument) to remove it.

Reinstall the Time Base/Power Supply circuit board in the instrument using the following steps:

16. Slide the circuit board into position and reinstall 10 Phillips-head screws (removed in step 14).

NOTE

When installing the three-terminal regulators (U190, U560, and U570), ensure that there is a mica insulator and silicone grease (or similar thermal-transfer compound) between the regulators and chassis ground.

WARNING

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

17. Insert the three-terminal regulators into their sockets at the locations noted in step 13 and reinstall the Phillips-head securing screws with the hex nuts (removed in step 12).

18. Reconnect P199 (five-wire connector from the Trigger circuit board).

19. Reconnect P380 (two-wire Fan lead connector).

20. Reconnect P140 (16-wire connector from the GPIB Option circuit board, if installed).

21. Reconnect four miniature coaxial connectors (removed in step 8).

22. Reconnect the five 10-wire connectors across the bottom of the Time Base/Power Supply circuit board. Retain the original lead spacing and arrangement of the wiring harness.

23. Push the hinged bracket into the fully up position to align the securing screw holes and reinstall two Phillips-head screws (one in each side).

24. Reinstall the Interconnect board into the pins of P278 (on the Memory circuit board) and P206 (on the Microprocessor circuit board).

25. Remove two Phillips-head screws holding the rear chassis to the main chassis.

26. Lift the rear chassis assembly and rotate it 180 degrees downward. Slide it into the main chassis until the securing-screw holes are aligned and reinstall four Phillips-head screws (removed in step 3).

27. Reconnect the 50-connector ribbon cable to P130 (on the Microprocessor circuit board) and to P152 (on the Memory circuit board), with the edge stripe positioned as noted in step 2.

28. Install two Phillips-head securing screws in the rear panel (removed in step 1).

GPIB Option Circuit Board, Assembly A17

The GPIB Option circuit board can be removed and reinstalled using the following procedure:

1. Disconnect P265, located near the right edge of the circuit board.

2. Remove four Phillips-head retaining screws and lift the board from the instrument.

Reinstall the GPIB Option circuit board in the instrument using the following steps:

3. Position the board and reinstall four Phillips-head securing screws (removed in step 2).

4. Reconnect P265.

Interface Circuit Board, Assembly A15

If repair of a circuit board run on the reverse side of the Interface circuit board is necessary, it is usually possible to gain access to that area of the board by removing one or two of the other circuit boards as previously described. Other than repairing a damaged run, there is no reason to remove the Interface circuit board except for exchange.

CAUTION

If the Interface circuit board becomes defective, it is recommended that your local Tektronix Field Office or representative be contacted to arrange for instrument repair at a Tektronix Service Center.

Removal and reinstallation of the Interface circuit board can be accomplished using the following procedure:

1. Remove the Trigger circuit board and Vertical Preamplifier circuit board using the previously described procedures in this section.

2. Position the instrument with the front panel to your right and the Interface circuit board facing you.

3. Remove four Phillips-head screws securing the High-Voltage Power-Supply shield and separate the shield from the Interface board. Note the location of the ground spring clip for reinstallation reference.

4. Disconnect the BEAM FIND, INVERT, and X10 MAG push-button extension shafts by inserting a scribe in the notch between the end of the white plastic shaft and the end of the black plastic extension shaft and gently pry them apart. Then, pull the extension shaft out of the front-panel holes toward the rear of the instrument.

5. Use a 0.050-inch Allen wrench to loosen the front set screws of the INTENSITY, FOCUS, SCALE ILLUM, ASTIG, and TRACE ROTATION control shafts. Note the position of each shaft for reinstallation reference and remove the shafts, with knobs attached, from the instrument.

6. Disconnect the following cables and connectors from the Interface circuit board:

a. P108, at the top left corner of the circuit board (from Q1180).

b. P137, near the top center of the circuit board (from the crt socket).

c. P151, near the INTENSITY potentiometer at the top center of the circuit board (from the Vertical Mode Switch circuit board).

d. P154, near the INTENSITY potentiometer at the top center of the board (from the Vertical Preamplifier circuit board).

e. P252, near the INTENSITY potentiometer at the top center of the board (from the Vertical Output Amplifier circuit board).

f. P288, near Q390 (from the graticule lights).

g. P359, near the front of the INTENSITY potentiometer at the top center of the board (from the crt Y-Axis deflection plates).

h. P473, near the TRACE ROTATION potentiometer (from the crt).

i. P799, at the front edge of the board (from the TRACE SEP and HOLDOFF potentiometers).

j. P699, at the front edge of the board (from the horizontal POSITION and B INTENSITY potentiometers).

k. P956, near the bottom center of the board (from the HOLDOFF control).

7. Unsolder the CALIBRATOR loop from the front edge of the Interface circuit board.

8. Unsolder six wires (listed below) from the Interface circuit board. Note each wire's color code and location for reinstallation reference.

a. Wire to the one-notch ceramic strip (white with a yellow stripe).

b. Wire to TP328, the −2450-V test point (white with a red stripe).

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c. Wire to the center notch on the three-notch ceramic strip (white with an orange stripe).

d. Lower wire of a pair of wires between the large high-voltage capacitors (white with brown and yellow stripes).

e. Upper wire of a pair of wires between the large high-voltage capacitors (white with a brown stripe).

f. Small wire near VR207 (white with brown and red stripes).

9. Using a pair of long-nose pliers, gently disconnect the horizontal deflection plate lead connectors from the neck of the crt. Pull the connectors straight out from the pins to avoid placing a strain on the metal-to-glass seal. Note the wire's color code and location for reinstallation reference.

a. Right (lower lead) deflection plate lead (white with a green stripe).

b. Left (upper lead) deflection plate lead (white with a red stripe).

10. Disconnect seven miniature-coaxial connectors (listed below) from the Interface circuit board. Verify the cable color code and location of each cable for reinstallation reference.

a. J526, white with black and brown stripes, from the rear center of the circuit board.

b. J683, white with black and red stripes, from near the front of the circuit board.

c. J686, white with a red stripe, from near the front of the circuit board.

d. J687, white with a blue stripe, from near the front of the circuit board.

e. J873, white with an orange stripe, located between interboard connectors J857 and J885.

f. J773, white with black and blue stripes, located above interboard connectors J857 and J885.

g. J750, white with black and green stripes, above and to the left of interboard connectors J857 and J885.

11. Unsolder the center conductor of one miniature-coaxial cable (white with a gray stripe) near the left center of the board. Note the location on the board for reinstallation reference.

12. Remove the mounting screws that secure power transistors Q401, Q501, and Q701 to the main chassis (along the rear of the board).

13. Remove the mounting screw that secures transistor Q718 to the main chassis (near the left center of the board);

14. Remove the mounting screw that secures transistor Q390 to the main chassis (near the top right corner of the board).

15. Use a 3/16-inch nut driver to remove four hexagonal posts (standoffs for the High-Voltage Power-Supply shield).

16. Remove seven Phillips-head securing screws from the Interface circuit board.

17. Remove three Phillips-head screws securing the shield over the High-Voltage Transformer and the High-Voltage Multiplier and remove the shield from the instrument.

18. Unsolder the black wire (connecting the High-Voltage Multiplier to the Interface board).

19. Unsolder the diode and wire from the terminal post on the High-Voltage Multiplier.

20. Use a 3/8-inch wrench to remove two nylon nuts securing the High-Voltage Multiplier to the Interface circuit board.

21. Separate the Interface circuit board from the instrument chassis. Use a flat-bit screwdriver to gently pry the connectors of J857 and J885 away from the Timing circuit board. Exercise care to prevent damage to components and wiring. Carefully thread interconnecting cables through the board and chassis as necessary to avoid any strain on the power transformer leads that are still connected to the circuit board.

NOTE

The preceding steps allow access for repairs on the reverse side of the Interface circuit board. To remove the Interface circuit board, continue with this procedure.

22. Unsolder the power transformer wires from the Interface circuit board. Confirm the color code and location of each wire (see Figure 5-5) for reinstallation reference.

23. Separate the Interface circuit board from the instrument. Exercise care not to damage the cables that must pass through the holes in the circuit board. Note their color, size, and routing for reinstallation reference.

24. Remove any of the components from the old Interface board (such as power transistors and filter capacitors) that are not included on the replacement Interface board. Either install the removed components on the replacement Interface circuit board or install new components.

Install the replacement Interface circuit board using the following steps:

25. Resolder the power transformer wires (disconnected in step 22), referring to Figure 5-5 for their colors and locations.

26. Insert the High-Voltage Multiplier mounting studs into the corresponding holes in the Interface board.

27. Mate Interface board connectors J857 and J885 with the corresponding pins of P524 and P555 on the Timing circuit board and press them together until the pins are fully engaged.

28. Reinstall two nylon securing nuts on the High-Voltage Multiplier (removed in step 20).

29. Resolder the diode and wire to the High-Voltage Multiplier terminal post.

30. Resolder the black wire from the High-Voltage Multiplier to the Interface circuit board.

31. Replace the High-Voltage Multiplier shield and reinstall three Phillips-head screws (removed in step 17).

32. Reinstall seven Phillips-head securing screws (removed in step 16).

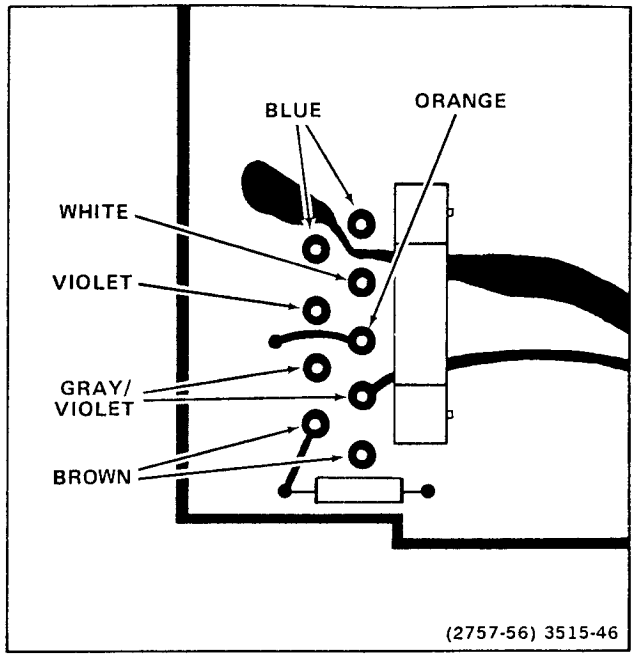

Figure 5-5. Location and color of the power transformer main power supply secondary leads.

33. Reinstall four standoff posts (removed in step 15). Use a 3/16-inch nutdriver to tighten the post.

NOTE

When reinstalling the chassis-mounted power transistors, ensure that there is a mica insulator and silicone grease (or similar thermal-transfer compound) between the transistors and the chassis.

WARNING

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

34. Reinstall the mounting screw for transistor Q390 (located near the top right corner of the circuit board).

35. Reinstall the mounting screw for transistor Q718 (located near the left center of the board).

36. Reinstall the mounting screws for power transistors Q401, Q501, and Q701 (located along the rear edge of the board).

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37. Resolder the center conductor of the miniature-coaxial cable (white with a gray stripe) at the location noted in step 11.

38. Reconnect the seven miniature-coaxial cables (disconnected in step 10).

39. Reconnect two horizontal deflection plate lead connectors (disconnected in step 9) at the locations noted. Push the connectors straight onto the crt pins (until the connectors are seated) to avoid strain on the metal-to-glass seal.

40. Resolder six wires to the Interface circuit board at locations noted in step 8.

41. Resolder the CALIBRATOR loop to the front edge of the Interface circuit board.

42. Reconnect the cables and connectors disconnected in step 6.

43. Reinstall the shafts of the INTENSITY, FOCUS, SCALE ILLUM, ASTIG, and TRACE ROTATION controls oriented as noted in step 5. Use a 0.050-inch Allen wrench to tighten the front set screws.

44. Insert the extension shafts of the BEAM FIND, INVERT, and X10 MAG switches (through the rear of the front panel) into the corresponding front-panel holes. Align the shaft extensions with the switch shafts and gently press them together until they snap into position.

45. Reinstall the High-Voltage Power-Supply shield with four securing screws (removed in step 3). Position the ground clip spring as noted in step 3.

46. Reinstall the Trigger Generator and Vertical Preamplifier circuit boards using the previously described procedures in this section.

CATHODE-RAY TUBE REMOVAL AND REINSTALLATION

The cathode-ray tube (crt) can be removed and reinstalled using the following procedure:

WARNING

Use care when handling a crt. Breakage of the crt may cause high-velocity scattering of glass fragments (implosion). Protective clothing and safety glasses should be worn. Avoid striking it on any object which may cause it to crack or implode. When storing a crt, place it in a protective carton or set it face down on a smooth surface in a protective location with a soft mat under the faceplate to protect it from scratches.

1. Remove four screws that secure the plastic bezel and light filter. Remove the bezel and light filter from the instrument.

2. Remove two Phillips-head screws from the rear cover.

3. Remove four Phillips-head screws from the top of the rear chassis assembly.

4. Slide the rear chassis assembly to the rear until all of the components are clear of the main chassis.

5. Lift the rear chassis assembly and rotate it upward 180 degrees. Place it on top of the main chassis and align the two innermost mounting holes with the corresponding threaded inserts on the main chassis. Then reinstall two of the screws removed in step 3 to hold the rear chassis assembly in place.

6. Remove two Phillips-head screws securing the bell-shaped crt socket shield and remove the shield to expose the crt socket.

7. Gently unplug the crt socket by pulling straight toward the rear until all pins are disengaged.

8. Use long-nose pliers to disconnect the two Y-Axis (vertical) deflection pin connectors from the neck of the crt. Pull straight out on these connectors to prevent strain on the metal-to-glass seal. Note the wire color and location for reinstallation reference.

9. Set the instrument on its left side (Vertical Preamplifier circuit board side down).

10. Use long-nose pliers to disconnect the two X-Axis (horizontal) deflection pin connectors from the neck of the crt. Pull straight out on these connectors to prevent strain on the metal-to-glass seal. Note the wire color and location for reinstallation reference.

11. Position the instrument so that the top is accessible.

WARNING

The crt anode and the output terminal of the High-Voltage Multiplier may retain a high-voltage charge after the instrument is turned off. To avoid electrical shock, ground both the output terminal of the multiplier and the crt high-voltage anode lead to the main instrument chassis when disconnecting the high-voltage lead.

12. Disconnect the anode lead connector (held in place by a metal retaining clip fastened to the chassis). Pull the top portion of the anode lead out of the connector (where the connector plugs together, just above the retaining clip) and discharge it to the chassis.

13. Hold the crt face with one hand and slowly push on the crt base with the other hand to remove the crt through the front of the instrument. Guide the anode lead through the front crt shield. If the plastic crt corner pads fall out, save them for reinstallation. (These pads hold the front corners of the crt in place.) Exercise care not to damage or move the Y-Axis coil that is mounted in the crt rear shield.

Reinstall the crt into the instrument using the following steps:

14. Insert the crt through the front of the instrument. While pushing gently on the crt face, guide the anode lead through the crt shield. Reinstall any plastic crt corner pads that may be out of place. Do not damage or move the Y-Axis coil mounted in the crt rear shield.

a. Ensure that the plastic corner pads are securely seated.

b. Ensure that the plastic spacer ring is firmly centered on the crt neck. Reposition the ring if necessary.

15. Reconnect the crt anode lead connector to the jack from the High-Voltage Multiplier.

16. Reinstall the X- and Y-Axis deflection pin connectors at the locations noted in steps 8 and 10. Gently push the connectors straight onto the crt neck pins to prevent strain on the metal-to-glass seal.

17. Align the index slot of the crt socket with the index guide on the crt base and press the socket in place.

18. Reinstall the bell-shaped crt socket shield using two screws (removed in step 6).

19. Remove two screws holding the rear chassis assembly, rotate it 180 degrees, and slide it into the main chassis until the mounting-screw holes are aligned.

20. Reinstall four Phillips-head screws (removed in step 3).

21. Reinstall the rear cover with two screws (removed in step 2).

22. Reinstall the plastic bezel and light filter on the front of the instrument with four screws (removed in step 1).

HIGH-VOLTAGE MULTIPLIER REMOVAL AND REINSTALLATION

The High-Voltage Multiplier can be removed and reinstalled using the following procedure:

WARNING

The crt anode and the output terminal of the High-Voltage Multiplier may retain a high-voltage charge after the instrument is turned off. To avoid electrical shock, ground both the output terminal of the multiplier and the crt high-voltage anode lead to chassis ground when disconnecting the high-voltage lead.

1. Remove the Vertical Preamplifier circuit board and the crt using the previously described procedures in this section.

2. Unplug P359 (Y-Axis) from the Interface circuit board and move the round part of the crt shield to the rear approximately two inches.

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3. Place the instrument on its side with the Trigger circuit board down and the Interface circuit board facing toward you.

4. Remove four Phillips-head screws securing the High-Voltage Power-Supply shield and remove the shield. Note the location of the cabinet grounding clip for reinstallation reference.

5. Use a 3/16-inch nutdriver to remove the four shield standoff posts.

6. Remove the mounting screws that secure Q401, Q501, and Q701 to the main chassis (located along the rear edge of the Interface circuit board).

7. Remove the Phillips-head screw located approximately one inch to the right of P359.

8. Remove three Phillips-head screws securing the shield for the High-Voltage Transformer and High-Voltage Multiplier and remove the shield.

9. Unsolder the black wire (connected between the High-Voltage Multiplier and the Interface circuit board) from the Interface circuit board.

10. Unsolder the diode and wire from the terminal post on the High-Voltage Multiplier.

11. Use a 3/8-inch wrench to remove two nylon nuts securing the High-Voltage Multiplier to the Interface circuit board.

12. Gently pull the upper left corner of the Interface circuit board away from the instrument and remove the High-Voltage Multiplier by pulling it away from the Interface circuit board. Return the Interface circuit board to its original position. Feed the high-voltage lead through the space between the rear and front crt shields.

Reinstall the High-Voltage Multiplier into the instrument using the following steps:

13. Feed the Multiplier high-voltage lead into the crt compartment. Then, gently pull the upper left corner of the Interface circuit board away from the instrument approximately 1/2 inch. Insert the High-Voltage Multiplier threaded mounting studs through the mounting holes in the Interface circuit board and return the board to its original position.

14. Reinstall two 3/8-inch nylon nuts (removed in step 11) to secure the High-Voltage multiplier.

15. Resolder the diode and wire (unsoldered in step 10) to the terminal post on the High-Voltage Multiplier.

16. Resolder the black wire (unsoldered in step 9) from the High-Voltage Multiplier to the Interface circuit board.

17. Reinstall the shield (removed in step 8) over the High-Voltage Transformer using three Phillips-head screws.

18. Reinstall the Phillips-head screw (removed in step 7) in the screw hole located approximately one inch to the right of P359.

NOTE

When installing power transistors Q401, Q501, and Q701, ensure that there is a mica insulator and silicone grease (or similar thermal-transfer compound) between these transistors and the instrument chassis.

WARNING

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

19. Reinstall the mounting screws (removed in step 6) for power transistors Q401, Q501, and Q701 (located along the rear edge of the board).

20. Reinstall four 3/16-inch mounting standoff posts (removed in step 5).

21. Reinstall the High-Voltage Power-Supply shield using four screws (removed in step 4). The cabinet grounding clip should be at the position noted in step 4.

22. Place the instrument with the Interface circuit board down.

23. Move the round part of the crt shield forward approximately two inches. Then reconnect P359 (disconnected in step 2).

24. Reinstall the Vertical Preamplifier circuit board and the crt using the previously described procedures.

HIGH-VOLTAGE OSCILLATOR TRANSISTOR REMOVAL AND REINSTALLATION

The High-Voltage Oscillator Transistor (Q1108) can be removed and replaced using the following procedure:

1. Remove the Vertical Preamplifier circuit board using the previously described procedure in this section.

2. Place the instrument on its side with the Trigger circuit board down and the High-Voltage Power-Supply shield facing you.

3. Remove four Phillips-head screws securing the High-Voltage Power-Supply shield and remove the shield from the instrument.

4. Use a 1/4-inch wrench to remove two hex nuts securing the mounting bracket for Q1108.

5. Use long-nose pliers (or a similar tool) to remove Q1108 and its mounting bracket from the instrument. Disconnect P108 from the Interface circuit board.

6. Unsolder the wires connected to the emitter, base, and collector of Q1108. Note the color and location of each for reinstallation reference.

7. Use a 1/4-inch wrench to remove two hex nuts retaining Q1108 to the bracket and separate it from the bracket.

NOTE

When installing Power Transistor Q1108 ensure that there is a mica insulator and silicone grease (or similar thermal-transfer compound) between the transistor and its mounting surface.

WARNING

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

Replace Q1108 into the instrument using the following steps:

8. Install the replacement transistor in the mounting bracket and reinstall two 1/4-inch hex nuts (removed in step 7).

9. Resolder the appropriate wires to the emitter, base, and collector of Q1108 at the locations noted in step 6.

10. Reinstall Q1108 and the mounting bracket in the instrument using two 1/4-inch hex nuts (removed in step 4).

11. Reconnect P108 (disconnected in step 5).

12. Reinstall the High-Voltage Power-Supply shield on the Interface circuit board using four Phillips-head screws (removed in step 3).

13. Reinstall the Vertical Preamplifier circuit board using the previously described procedure in this section.

POWER TRANSFORMER REMOVAL AND REPLACEMENT

If the Power Transformer becomes defective, replace it only with a Tektronix direct-replacement part. After the transformer is replaced, check the performance of the entire instrument. The Power Transformer can be removed and installed using the following procedure:

1. Remove two Phillips-head screws from the rear panel of the instrument (one in each lower corner of the rear chassis assembly).

2. Remove four large Phillips-head screws from the top of the rear chassis assembly.

3. Disconnect P138, a 50-conductor ribbon cable from the Storage Display circuit board. Note the edge-stripe position for reinstallation reference.

4. Slide the rear chassis assembly to the rear until all the components are clear of the main chassis.

5. Disconnect P199, a five-wire connector located near the large filter capacitor on the Time Base/Power Supply circuit board.

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6. Disconnect P380, a two-wire connector from the Fan to the Time Base/Power Supply circuit board.

7. Lift the rear chassis, rotate it upward 180 degrees, and set in on top of the main chassis.

8. Remove two Phillips-head securing screws from the hinged bracket assembly (one on each side) and rotate the bracket down approximately 90 degrees.

9. Disconnect P160, a two-wire connector located near the 50-conductor ribbon-cable connector (P162) on the Memory circuit board. Note the wire routing for reinstallation reference.

10. Disconnect four miniature coaxial-cable connectors (listed below). Note cable color, location, and routing for reinstallation reference.

a. J101, white with a yellow stripe.

b. J105, white with a green stripe.

c. J11103, white with a purple stripe (CH 1 VERT SIGNAL OUT bnc connector).

d. J11526, white with black and brown stripes (EXT Z-AXIS INPUT bnc connector).

11. Push the hinged bracket into the fully up position and disconnect five miniature coaxial-cable connectors (listed below) from the Microprocessor circuit board. Note wire color and connector location for reinstallation reference.

a. J107, white with green and black stripes.

b. J110, white with blue and black stripes.

c. J112, white with purple and black stripes.

d. J118, white with gray and black stripes.

e. J120, white with orange and black stripes.

12. Lift the rear chassis assembly away from the main chassis. Guide the disconnected wires through the holes in the circuit board to prevent excessive strain on the wiring. Set the rear chassis assembly in a secure location while removing the Power Transformer.

13. Lay the instrument on its Trigger circuit board side and remove the Phillips-head screw from the side cover of the Line-Selector-Switch Assembly. Remove the cover from the instrument by lifting the end from which the securing screw was removed.

14. Disconnect the single-wire connectors (listed below) from the Line-Selector-Switch Assembly circuit board. Note wire color and location for reinstallation reference.

a. P230, gray with brown and white stripes.

b. P222, gray with an orange stripe.

c. P206, gray with a red stripe.

d. P204, black with a gray stripe.

e. P224, gray with yellow and black stripes.

15. Remove two Phillips-head securing screws from the ac-power-source receptacle and slide the receptacle out of the chassis approximately one inch.

16. Use a 5/16-inch nutdriver to remove the hex nut securing the gray ground wire and lift the terminal lug from the mounting stud.

17. Use a 5/16-inch open-end wrench to remove the hex nut securing the Power Transformer to the chassis through the crt compartment side panel.

18. Lay the instrument on its Vertical Preamplifier circuit board side.

19. Disconnect P4008, a five-wire connector leading through a slot in the rear of the main chassis and remove the wiring harness from the instrument. Lay the harness near the rear chassis assembly.

20. Remove the Phillips-head screw securing the cable clamp at the rear of the Trigger circuit board and disconnect P3008, a five-wire connector from the Power Transformer secondary windings.

21. Remove the remaining Phillips-head screw securing the Power Transformer mounting bracket to the Trigger circuit board and remove one Phillips-head screw securing the bracket to the Interface circuit board.

22. Remove three 5/16-inch nuts securing the transformer mounting bracket to the main chassis frame (two from the top of the bracket and one from below the

transformer). A 5/16-inch nutdriver is required to reach the lower nut, and a 5/16-inch open-end wrench and a Phillips screwdriver are required to remove the other two nuts.

23. Disconnect the POWER-switch-extension shaft from the POWER switch by inserting a scribe (or similar tool) into the notch between the end of the extension shaft and the end of the switch shaft. Then gently pry them apart.

24. Lift up gently on the rear of the Trigger circuit board to separate the pins of P944 (on the Interface circuit board) from J580 (on the Trigger circuit board).

25. Hold the rear end of the Trigger circuit board up approximately 3/4 inch and lift the Power Transformer up enough to clear the mounting studs from the chassis. Then slide the transformer toward the top of the chassis approximately one inch. Release the end of the Trigger circuit board.

26. Remove the POWER-switch-extension shaft from the instrument by pulling it out of the front panel and shaft support, toward the rear of the instrument.

27. Unsolder the Power Transformer secondary wires from the Interface circuit board. Refer to Figure 5-5 to verify correct wire color and location for reinstallation reference. Remove all excess solder from the lead holes in the circuit board to facilitate installation of the replacement transformer.

28. Pull the wires from the Line-Selector-Switch Assembly through the slot in the main chassis one at a time. The connectors must be oriented in the same direction as the slot to pass through the slot.

29. Lift the rear of the Trigger circuit board again, lift the transformer enough to clear the main chassis, and slide the transformer from the top of the instrument.

30. Use a 1/4-inch wrench on the nut and a 5/16-inch wrench on the bolt head to remove the bolts securing the mounting bracket to the transformer.

Install a replacement transformer into the instrument using the following steps:

31. Attach the mounting bracket to the replacement transformer using four bolts and 1/4-inch hex nuts (removed in step 30).

32. Lift the rear of the Trigger circuit board and slide the transformer into place so that the transformer bracket mounting stud just clears the top of the main chassis.

33. Let the transformer rest at this position and release the end of the Trigger circuit board.

34. Feed the transformer primary leads (nearest the rear of the chassis) through the slot in the main chassis to the Line-Selector-Switch Assembly one at a time.

35. Solder the transformer secondary leads to the Interface circuit board (start with the ones farthest in and work out toward the edge of the circuit board). Refer to Figure 5-5 to verify correct wire color and location.

36. Insert the POWER-switch-extension shaft through both the support bracket and the front-panel hole (from the rear of the instrument).

37. Lift the rear of the Trigger circuit board and slide the transformer into position (mounting studs must align with the mounting holes in both the chassis and transformer bracket).

38. Reinstall two Phillips-head screws (removed in step 21) used to secure the transformer bracket to the Trigger circuit board and the Interface circuit board. Press down on interboard connector J580 (on the Trigger circuit board) to ensure that the connector pins are properly seated.

39. Reinstall three 5/16-inch hex nuts (removed in step 22) used to secure the transformer bracket to the main chassis.

40. Align the POWER-switch-extension shaft with the switch shaft and gently press them together until they snap into position.

41. Reconnect P3008, a five-wire connector from the transformer (disconnected in step 20) and reinstall the Phillips-head securing screw used to hold the cable clamp to the Trigger circuit.

42. Insert the five-wire harness connected to P4008 through the slot in the rear of the main chassis and reconnect P4008 to the Trigger circuit board.

43. Lay the instrument on its Trigger circuit board side.

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44. Reinstall a 5/16-inch hex nut used to secure the transformer bracket to the crt compartment side panel.

45. Remove the terminal lug from the old transformer ground wire and solder it on the replacement transformer ground wire.

46. Place the terminal lug on the grounding stud and reinstall a 5/16-inch hex nut to secure it. To prevent the wire from twisting, hold the terminal lug in place as the nut is tightened.

47. Reconnect the single-wire connectors that were removed in step 14.

48. Push the ac-power-source receptacle back into place and reinstall two Phillips-head securing screws (removed in step 15).

49. Place the Line-Selector-Switch Assembly cover in position and reinstall the Phillips-head securing screw (removed in step 13).

50. Lay the instrument on its Interface circuit board side and set the rear chassis on top of the main chassis in preparation for reinstalling the rear chassis assembly. (Rear of the assembly should be facing toward the front of the instrument.)

51. Reconnect five miniature cables that were disconnected in step 11.

52. Pull the hinged bracket down approximately 45 degrees and reroute the four miniature cables as noted in step 10. Then reconnect them.

53. Reroute the two-wire connector to P160 as noted in step 9 and reconnect it.

54. Push the hinged bracket into its fully up position and reinstall two small Phillips-head securing screws (one in each side).

55. Lift the rear chassis assembly, rotate it downward 180 degrees, and set it down behind the main chassis.

56. Reconnect P380 (two-wire connector from the Fan that was disconnected in step 6).

57. Reconnect P199 (five-wire connector that was disconnected in step 5).

58. Slide the rear chassis assembly into the main chassis until the mounting-screw holes are aligned and reinstall four large Phillips-head securing screws across the top of the assembly (removed in step 2).

59. Reconnect P138 (50-conductor ribbon cable to the Storage Display circuit board) with the edge stripe oriented as noted in step 3.

60. Reinstall two Phillips-head securing screws (removed in step 1) into the rear chassis (one at each lower corner).

LINE VOLTAGE SELECTOR SWITCH REMOVAL AND REPLACEMENT

The Line Voltage Selector switch may be removed and replaced using the following procedure:

1. Remove two Phillips-head screws from the rear panel of the instrument (one in each lower corner).

2. Remove four large Phillips-head screws from the top of the rear chassis assembly.

3. Slide the rear chassis assembly to the rear until all the components are clear of the main chassis.

4. Lift the rear chassis assembly, rotate it upward 180 degrees, and place it on top of the main chassis. Align the two innermost mounting holes with the corresponding threaded inserts on the main chassis and install two of the screws removed in step 2.

5. Remove the Phillips-head screw from the side cover of the Line-Selector-Switch Assembly and remove the cover from the instrument.

6. Disconnect the single-wire connectors listed below. Note wire color and location for reinstallation reference.

   a. P230, gray with brown and white stripes.

   b. P222, gray with an orange stripe.

   c. P206, gray with a red stripe.

d. P204, black with a gray stripe.

e. P224, gray with yellow and black stripes.

f. P214, gray with a green stripe.

g. P212, gray with yellow and black stripes.

h. P110, gray with red and black stripes.

i. P108, gray with brown and black stripes.

7. Insert a scribe (or similar tool) in the notch between the POWER-switch control shaft and the extension shaft and gently pry them apart.

8. Remove two Phillips-head screws securing the ac-power-input receptacle and push it through the mounting hole until it clears the Line-Voltage Selector Switch circuit board.

9. Use a 9/16-inch wrench to remove the securing nut on the fuse holder and push the holder through the mounting hole until it clears the Line-Voltage Selector Switch circuit board.

10. Remove three Phillips-head screws securing the Line-Voltage Selector Switch circuit board and remove the board from the instrument.

Replace the Line-Voltage Selector Switch Assembly using the following steps:

11. Set the Line-Voltage Selector Switch Assembly in position and secure it with three Phillips-head screws (removed in step 10).

12. Reinsert the fuse holder in the mounting hole and secure it with a 9/16-inch nut.

13. Reinsert the power-input receptacle in its mounting hole and secure it with two Phillips-head screws (removed in step 8).

14. Align the POWER-switch control shaft and the extension shaft and press them together gently until they snap into position.

15. Reconnect the single-wire connectors that were disconnected in step 6.

16. Remove two Phillips-head screws that secure the rear chassis to the main chassis.

17. Lift the rear chassis assembly, rotate it 180 degrees, and slide it into the main instrument chassis until the mounting-screw holes are aligned.

18. Reinstall four Phillips-head screws (removed in step 2) in the mounting holes across the top of the rear chassis assembly.

19. Reinstall two Phillips-head screws (removed in step 1) in the rear panel.

REMOVAL AND REPLACEMENT OF TRANSISTORS AND INTEGRATED CIRCUITS

Transistors and integrated circuits should not be replaced unless they are actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement or switching of semiconductor devices may affect the adjustment of the instrument. When a semiconductor is replaced, check operation of the instrument part that may be affected.

Any replacement component should be of the original type or a direct replacement. Bend the leads to fit the socket and cut the leads to the same length as on the component being replaced. See Figure 8-2 for lead-configuration illustrations.

To remove dual-in-line-packed (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.

WARNING

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

WARNING

Voltages are present on the exterior surface of the chassis-mounted power supply transistors if power is applied to the instrument and the POWER switch is ON.

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The chassis-mounted power supply transistors and their mounting bolts are insulated from the chassis. In addition, silicone grease is used to increase heat transfer capabilities. Reinstall the insulators and replace the silicone grease when replacing these transistors. The grease should be applied to both sides of the mica insulators and should be applied to the bottom side of the transistor where it comes in contact with the insulator.

NOTE

After replacing a power transistor, check that the collector is not shorted to ground before applying power to the instrument.

REMOVAL AND REPLACEMENT OF INTERCONNECTING PINS

Two methods of interconnection are used in this instrument to connect the circuit boards with other boards and components. When the interconnection is made with a coaxial cable, a special end-lead connector plugs into a socket on the board. Other interconnections are made with pins soldered onto the board. Two types of mating connections are used for these interconnecting pins. If the mating connector is on the end of a lead, an end-lead pin connector is used that mates with the interconnecting pin. The following information provides the replacement procedure for the various interconnecting methods.

Coaxial-Type End-Lead Connectors

Replacement of the coaxial-type end-lead connectors requires special tools and techniques; only experienced maintenance personnel should attempt replacement of these connectors. It is recommended that the cable or wiring harness be replaced as a unit. For cable or wiring harness part numbers, see the "Replaceable Mechanical Parts" list in Volume II. An alternative solution is to refer the replacement of the defective connector to your local Tektronix Field Office or representative.

End-Lead Pin Connectors

Pin connectors used to connect the wires to the interconnecting pins are factory assembled. They consist of machine-installed pin connectors mounted in plastic holders. The plastic holders are easily replaced as individual items; but if the connectors are faulty, the entire cable assembly should be replaced. Individual pin connectors are listed in the "Replaceable Mechanical Parts" list in Volume II, but special tools are required for installation.

When pin connectors are grouped together and mounted in a plastic holder, they are removed and installed as a multi-pin connector. To provide correct orientation of this multi-pin connector when it is replaced, an arrow is stamped on the circuit board, and a matching arrow is molded into the plastic housing of the multi-pin connector. Be sure these arrows are aligned when the multi-pin connector is reinstalled. If the individual end-lead pin connectors are removed from the plastic holder, note the color of each individual wire to facilitate replacement.

REMOVAL AND REPLACEMENT OF CERAMIC TERMINAL STRIPS

Replacement strips (including studs) and spacers are supplied under separate part numbers. However, the old spacers may be reused if they are not damaged. The applicable Tektronix part numbers for the ceramic strips and spacers used in this instrument are given in the "Replaceable Mechanical Parts" list in Volume II.

Remove ceramic terminal strips as follows:

1. Unsolder all components and connections on the strip. To aid in replacing the strip, it may be advisable to mark each lead or draw a sketch to show locations of the components and connections.

2. Gently pry or pull the damaged strip from the circuit board.

3. If spacers come out with the strip, remove them from the stud pins for use on the new strip (spacers should be replaced if they are damaged).

Install ceramic terminal strips as follows:

4. Place spacers in the chassis holes.

5. Carefully press the studs of the strip into the spacers until they are completely seated.

6. If the stud extends through the spacers, cut off the excess.

7. Replace all components and resolder connections. Observe the soldering precautions under "Soldering Techniques" in this section.

READJUSTMENT AFTER REPAIR

After any electrical component has been replaced, the adjustments for that particular circuit should be checked, as

well as the adjustments of other closely related circuits. Since the Power Supply affects all circuits, adjustment of the entire instrument should be checked if work has been done in the Power Supply or if the Power transformer has been replaced.

INSTRUMENT REPACKAGING

Should reshipment become necessary, reuse the carton in which your instrument was shipped. If the original packaging is unfit for use or is not available, contact your local Tektronix Field Office or representative to order a replacement shipping carton.

If the instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag containing the following information:

1. Owner's name and address, with the name of an individual at your firm who can be contacted.

2. Complete instrument serial number.

3. Description of the services required.

WARNING

During rackmount installation, interchanging the left and right slide-out track assemblies defeats the extension stop (safety latch) feature of the tracks. Equipment could, when extended, come out of the slides and fall from the rack, possibly causing personal injury and equipment damage.

When mounting the supplied slide-out tracks, inspect both assemblies to find the LH (left hand) and RH (right hand) designations to determine correct placement. Install the LH assembly to your left side as you face the front of the rack and install the RH assembly to your right side. Refer to the rackmounting instructions in this manual for complete information.

SERVICE TESTS

SERVICING SETUP

The 468 is mechanically structured to allow access to digital storage components while the instrument is operating. The rear section of the frame may be removed from the main oscilloscope frame and repositioned on top of the main frame by lifting and rotating it 180 degrees. Holes for mounting screws are arranged to secure the rear frame in the servicing position.

Place the 468 in the servicing position as follows:

1. Disconnect the 468 from the power source.

2. Remove the instrument cabinet (see "Cabinet Removal" in this section).

3. Remove six screws holding the rear chassis assembly to the main chassis. Four screws are located across the top, and one is at each lower rear corner of the rear panel.

4. Lift the rear chassis assembly slightly to separate it from the main chassis and carefully rotate it 180 degrees and forward to position it on top of the main chassis.

5. Align two screw holes in the rear chassis assembly with screw holes in the main chassis and use two of the screws removed in step 3 to secure the rear chassis assembly to the main chassis (see Figure 5-6). Verify that the 50-conductor ribbon cable is securely in place at both end connectors.

6. To gain access to the Memory and Time Base/Power Supply circuit boards, remove the two screws on either end of the holding bracket. The two rear boards are mounted on a hinged plate to allow them to swing away from the rear frame.

CAUTION

The lead arrangement and spacing of the five 10-wire cables between the Time Base and the Memory circuit boards must be maintained to prevent possible failure.

TRAP TEST

This test is programmed into the Microprocessor and ROM. It is used to check the Microprocessor address sequencing and the address-generated strobes. It is not necessary to remove or exchange any ROM for this test.

To initiate the test, momentarily unplug P262 (see Figure 5-7) and then reconnect it. Microprocessor operation will be interrupted, and the Trap Test routine will begin. To end the test, cycle the POWER switch OFF then ON. The Microprocessor will return to its normal operating routines.

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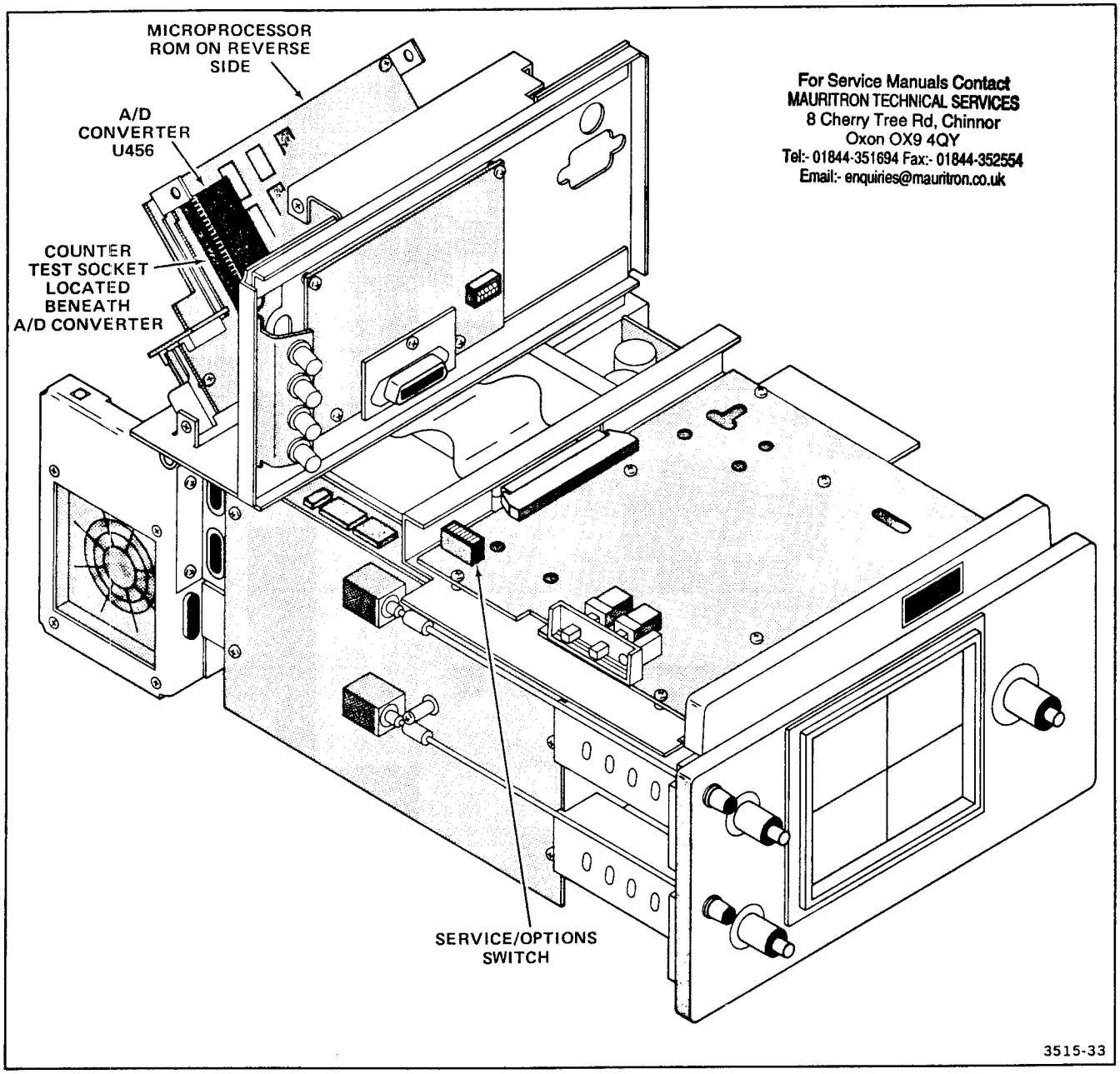

Figure 5-6. The 468 in the servicing position.

KERNEL TEST

This test isolates the Microprocessor from the return loops to allow a check of the Microprocessor operation as it free runs. Bus Buffers U452 and U558 are removed to unload the Microprocessor AD0 through AD7 lines. Set up the 468 Kernel test as follows:

1. With the instrument in the servicing position, disconnect it from the power-input source.

2. Carefully remove U452 and U558 (see Figure 5-7) while observing the "Static Sensitive" precautions given at the beginning of the "Corrective Maintenance" portion of this section. Store the IC in a static-safe location until they are reinstalled.

3. To start the Kernal Test, reconnect the 468 to the power source and set the POWER switch to ON. To restart the test, momentarily place Power-on Restart Jumper P182 to the RESET position and then return it to the RUN position (see Figure 5-7).

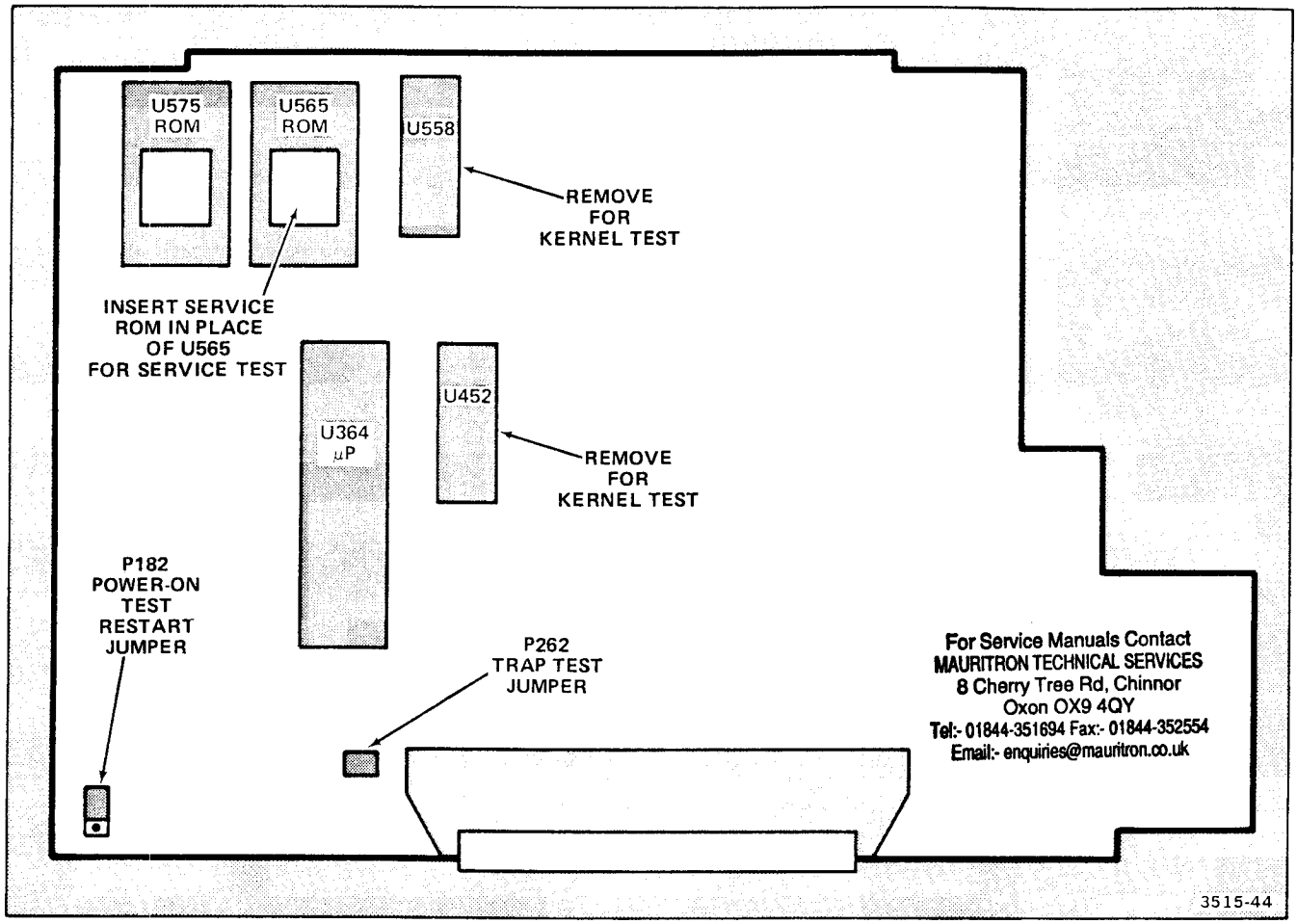

Figure 5-7. Location of the test ROM and test jumpers on the Microprocessor circuit board.

A/D CONVERTER SIMULATOR

An optional accessory (a Test-Counter IC) may be installed to simulate operation of A/D Converter U456. This Test-Counter IC produces a ramp signal that exercises the digital circuitry for testing purposes. See Table 5-3 "Maintenance Aids" in this section of the manual for its part number (included in the Service Accessory package).

Install the A/D Converter Simulator as follows:

1. With the instrument in the servicing position, disconnect it from the power-input source.

2. Carefully remove U456 (see Figure 5-7) while observing the "Static Sensitive" precautions given at the beginning of the "Corrective Maintenance" portion of this section. Pull evenly on both ends of the IC so that all pins come free together. Carefully removing U456 will prevent bending the pins. Store the IC in a static-safe location until it is reinstalled.

3. Install the Test-Counter IC in the smaller socket located beneath U456.

4. Reconnect the 468 to the power-input source and set the POWER switch to ON. The ramp display will begin, with the 468 in any storage mode, as soon as the power-on self-test is completed.

SERVICE ROUTINE PROCEDURES

A Service ROM accessory contains the programming for the selectable service routines used for testing digital circuitry in the 468. Some of these routines are display routines and some are used only for signature analysis testing. See Table 5-3 "Maintenance Aids" in this section of the manual for the part number of the optional Service ROM.

One of the Microprocessor ROM must be exchanged with the Service ROM to obtain the programmed routines. Install the Service ROM as follows:

1. With the 468 in the servicing position, disconnect it from the power-input source.

2. Remove ROM U565 from its socket (see Figure 5-7) while observing the "Static Sensitive" precautions given at the beginning of the "Corrective Maintenance" portion of this section. Pull evenly on both ends of the IC so that all pins come free together. Carefully removing U565 will prevent bending the pins. Store the IC in a static-safe location until it is reinstalled.

3. Install the Service ROM in the U565 socket.

Selecting a Service Routine

To select a specific service routine, set Service/Options switch S707 (an eight-section DIP-switch assembly) to the number of the test desired. Figure 5-6 shows the location of the switch on the Storage Display circuit board, and Table 5-4 lists the test routines and corresponding test numbers to be set into S707. Position 1, at the rear of the switch assembly, corresponds to the least-significant bit (LSB) of the test number. Position 8 is the Options-bit switch. If the GPIB option is not installed in the instrument, or when the GPIB option is not going to be used, switch 8 should be open. The GPIB service routines can be executed only when switch 8 is closed and the option installed. If you select a GPIB test, verify that the option bit is set to 1 (closed).

NOTE

When servicing of the instrument is completed, section 7 of Service/Options Switch S707 must be set to the closed position to enable the RAM Verification portion of the power-on self-test, and switch section 8 must be set to the closed position to enable the GPIB option.

Beginning a Service Routine

Once the service routine number has been set, power may be applied to the 468. The selected routine will begin to run in place of the normal power-on self-test. If the oscilloscope is already in operation, a routine can be started by removing Restart Jumper P182 from the RUN position and placing it momentarily in the RESTART position; then returning it to the RUN position. See Figure 5-7 for the location of the Restart Jumper on the Microprocessor circuit board.

Restarting a Service Routine

To restart a routine already in progress, remove Restart Jumper P182 from the RUN position and place it momentarily in the RESTART position; then return it to the RUN position. Cycling the POWER switch OFF then ON will also restart a service routine.

Table 5-4

Service Routine Switch Settings

Routine	Switch Setting
ROM Checksum	X0000000[a]
Lamp Test	X0000001
System and Scratch RAM Exercise	X0000010
I/O Registers	X0000011
Position-Rate Counter	X0000100
Switch Closure	X0000101
Basic Display System	X0001000
Stop at 256/Jitter Correction	X0001001
Stop at 512/Dot RAM	X0001010
Time Base Counter String (Signature Analysis Testing)	X0010000
Time Base Record String (Signature Analysis Testing)	X0010001
Time Base Jitter Counters (Signature Analysis Testing)	X0010010
Acquisition RAM	X0010011
GPIB Data Bus	11111000
Acceptor Handshake	11111001
Source Handshake	11111010
Default to 8888 display	Any other setting

[a]X in the switch setting column means "don't care." Either position of that switch selection is acceptable.

Selecting Another Routine

To select a different service routine, set the number of the desired new routine in the Service/Options switch and perform the service routine restart procedure. If the switch is inadvertently set to an invalid routine number, the seven-segment LED readout will display 8888. If you determine that the Service/Options DIP switch is set correctly but is not being read correctly, check the outputs of U522 (DIP Switch Register). The output of U522 is an inverted copy of the Service/Options switch setting.

SERVICE ROUTINE DESCRIPTIONS

ROM Checksum

This routine computes a checksum for the Service ROM. If the checksum computed by the routine is the same as the checksum stored in the ROM, the seven-segment display will read out all zeros. If there is a checksum failure, no display will appear and the Microprocessor will halt. If the checksum routine does not execute, oscilloscope operation is undefined.

Lamp Test

The lamp test routine will light each of the Microprocessor-controlled LED indicators on the instrument front panel (and the $\overline{\text{TIDS}}$/SRQ LED if the GPIB option is installed) in a predefined order. One LED at a time will be illuminated, and the test will continue until it is manually terminated. The order in which each LED illuminates is as follows:

1. Scaling: V/S, mV/ns, then DIV/μs.

2. The four digits of the seven-segment display will show a moving "8." from right to left (decimal points also illuminate).

3. CH 1 VOLTS/DIV Scale-factor: X1, then X10.

4. CH 2 VOLTS/DIV Scale-factor: X1, then X10.

5. $\overline{\text{TIDS}}$/SRQ: shows red then green.

NOTE

The red portion of the scaling LED will be illuminated when VOLTS CURSOR FUNCTION is selected and the green portion will be illuminated when the VOLTS CURSOR FUNCTION push button is released.

Position-Rate Counter

This routine exercises the Position-rate Counter circuitry. The contents of the counter (three binary-coded decimal characters) will be read and transferred directly to the seven-segment LED display. As the CURSOR control knob is rotated, the observed display should change. The range of the counter outputs should be within 000 to 800, with 80 being an average low-end count and 480 being an average high-end count. As the rate region of the control knob rotation is entered, the top scale-factor LED should illuminate. The bottom scale-factor LED should illuminate when the CURSOR SELECT push button is pressed in.

Switch Closure

This routine reads all of the Microprocessor-accessible switches and displays them in a logic analyzer type display. Four waveform displays will indicate the operation of 40 switches. The EXT trigger position of the SOURCE switch is not displayed, but it is indicated by illumination of the scale-factor LED when an external trigger is selected. See Figure 5-8 for an illustration of the waveform and the assigned area for each switch.

Each switch is assigned to one graticule division. A HI level means that the switch is closed, and a LO means that the switch is open. However, in the case of the AC-GND-DC switch, a three-level presentation is used to indicate all three possible switch positions. Switch operation can be checked by changing the switch position and observing the change seen on the display.

Basic Display System

No crt display is produced by this routine. A looping routine continually fills the Display RAM with a ramp to generate signatures. These signatures verify circuit operation when checked against the correct signatures contained in the Signature Tables. The following circuitry is exercised: display bus, counter addressing functions, Z-axis control circuitry used with the display bus, the Display RAM chip select circuitry, and the display address bus.

The vertical and horizontal digital-to-analog converters in the Storage Display circuitry will also be exercised, and their outputs may be checked with a test oscilloscope.

Stop at 256/Jitter Correction

This routine will fill the Display RAM with a 256-point waveform consisting of two ramps (see Figure 5-9A). The waveform data-point values range from 0 to 255 to obtain a display with both full vertical and full horizontal ranges. The jitter-correction circuitry is checked by selecting the X10 MAG function and using the Horizontal POSITION control to align the falling edge of the ramp with the center vertical graticule line. The waveform is cycled through the maximum value, the middle value, and the minimum value of the jitter correction, and the resulting display is three vertical lines. The lines should have a spacing of no more than 0.4 division between two adjacent lines, as illustrated in Figure 5-9B.

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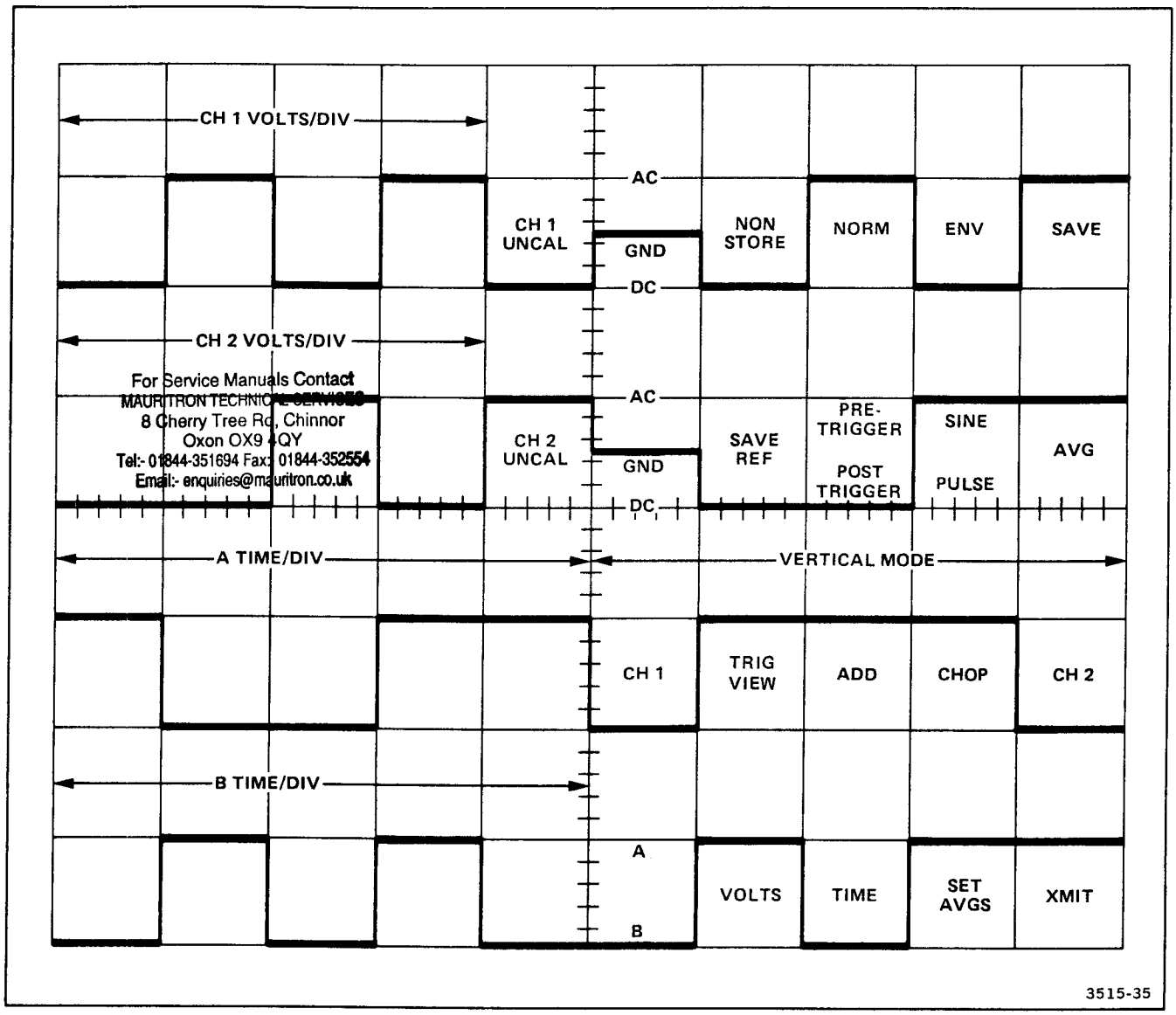

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Figure 5-8. Switch closure test crt display.

Stop at 512/Dot RAM

This routine stores a 512-point waveform into the Display Memory. The display will consist of four 128-point ramps, with data-point values ranging from 65 to 190 (a five-division display). At the end of the waveform, four-point steps will appear. These steps have data-point values of 65, 128, and 190 respectively. The steps can be used to calibrate the vertical display gain by aligning the levels with both the dotted reference lines and the center horizontal graticule line (see Figure 5-10).

A dot display from the Dot RAM is moved through the ramp display to verify that a dot can be displayed on all 512 data points of the display.

Time Base Routine

The Time Base verification routines listed in Table 5-5 are used to generate signatures for signature-analysis testing. The portions of the Time Base circuitry not listed in the table cannot be controlled by the Microprocessor, and other troubleshooting methods are required (see "Troubleshooting Charts" in Volume II of this manual).

Acquisition RAM

This routine is used to generate signatures for testing the acquisition random-access memory. Data is written into each address in the RAM and then read back in a continuous loop routine. No crt display is generated by the routine.

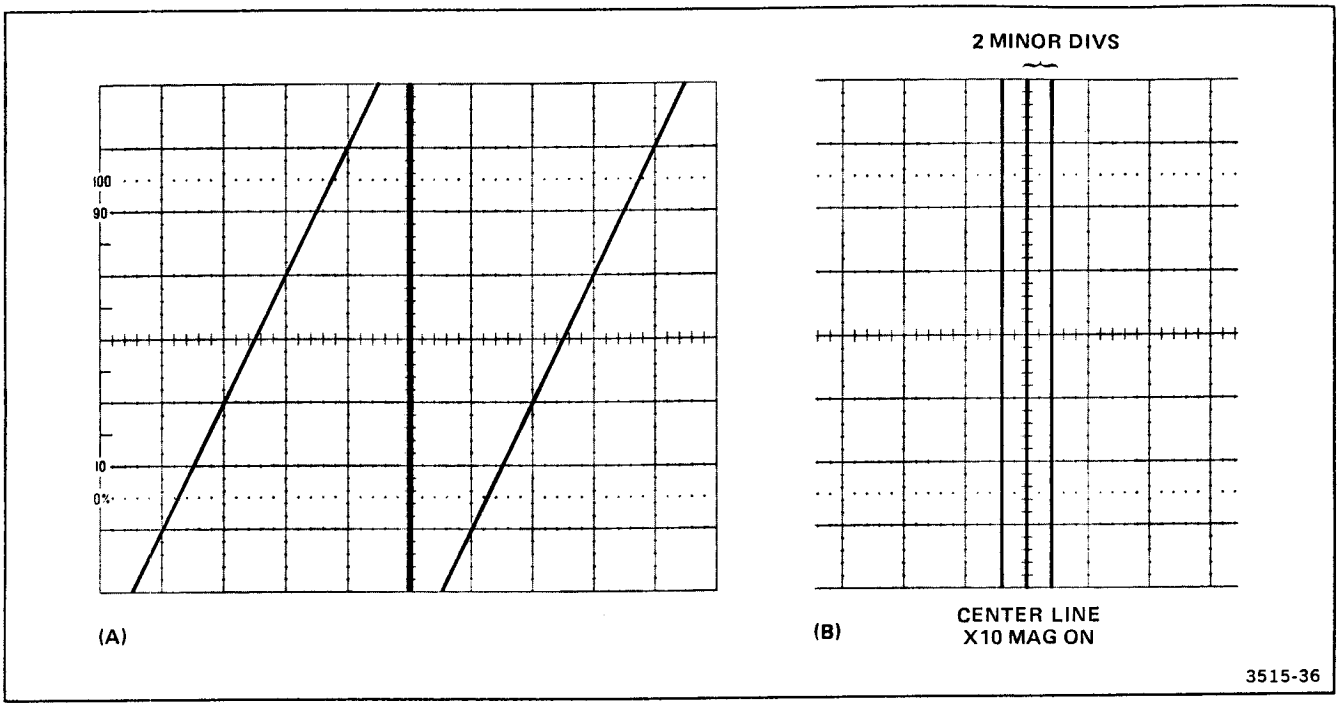

Figure 5-9. Stop at 256/jitter correction test crt display.

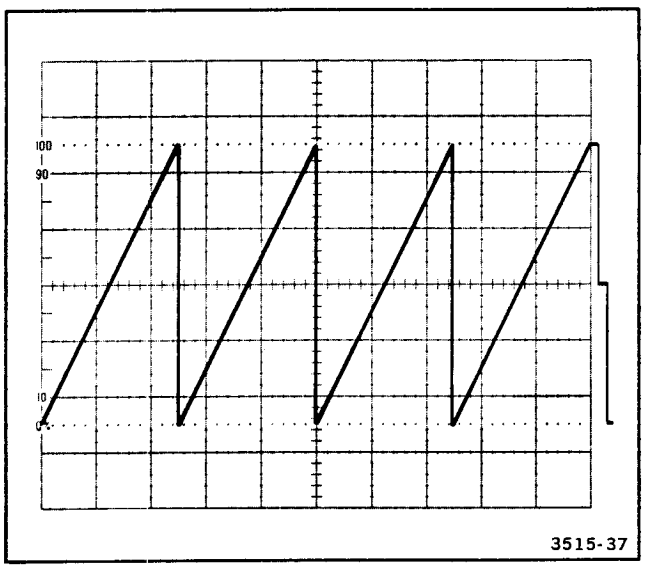

Figure 5-10. Stop at 512/dot RAM test crt display.

Table 5-5

Time Base Verification Routines

Test	Setup Requirements	Test Number
Time Base Counter String	Counter chain test jumper (P420) set to "Test" and triggers disabled.	X0010000
Time Base Record String	No additional requirements.	X0010001
Time Base Jitter Counters	No additional requirements.	X0010010

GPIB Data Bus

This routine toggles all the bits of the data path from the output data register through the bus bidirectional buffers and back to the Microprocessor bus through the data input buffer. The Microprocessor reads the Service/Options switch register and status buffer and compares the data against known values. The check value for the switch register must be manually set. The GPIB control register is also toggled, but only the TADS condition can be tested by the Microprocessor. The generated signatures can be checked by using signature-analysis testing to compare them with the Signature Tables.

Error codes are displayed in the seven-segment display and are updated at the completion of each pass through the routine. Table 5-6 shows the digit assignments and error indications.

To run the GPIB Data Bus routine, the following preliminary steup must be performed:

1. Disconnect the GPIB output cable.

2. Set the Service/Options switch to 111111000.

3. Set the GPIB switch talk address to 00000.

4. Set the TALK ONLY switch (switch-section 8) off (0).

Table 5-6

GPIB Data Bus Error Display

	Digit 1 Data Bus	Digit 2 Status Check	Digit 3 Switch Register	Digit 4 TADS
Pass	0	0	0	0
Fail	1-9	1-2	1	1-2

Acceptor Handshake

This rountine executes an acceptor handshake of the GPIB circuitry. Unused bits of the Interface Control register are used to drive the ATN and DAV lines, enabling the handshake to be executed. Signatures generated can be compared with the Signature Tables.

First perform the following preliminary setup:

1. Disconnect the GPIB output cable.

2. Set the Service/Options switch to 11111000.

3. Connect TP335 to TP112 on the GPIB board to drive ATN.

4. Connect TP333 to TP114 on the GPIB board to drive DAV.

Source Handshake

In this routine, a source handshake loop is executed and the bits of the Interface Status register are tested by the Microprocessor. Errors are displayed in the seven-segment display. Generated signatures can be compared with the Signature Tables. A jumper is needed to assert DAC, and RFD is always True to enable the handshake routine.

First perform the following preliminary setup:

1. Disconnect the GPIB output cable.

2. Set the Service/Options switch to 11111010.

3. Connect TP335 to TP111 on the GPIB board to assert DAC.

4. Connect TP333 to TP113 on the GPIB board to assert IFC.

If no errors occur during execution of the routine, the readout in the seven-segment display will be 0000. If a status-bit error occurs, a number from 1 through 7 will appear in the LSB of the readout. The remaining digits are not used.

SIGNATURE-ANALYSIS TESTING

The 468 is designed for signature-analysis testing when troubleshooting digital circuit malfunctions. The Service ROM, installed in place of one of the Microprocessor ROM, contains selectable looping routines suitable for signature generation.

The looping routines are continuous, and the resulting data enclosed between a defined starting point and stopping point results in a predictable data string. The data string produces a signature (type of checksum) that may be used as a check of circuit operation. A correct signature obtained at a testing point indicates that the circuit operation is correct to that point.

A list of signatures obtained from properly operating instruments is included in this section of the manual. The Signature Tables include required 468 setup procedures; start, stop, and clock pulse information; and check signatures to verify that the Signature Analyzer in use is set correctly to obtain the listed signatures.

Refer to the Operators Manual of the Signature Analyzer in use to obtain the necessary information regarding its operation.

Table 5-7 lists the current firmware and hardware versions applicable to the 468. Future firmware or hardware changes to the instrument may require updates to some of the Signature Tables. When update pages are received for later versions, they should be inserted behind the corresponding earlier versions, which should remain in the manual.

The signature lists are contained in Tables 5-8 through 5-23.

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Table 5-7

468 Digital Storage Oscilloscope Signature Versions

Assy Number	Board Name	Signature Versions			
		1.0 & 2.0			
A14	Vertical Mode Switch	670-6375-00			
A16	Storage Display	670-6377-00 670-6377-01 670-6377-02			
A17	GPIB	670-6378-00			
A18	Memory	670-6379-00			
A19	Time Base/Power Supply	670-6380-00			
A21	Microprocessor	670-6382-00,-01			

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Table 5-8

Kernel Test Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A21	Microprocessor	670-6382-00 and 670-6382-01	8-20	18

Test 1—Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	U364-31	A21
Start	↑	TP580	A21
Stop	↓	TP580	A21

Test 2—Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	U364-31	A21
Start	↓	TP580	A21
Stop	↑	TP580	A21

468 Setup (Both Tests)

468 in Servicing Setup. U452 and U558 removed. To restart test with POWER ON, move P182 to RESET position momentarily; then return it to RUN position. (Service ROM is not required.)

Test 1
+5 V Check Signature—4P0A

Component	Pin	Signature
U364	21	P3P4
	22	99UF
	23	FP52
	24	0056
	25	P2HH
	26	759F
	27	762H
	28	3C55
U472	2	P2HH
	3	P2HH
	4	0056
	5	0056
	6	FP52
	7	FP52
	8	99UF
	9	99UF
	11	P3P4
	12	P3P4
U550	2	8CU3
	5	0H5H
	6	A44P
	9	404A
	12	1C51
	15	8598
	16	A0C1
	19	939A
U478	1	759F
	2	762H
	3	3C55
	9	5FU8
	10	A50A
	11	8FAH
	14	CHHP
	15	AF5P
U246A	3	H327
	4	H327
	5	H327
	6	9H2H
U246B	8	H327
U246C	1	3827
	2	3C55
	12	A50A
	13	759F
U272B	3	PC00
	17	A50A
U272F	7	AFH7
	13	P2HH
U278A	1	3827
	2	762H
U278C	8	A50A
	9	P2HH
	10	57HF
U278D	11	A50A
	12	AFH7
	13	CFHF
U378	11	8P49
	12	HA27

Test 2
+5 V Check Signature—P254

Component	Pin	Signature
U378	5	79PF
	6	P4HF
	7	84P6

Table 5-9

ROM Test Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A21	Microprocessor	670-6382-00 and 670-6382-01	8-20	18

ROML Test—Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	U364-31	A21
Start	↓	U478-15	A21
Stop	↓	TP580	A21

ROMH Test—Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	U364-31	A21
Start	↓	U478-14	A21
Stop	↓	U478-15	A21

468 Setup (Both Tests)

U452 and U558 removed. To start or restart test with POWER ON, move P182 to RESET position momentarily, then return it to RUN position. (Service ROM is not required.)

ROML Test
+5 V Check Signature-P254

Component	Pin	Signature	
		Version 1.0	Version 2.0
U565	9	54F2	954U
	10	43PA	H3P1
	11	60U2	660F
	13	HA4U	34A6
	14	P522	F6H0
	15	PU35	2H6H
	16	97H8	98A3
	17	6139	A99F

ROMH Test
+5 V Check Signature-P254

Component	Pin	Signature	
		Version 1.0	Version 2.0
U575	9	6507	A42C
	10	0AUF	PH78
	11	FP66	3289
	13	2AH0	A34P
	14	059U	8CA1
	15	049F	A542
	16	1C16	FF59
	17	HPPF	96A8

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Table 5-10

Trap Test Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A21	Microprocessor	670-6382-00,-01	8-20	18
A19	Time Base/Power Supply	670-6380-00	8-23	19
A14	Vertical Mode Switch	670-6375-00	8-15	4

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	TP477	A21
Start	↓	U478-14	A21
Stop	↓	U478-13	A21

468 Setup

Reinstall U452 and U558 if previously removed. To start or restart test, momentarily remove Service Jumper P262 on A21; then replace it. To end test, cycle POWER switch OFF then ON. (Service ROM will not affect the test, may be installed or removed as desired.)

+5 V Check Signature—5FU8

A21

Component	Pin	Signature Version 1.0	Signature Version 2.0
U364	12	4305	0A16
	13	CHC7	35PA
	14	4332	UHCA
	15	852P	312H
	16	43F0	U34H
	17	FF10	99H5
	18	9131	5FP0
	19	1552	2262
U558	1	5FU8	5FU8
	2	1552	2262
	3	9131	5FP0
	4	FF10	99H5
	5	43F0	U34H
	6	852P	312H
	7	4332	UHCA
	8	CHC7	35PA
	9	4305	0A16
	11	4305	0A16
	12	CHC7	35PA
	13	4332	UHCA
	14	852P	312H
	15	43F0	U34H
	16	FF10	99H5
	17	9131	5FP0
	18	1552	2262
	19	0000	0000
U452	1	0000	0000
	2	4305	0A16
	3	CHC7	35PA
	4	4332	UHCA
	5	852P	312H
	6	43F0	U34H
	7	FF10	99H5
	8	9131	5FP0
	9	1552	2262
	11	1552	2262
	12	9131	54P0
	13	FF10	99H5
	14	43F0	U34H
	15	852P	312H
	16	4332	UHCA
	17	CHC7	35PA
	18	4305	0A16
	19	0000	0000

A14

Component	Pin	Signature Version 1.0	Signature Version 2.0
P142	2	4305	0A16
	3	CHC7	35PA
	4	4332	UHCA
	5	852P	321H
	6	43F0	U34H
	7	FF10	99H5
	8	9131	5FP0
	9	1552	2262

A19

Component	Pin	Signature Version 1.0	Signature Version 2.0
P125	1	852P	312H
	2	4332	UHCA
	3	CHC7	35PA
	4	4305	0A16
P135	6	1552	2262
	7	9131	5FP0
	8	FF10	99H5
	9	43F0	U34H

Table 5-11

I/O Register Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A21	Microprocessor	670-6382-00,-01	8-20	18
A19	Time Base/Power Supply	670-6380-00	8-23	19
A16	Storage Display	670-6377-00 670-6377-01 670-6377-02	8-22	15,17
A14	Vertical Mode Switch	670-6375-00	8-15	4

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	TP477	A21
Start	↑	TP358	A21
Stop	↓	TP358	A21

468 Setup

468 in Servicing Setup. Service Test ROM installed in U565 socket on A21. Service/Options switch set to X0000011. To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—1886

A16

Component	Pin	Signature
U207	2	C5P2
	5	343A
	9	3860
	19	03PF
U213	1	C5P2
	2	03PF
	3	343A
	5	890U
	6	H36F
	7	1886
	9	1886
	10	1886
	11	1886
	12	1886
	13	A580
	14	76PF
	15	1886
U218	1	C5P2
	2	03PF
	3	343A
	5	890U
	6	3860
	10	5A0P
	11	3005
	12	1886
	13	1886
	14	593P
	15	1541

A16

Component	Pin	Signature
U223	2	F623
	5	HPA9
	6	H927
	9	013A
	12	340A
	16	U748
	19	58HP
U228	2	311U
	5	U549
	6	F93F
	9	09H7
	12	7FP3
	15	1F6H
	16	CA45
	19	F6U0
U748	2	1801
	5	1801
	6	1801
	9	1801
	12	UP0F
	15	UP0F
	16	UP0F
	19	UP0F
U753	5	1801
	6	0087
	7	1801
	10	UP0F
	12	1801
	15	UP0F

A16

Component	Pin	Signature
U759	5	5A0P
	9	H6P6
	10	1766
	11	1766
	12	H6P6
	13	1766
	14	F180
	15	1766
U723	5	5C7A
	6	H364
	15	7H0P
	9	P004
	12	5F34
	19	9963
	2	0318
	16	FCHH
U643B	4	5C7A
	5	5C7A
	6	43UF
U523	8	43UF
	9	1886
	10	43UF
U737	1	H927
	11	76PF
U776	4	F6U0
	10	U549
	13	CA45
U466	10	1F6H
	11	F93F

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Table 5-11 (cont)
I/O Register Signatures

A14

Component	Pin	Signature
U358[a]	1	C5P2
	2	03PF
	3	343A
	6	1948
	5	890U
	4	0000
	15	1886
	13	1886
	12	1886
	10	1886
	9	01FP
	11	1886
	14	1886
P355[a]	5	C5P2
	6	03PF
	7	343A
	2	1948
	3	890U
	8	0000
U310[b]	19	2903
	16	P520
	15	HFA4
	12	HC94
	9	7C72
	6	FU6P
	2	1P64
	5	79PH
P307[b]	1	2903
	2	P520
	3	HFA4
	4	HC94
	5	7C72
	6	FU6P
	7	1886
P130	7	1P64

[a] P355 may be used for easy access to U358 inputs (pins 1 through 6). Outputs of U358 (pins 9 through 15) can be readily probed from the top of the instrument.

[b] P307 may be used for easy access to U310 outputs.

A19

Component	Pin	Signature
U436	5	9F84
	6	5390
	19	6A72
	16	AH4P
	15	15A9
	12	A41H
	2	P246
	9	322C
	11	C48U
U236	5	2900
	6	A165
	12	9069
	15	3648
	16	A28F
	19	7014
	2	4A47
	9	6CF5
	11	15P5
U140	2	C5P2
	5	03PF
	7	343A
U146	1	C5P2
	2	03PF
	3	343A
	4	324U
	13	C48U
	14	15P5
	10	4159
	12	32H7
	15	CH96
	9	4H1C
	11	857U
	7	8HHU
U100D	12	2PFP
U434A	2	2PFP
U110A	4	32H7
	1	CH96
	5	12U8
	6	0A7P
U118	1	853F
	15	853F
	2	6CF5
	14	7014
U120	2	322C
	14	P246

Table 5-12

Display RAM Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A16	Storage Display	670-6377-00 670-6377-01 670-6377-02	8-22	15
A21	Microprocessor	670-6382-00,-01	8-20	18

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↓	U278-10	A21
Start	↑	TP358	A21
Stop	↓	TP358	A21

468 Setup

468 in Servicing Setup. Service Test ROM installed in U565 socket on A21. Service/Options switch set to X0001000. To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—7A70

Component	Pin	Signature
U723	5	0000
	12	7A70
U618B	8	7A70
	9	0000
	12	0000
U643A	1	7A70
	2	0000
	3	7A70
U643D	11	0000
	12	7A70
	13	7A70
U523B	4	7A70
	5	7A70
	6	7A70
U238B	4	0000
	5	7A70
	6	7A70
U238C	9	7A70
	10	0000
U238D	11	7A70
	12	7A70
	13	0000
U407	1	7A70
	3	C21A
	4	HA07
	5	H0AA
	6	P030
	7	0000
	9	0000
	10	0000
	11	H0AA
	12	HA07
	13	C21A
	14	0000
	15	0000

Component	Pin	Signature
U413	1	7A70
	3	4442
	4	4U2A
	5	0772
	6	9635
	7	0000
	9	0000
	10	0000
	11	0772
	12	4U2A
	13	4442
	14	P030
	15	0000
U418	1	7A70
	3	9635
	4	1734
	5	8P54
	7	0000
	9	0000
	10	0000
	12	8P54
	13	1734
	14	9635
U637	1	4U2A
	2	4442
	3	P030
	4	9635
	5	9270
	6	74PF
	8	C21A
	9	HA07
	10	H0AA
	13	0772
U631A	1	4U2A
	2	4442
	4	H0AA
	5	HA07
	6	8F88

Component	Pin	Signature
U631B	8	C06F
	9	C21A
	10	9635
	12	P030
	13	0772
U648	1	0000
	2	HA07
	3	74PF
	4	9270
	5	74PF
	6	F783
	12	8F88
	13	C06F
U731	1	7A70
	2	C21A
	3	HA07
	4	H0AA
	5	P030
	6	4442
	7	4U2A
	8	0772
	9	9635
	11	9635
	12	0772
	13	4U2A
	14	4442
	15	P030
	16	H0AA
	17	HA07
	18	C21A

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Table 5-12 (cont)
Display RAM Signatures

Component	Pin	Signature
U737	1	7A70
	2	C21A
	3	C21A
	4	H0AA
	5	H0AA
	6	4442
	7	4442
	8	0772
	9	0772
	11	7A70
	12	9635
	13	9635
	14	4U2A
	15	4U2A
	16	P030
	17	P030
	18	HA07
	19	HA07
U334	1	9635
	2	1734
	3	8P54
	4	4U2A
	5	0772
	6	H0AA
	7	HA07
	8	0000
	10	7A70
	11	HA07
	12	9635
	13	C21A
	14	0772
	15	C21A
	16	4442
	17	P030

Component	Pin	Signature
U328	1	9635
	2	1734
	3	8P54
	4	4U2A
	5	0772
	6	H0AA
	7	HA07
	8	0000
	10	7A70
	11	H0AA
	12	P030
	13	4442
	14	4U2A
	15	C21A
	16	4442
	17	P030
U234	1	0000
	2	0000
	3	C21A
	4	HA07
	5	H0AA
	6	1734
	7	F256
	9	4442
	10	4U2A
	11	0772
	12	9635
	13	P030
	14	7A70
	15	C21A
U770	3	C21A
	5	H0AA
	7	4442
	9	0772
	11	9635
	13	4U2A
	15	P030
	17	HA07

Table 5-13

System and Scratch RAM Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A21	Microprocessor	670-6382-00,-01	8-20	18

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	U364-32	A21
Start	↑	TP358	A21
Stop	↓	TP358	A21

468 Setup

468 in Servicing Setup. Service Test ROM installed in U565 socket. Service/Options switch set to X0000010. To start or restart routine with POWER ON, move P182 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—1HF9

Component	Pin	Signature
U525	1	C71C
	2	4HCU
	3	9A55
	4	UC76
	5	HP24
	6	9C73
	7	UH73
	8	PAP7
	11	H9PP
	12	U0H1
	13	U38F
	14	U820
	15	H5C4
	16	9U82
	17	AU7U
U530	1	C71C
	2	4HCU
	3	9A55
	4	UC76
	5	HP24
	6	9C73
	7	UH73
	8	PAP7
	11	8826
	12	87A8
	13	U1FC
	14	5F49
	15	H5C4
	16	9U82
	17	AU7U

Component	Pin	Signature
U540	1	C71C
	2	4HCU
	3	9A55
	4	UC76
	5	HP24
	6	9C73
	7	UH73
	8	3999
	11	H9PP
	12	U0H1
	13	U38F
	14	U820
	15	H5C4
	16	9U82
	17	AU7U
U545	1	C71C
	2	4HCU
	3	9A55
	4	UC76
	5	HP24
	6	9C73
	7	UH73
	8	3999
	11	8826
	12	87A8
	13	U1FC
	14	5F49
	15	H5C4
	16	9U82
	17	AU7U

Component	Pin	Signature
U558	1	1HF9
	2	H9PP
	3	U0H1
	4	U38F
	5	U820
	6	8826
	7	87A8
	8	U1FC
	9	5F49
	11	5F49
	12	U1FC
	13	87A8
	14	8826
	15	U820
	16	U38F
	17	U0H1
	18	H9PP
	19	0000
U472A	3	0000
U472B	5	U72P
U472C	7	0000
U472D	9	9U82
U472E	11	H5C4
U550	2	C71C
	5	4HCU
	6	9A55
	9	UC76
	12	HP24
	15	9C73
	16	UH73
	19	AU7U

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Table 5-14

Acquisition RAM (Write) Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A18	Memory	670-6379-00	8-21	14

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↓	U220-10	A18
Start	↑	U206-6	A18
Stop	↑	U206-6	A18

468 Setup

468 in Servicing Setup. Service Test ROM installed in U565 socket on A21. Service/Options switch set to X0010011. To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—4596

Component	Pin	Signature
U120	8	791C
	9	3F8H
	10	4596
	11	4596
	12	3F8H
	13	4596
U216	1	0000
	2	4596
	3	4596
	4	4596
	7	0000
	9	791C
	12	3F8H
U220	8	791C
	11	3F8H
U240	2	3F8H
	3	3F8H
	4	PC84
	5	PC84
	6	627P
	7	627P
	8	CHU8
	9	CHU8
	11	HFP7
	12	HFP7
	13	41F7
	14	41F7
	15	FA11
	16	FA11
	17	8C36
	18	8C36
U206	2	4596
	3	FA11
	4	41F7
	5	HFP7
	11	UPA2
	12	HFP7
	13	41F7
	14	FA11
	15	57P4

Component	Pin	Signature
U210	2	4596
	3	PC84
	4	627P
	5	CHU8
	6	8C36
	11	8C36
	12	CHU8
	13	627P
	14	PC84
U306	1	FA11
	2	41F7
	3	HFP7
	4	UPA2
	5	8C36
	6	CHU8
	7	627P
	9	8C36
	11	FA11
	13	41F7
	15	HFP7
U312	1	FA11
	2	41F7
	3	HFP7
	4	UPA2
	5	8C36
	6	CHU8
	7	627P
	9	3F8H
	11	PC84
	13	627P
	15	CHU8
U508	1	FA11
	2	41F7
	3	HFP7
	4	UPA2
	5	8C36
	6	CHU8
	7	627P
	9	8C36
	11	FA11
	13	41F7
	15	HFP7

Component	Pin	Signature
U512	1	FA11
	2	41F7
	3	HFP7
	4	UPA2
	5	8C36
	6	CHU8
	7	627P
	9	3F8H
	11	PC84
	13	627P
	15	CHU8
U112	2	3F8H
	3	PC84
	4	627P
	5	PC84
	6	627P
	7	CHU8
	8	8C36
	9	CHU8
	11	4596
	12	HFP7
	13	UPA2
	14	HFP7
	15	41F7
	16	FA11
	17	41F7
	18	FA11
	19	8C36

Table 5-15

Acquisition Data Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A18	Memory	670-6379-00	8-21	14

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	TP446	A18
Start	↑	TP252	A18
Stop	↓	TP252	A18

468 Setup

468 in Servicing Setup. Service Test ROM installed in U565 socket on A21. Service/Options switch set to X0010000. A/D Converter Simulator installed in U456 socket on A18. Counter chain test jumper P420 on A19 set to TEST position. To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—6PCP

Component	Pin	Signature	Alternate Signature
U312[a]	9	0000	6PCP
	11	7232	3919
	13	8C4P	9F46
	15	P39F	282U
U248	2	6PCP	
	3	6PCP	
	4	3CPF	
	5	3CPF	
	6	5A34	
	7	5A34	
	8	1F8F	
	9	1F8F	
	12	2595	
	13	2595	
	14	U97F	
	15	U97F	
	16	91FC	
	17	91FC	
	18	A70F	
	19	A70F	
U448	2	57A7	7232
	3	1F8F	1F8F
	4	5A34	5A34
	5	74UC	P39F
	6	F417	CCPA
	7	3CPF	3CPF
	8	6PCP	6PCP
	9	C75U	5CAU
	12	8A67	1FH2
	13	A70F	A70F
	14	91FC	91FC
	15	9104	9163
	16	A55U	8C4P
	17	U97F	U97F
	18	2595	2595
	19	0000	6PCP

[a] If initial signature on U312-9 is 0000, use "Signature" column throughout this test. If initial signature on U312-9 is 6PCP, use "Alternate Signature" column. Should an incorrect signature be obtained, recheck the signature on U312-9 to verify that logic state did not change.

Component	Pin	Signature	Alternate Signature
U320	2	5CAU	AHH7
	3	C75U	5CAU
	4	8A67	1FH2
	5	1FH2	5788
	6	CCPA	8414
	7	F417	CCPA
	8	9104	9163
	9	9163	1150
	12	0000	6PCP
	13	0000	6PCP
	14	57A7	7232
	15	7232	3919
	16	8C4P	9F46
	17	A55U	8C4P
	18	74UC	P39F
	19	P39F	282U
U432	1	5A34	5A34
	5	00FU	00A8
	6	0000	0000
	7	6P71	6P16
	9	2595	2595
	10	0000	6PCP
	11	1F8F	1F8F
	12	57A7	7232
	13	A55U	8C4P
	14	U97F	U97F
	15	74UC	P39F
U426	1	6PCP	6PCP
	2	6P71	6P16
	3	0000	0000
	4	00FU	00A8
	5	0000	0000
	9	91FC	91FC
	10	9104	9163
	11	3CPF	3CPF
	12	F417	CCPA
	13	8A67	1FH2
	14	A70F	A70F
	15	C75U	5CAU

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Table 5-16

Acquisition Address Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A18	Memory	670-6379-00	8-21	14

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	TP446	A18
Start	↑	U206-11	A18
Stop	↑	U206-11	A18

468 Setup

468 in Servicing Setup. Service Test ROM installed in U565 socket on A21. Service/Options switch set to X0010000. A/D Converter Simulator installed in U456 socket on A18. Counter chain test jumper P420 on A19 set to TEST position. To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—4596

Component	Pin	Signature
U206	9	4596
	7	P254
	15	57P4
	14	FA11
	13	41F7
	12	HFP7
	11	UPA2
	2	791C
U210	7	4596
	10	4596
	15	P254
	14	PC84
	13	627P
	12	CHU8
	11	8C36
	1	4596
	2	791C
U440A	1	4596
	2	791C
	3	0000
	4	4596
	5	3F8H
	6	791C

Component	Pin	Signature
U540	1	0000
	2	0000
	3	4596
	6	0000
	7	791C
	9	3F8H
	10	0000
	11	3F8H
	13	4596
	14	4596
	15	0000
U216	1	4596
	3	791C
	4	791C
	6	0000
	7	0000
	9	791C
	10	791C
	11	4596
	12	791C
	13	791C
	15	0000

Table 5-17

Acquisition RAM (Read) Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A18	Memory	670-6379-00	8-21	14

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	U108-1	A18
Start	↑	TP358	A21
Stop	↓	TP358	A21

468 Setup

468 in Servicing Setup. Service Test ROM installed in U565 socket on A21. Service/Options switch set to X0010011 To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—4596

Component	Pin	Signature
U108	2	3F8H
	3	3F8H
	4	PC84
	5	PC84
	6	627P
	7	627P
	8	CHU8
	9	CHU8
	11	HFP7
	12	HFP7
	13	41F7
	14	41F7
	15	FA11
	16	FA11
	17	8C36
	18	8C36
	19	0000

Component	Pin	Signature
U512	10	3F8H
	12	PC84
	14	627P
	16	CHU8
U508	10	8C36
	12	FA11
	14	41F7
	16	HFP7
U312	10	3F8H
	12	PC84
	14	627P
	16	CHU8
U306	10	8C36
	12	FA11
	14	41F7
	16	HFP7

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Table 5-18

Stop at 512 Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A16	Storage Display	670-6377-00 670-6377-01 670-6377-02	8-22	15,16

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	U245-3	A16
Start	↑	U618-9	A16
Stop	↑	U623-4	A16

468 Setup

468 in Servicing Setup. Service Test ROM installed in U565 socket on A21. Service/Options switch set to X0001010. To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—4596

Component	Pin	Signature
U407	11	CHU8
	12	627P
	13	PC84
	14	3F8H
U413	11	HFP7
	12	41F7
	13	FA11
	14	8C36
U418	12	0000
	13	0000
	14	CC34
U234	2	3F8H
	3	PC84
	4	627P
	5	CHU8
	6	0000
	7	4596
	9	FA11
	10	41F7
	11	HFP7
	12	CC34
	13	8C36

Component	Pin	Signature
U328	1	CC34
	2	0000
	3	0000
	4	41F7
	5	HFP7
	6	CHU8
	7	627P
	11	5641
	12	HU41
	13	UCHH
	14	31AU
	15	PC84
	16	FA11
	17	8C36
U334	1	CC34
	2	0000
	3	0000
	4	41F7
	5	HFP7
	6	CHU8
	7	627P
	11	HPH7
	12	590C
	13	6FU4
	14	1F9H
	15	PC84
	16	FA11
	17	8C36

Component	Pin	Signature
U623	1	HFP7
	2	0000
	3	0000
	5	4596
	6	4596
	10	0000
	11	0000
	12	CC34
	13	0000
U435	4	590C
	5	1F9H
	6	31AU
	7	UCHH
	8	HU41
	9	5641
	10	HPH7
	11	6FU4

Table 5-19

GPIB Data Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A17	GPIB	670-6378-00	8-24	23
A21	Microprocessor	670-6382-00,-01	8-20	18

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	U460-4	A17
Start	↑	TP358	A21
Stop	↓	TP358	A21

468 Setup

468 in Servicing Setup. Service Test ROM installed in U565 socket on A21. Service/Options switch set to 11111000. GPIB cable J135 disconnected. GPIB switch talk address set to 00000 and TALK ONLY switch set to 0 (off). To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—5456

Component	Pin	Signature
U450	1	5456
	10	54A7
	12	62UP
	15	3396
U460	1	3396
	2	62UP
	3	54A7
	5	0000
	6	5456
	7	75C4
	9	177A
	10	4672
	11	701C
	12	5446
	13	5476
	14	5416
	15	54H7
U340	2	40A3
	5	7C49
	6	040F
	9	0104
	12	0203
	16	4C32
	19	PA2A
U320[a]	1	54H7
	2	5456
	4	5456
	6	5456
	10	5456
	12	5456
	14	5456
	15	54H7
U320[b]	1	54H7
	2	0000
	4	0000
	6	0000
	10	0000
	12	0000
	14	0000
	15	54H7

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Component	Pin	Signature
U330	1	75C4
	2	5456
	4	0000
	6	0000
	8	PA2A
	12	0000
	14	5456
	16	0000
	18	0000
	19	75C4
U310D	8	5456
U310E	10	505A
	11	040F
U350	1	5456
	2	U706
	5	UU73
	6	PUU4
	9	1PUF
	11	701C
	12	7CUP
	15	CUHU
	16	UHF2
	19	HF17
U442A	1	0000
	2	505A
	3	5456
U442B	4	5456
	5	0000
	6	0000
U434B	3	PA2A
	5	5456
	6	CP7F

[a] Signatures with all switches on GPIB switch (S210) set to OPEN (OFF).

[b] Signatures with all switches on GPIB switch (S210) closed (ON).

Table 5-19 (cont)
GPIB Data Signatures

Component	Pin	Signature
U434C	8	0000
	9	5456
	10	5456
	11	5456
U152	1	0000
	2	8840
	3	HF16
	4	HF17
	5	U706
	6	U707
	7	A351
	9	A995
	10	UHF3
	11	UHF2
	12	CP7F
	13	UU73
	14	UU72
	15	AC24
U168	1	0000
	2	CCA3
	3	PUU5
	4	PUU4
	5	CUHU
	6	CUHP
	7	PC88
	9	4AAC
	10	1PUH
	11	1PUF
	12	CP7F
	13	7CUP
	14	7CUU
	15	2UA9

Component	Pin	Signature
U342	1	4672
	2	HF16
	4	UHF3
	6	CUHP
	8	7CUU
	12	1PUH
	14	PUU5
	16	UU72
	18	U707
	19	4672
U121	3	0000
	4	0000
	11	7C49
	12	CP7F
	14	0000
U110	2	5456
	7	5456
	9	5456
	12	5456
	15	1U64
U410A	1	5476
	3	0000
	5	0000

Table 5-20

Acceptor Handshake Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A17	GPIB	670-6378-00	8-24	23
A21	Microprocessor	670-6382-00,-01	8-20	18

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	U460-4	A17
Start	↑	TP358	A21
Stop	↓	TP358	A21

468 Setup

468 in Servicing setup. Service Test ROM installed in U565 socket on A21. Service/Options switch set to 11111001. GPIB cable J135 disconnected. TP335 connected to TP112. TP333 connected to TP114. To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—0UP7

Component	Pin	Signature
U460	1	0ACC
	2	0UP7
	3	0UA5
	6	0UP7
	7	055P
	9	0AUC
	12	0UP5
	13	0UA7
U330	2	0UP7
	4	03U8
	6	03FA
	8	0000
	12	0000
	14	0U16
	16	0081
	18	03U8
U121	2	0U16
	3	00U1
U110	2	0U16
	3	00U1
	6	03FA
	7	0F2H
	9	0F1H
	10	03UA

Component	Pin	Signature
U430A	3	0UP5
	4	0F1H
	5	03U8
	6	0F1U
U410A	1	0UA7
	2	03UA
	3	00U1
	5	0081
U410B	8	0UH7
	11	0UA7
	13	00U1
U421A	1	03UA
	2	00U1
	12	00U1
	13	03UA

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Table 5-21

Source Handshake Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A17	GPIB	670-6378-00	8-24	23
A21	Microprocessor	670-6382-00,-01	8-20	18

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	U460-4	A17
Start	↑	TP358	A21
Stop	↓	TP358	A21

468 Setup

468 in Servicing setup. Service Test ROM installed in U565 socket on A21. Service/Options switch set to 11111010. GPIB cable J135 disconnected. TP335 connected to TP111. TP333 connected to TP113. To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—UFP6

Component	Pin	Signature	Alternate Signature
U450	10	U8PF	
	12	U8PF	
	15	54C6	
U460	1	54C6	
	2	U8PF	
	3	U8PF	
	7	AF5A	
	9	54C6	
	14	U8PF	
U330	2	UFH5	
	4	0000	
	6	P4HC	
	8	7UF7	
	12	183H	
	14	UFP6	
	16	0000	
	18	0000	
U340	2	78FA	
	6	0007	
	19	7UF7	
U121	2	9F11	
	4	60U7	
	12	8321	
	14	0032	
	15	UFH4	
U110	2	UFP6	
	3	0000	
	6	P4HC	
	7	183H	
U310A	1	9F11	
	2	60U7	
U310E	10	UFP1	
	11	0007	
U310F	12	UFP6	
	13	0000	

Component	Pin	Signature	Alternate Signature
U442A[a]	1	0003	(0000)
	2	UFP1	
	3	UFH5	(0000)
U442B[a]	4	UFH5	(183H)
	5	0003	
	6	0032	
U442C[a]	9	60U7	
	10	9F11	(0000)
U442D[a]	11	9F11	(0000)
	12	P4HC	
	13	0000	(183H)
U434A	1	78FA	
	2	UFP6	
	13	P4HC	
U434B	3	7UF7	
	4	UFH5	
	6	8321	
U434C	8	0033	
	11	UFH5	
U421C	8	67UA	
	10	7UF7	
	11	P4HC	
U430B	8	9F11	
	10	9F11	
	13	67UA	
U440A[a]	1	U8PF	
	3	0000	(183H)
	5	183H	
	6	P4HC	

[a] Signatures in parentheses are derived by jumpering +5 V to U442-8 to break feedback path.

Table 5-22
Record Counter String Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A19	Time Base/Power Supply	670-6380-00	8-23	19

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	U120-9	A19
Start	↑	U110B-9	A19
Stop	↑	U524-13	A19

468 Setup

468 in Servicing Setup. Service Test ROM installed in U565 socket. Service/Options switch set to X0010001. To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—991H

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Table 5-23
Time Base Counter String Signatures

Version 1.0

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A19	Time Base/Power Supply	670-6380-00	8-23	19

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	U220B-9	A19
Start	↑	P420-1	A19
Stop	↑	P420-1	A19

468 Setup

468 in Servicing Setup. Service Test ROM installed in U565 socket. Service/Options switch set to X0010000. P420 moved to TEST position. To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—53UC

OPTIONS

Your instrument may be equipped with one or more options. This section provides a description of the available options and indicates, if necessary, where more detailed information is located in this manual.

NOTE

The 468 Oscilloscope cannot be equipped with both Option 02 and Option 11 due to use of common space.

OPTION 02—GPIB

When equipped with this option, the 468 has the capability to transmit a waveform message on a GPIB (General Purpose Interface Bus). During transmission, the last waveform acquired by the 468 will be sent to either a bus controller or a listener instrument. The waveform message format will conform to the Waveform Transmission Standard as specified in the Tektronix Standard, "General Purpose Interface Bus (GPIB, Codes and Formats (Rev C)".

Option 02 operating information and circuit descriptions are contained in this section of this manual. The schematic diagram, circuit board illustration, and block diagram are located in Section 8 of Volume II. Electrical and mechanical replaceable parts of Option 02 are integrated into the standard Replaceable Parts lists also located in Volume II of this manual.

NOTE

Section 8 of the internal Service/Options switch must be set to the closed position for the GPIB option to be enabled. Refer to Figure 5-6 in the Maintenance section of this manual for the switch location.

OPTION 04—EMC ENVIRONMENTAL

The instrument is modified to meet certain specification requirements related to conducted and radiated electromagnetic interference. This option does not affect the basic instrument operating instructions presented in this manual. Option 04 reduces conducted interference over the frequency range of 150 kHz to 25 MHz and radiated interference over the frequency range of 150 kHz to 1 GHz by the following modifications:

1. A cathode-ray tube mesh is installed to minimize crt faceplate radiation.
2. Capacitors are added acros the transformer secondary windings and from the B +GATE connector to ground to reduce conducted interference.
3. Shielding is added over the Storage Display circuit board and at the front rame to reduce radiated interference.
4. If the Option 02 GPIB circuit board is installed, additional shielding is added over the top of the board to reduce radiated interference.

Electrical circuitry changes are reflected in the partial schematic diagram of the power-input and transformer circuitry shown in Figure 6-1.

Electrical and mechanical replacement parts for Option 04 are integrated into the standard Replaceable Parts List located in Volume II of this manual.

OPTION 05—TV SYNC SEPARATOR

This option provides the instrument with front-panel selection of additional trigger-signal processing capabilities to facilitate observation and measurement of composite video and related television waveforms. A choice of either FIELD 1 or FIELD 2 sync is made available to the A Trigger Generator via the A TRIGGER SLOPE switch.

Option 05 operating information and circuit descriptions are located in this section. The schematic diagrams and circuit board illustration are located in the Diagrams section of Volume II of this manual. Replaceable electrical and mechanical parts lists are located in Volume II of this manual.

OPTION 11—X-Y OUTPUT

This option enables the 468 to convert the digital data stored in memory into analog X and Y outputs for driving an X-Y Plotter. Because the operation is largely automatic, only a few switch settings are required.

Option 11 operating information and circuit descriptions are located in this section. The schematic diagrams and circuit board illustration are located in the Diagrams section of Volume II of this manual. Replaceable electrical and mechanical parts list are located in Volume II of this manual.

OPTION 12—AVERAGING
(Standard SN B032430 and up)

This option enables the 468 digital storage circuitry to average the input signal for a selected number of sweeps. The displayed waveform will be updated at the end of each averaging cycle, and then the cycle will be repeated. Acquisition of low-amplitude waveforms is greatly enhanced by noise cancellation that occurs in the averaging process.

Operating information and circuit descriptions are located in Section 2 and 3 of this volume. Averaging option circuitry is integrated into the standard instrument schematic diagrams located in Section 8 of Volume II of this manual. Electrical and mechanical replaceable parts of Option 12 are integrated into the standard Replaceable Parts list also located in Volume II of this manual.

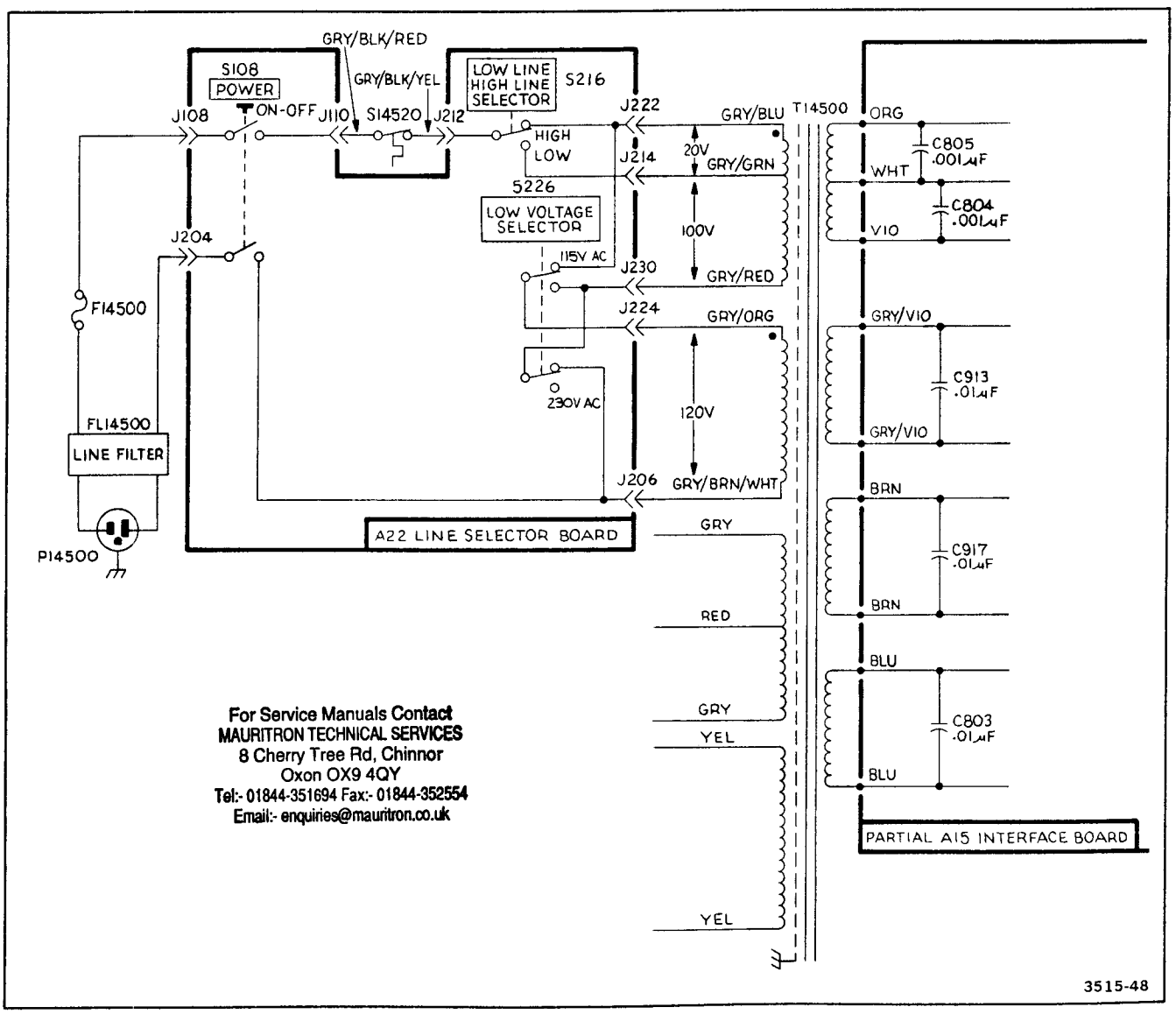

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Figure 6-1. The 468 Option 04 power-input and transformer circuitry.

OPTION 02—GPIB

GENERAL INFORMATION

The GPIB is a digital interface that allows efficient communication between the components of an instrumentation system. It is used for transmitting and receiving data between self-contained instruments or devices and acts as an interface system that is independent of device functions.

If the 468 is to be used without a GPIB hookup, service personnel can disable the GPIB option by setting section 8 of the internal Service/Options switch (S707) to the "OPEN" position. To enable the GPIB option prior to connecting the 468 to a GPIB system, service personnel must set section 8 of the Service/Options switch to the closed position. The Service/Options switch is located on the A16 STORAGE DISPLAY board and is shown in Figure 5-6 in the Maintenance section of this manual.

A Typical System on the GPIB

Figure 6-2 illustrates a typical system using the GPIB and shows the nomemclature established for the 16 active signal lines. While only four instruments are shown, the GPIB can support up to 15 independent devices connected directly to the bus. It is possible, however, to interface more than 15 instruments to a single bus. This is accomplished by connecting several instruments to a primary device, and then connecting only the primary device to the bus. Such a scheme can be used for programmable plug-in units housed in a mainframe. In this configuration the mainframe can be addressed with a primary address code, and the plug-in units can be addressed with a secondary address code.

Instruments connected to a single bus cannot be physically separated by more than 20 meters (total cable length), and at least one more than half the number of instruments on a bus must be in the power-on state. To maintain the electrical characteristics of the bus, one device load must be connected for each two meters of cable length.

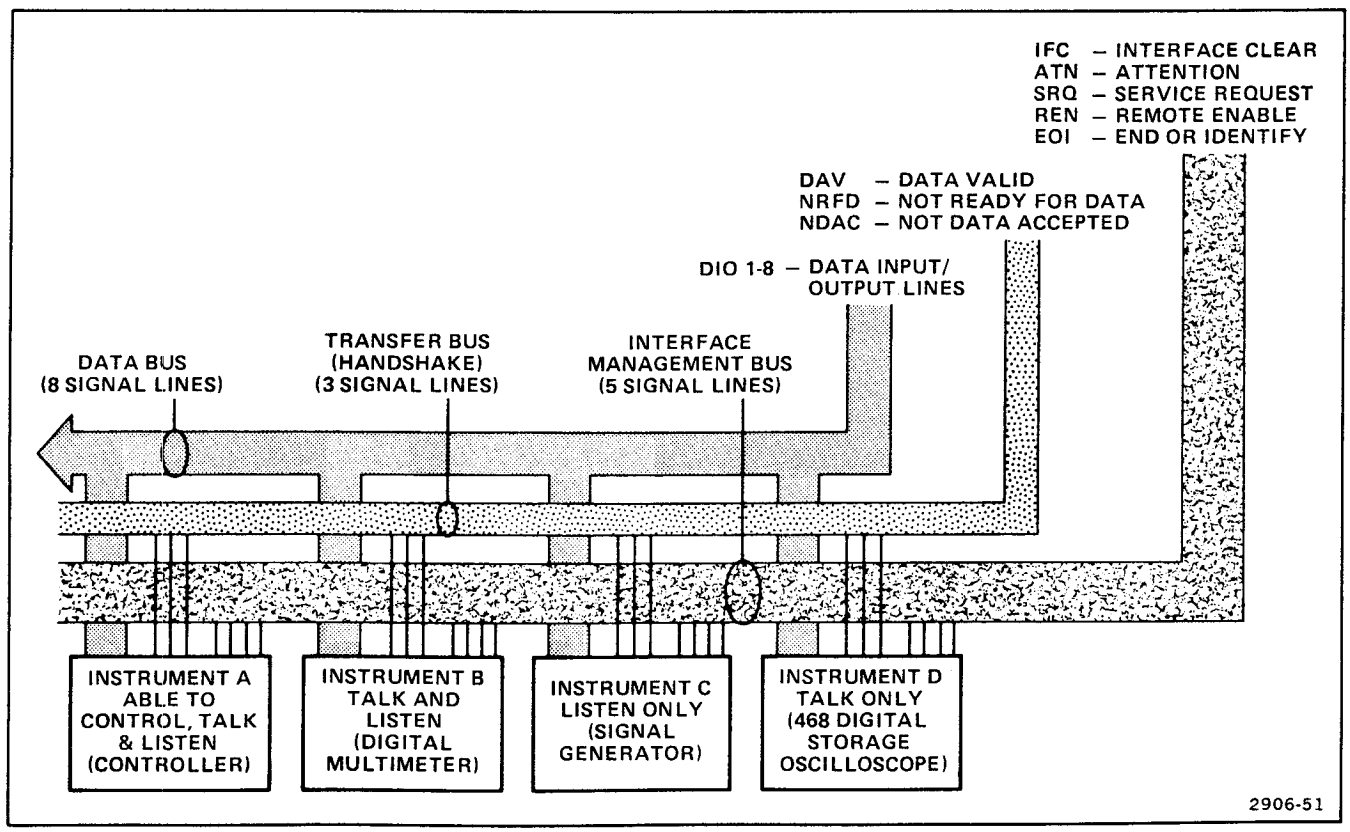

Figure 6-2. Atypical system using the general purpose interface bus (GPIB).

Controllers, Talkers, and Listeners

A talker is an instrument that can send data over the bus, while a listener is an instrument that can accept data from the bus. No instrument can communicate until it is enabled by the controller in charge of the bus. The 468 is a talker only. By setting the TALK ONLY switch (located on the 468 back panel) to the TALK ONLY position, it can be set up to operate as a talker without needing a controller on the bus. This setup is used when the 468 is in a system that has only listeners on the bus.

A controller is an instrument that determines which of the other instruments on a bus will talk and which instruments will listen during any given time interval. The controller also has the ability to assign itself as either a talker or a listener, whenever the program routine requires. In addition to designating the current talker and listeners for a particular communication sequence, the controller has the task of sending special codes and commands (called interface messages) to any or all of the instruments on the bus.

GPIB Signal Line Definitions

Figure 6-2 shows the 16 signal lines of the GPIB functionally divided into three component busses: an eight-line data transfer bus, a three-line transfer control (handshake) bus, and a five-wire management bus.

THE DATA BUS. The data bus has eight bidirectional signal lines, DIO1 through DIO8. Information, in the form of data bytes, is transferred over this bus. A handshake sequence between an enabled talker and the enabled listeners transfers one data byte (eight parallel bits) at a time. Data bytes in either an interface or device-dependent message are sent in a byte-serial, bit-parallel fashion over the data bus.

Since the GPIB handshake sequence is an asynchronous operation, the data transfer rate at any one time is only as fast as the slowest instrument involved in the data-byte transfer. A talker cannot place data bytes on the bus faster than any one listener can accept them.

THE TRANSFER BUS (HANDSHAKE). Each time a data byte is sent over the data bus, an enabled talker and all enabled listeners execute a handshake sequence via the transfer bus. A typical handshake routine showing the activity on the transfer-bus signal lines is illustrated in Figure 6-3. The attention (ATN) line is also shown to illustrate the controller's role in the process.

NOTE

On the GPIB signal lines, the TRUE level is the low voltage amplitude and the FALSE level is the high voltage amplitude.

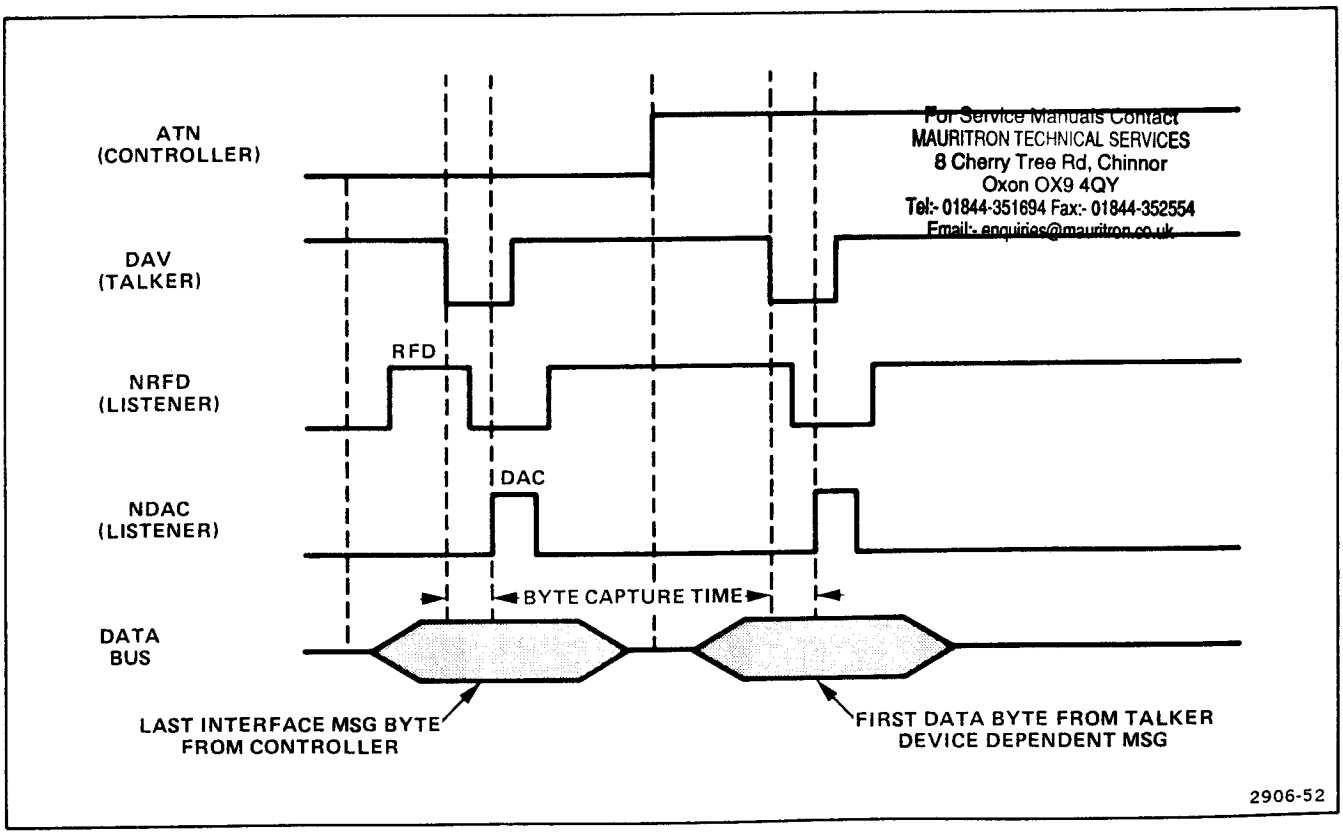

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Figure 6-3. A typical handshake timing sequence (idealized).

NOT READY FOR DATA (NRFD)—An asserted (TRUE) NRFD message indicates that one or more assigned listeners are not ready to receive the next data byte from the talker. When all of the assigned listeners for a particular data-byte transfer have released their NRFD, the NRFD message becomes FALSE. This RFD (Ready for Data) message tells the talker it may place the next data byte on the data bus.

DATA VALID (DAV)—The DAV message is asserted TRUE by the talker after the talker places a data byte on the data bus. When TRUE, DAV tells each assigned listener that a new data byte is on the data bus. The talker is inhibited from asserting DAV as long as any listener asserts the NRFD message.

NOT DATA ACCEPTED (NDAC)—Each assigned listener holds the NDAC message asserted TRUE until that listener accepts the data byte currently on the data bus. When all assigned listeners accept the current data byte, the NDAC message becomes FALSE. This DAC (Data Accepted) message tells the talker that all assigned listeners have accepted the current data, and the data may be removed from the bus.

When both NDAC and NRFD are FALSE at the same time, an invalid state exists on the bus, indicating that no listener is on the bus.

THE MANAGEMENT BUS. The management bus is a group of five signal lines (IFC, ATN, SRQ, REN, and EOI) which are used to control the operation of the GPIB.

INTERFACE CLEAR (IFC)—The system controller asserts the IFC message TRUE to place all interface circuitry in a predetermined quiescent state (this may or may not be the power-on state). Only the system controller can generate this signal. While IFC is TRUE, no other messages will be recognized.

ATTENTION (ATN)—A controller asserts the ATN message TRUE when instruments connected to the bus are being enabled as either talkers or listeners and when there is other interface-control traffic. As long as the ATN message is TRUE, only instrument address codes and control messages can be transferred over the data bus. With the ATN message FALSE, only those instruments enabled as a talker and listener(s) can transfer data. Only a controller can generate the ATN signal.

SERVICE REQUEST (SRQ)—Any instrument connected to the bus can request the controller's attention by sending the SRQ message. The controller may respond by executing a serial poll to determine which instrument is requesting service. An instrument requesting service identifies itself by asserting its DIO7 line TRUE in its status byte. When polled, the instrument requesting service removes the SRQ message.

REMOTE ENABLE (REN)—The system controller sends the REN message TRUE whenever the interface system is operating under remote program control. Used with other control messages, the REN message causes an instrument on the bus to select between two alternate sources of programming data. A remote-local interface function indicates to an instrument that it will receive information input from either the front-panel control (LOCAL) or from the interface (REMOTE). Since the 468 does not have a remote capability, it transmits data as determined by the setting of its front-panel controls.

END OR IDENTIFY (EOI)—A talker can use the EOI message to indicate the end of a data-transfer sequence. The talker sends the EOI message TRUE as the last byte of data is transmitted. In this sense, EOI is essentially a ninth data line and must observe the same setup times as the data bus lines.

GPIB Connector

Physical arrangement of the 24-pin GPIB connector (located on the rear panel of the 468) meets IEEE-488 (1978) GPIB standards. Sixteen pins are assigned to specific signals, and eight to shields and grounds. Voltage and current values required at the connector nodes are based on TTL technology (power source not to exceed +5.5 volts referenced to ground). The logic levels are defined as follows. Logical 1 is a TRUE state, low-voltage level ($\leq +0.8$ V), that is implemented when the signal line is asserted. Logical 0 is a FALSE state, high-voltage level ($\geq +2$ V), that is implemented when the signal line is not asserted. See Figure 6-4 for an illustration of connector pin assignments and physical arrangement.

Use a standard shielded GPIB cable with all the shields and grounds correctly connected to interconnect the 468 to other instruments on the bus. See the "Accessories" tab page at the back of Volume II of this manual for recommended part numbers.

Interface Functions and Commands

Since the 468 is a talker only, not all of the interface functions are enabled. Table 6-1 is a listing of the function subsets, including a description of the 468 capabilities with regard to those subsets. Table 6-2 is a listing of the interface commands to which the 468 responds, along with a brief description of each response.

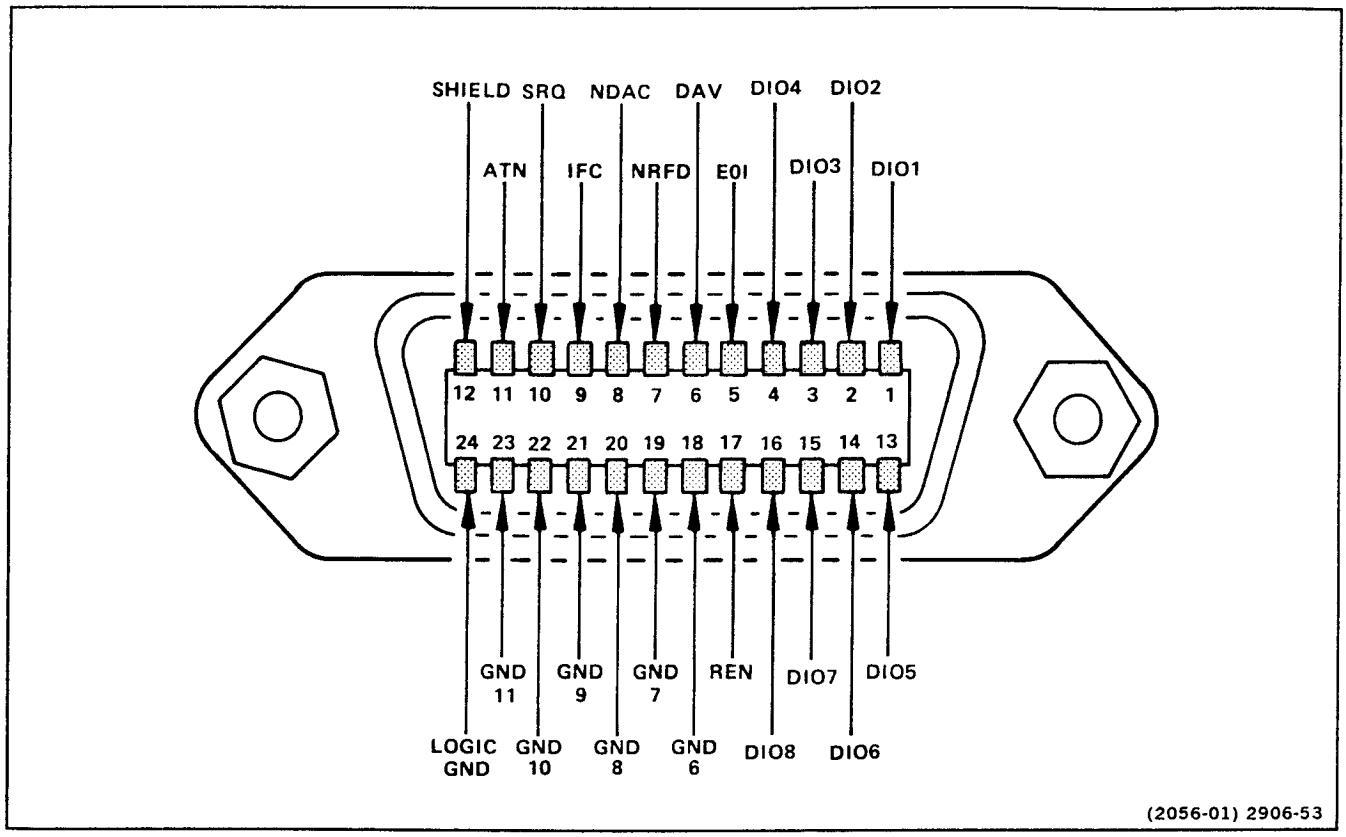

Figure 6-4. GPIB connector and pin assignments.

Table 6-1
468 GPIB Function Subsets

Identification	Description	States Omitted	Other Requirements	Other Required Subsets Used
SH1 (Source Handshake)	Complete Capability	None	None	T1
AH1 (Acceptor Handshake)	Complete Capability	None	None	None
T1 (Talker)	Basic Talker, Serial Poll, Talk Only Mode	None	Omit [MLA∧(ACDS)]	SH1 and AH1
L0 (Listener)	No Capability	All	None	None
SR1 (Service Request)	Complete Capability	None	None	T1
RL0 (Remote/Local)	No Capability	All	None	None
PP0 (Parallel Poll)	No Capability	All	None	None
DC2 (Device Clear)	Omit Selective Device Clear	None	Omit [SDC∧(LADS)]	AH1
DT0 (Device Trigger)	No Capability	All	None	None
C0 (Controller)	No Capability	All	None	None

Table 6-2

Interface Commands

GPIB Message	468 Interface Response
Interface Clear (IFC)	The 468 returns to the serial-poll-idle state (SPIS) and enters the talker-idle state (TIDS). End or Identify (EOI) and new byte available (nba) become unasserted. Talker LED ($\overline{\text{TIDS}}$) goes out, but the service request LED (SRQ) remains on if asserted. The 468 interface then waits for IFC to become unasserted before processing other GPIB traffic, including attention (ATN).
Device Clear (DCL)	If received during transmission of data, the 468 goes to a state of having completed the transmission. The SRQ is unasserted, and the 468 must receive a new My Talk Address (MTA) before it will begin transmitting again. DCL will not clear an SRQ issued by the 468 as part of the power-on routine. To remove the power-on SRQ, the instrument must be made a talker and the status byte sent. This ensures that the controller knows the 468 is powered up on the bus.
Serial Poll Enable (SPE)	The 468 interface enters the serial-poll-mode state (SPMS).
Serial Poll Disable (SPD)	The 468 leaves serial-poll-mode state (SPMS).
My Talk Address (MTA)	Binary address set by the GPIB switch on the 468 rear panel. Bus controller sends MTA to the 468 to obtain its status byte (serial poll) or to start its transmission of waveform data.
Untalk (UNT) or Other Talk Address (OTA)	468 untalks.

GPIB Switch Operation

The GPIB switch is located on the 468 rear panel (see Figure 2-10). It is used for selecting the talk address (MTA) to which the interface will respond and for controlling the TALK ONLY switch, and the remaining five sections of the switch select a five-binary talk address. Section 2 is the most significant bit of the address, and section 6 is the least significant bit (see Figure 6-5).

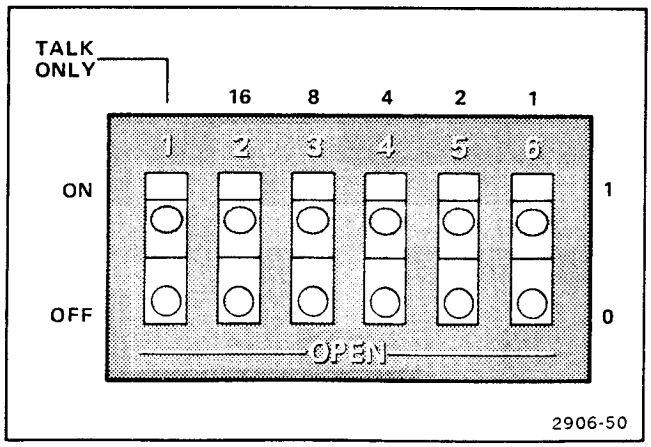

Figure 6-5. GPIB switch register.

The 468 waveform data transmission can be initiated in two ways: either by pressing the TRANSMIT push button (located on the digital storage right-side panel), or by being under the direction of a bus controller. Either method will cause the waveform to be transmitted, but the sequence of events that occur in the 468 GPIB interface and on the bus depends on the setting of the TALK ONLY switch.

TALK ONLY OFF. With a controller on the bus, the TALK ONLY mode should be OFF. This gives the controller maximum control of bus transactions. In this mode, a possible series of actions that may occur when the operator wants to send a waveform is as follows:

1. The TRANSMIT push button is pressed in.

2. A service request message (SRQ) is sent to the controller, and the 468 interface waits for the controller to respond.

3. The controller may respond by doing a serial poll. (This is optional and would not be required if the 468 were the only instrument on the bus.) A typical serial poll routine would be in the following sequence:

   a. Controller asserts the attention message (ATN) TRUE to gain control of the bus, then sends

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unlisten (UNL) and untalk (UNT). This prevents the listeners from receiving status bytes and prevents the current talker from sending data when the ATN is removed.

b. Controller then sends the serial-poll-enable message (SPE) to place all devices on the bus in the serial-poll mode.

c. During the poll, the controller sends ATN and each device's talk address (MTA), one at a time. As each device receives its own talk address, the controller will remove the ATN message, and the addressed device will send its status byte. The status byte will indicate to the controller each device's present state and which one(s) require servicing. (The 468 status byte will indicate that a waveform is available when the TRANSMIT button has been pressed.)

NOTE

The 468 will send (or attempt to send) its status byte as soon as the controller removes the ATN message. Should the controller fail to assign a listener for the status byte, the 468 status byte will be lost when ATN is asserted TRUE at a later time.

d. Upon finishing the serial poll, the controller sends ATN and the serial-poll-disable message (SPD), placing all devices in the serial-poll-idle state.

4. After the poll, the controller may reconfigure the bus, assigning listeners to receive the waveform data, if necessary.

5. With the listeners assigned, the controller then sends the 468 its talk address (MTA) to make the 468 a talker. When the controller removes the ATN message this time, the 468 sends waveform data. The waveform message is then handshaked out to the listeners, one byte at a time, and the message is terminated by the 468 sending LF (line feed) and EOI (end or identify) concurrently.

NOTE

Once the waveform message is completed and EOI sent, the 468 must receive its My Talk Address (MTA) again before it will transmit any other messages. The controller cannot cause the 468 to be a permanent talker.

Under the direction of a bus controller, the 468 will initiate a message transmission whenever it receives its talk address. Either a status byte or a waveform message (depending on the state of the 468 GPIB interface when the MTA is sent) will be transmitted by the 468, when the controller removes the ATN message.

TALK ONLY ON. When the 468 is in the TALK ONLY mode, the controller has less control of the 468 GPIB interface. In this mode the 468 will never enter the talker idle state (TIDS), because it is permanently addressed as a talker. The TALK ONLY mode is most useful when there is no controller on the bus, and the 468 is used to transmit waveform data to a listener. In the TALK ONLY mode with no bus controller, a typical series of actions that may occur when the operator wants to send a waveform is as follows:

1. The TRANSMIT button is pressed in.

2. A service request (SRQ) is sent, and the 468 begins to handshake the waveform data to a listener.

3. The transmission is completed, the message is terminated with line feed (LF) and end or identify (EOI), and the SRQ message is removed.

In the TALK ONLY mode with a controller on the bus, a typical series of actions that may occur when the operator wants to send a waveform is as follows:

1. The TRANSMIT button is pressed in.

2. The SRQ message is sent, and the 468 begins the handshake routine. At this point a controller may interrupt to respond to the SRQ and perform a serial poll. A response from the controller is not necessary; and if listeners are on the bus, the 468 GPIB interface will send the waveform message unless interrupted. If a controller either performs a serial poll or interrupts the message for any reason, the 468 will resume transmitting the message as soon as ATN is removed if it is out of the serial poll mode.

3. Again, the waveform message is terminated with LF and EOI, and the SRQ message is removed.

NOTE

If a listener or controller is not present to receive the waveform data when the TRANSMIT button is pressed, the 468 will remain in the SAVE Storage Mode while attempting to send the message. To exit this condition, it is necessary to cycle the POWER switch OFF, then ON again.

When a bus controller is used, any ATN message on the bus will cause the 468 interface to respond with a message when the ATN message is removed. In the TALK ONLY mode, the 468 is permanently addressed as a talker and does not require receipt of its talk address (MTA) before commencing a message transmission. The message to be sent depends on the state of the interface when the ATN message is removed. If the interface is in the serial-poll-active state (SPAS), a status byte will be sent; and if the interface is in the talker-active state (TACS), a waveform message will be sent.

NOTE

If the 468 is in the TALK ONLY mode, a bus controller cannot assign any other talkers on the bus. Therefore, when operating with a bus controller, the TALK ONLY switch should be OFF. The TALK ONLY switch must be set to ON when the bus has only listeners and when there is no controller to respond to a service request.

Power-up State

The state of the GPIB existing when the 468 is powered up is as follows:

1. If the 468 is powered on during a transmission on the bus, an error may occur in the handshake routine.

2. A power-on service request is issued. The power-on service request must be handled by a controller to remove it from the bus. When a controller receives the power-on status byte, it may reinitiate a bus transmission if one was in progress during the 468 power-on period.

3. The 468 interface is in the talker-idle and serial-poll-idle states.

4. Each power up completely resets the 468 interface, and the interface will be ready to transmit waveform data as soon as the 468 power-up routine is completed.

NOTE

When no waveform has been acquired, only the instrument ID portion of the waveform message will be transmitted.

Power-Down State

The 468 does not have any capability for handling momentary power interrupts. No settings are retained on power down, and no power-down routine is used. If the power level drops below the logic circuitry operating level, the 468 will fail in its processing.

GPIB Status Indicator

The GPIB Status LED ($\overline{\text{TIDS}}$/SRQ), located on the left side panel of the digital storage section, will be illuminated red when the service request (SRQ) is issued by the 468. During the serial poll (when the status byte is sent), it will flash green. During the transmission of data, it will be illuminated green to indicate to the user that the interface is not in the talker-idle state (TIDS).

GPIB Status Bytes

Status information relating to the state of the 468 GPIB interface is sent to the controller in the status byte during a serial poll. Two possible conditions exist: status with a service request asserted and status with no service request asserted. Table 6-3 contains a listing of the status bytes available.

When the controller is responding to a service request from another device, the 468 status bytes without a service request asserted tell the controller the state of the 468.

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Table 6-3

468 Status Bytes

Status		Status Byte			
		Binary	Octal	Hexidecimal	Decimal
SRQ ASSERTED	POWER ON	01000001	101	41	65
	TRANSMIT RQST	11000011	303	C3	195
	TON TRANSMIT RQST	11000100	304	C4	196
SRQ NOT ASSERTED	POWER ON	00000001	001	01	1
	TRANSMIT RQST	10000011	203	83	131
	TON TRANSMIT RQST	10000100	204	84	132
	NO STATUS	00000000	000	00	0

After the other device service request is handled, the controller uses the status reported by all the devices on the bus to determine what action occurs next. The action depends on controller programming.

As an example, assume that the 468 is in the middle of a transmission and some other device on the bus issues a service request. The controller interrupts the transmission of the 468 by asserting attention (ATN) TRUE, and then does a serial poll to determine the status of each device on the bus. Having handled the service request, the controller can then use the status reported by the 468 to restart or continue the transmission.

The controller may interrupt the transmission either synchronously (in step with the handshake) or asynchronously (no regard to handshake progress). If the controller interrupts synchronously, the last data byte sent will be data accepted (DAC) by all the assigned listeners, and it will not be lost. An asynchronous interruption may or may not cause the loss of a byte, depending upon the point of interruption.

The method of interruption may determine what action takes place to restart the 468 transmission. If no data is lost, the controller can reassign listeners and remove attention (ATN) to cause the 468 to resume transmission at the point of interruption. If data was lost, the controller might send a device clear (DCL) to reset the 468 (and all the listeners on the bus) and assign listeners. It will then send the 468 talk address to restart the waveform transmission.

468 GPIB Message Protocol

When the 468 is connected to a bus having a bus controller, it will send a message whenever it receives its talk address (MTA). The talk address is set by the GPIB switch located on the 468 rear panel (see GPIB Switch Operation).

If a Device Clear (DCL) message is received by the 468 during a transmission, the 468 stops transmitting and moves to a state equivalent to a completed transmission. The MTA message must be sent by the controller before another transmission can begin. A DCL message will not turn off the SRQ issued by the 468 as part of the power-on routine. To remove the power-on SRQ, the instrument must first be made a talker and the status byte sent. This ensures that the bus controller knows the 468 is powered up on the bus.

468 Message

The message sent by the 468 conforms to Tektronix Standard General Purpose Interface Bus (GPIB), Codes and Formats, Revision C and Appendices.

The term "message" as used here, refers to a device-dependent remote message. It is not an interface message, and it does not interfere with interface message coding or use.

A message represents a given amount of information, with the beginning and ending clearly defined. It is communicated between the 468 (as a talker) and one or more devices acting as listeners. The message begins when the 468

first begins functioning as a talker and receiving devices begin functioning as listeners.

MESSAGE FORMAT. A waveform message consists of an identification block and 0, 1, 2, or 3 waveforms, separated by delimiters. The following message format is described using BNF notation. The BNF symbols used are defined in Table 6-4.

Table 6-4
BNF Symbol Notation

Symbol	Definition
<>	Defined element.
::=	Is defined as.
()	Explanation.
{}	Grouping.
[]	Optional, may be omitted.
¦	Exclusive OR.
&	AND — designates concurrent messages on the bus (the element on the right of & is concurrent with the last element of the expression on the left.
"	String argument delimiter.
:	Link argument delimiter.
;	Message unit delimiter.
,	Argument delimiter.
%	Precedes a binary block argument.

The transmitted message is in the following format:

<MESSAGE>::=<ID>;
[<WAVEFORM>[;<WAVEFORM>]]]<TERMINATOR>

Each defined element is further broken down as follows:

<ID>::=ID <SCOPE TYPE>,<C AND F VERSION>,<FIRMWARE VERSION>

These message elements are further defined as follows:

<SCOPE TYPE>::=TEK/468 (Identifies the instrument as a Tektronix 468 Digital Storage Oscilloscope).

<C AND F VERSION>::=V79.1 (States the version of Tektronix Standard GPIB Codes and Formats in use—Version 79.1).

<FIRMWARE VERSION>::=FV:00000 (States the firmware version installed in the instrument).

An example of the identification element is:

ID TEK/468,V79.1,FV:1.0

NOTE

All punctuation, including spaces, must be as shown.

The waveform element is in the following format:

<WAVEFORM>::=<PREAMBLE>,<BLOCK BINARY CURVE>

These message elements are further defined as follows:

<PREAMBLE>::=WFMPRE <WPA>[{,<WPA>}...]

Where <WPA>::=(WAVEFORM PREAMBLE ARGUMENTS)

The following waveform preamble arguments are listed in the order in which they are transmitted in a message. After each, a brief description is given.

<WAVEFORM ID>::=WFID:"{CH1¦CH2¦ADD}{AC¦DC¦GND¦UNK}"

The defined elements of <WAVEFORM ID> are: the Vertical Mode selected for the waveform, the Input Coupling, and the Storage Mode. UNK will be sent for the Input Coupling when ADD is sent and when the Input Coupling is not the same for both channels.

<NUMBER OF POINTS>::=NR.PT:{256¦512}

The defined element is the length of the data record for the waveform being transmitted (256 or 512).

<POINT FORMAT>::=PT.FMT:Y

The Y-coordinate is transmitted, but the X-coordinate is determined from the data point number and the X INCREMENT.

<X INCREMENT>::=XINCR:{100¦40¦20¦10¦4¦2¦1¦400¦200}

The defined element increment multiplied by the X UNITS is the time between data points.

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<X ORIGIN>::=XZERO:0

X ORIGIN is defined as zero.

<POINT OFFSET>::=PT.OFF:{32!64!224!448}

The defined element is the trigger point, determined by the STORAGE WINDOW (PRE TRIG or POST TRIG). Actual trigger point is within ±3 of the given example values for point offset.

<X UNITS>::=XUNIT:{S!MS!US!NS}

X UNITS are used with the X INCREMENTS for the time scale of the waveform.

<Y MULTIPLIER>::=YMULT:{200!400!800'2!4!8!20!40!80!25!50!100!250!500!1000}

The defined element is a vertical scaling quantity determined by the VOLTS/DIV setting.

<Y ORIGIN>::=YZERO:0

Y ORIGIN is defined as zero.

<Y VALUE OFFSET>::=YOFF:<GND REF VALUE>

The defined element is the value of the vertical position of ground reference.

<Y UNITS>::=YUNIT:{V!MV!UV!DIV}

Defined element is the unit attached to the vertical value of each data point.

<DATA ENCODING>::=ENCDG:BIN

Curve data encoding is in low-level binary code.

<BINARY FORMAT>::=BN.FMT:RP

Each number sent is a binary, positive integer.

<BYTES PER NUMBER>::=BYT/NR:1

One byte is sent for each number.

<BITS PER NUMBER>::=BIT/NR:8

Eight bits are in each byte.

This ends the message preamble. The message continues with the waveform binary information.

<BLOCK BINARY CURVE>::=%<BINARY COUNT><BINARY DATA POINT>...<CHECKSUM>

These defined elements contain the waveform data and are further broken down as follows:

<BINARY COUNT>::=

(A two-byte binary integer to specify the number of data bytes plus the checksum byte—data bytes + 1. The high-order byte is sent before the low-order byte.)

<BINARY DATA POINTS>

(The binary value of the waveform at a specific data point.) This area contains a binary data-point-defined element for each data point in the waveform message.

<CHECKSUM>::=

(The two's complement of the modulo 256 sum of the preceding binary data bytes and the binary count bytes. Does not include the % symbol preceding the binary count.)

After the binary information of all the displayed waveforms is transmitted, the message is ended with the terminator.

<TERMINATOR>::=LF&EOI

(Line Feed and End or Identify). Line Feed sent concurrently with End or Identify terminates the message transmission.

The following example illustrates a typical waveform message with the ID element added to make a complete message.

ID TEK/468,V79.1,FV:1.0;WFMPRE WFID:"CH1 DC",NR.PT:512,PT.FMT:Y,XINCR:40,XZERO:0,PT.OFF:64,XUNITS:NS,YMULT:40,YZERO:0,YOFF:43,YUNIT:MV,ENCDG:BIN,BN.FMT:RP,BYT/NR:1,BIT/NR:8,%<BINARY COUNT><BINARY DATA POINT>....<CHECKSUM>LF&EOI

A more detailed explanation of the codes and formats is contained in Tektronix Standard General Purpose Interface Bus (GPIB), Codes and Formats (Rev. C).

Calculating Coordinate Values

The absolute coordinate values of the waveform data points are calculated using the information obtained from the message. In the point format used (PT.FMT:Y), only the Y-values are transmitted; the X-values are determined from both the data point number and the X-increment value. The transmitted data is used in the following formulas:

$$X_n = X0 + DX\,(n - N0) \quad \text{and}$$

$$Y_n = Y0 + SY\,(y_n - YR),$$

where the symbols used are defined as follows:

X_n, Y_n::=Absolute X- and Y-coordinate values at point n.

n::=data point number in the waveform curve (n = 1,2,3, ...512).

DX::=X-increment (horizontal distance between data points).

N0::=X-point offset (trigger point).

X0::=X-origin.

Y0::=Y-origin.

SY::=Y-multiplier (scaling factor).

y_n::=Y-data point value.

YR::=Y-value offset (ground reference).

X-COORDINATE VALUES. For example, the following information obtained from a sample message is used to find the X-coordinate of data point 14.

n = 14
X0 = 0
DX = 40
N0 = 64
X-units = ns

Substituting these values into the formula for X_n:

$$X_{14} = 0 + 40\ (14 - 64)$$

$$X_{14} = 40\ (-50) = -2000.$$

Adding the X-units, we find that the absolute coordinate value at data point 14 with respect to the trigger point (N0 = 64) is:

$$X_{14} = -2000 \text{ ns} = -2\ \mu\text{s}.$$

Positive X-coordinate values will be obtained for data points occurring after the trigger point.

NOTE

The position of the trigger point is determined by the selection of either PRE TRIG or POST TRIG Storage Window and by the manner in which dual-trace waveforms are stored (either ALT or CHOP).

The TIME/DIV switch setting and the horizontal graticule locations of data points 14 and 64 (trigger point) can then be determined from the X-increment, X-units, and absolute X-coordinate values.

Since there are 500 data points spanning the full 10 horizontal graticule divisions, the TIME/DIV switch setting can be found by the equation:

$$\text{TIME/DIV switch setting} = \frac{500\ DX}{10} = 50\ DX$$

where the units of DX are as specified by the X-units message element.

Substituting values into the formula, we obtain:

$$\text{TIME/DIV switch setting} = 50 \text{ data points/div} \times 40 \text{ ns/data point}$$
$$= 2000 \text{ ns/div}$$
$$= 2\ \mu\text{s/div}$$

The horizontal distance of data point 14 from the beginning of the trace can then be calculated from the formula:

$$\text{Horizontal distance} = \frac{DX\ (n)}{\text{TIME/DIV switch setting}}$$

Substituting values into the formula, we obtain:

$$\text{Horizontal distance} = \frac{40 \text{ ns/data point} \times 14 \text{ data points}}{2\ \mu\text{s/div}}$$

$$= \frac{560 \text{ ns}}{2\ \mu\text{s/div}} = \frac{0.56\ \mu\text{s}}{2\ \mu\text{s/div}}$$

$$= 0.28 \text{ divisions}$$

The horizontal distance from the beginning of the trace at which the trigger occurs can also be calculated using the same formula:

$$\text{Horizontal distance} = \frac{40 \text{ ns/data point} \times 64 \text{ data points}}{2\ \mu\text{s/div}}$$

$$= \frac{2500 \text{ ns}}{2\ \mu\text{s/div}} = \frac{2.5\ \mu\text{s}}{2\ \mu\text{s/div}}$$

$$= 1.25 \text{ divisions}$$

Y-COORDINATE VALUES. In a similar manner the absolute value of the Y-coordinate at data point 14 can

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also be calculated using the transmitted information. Continuing with the preceding example, the following Y-axis values are obtained from the sample message:

y_n = 63 (assumed value)

Y0 = 0

SY = 40

YR = 43

Y-units = mV

Substituting these values into the equation for Y_n:

$$Y_n = Y0 + SY(y_n - YR)$$

$$Y_{14} = 0 + 40\ (63 - 43)$$

$$Y_{14} = 40\ (20) = 800$$

Adding the Y-units, we find that the absolute Y-coordinate value at data point 14 is:

Y_{14} = 800 mV.

The positive value of Y_{14} indicates that the data point is located above the ground reference. Negative Y-coordinate values will be obtained for data points occurring below the ground reference. The Vertical POSITION control may be adjusted to place the ground reference at any desired location within the graticule area. Therefore the physical location of any data point (along the vertical axis) is determined by the positioning of the ground reference.

Knowing that the vertical resolution is 25 data points per division and using the given Y-axis example value, the vertical displacement of data point 14 above the ground reference can then be calculated from the formula:

$$\text{Vertical displacement} = \frac{Y_n}{25\ SY}$$

where the units of SY are as specified by the Y-units message element.

Substituting values into the formula, we obtain:

$$\text{Vertical displacement} = \frac{800\ \text{mV}}{25\ \text{data points/div} \times 40\ \text{mV/data point}}$$

$$= \frac{800\ \text{mV}}{1000\ \text{mV/div}}$$

= 0.8 divisions above ground reference

Driver Program

A sample program listing, useful when using the Tektronix 4051 Active Terminal, is given below. This program will act as a driver for the 4051 to control a bus with the 468 connected. In order to handle the service request issued by the 468 as part of the power-up self test, the driver program, or an operator-developed program, must be running when the 468 is powered up. This program will handle the 468 SRQ, copy the waveform message, and display the waveform with graticule and preamble.

When entering the program for use, the remarks (REM) may be omitted from the program. Additionally, the program lines less than 100 must be numbered as listed.

```
  1 ON SRQ THEN 2000
  2 REM: FOR INSTRUCTIONS ON USING THIS
    PROGRAM, SEE LINE 1000
  3 GO TO 100
  4 REM USER KEY #1: RUNS PROGRAM FROM
    BEGINNING WITH INSTRUCTIONS
  5 GO TO 100
  8 REM: USER KEY #2: DEVICE CLEAR
  9 WBYTE @20,95:
 10 GO TO 100
 12 REM: USER KEY #3: REQUEST WFM FROM
    INSTRUMENT
 13 WBYTE @A+64:
 14 RETURN
 99 REM: NOTE THAT INIT SENDS AN IFC
100 INIT
105 GOSUB 1000
106 H=1
108 T=1
110 ON SRQ THEN 3000
120 ON EOI THEN 4000
130 SET KEY
140 DIM X(512),Y(512),Q(10),P$(1)
150 X=0
160 Y=0
175 E=0
180 REM: PROCESS REQUEST QUEUE
185 REM: THE QUEUE ALLOWS UP TO 9 SRQ'S TO
    BE RECEIVED AND SAVED FOR
186 REM: PROCESSING IF THIS PROGRAM IS
    ALREADY PROCESSING A PREVIOUSLY
187 REM: RECEIVED SRQ.
195 PRINT "WAITING FOR GPIB INTERRUPT"
200 IF H=T THEN 200
210 GO TO Q(H) OF 270,215,290,320
215 PRINT "ILLEGAL REQUEST"
219 REM: REMOVE REQUEST FROM QUEUE
220 Q(H)=0
223 REM: DON'T LET SRQ INTERRUPT NEXT FEW
    LINES
225 OFF SRQ
230 H=H+1
```

```
235 REM: SEE IF PAST QUEUE END; IF SO, WRAP
    AROUND TO BEGINNING
240 IF H<=10 THEN 260
250 H=1
255 REM: TURN SRQ ENABLE BACK ON
260 ON SRQ THEN 3000
265 GO TO 195
269 REM: POWER-ON SERVICE REQUEST ROUTINE
270 PRINT "POWER-ON SERVICE REQUEST
    RECEIVED"
275 PRINT
280 GO TO 220
289 REM: REQUEST TO SEND WAVEFORM
290 PRINT "READY TO SEND WAVEFORM"
295 PRINT
300 GOSUB 500
310 GO TO 220
320 REM: TALKER-ONLY SERVICE REQUEST
330 PRINT "TALKER-ONLY SERVICE REQUEST
    RECEIVED"
340 PRINT "UNABLE TO PROCESS REQUEST;
    ISSUING DEVICE CLEAR"
345 PRINT
350 GO TO 8
500 REM:##############################
501 REM:
502 REM: SUBROUTINE TO ASSIGN TALKER AND
    PICK UP WAVEFORM
503 REM:
504 REM:##############################
505 REM: SEND TALK ADDRESS TO DEVICE
506 REM: ADD 64 TO DEVICE ADDRESS (SET BIT 7
    TO TALK DEVICE)
510 WBYTE @A+64:
515 PAGE
519 REM: CALL ROUTINE TO DRAW GRATICULE
520 GOSUB 6000
550 REM: SET FIELD TO 0
560 F=0
564 REM: SET OUTPUT FLAG TO FALSE (0)
565 O=0
568 REM: SET COORDINATES OF FIRST PRINT
    FIELD OF SCREEN
570 X1=0
580 Y1=98.176
585 REM: DEFINE LIMITS OF SCREEN
586 VIEWPORT 0,130,0,100
587 WINDOW 0,130,0,100
590 REM: PICK UP A BYTE AND DECIDE WHETHER
    OR NOT TO PRINT IT
600 MOVE X1,Y1
605 RBYTE P
606 IF E=0 THEN 609
607 E=0
608 RETURN
609 REM: CHECK INPUT
610 IF P<0 THEN 605
620 IF P=10 THEN 605
630 REM: CONVERT BYTE TO A CHARACTER
635 P$=CHR(P)
638 REM: IF ;, THEN END OF WFM ID OR END OF A
    WAVEFORM
640 IF P$=";" THEN 830
645 REM: IF % , MEANS BEGINNING OF WAVEFORM
    POINT DATA
650 IF P$="%" THEN 860
655 REM: IF ANYTHING OTHER THAN COLON, GO
    ON TO SEE IF SHOULD PRINT IT
660 IF P$<>":" THEN 710
665 REM: HAVE ENCOUNTERED A COLON; END OF
    FIELD, INCREMENT FIELD COUNT
670 F=F+1
675 REM: SEE IF WE HAVE ENCOUNTERED TOO
    MANY FIELDS (SHOULD HAVE 16 MAX)
680 IF F<16 THEN 700
685 REM: RESET FIELD COUNT TO 1 IF HAVE
    EXCEEDED COUNT OF 16
690 F=1
695 REM: TURN OUTPUT FLAG ON (1)
700 O=1
705 REM: CHECK FIELD #'S TO SEE IF SHOULD
    PRINT THIS FIELD
710 IF F=1 THEN 760
720 IF F=4 THEN 760
730 IF F>5 AND F<9 THEN 760
740 IF F>9 AND F<12 THEN 760
745 REM: IF NOT A FIELD TO BE PRINTED, GO
    BACK AND GET NEXT BYTE
750 GO TO 605
760 REM: SEE IF WE SHOULD PRINT THIS PART OF
    THE FIELD
765 IF O=0 THEN 605
766 REM: OUTPUT FLAG SET TRUE
769 REM: DON'T WANT TO PRINT COLONS
770 IF P$=":" THEN 605
775 REM: PRINT CHARACTER AND SUPPRESS LINE
    FEED
780 PRINT P$;
785 IF P$<>"," THEN 605
786 REM: COMMA MEANS END OF FIELD. TURN
    OFF OUTPUT FLAG.
790 O=0
794 REM: CHECK TO SEE IF WE SHOULD GO TO
    NEXT LINE OF SCREEN
795 REM: IF HAVE JUST FINISHED FIELD 1 OR 7,
    NEXT LINE
796 IF F=1 THEN 800
797 IF F=7 THEN 800
798 GO TO 605
800 REM: CHANGE YCOORD TO POINT TO NEXT
    LINE
810 Y1=Y1-2.816
820 GO TO 600
825 REM: HAVE COME TO END OF ID OR END OF
    WAVEFORM. RESET FIELD, OUTPUT
830 F=0
835 O=0
838 REM: MOVE TO NEXT X PRINT FIELD
```


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```
840  X1=X1+26.88
850  GO TO 580
860  REM: PICK UP WAVEFORM DATA. FIRST GET
     HIGH BYTE COUNT.
865  RBYTE B1
869  REM: GET LOW BYTE OF BYTE COUNT.
870  RBYTE B2
872  REM: INITIALIZE CHECKSUM TO SUM OF HIGH
     AND LOW BYTES
875  C=B1+B2
879  REM: CONVERT TWO BYTES OF COUNT TO
     ONE NUMBER
880  B=B1*256+B2-1
885  REM: REDIMENSION WAVEFORM DATA
     ARRAYS
886  DIM Y(B),X(B)
890  REM: READ IN WAVEFORM DATA POINTS
895  FOR I=1 TO B
900  RBYTE Y(I)
905  X(I)=I
908  REM: ADD BYTE TO CHECKSUM TOTAL
910  C=C+Y(I)
920  NEXT I
925  C=C-INT(C/256)*256
930  REM: READ IN CHECKSUM FROM GPIB NOW
935  RBYTE C1
936  REM: VERIFY CHECKSUM
940  IF C1+C<>256 THEN 990
950  REM: IF CHECKSUM WAS OKAY, GO AHEAD
     AND DRAW WAVEFORM
960  GOSUB 1350
965  REM: GO BACK NOW AND SEE IF MORE
     WAVEFORMS BEING SENT
970  GO TO 605
990  PRINT "CHECKSUM INCORRECT"
995  GO TO 8
999  REM:##############################
1000 REM:##############################
1001 REM:
1002 REM: INSTRUCTIONS FOR RUNNING THIS
     PROGRAM
1003 REM:
1004 REM:--------------------------
1005 PAGE
1006 PRI "THIS IS A PROGRAM TO DEMONSTRATE
     THE GPIB OPTION OF THE 468."
1007 PRINT
1008 PRINT "INSTRUCTIONS:"
1009 PRINT
1010 PRINT "USER KEYS USED IN THIS PROGRAM:"
1011 PRINT
1012 PRINT " #1: STARTS THIS PROGRAM
     RUNNING"
1013 PRINT
1014 PRINT " #2: ISSUES A DEVICE CLEAR TO THE
     468 AND RESTARTS PROGRAM "
1015 PRINT
1016 PRINT " #3: ASSIGNS INSTRUMENT AS
     TALKER (REQUESTS A WAVEFORM)"
1017 PRINT
1018 PRI "WHEN A WAVEFORM IS SENT THE
     FOLLOWING INFORMATION IS PRINTED"
1019 PRINT
1020 PRINT "VERSION NO.  CHANNEL, COUPLING"
1021 PRINT "                XMULTIPLIER,
                TRIGGER POINT, X
                UNITS"
1022 PRINT "                YMULTIPLIER,
                GROUND POINT, Y
                UNITS"
1023 PRINT
1024 PRINT "AFTER ALL WAVEFORMS HAVE BEEN
     DRAWN, YOU MUST PRESS <CR>"
1025 PRINT " TO PAGE THE SCREEN AND GO BACK
     TO WAITING FOR THE NEXT"
1026 PRINT " GPIB REQUEST."
1027 PRINT
1028 PRINT "MAKE SURE THE GPIB CABLE IS
     CONNECTED BEFORE SENDING A"
1029 PRINT " WAVEFORM OR REQUESTING ONE
     USING THE 4051."
1030 PRINT
1031 PRINT "THIS PROGRAM CAN BE
     AUTOLOADED IF IT IS FILE #1 ON TAPE."
1032 PRINT
1033 PRINT "PRESS <CR> TO CONTINUE"
1034 DIM I$(1)
1035 INPUT I$
1038 PAGE
1040 PRINT "ENTER GPIB ADDRESS OF 468
     (NUMBER BETWEEN 0 AND 30):";
1045 INPUT A
1050 IF A<0 THEN 1065
1055 IF A>30 THEN 1065
1060 RETURN
1065 PRINT "ADDRESS IS OUTSIDE 0-30 RANGE.
     RE-ENTER ADDRESS:";
1070 GO TO 1045
1350 REM:##############################
1351 REM:
1352 REM:  ROUTINE TO PLOT WAVEFORM
1353 REM:
1354 REM:##############################
1355 VIEWPORT 20,122.4,0,102.4
1358 REM: CHECK NUMBER OF WAVEFORM BYTES
1360 IF B=256 THEN 1375
1363 REM: IF 512 POINTS, SET PLOT FOR 512 PTS
1365 WINDOW 1,512,0,255
1370 GO TO 1380
1374 REM: IF 256 POINTS, ONLY SET FOR 256 PTS
1375 WINDOW 1,256,0,255
1378 REM: MOVE TO ORIGIN OF PLOT
1380 MOVE 0,0
1385 REM: DRAW WAVEFORM
1390 DRAW X,Y
1394 REM: RETURN CURSOR TO UPPER LEFT
     CORNER OF SCREEN
1395 HOME
```

```
1398  RETURN
2000  REM: THIS IS HERE IN CASE AN SRQ IS
      ASSERTED BEFORE THIS PROGRAM
2001  REM:  IS STARTED RUNNING.
2005  DIM Q(10)
2010  GOSUB 1000
2015  H=1
2020  T=1
2025  GOSUB 3000
2030  GO TO 110
3000  REM:################################
3001  REM:
3002  REM:  SRQ SERVICE ROUTINE
3003  REM:
3004  REM:################################
3005  REM: POLL DEVICES TO SEE WHICH
      INSTRUMENT REQUESTED SERVICE
3010  POLL D,S;A
3020  REM: ONLY 1 DEVICE ATTACHED, NO NEED
      TO CHECK DEVICE NUMBER (D)
3021  REM: ADJUST STATUS SO IT IS A NUMBER
      BETWEEN 1 AND 4
3022  REM: STATUSES: PON = 65, TRANSMIT
      REQUEST = 195, TON = 196
3025  IF S<64 THEN 3100
3030  S=S-64
3035  REM: NOW CHECK TO SEE IF IT IS TRANSMIT
      OR TON
3040  IF S<100 THEN 3060
3045  REM: IF TRANSMIT OR TON, MUST ADJUST
      AGAIN (SUBTRACT 128)
3050  S=S-128
3055  REM: NOW SET TASK TO BE PROCESSED (ADD
      TO TASK QUEUE)
3060  Q(T)=S
3065  T=T+1
3070  IF T<=10 THEN 3080
3075  T=1
3080  IF H=T THEN 3090
3085  RETURN
3090  REM: A QUEUE ERROR OCCURRED. QUEUE IS
      FULL.
3095  PRINT "QUEUE FULL - PROGRAM ABORTED"
3099  GO TO 8
3100  REM: ILLEGAL STATUS BYTE PICKED UP
3110  PRINT "ILLEGAL STATUS BYTE RECEIVED.
      STATUS = ";S
3115  PRINT "ISSUING DEVICE CLEAR"
3120  GO TO 8
4000  REM:################################
4001  REM:
4002  REM:  EOI ROUTINE
4003  REM:
4004  REM:################################
4005  REM: SET FLAG TO SAY EOI ENCOUNTERED
4006  REM: UNTALK AND UNLISTEN ALL DEVICES
4007  WBYTE @63,95:
4008  DIM C$(1)
4010  E=1
4015  REM: WAIT FOR OPERATOR TO ENTER A KEY
      BEFORE RETURNING
4020  INPUT C$
4025  PAGE
4030  RETURN
6000  REM:################################
6001  REM:
6002  REM:  ROUTINE TO DRAW GRATICULE FOR
      WAVEFORM DISPLAY
6003  REM:
6004  REM:################################
6005  REM: DRAW GRATICULE IN LOWER RIGHT
      PORTION OF SCREEN
6010  VIEWPORT 20,120,10,90
6015  REM: SET LIMITS OF GRAPHICS
6020  WINDOW 0,511,101.4,920.6
6025  REM: POSITION CURSOR TO BEGIN DRAWING
      GRATICULE
6030  MOVE 0,101.4
6040  DRAW 511,101.4
6050  DRAW 511,920.6
6060  DRAW 0,920.6
6070  DRAW 0,101.4
6080  AXIS 10.24,20.48,255,511
6090  FOR I=1 TO 9
6100  AXIS 0,0,I*51.2,I*102.4+101.4
6110  NEXT I
6120  VIEWPORT 30,130,0,100
6130  WINDOW 0,511,0,1023
6140  HOME
6150  RETURN
```

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OPTION 05—TV SYNC SEPARATOR

The information and instructions presented here apply to the use of the 468 Option 05 instrument in TV applications. Refer to the appropriate sections of the Operator's or Service manuals for use and operation of the instrument for non-TV applications.

GENERAL INFORMATION

Option 05 includes a TV Sync Separator and provides the instrument with front-panel selection of additional trigger-signal processing to facilitate observation and measurement of composite video and related television sync recognition. Vertical (field rate) and horizontal (line rate) trigger signals are selected with the A TRIGGER COUPLING switch for A Sweep triggering. Horizontal (line rate) trigger signals for B Sweep triggering are selected with the B TRIGGER SOURCE switch.

For interlaced video signals, the TV FIELD trigger signals may start the A Sweep on either Field 1 or Field 2 ("even" or "odd" fields respectively in CCIR System B terminology). Trigger signal selection is accomplished with the A TRIGGER SLOPE switch.

When the A TRIGGER COUPLING switch is set to either TV FIELD or TV LINE (see Figure 6-6), the A TRIGGER SOURCE switch selects the source of the signals to be processed in the Sync Separator. This includes NORM (composite vertical signal), CH 1, CH 2, EXT, or EXT/10. (LINE source is not a usable function with TV FIELD or TV LINE coupling.)

With the A TRIGGER COUPLING switch set to either TV FIELD or TV LINE, the selected sync output from the Sync Separator is automatically applied to the A Sweep TRIGGER circuit for use as the triggering signal for the A Sweep. For the B Sweep, the horizontal-sync signal (line-rate sync) from the Sync Separator is fed only to the TV LINE position of the B TRIGGER SOURCE switch to be selected at the option of the user.

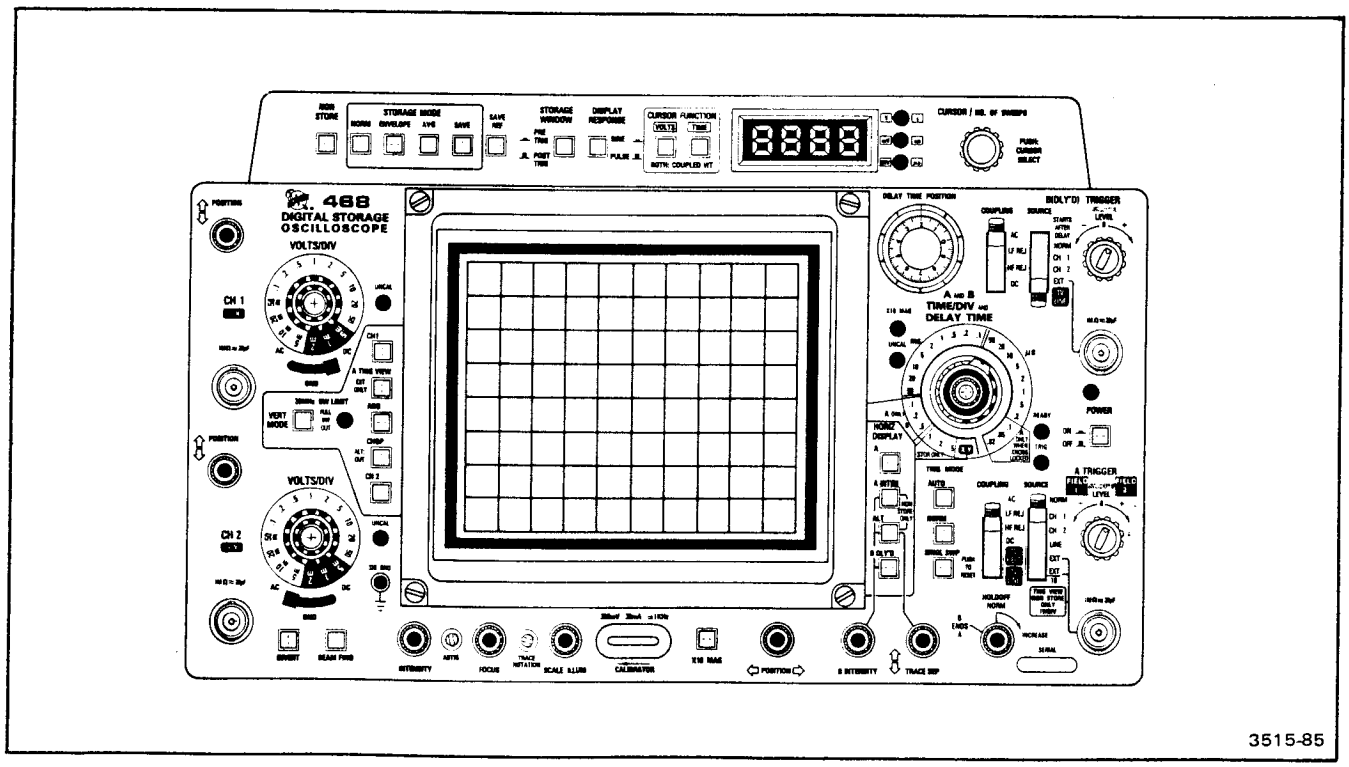

Figure 6-6. The 468 Oscilloscope with Option 05.

Option 05 circuitry requires sync-negative composite video for proper operation. This signal polarity is used with most standard broadcast systems employing 405 to 819 lines at 50- or 60-Hz field rates and with closed-circuit systems having up to 1201 lines at a 60-Hz field rate. Sync-positive video may be used as discussed later under "Operation of the Sync Separator."

To optimize video measurements, the vertical amplifier AC coupling input capacitors are increased from 0.019 μF to 0.2 μF. The larger physical size of these capacitors increases the input shunt capacitance to a normalized value of 24 pF.

SPECIFICATION

Electrical characteristics and performance requirements listed in the "Specification" part of this manual are applicable to the 468 Option 05 oscilloscope with the following exceptions or additions.

Vertical Input

Resistance	1 MΩ ±2%
Capacitance	24pf ± 10%
Time Constant	24μs ± 12%

AC Input Coupling

Low Frequency —3dB Point

Direct	1 Hz
Via 10X Passive Probe	0.1 Hz

Tilt (10-ms pulse)

Direct	2.5%
Via 10X Passive Probe	0.25%

Triggering

Sync Separation	Stable video rejection and sync separation from sync-negative composite video, 525- to 1201-line, 50- or 60-Hz field rate.

Sync-positive composite video can be separated by applying the input signal to the CH 2 input connector and using the CH 2 INVERT feature.

FIELD 1 and FIELD 2 trigger signals are selectable with the A TRIGGER SLOPE switch for interlaced field systems. A trigger signal is generated for every field in noninterlaced field systems.

Trigger Amplitude		Min	Max
Internal	Composite Video (nominal)[a]	1.5 div	15 div
	Composite Sync	0.5 div	20 div
External	Composite Video (nominal)	150 mV	1.5 V
	Composite Sync	50 mV	2.0 V
EXT/10	Composite Video (nominal)	1.5 V	15 V
	Composite Sync	500 mV	20 V

[a] **Peak video is approximately 7/3 sync amplitude.**

Furnished Accessories

The following accessories are provided with Option 05 instruments:

1 Graticule, NTSC (CCIR System M): −40 to +100 units, with 7.5-unit setup line; horizontal divisions along line zero (for part number see Option 05 "Accessories" in Volume II of this manual).

1 Graticule, CCIR (CCIR System B): zero to +100 units, 35-unit setup line; horizontal divisions along line 30 (for part number see Option 05 "Accessories" in Volume II of this manual).

OPERATING INSTRUCTIONS

Installation of the Video Graticule

To install a video graticule:

1. Loosen the four captive bezel securing screws about six turns and remove the bezel.

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2. Remove the implosion shield from the two bosses on the bezel and install the desired graticule ensuring that the markings are on the surface away from the crt face. The graticule can be positioned horizontally a small amount to align the external graticule and mask with the internal crt graticule lines.

NOTE

The extended tab at the bottom of the video graticule mates with the slightly wider bottom margin of the graticule cover.

3. Position the bezel in place and secure it with the four captive screws.

Vertical Calibration for CCIR and NTSC Video Graticules

When the video graticule is installed, the 10 horizontal divisions along line 0 correspond to the internal graticule divisions, and the TIME/DIV calibration of the oscilloscope remains unchanged. However, the vertical divisions represent only proportions of the 100-unit (CCIR) or the 140-unit (NTSC) video waveform, and the vertical VOLTS/DIV calibration is inapplicable.

To calibrate for a standard 1-volt (nominal) video signal, apply the 300-mV CALIBRATOR square-wave signal to either the CH 1 or CH 2 vertical input and adjust the associated VOLTS/DIV and VOLTS/DIV VAR controls so that the displayed waveform occupies either 30 units on the CCIR graticule or 42 units on the NTSC graticule. This adjustment may be made with a well-focused, free-running display.

Operation of the Sync Separator

To trigger the 468 on a video signal, perform the following steps:

1. Set the A TRIGGER COUPLING switch to either TV FIELD or TV LINE.

2. Determine the polarity of the composite video or composite sync waveform applied to the 468. The Sync Separator requires normal (sync-negative) video sync at the negative peak. To obtain proper Sync Separator operation from inverted (sync-positive) video (sync at the positive peaks and peak video at the negative peaks), apply the signal to the CH 2 input connector, select CH 2 as the A TRIGGER SOURCE, and use the CH 2 INVERT feature to obtain the proper signal polarity.

NOTE

Composite Sync is the vertical and horizontal sync signals combined in a single waveform, but without video (picture) information. Composite Video is the picture waveform complete with vertical and horizontal blanking and sync components.

3. Use the A TRIGGER SLOPE switch to select the desired field for use as the trigger signal if the A TRIGGER SOURCE switch is set to the TV FIELD position.

For special considerations in dual-trace modes (ALT or CHOP), refer to "Vertical Operating Modes-Special Considerations" in this section. For internal triggering, the sync portion of the displayed waveform should be at least 0.5 cm high (7 units, or 0.35-division, on the CCIR graticule; on the NTSC graticule it should be 10 units, or about 0.5-division). For external triggering, the sync portion of the waveform should be at least 50 mV in amplitude (or 0.50 V with the SOURCE switch set to EXT/10). To avoid circuit overload and partial or complete loss of sync, do not exceed the specified maximum composite video amplitude (15 div for internal triggering; 1.5 V for external triggering).

Triggering the Sweep

The output of the Sync Separator is fed via the A TRIGGER COUPLING switch to the A Sweep Trigger circuit and via the B TRIGGER SOURCE switch to the B Sweep Trigger circuit. Triggering the A Sweep from the TV FIELD or TV LINE sync signal rerquires only the proper setting of the A TRIGGER LEVEL control.

When TV FIELD rate triggering is used, selecting either Field 1 or Field 2 sync is accomplished by setting the A TRIGGER SLOPE switch to the desired field. In the PAL four-field TV system, the FIELD 1 position selects either Field 1 or Field 3, and the FIELD 2 position selects either Field 2 or Field 4. Refer to "Identifying Fields, Frames, and Lines in 525/60 and 625/50 TV Systems" to identify the specific field being viewed.

To trigger the B Sweep from the line-rate trigger output of the Sync Separator, perform the following steps:

1. Set the A TRIGGER COUPLING switch to either TV FIELD or TV LINE and ensure that the A Sweep is running.

NOTE

The B Sweep cannot be operated independently of the A Sweep and cannot run more than once for each A Sweep cycle. For composite line displays, refer to "Special Measurements" in this section.

2. Set the B TRIGGER SOURCE switch to TV LINE.

3. Adjust the B TRIGGER LEVEL control for a stable, triggered sweep.

Vertical Operating Modes-Special Considerations

DUAL-TRACE MODES. For dual-trace operation, the Sync Separator input must be taken from CH 1, CH 2, or an external source. (When only one trace is displayed on the crt, the NORM position of the A TRIGGER SOURCE switch may be used.) The Sync Separator cannot correctly process switched (composite vertical deflection) waveforms present on the NORM trigger signal line in either the ALT or CHOP dual-trace vertical mode; it is therefore not possible to obtain stable simultaneous displays of two independent video signals that are not time related.

SINGLE-CHANNEL TRIGGERING. When triggering from Channel 1 or Channel 2, the waveform fed to the Sync Separator is the same (except for positioning) as that displayed on the crt when the channel is selected to display a signal. If the VOLTS/DIV VAR control is used to reduce displayed ampliltude, then the signal to the Sync Separator is also reduced. When the Channel 2 INVERT switch is pressed in, the CH 2 signal to the A TRIGGER SOURCE switch is also inverted. Since the Sync Separator requires sync-negative waveforms for proper operation, it will be necessary to observe correct signal polarity when selecting the A TRIGGER SOURCE signal.

It is not necessary to display the Channel 1 or Channel 2 signal to obtain CH 1 or CH 2 triggering. Whenever the AC-GND-DC input coupling switch for the channel is not set to GND, the input amplifier and trigger channel are active, regardless of the selection of VERT MODE push buttons.

ADD MODE. A single-channel trigger signal amplitude is not affected by contribution of the other channel to an ADD vertical mode display. When the ADD mode, with Channel 2 inverted, is used to compare two video waveforms by subtraction, the Channel 1 or Channel 2 signal to the Sync Separator will be adequate for stable triggering, providing the individual channel signal meets the triggering requirements (including correct polarity).

When the ADD mode is used to display the full signal from both sides of a balanced line, it may be necessary to use the NORM (composite vertical signal) A TRIGGER SOURCE switch position (if neither side of the line has sufficient amplitude for suitable triggering or if common-mode signals interfere with stable sync-separation and triggering).

Typical Operation

NOTE

The following procedures for selecting individual lines, fields, or frames are applicable to the operation of the 468 as a conventional (nonstorage mode) oscilloscope only. Due to the signal processing time required by the digital microprocessor when storing a waveform, the holdoff time between sweeps is increased in all storage modes. Therefore, the A TRIGGER HOLDOFF control has reduced action over the holdoff timing, except near its maximum clockwise rotation.

In a typical operating mode for the Option 05 instrument, the A Sweep establishes the basic frame and field presentation, and the B Sweep allows detailed observation and measurement of various portions of the video waveform.

For 50- and 60-Hz field rates, the 2 ms/division setting of the A TIME/DIV switch is usually selected. For some PAL system observations, a setting of 5 ms/division (approximately a 2 1/2-field display), with the A TRIGGER HOLDOFF control set to approximately the four-o'clock position (additional one-field holdoff), may be desirable to maintain a stable display relationship to the four-field PAL burst-blanking sequence.

All detailed measurements are then made using the B Sweep, (HORIZ DISPLAY switches set either to B DLY'D or ALT) with the B TRIGGER SOURCE switch set either to STARTS AFTER DELAY (continuously variable B Sweep start point) or to TV LINE (B Sweep starts after the next horizontal sync pulse following the delay interval set by the DELAY TIME POSITION control and the A TIME/DIV switch setting).

Because the leading edge of the sync pulse will not be displayed, the typical B TIME/DIV switch setting for width measurement (front porch, back porch and horizontal-blanking intervals, horizontal sync, serration, and equalizing pulses) is 10 μs/division. This setting will allow display of two consecutive pulses. Use the X10 MAG switch to display the second pulse at 1 μs/division sweep rate.

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For rise- and fall-time measurements on blanking and sync waveforms, trigger the A or B Sweep directly from the displayed waveform (avoiding the processing delay of the Sync Separator). This permits viewing the trigger edge at sweep rates from 0.5 μs/division to 0.02 μs/division.

Selecting an Individual Line

NOTE

For field and line identification systems, refer to "Identifying Fields, Frames, and Lines in 525/60 and 625/50 TV Systems" at the end of these Operating Instructions.

ONE-FRAME CYCLE. To display an entire vertical blanking interval for locating a specific line (e.g., one of the lines containing a specific VIT waveform), set the A TIME/DIV switch to 2 ms/division and the B TIME/DIV switch (pull to unlock from A) to 10 μs/division. Ensure that the A TRIGGER HOLDOFF control is set to NORM (fully ccw) and the A TRIGGER COUPLING switch is set to TV FIELD. Then, select the desired field (FIELD 1 or FIELD 2) with the A TRIGGER SLOPE switch.

Press in the A INTEN push button and use the DELAY TIME POSITION control to position the intensified zone (B Sweep) on the desired line. Pressing the B DLY'D button will then display the desired line on the B trace. Set HORIZ DISPLAY to ALT to view the A INTEN trace and B DLY'D trace simultaneously.

TWO-FRAME CYCLE. If PAL burst blanking is to be checked, set the A Sweep time for a 3 1/2-field cycle (5 ms/division, with the A TRIGGER HOLDOFF control set to about the four o'clock position). Then, use the B Sweep (ALT HORIZ DISPLAY is recommended) to identify fields and lines. At 5 ms/division, only slightly more than two fields will be displayed, while the trigger holdoff interval covers a full field. Putting a specific field on screen in a particular location will typically require several operations of the A TRIGGER SLOPE switch (switching back and forth between FIELD 1 and FIELD 2) to select the proper frame cycle.

Special Measurements

OVERSCANNED DISPLAYS. For various video measurements it may be desirable to expand the video waveform vertically beyond the limits of the screen. Under these circumstances either the trigger amplifiers or Sync Separator may be overloaded, blocking out some sync pulses in the vicinity of strong video transitions, or losing sync pulses altogether. To avoid overload problems, use either an external sync signal or the other vertical channel to supply a constant-amplitude signal to the Sync Separator while overscanned observations are being made. Note, however, that transient-response aberrations in the main vertical amplifier will be increased when the signal is driven offscreen, and the aberrations will become relatively serious if the amplifier is driven to saturation and cutoff.

HORIZONTAL-SYNC PULSE MEASUREMENTS. Measurements of the rise and fall times and the width of horizontal sync pulses typically do not require use of the Sync Separator, except when only certain lines or groups of lines appear abnormal. A bright display of all horizontal sync pulses is obtained when the A Sweep is triggered on the appropriate slope using LF REJ coupling and an A Sweep TIME/DIV switch setting of 5 μs or less. Triggering stability may be upset by sharp luminance transitions at the right side of the picture, but a careful setting of the LEVEL control will typically permit accurate measurements. Use of the 5 μs/division basic rate locks out most of the video (for 525- or 625-line systems) from triggering the A Sweep. When faster sweeps are needed, the A TRIGGER HOLDOFF control may be adjusted to block out video information.

RF INTERFERENCE. Operation in the vicinity of some FM and TV transmitters may cause objectionable amounts of rf signal energy in the display, even when coaxial cables are used to make signal connections to the instrument. The front-panel 20 MHz BW LIMIT switch will usually eliminate such interference from the display, but it will not affect the signal applied to the Sync Separator. Where rf energy interferes with Sync Separator operation, external filters will be required. Use of probes designed for 10- to 30-MHz bandwidth oscilloscopes will provide 6- to 10-dB attenuation in the 50- to 100-MHz range and may be beneficial in reducing rf interference.

Identifying Fields, Frames, and Lines in 525/60 and 625/50 TV Systems

NTSC (CCIR SYSTEM M). Field 1 is defined as the field whose first equalizing pulse is one full H interval (63.5 μs) from the preceding horizontal-sync pulse. The Field 1 picture starts with a full line of video, and lines are numbered 1 through 263, starting with the leading edge of the first equalizing pulse. The first regular horizontal-sync pulse after the second equalizing interval is the start of line 10.

Field 2 starts with an equalizing pulse a half-line interval from the preceding horizontal-sync pulse. The Field 2 picture starts with a half line of video, and lines are numbered 1 through 262, starting with the leading edge of the second equalizing pulse. After the second equalizing interval, the first full line is line 9.

In the M/NTSC four-field color system, Fields 3 and 4 are defined identically to Fields 1 and 2 respectively, except for the phase of the color reference subcarrier. In Fields 1 and 4, positive-going zero crossovers of the reference subcarrier nominally coincide with the leading edge of even-numbered horizontal sync pulses. In Fields 2 and 3, negative-going zero crossovers of the reference subcarrier nominally coincide with the leading edge of even-numbered horizontal sync pulses.

CCIR SYSTEM B AND SIMILAR 625/50 SYSTEMS. Except for PAL systems, identification of parts of the picture in most 625-line, 50-Hz field-rate systems relies primarily on continuous line numbering rather than on field-and-line identification.

The CCIR frame starts with the first (wide) vertical-sync pulse following a field which ends with one-half line of video. The first line after the second equalizing interval is line 6; the first picture line is line 23 (one-half line of video). The first field of the frame contains lines 1 through the first half of line 313; the picture ends with a full line of video (line 310).

The second field of the frame commences with the leading edge of the first (wide) vertical sync pulse (in the middle of line 313) and runs through line 625 (end of the equalizing interval). The first full line after the equalizing interval is line 318; the picture starts on line 336 (full line of video).

The first field is referred to as "odd," and the second field is referred to as "even." Note that while the identification systems for System M and System B are reversed, the correct field sync (Field 1 or Field 2) (as indicated by the A TRIGGER SLOPE switch setting) is selected.

In the four-field PAL sequence with Bruch Sequence Color-Burst blanking, the fields are identified as follows:

Field 1: Field that follows a field ending in one-half line of video, when the preceding field has color burst on the last full line. Field 1 lines are 1 through 312 and half of line 313. Color burst starts on line 7 of Field 1; one-half line of video appears on line 23.

Field 2: Field that follows a field ending in a full line of video which does not carry color burst. Field 2 lines are the last half of line 313 through line 625. Color burst starts on line 319 (one line without burst following the last equalizing pulse); a full line of video appears on line 336.

Field 3: Field that follows a field ending in a half line of video when preceding field has no color burst on the last full line. Field 3 lines are 1 through the first half of line 313. Burst starts on line 6 (immediately following the last equlizing pulse); one-half line of video appears on line 23.

Field 4: Field that follows a field ending in a full line of video carrying color burst. Field 4 lines are the second half of line 313 through line 625. Color burst for Field 4 starts on line 320 (two full lines without burst follow the last equalizing pulse); video starts with a full line on line 336.

NOTE

The FIELD 1 position of the A TRIGGER SLOPE switch selects NTSC or PAL Field 1 or 3 to start the display; the FIELD 2 position selects NTSC or PAL Field 2 or 4.

THEORY OF OPERATION

Introduction

This text describes circuitry unique to Option 05. Refer to the Theory of Operation section of this manual for information concerning those portions of the oscilloscope circuitry that are unchanged by Option 05. Figure 6-7 shows in a simplified block diagram, those circuits added or changed by Option 05. The following discussion is limited to a description of those stages. Schematic diagrams 24 and 25, pertaining to circuitry added to or changed from the standard instrument, are located in Service Volume II.

Switching

The added TV FIELD and TV LINE positions of the A TRIGGER COUPLING switch open the usual signal path to the A Trigger circuitry and couple the appropriate output of the Sync Separator stage to the A Trigger Generator circuitry.

The Option 05 TV LINE position on the B (DLY'D) TRIGGER SOURCE switch couples the line-rate trigger signal from the Sync Separator output to the B Trigger Generator circuitry.

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Trigger Pickoff

A Trigger Pickoff stage composed of source follower Q520 and emitter follower Q521 provides isolation and impedance matching to Trigger Amplifier U315 and minimizes loading of the input signal. Gain of the Trigger Pickoff stage is slightly less than unity. The video trigger signal (internal or external) from the A TRIGGER SOURCE switch is coupled to the input of Q520, while the output of the Trigger Pickoff stage (emitter follower Q521) is fed through P520 and P2810 to the Trigger Amplifier. Diode CR519 prevents high amplitude negative-going signals from damaging the input of Q520. High-amplitude positive-going signals are limited by the gate-to-drain current that flows when the source-gate junction of Q520 become forward biased.

Trigger Amplifier

Trigger Amplifier U315 and associated components provide adequate drive for the Sync-Separator. Output from the Trigger Amplifier stage is fed to Q325, the Sync Separator circuitry input transistor. Feedback resistor R310 (from

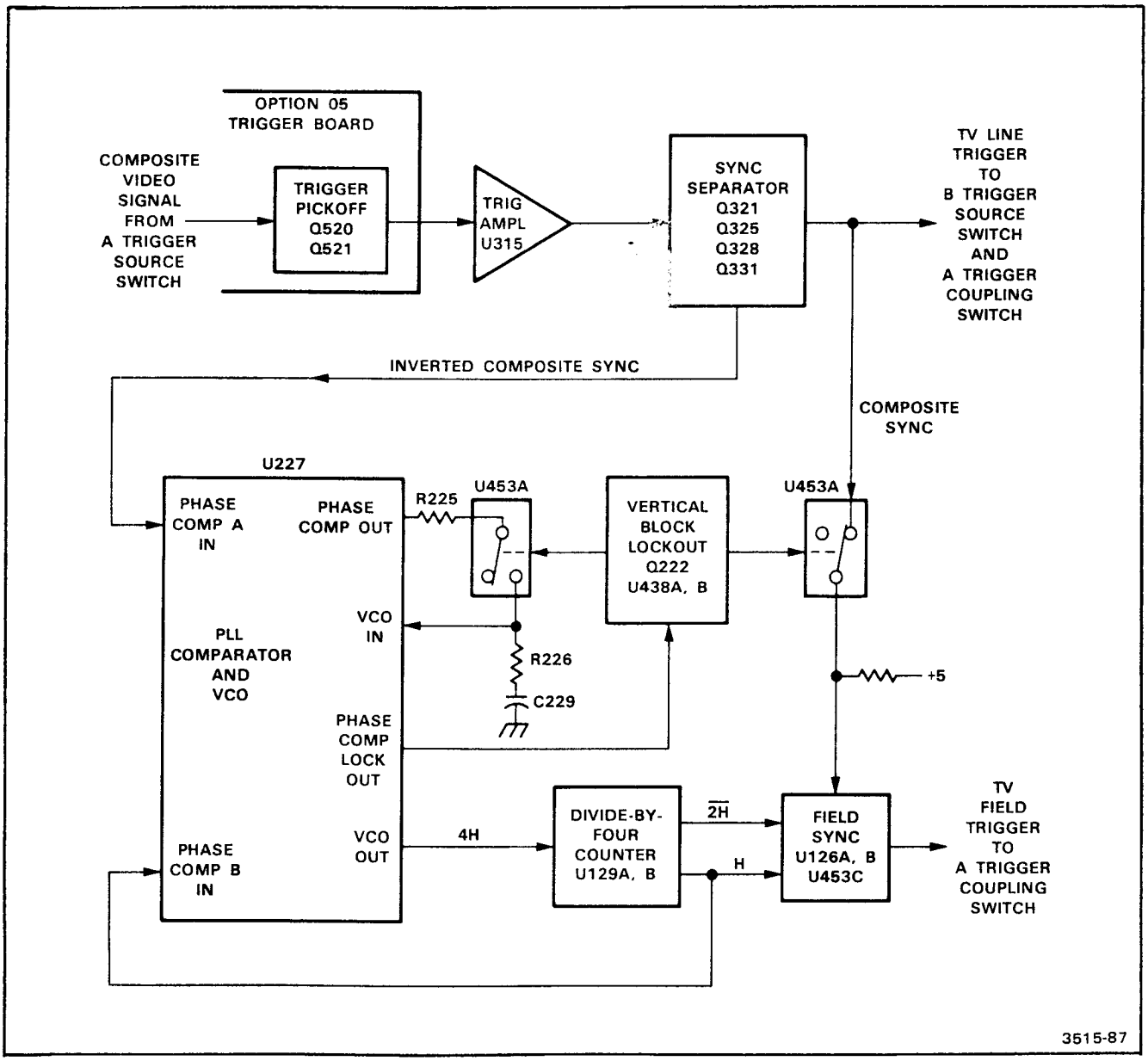

Figure 6-7. Option 05, TV Sync Separator, simplified block diagram.

U315 pin 8 to U315 pin 3) controls the gain of U315 for low-amplitude signals, while R311, CR310, and CR311 control the gain for higher amplitude signals.

Sync Separator

The Sync Separator circuit (composed of Q321, Q325, Q328, Q331, and associated components) is arranged as a wide-band, high-gain, self-biasing clipping amplifier that performs several functions:

1. Positive video information is removed (stripped) from incoming sync-negative, composite video signals.

2. Negative sync tips are clipped to eliminate possible noise or, in some systems, subsidiary signals.

3. The "middle" portion of the resulting composite sync is amplified for use as the A and B Sweep (TV LINE) sync. The amplified signal is further processed by the Field Selection circuitry to obtain the TV Field trigger signal to apply to the A Sweep trigger circuitry.

SYNC STRIPPER. With no signal applied (quiescent state), Q325 and Q321 are biased to produce approximately +5 V on the Q321 collector, and Q331 is biased into saturation. The collector of Q331 will be at approximately 0 V.

When the composite video signal from U315 is applied to the base of Q325 (via R324 and C323) the negative-sync portion increases the forward bias of Q325 thereby lowering the Q325 emitter voltage. This negative-going emitter voltage,applied directly to the base of Q321, reduces the forward bias on Q321 and allows the Q321 collector voltage level to rise. Thus, the negative-sync portion of the composite video signal is amplified and inverted. However, transistor Q321 remains saturated during the positive voltage changes at the Q321 collector, so the negative sync tips are not passed on to the composite sync bus.

The amount of dc feedback applied to the base of Q325 is determined by the sync-tip amplitude, Current through CR333 rapidly charges C329, and the forward bias on Q328 increases. The increased current flow through Q328 applies a negative dc feedback to Q325 through the parallel combination of R327, C321, and R321, thereby limiting the positive output level of Q321.

The negative transition of the sync pulse output from Q321 is applied to C329 through R331 and R332, thus producing a relatively long time-constant-discharge path. Between sync pulses, the charge on C329 reduces only a small amount, and the dc feedback remains at the level determined by the sync tip amplitude. If the signal amplitude were to reduce, the sync tip amplitude would also be less. The negative feedback generated would be reduced, increasing the gain and thus adjusting to lower input signal level.

The gain for positive-going portions of the input signal is over 100 (limited primarily by the finite gain of Q321). The positive video portions of the input signal saturate Q321 whenever the peak-to-peak input amplitude exceeds about 60 mV. Any signal applied to Q321 while it is saturated will not be amplified. This results in the positive portion of the composite-video signal being clipped. However, the negative-sync portion of the input signal is amplified to nearly 6 V peak-to-peak and inverted at the output of Q321. This inverted composite sync signal is fed (via R409 and R408) to the Phase Comparator A input of U227, to control the phase-locked-loop oscillator, and applied via R326 to the base of Sync Clipper Q331.

SYNC CLIPPER. Transistor Q331 passes a signal only during a narrow input signal level range, During the quiescent state, and also whenever the sync tips drive the collector of Q321 positive, Q331 is saturated. On the negative transition of a sync pulse, Q331 comes out of saturation as the Q321 output signal level drops through +4 V, but it becomes cutoff as the signal level continues to drop through +3 V. Sync Clipper Q331 then amplifies only the middle portion of the sync signal, clipping off the sync tips and any excursions of color subcarrier peaks which may have extended into the sync area. The amplified composite sync is fed to a voltage divider composed of R101 and R102 to reduce the signal amplitude to the correct level for application via P2834 to the A and B Trigger Generator circuits. This composite-sync signal is also applied via U453A, a MOSFET bilateral switch, to the Field Selection circuitry.

Field Selection

The Field Selection circuitry consists of the following:

1. A phase-locked-loop oscillator, operating at four times the television horizontal line rate (4H).

2. A sync block lockout circuit that opens the error-correction input to the phase-locked-loop oscillator during the vertical sync interval to prevent equalizing pulses, serrations, or (in some systems) the absence of horizontal sync pulses from affecting the oscillator frequency.

3. Sampling circuits that, after each horizontal sync pulse, interrogate the state of the composite sync bus at the one-quarter and three-quarter points in a line interval and then generate the FIELD output sync signal.

PHASE-LOCKED LOOP. The phase-locked loop is composed of U227, a CMOS phase comparator and voltage-controlled oscillator (VCO), and U129A and B, a divide-by-four counter. The VCO operates at four times the horizontal frequency, while the output of U129A and B is one-fourth the VCO frequency (the horizontal frequency). The minimum

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VCO frequency is set by C228 to less than 40 kHz, or four times the line rate of a 405-line, 50-Hz video system. Range-setting resistor R224 extends the upper frequency range to above 144 kHz (four times the line rate of a 1201-line, 60-Hz system).

Inverted composite sync is applied to U227 at pin 14 (the Phase Comparator A input). The VCO output is divided by four by U129A and B, and the Q output signal of U129A at pin 1 is applied to the Phase Comparator B input of U227 at pin 3. Positive-going edges of the two signals are compared to produce the required correction voltage to the VCO. If the positive-going leading edge of the incoming inverted horizontal sync pulse occurs before the positive-going edge of the U129A output, the comparator produces a +5 V pulse at pin 13. If the U129A output comparison point occurs prior to the inverted composite sync positive-going leading edge, a 0-V pulse is produced by the comparator.

The duration of any generated correction pulse is the time difference between the sync signal and counter output edges. The greater the phase difference, the wider the correction pulse. Between correction pulses, the phase-comparator output at pin 13 is an open circuit and has no effect on the oscillator frequency.

Correction signals are applied to the VCO input of U227 at pin 9 via a low-pass filter composed of R225, R226, C229, C425, and U453B (one-third of a CMOS triple bilateral switch). The low-pass filter circuit compensates the phase-locked loop and attenuates the fast switching transients of the comparator ouput. When pin 10 of U453B is HI, VCO IN is connected to COMP OUT through the low-pass filter. When pin 10 of U453B is LO, COMP OUT is disconnected from VCO IN, and only the voltage level stored on C229 is applied to VCO IN. This voltage level remains constant between correction pulses to maintain the oscillator frequency. Resistor R425 supplies a bias current to the filter network to cause the signal at VCO IN to always slightly lead the incoming sync pulses at COMP IN (pin 14). This results in improved VCO output jitter characteristics.

SYNC BLOCK LOCKOUT. The phase comparator produces a "lock" signal at U227 pin 1. As long as the input comparison edges are exactly coincident, the lock signal remains HI, but it goes LO for the duration of any corrction pulses. The lock signal is applied to the Vertical-Block-Lockout circuit for use in recognizing changes in the vertical sync block that would cause the VCO to be forced off frequency. During such periods, the correction loop is opened to allow the VCO to maintain a constant frequency without correction.

The negative-going out-of-lock pulse from the phase comparator is applied via R222 and R221 to the base of Q222. Capacitor C213, connected between the junction of the two resistors and ground, must discharge before Q222 can be biased off. The time constant of R221 and C213 is long enough that the duration of the out-of-lock pulse must exceed about 10 μs before the collector voltage of Q222 goes high enough to cross the threshold level of U438A. Errors of such a duration are introduced by either the 2H equalizing pulses and sync pulse serrations in the vertical sync block (VCO attempts to increase frequency) or by the absence of H pulses in the sync bolck, as is common in 405/50 and many closed-circuit TV systems (VCO attempts to decrease frequency).

When the error exceeds 10 μs in duration, the voltage level at the collector of Q222 crosses the threshold level of U438A and the one-shot multivibrator is triggered. The resulting signal from U438A is an approximately 1 ms, negative-going pulse from the $\overline{Q}$ output (pin 7) that opens bilateral switch U453B. The phase comparator output is opened to prevent correction pulses from being applied to the VCO input. The VCO maintains its previous frequency, as determined by the charge present on C229, for the duration of the 1-ms pulse. Current through R124 holds Q222 on during this time to inhibit the output of U227 pin 1 from resetting U438A.

A second one-shot circuit composed of U438B is triggered by the rising edge of the end of the 1-ms negative pulse from U438A pin 6 (Q output). An approximately 10-ms positive inhibit pulse from U438B pin 10 is fed back to the base of Q222. This inhibit pulse prevents any further lockouts for approximately 10 ms, thus ensuring that in the event of severe frequency or phase discrepancies, the phase comparator will actively compare the loop signal with the incoming sync signal for at least 90% of the time. The VCO circuit is then able to ignore 1-ms-long blocks that occur at intervals no closer than 10 ms, but the 90% active cycle still provides a quick lockup when a new video signal is applied.

A negative pulse from U438B pin 9 opens bilateral switch U453A for the duration of the 10 ms inhibit pulse. This prevents the incoming composite sync from being clocked through U126B in the Field Selection circuit while U227 is relocking to the signal.

FIELD SYNC. In all standard interlaced television signals, the vertical sync pulse ahead of a field which starts with a full line of video will occur halfway between two horizontal sync pulses (Field 1 in NTSC terminology, Even field in CCIR system B). A field starting with a half line of video will be preceded by a vertical sync pulse which starts at the end of a line.

The Field Sync circuit uses the $\overline{2H}$ and H rate outputs of divide-by-four counter U129A and B to sample the state of the composite sync bus at two points in the line interval between H pulses. This sampling determines when a vertical sync block has started. One sample point is at about the one-quarter point in the H interval, and the other is at about the three-quarter point.

A positive-going edge used to clock U126B at both the one-quarter and three-quarter points is provided from the U129B $\overline{Q}$ output (pin 12). The composite sync level applied to U126B at pin 9 (the D input of the flip-flop) is sampled and latched into U126B on each rising clock edge. If the level is HI when it is sampled (no vertical sync pulse present), the U126B $\overline{Q}$ output (pin 12) will go LO and remain there. If the sync level is LO when sampled (signifying a vertical sync pulse), the $\overline{Q}$ output of U126B will go from LO to HI to clock U126A at pin 3 (refer to the timing diagram, Figure 6-8). When the vertical sync pulse has ended, the $\overline{Q}$ output of U126B clocks back to LO.

The Q output of U129A is applied to the U126A D input. This output level is HI for the first half of each H interval (horizontal line) and LO for the second half. When the rising edge clock transistion occurs at U126A (pin 3), the state of the D input (pin 5) will be transferred to the Q output (pin 1), and the complement will appear on the $\overline{Q}$ output (pin 2).

Thus, each occurrence of a vertical sync pulse is detected by U126B, and U126A determines whether it occurred in the first half or second half of a line. If the vertical sync pulse is present in the first half of the line, the Q output of U126A at pin 1 will go HI; and if it occurs in the second half, the Q output will go LO.

Therefore, in an interlaced system, the outputs of U126A will toggle at the full frame rate, with transitions occurring just after the start of each vertical sync pulse. The Q output will be HI during Field 1 and LO during Field 2.

Bilateral switch U453C is used to automatically select either the "Field 1/Field 2" trigger signal from the $\overline{Q}$ output of U126A (for interlaced video) or the "Field" trigger signal from the $\overline{Q}$ output of U126B (for noninterlaced systems.) In an interlaced video system, U126A toggles at the frame rate. The circuit composed of C404, CR404, R113, CR112, C405, and R110 rectifies the ac-coupled U126A Q output to produce a HI level at pin 9 of U453C. This causes the $\overline{Q}$ output of U126A to be passed to R404. In a noninterlaced system, U126A does not toggle. The level at pin 9 of U453C is LO, and the $\overline{Q}$ output of U126B is passed to R404 to produce a trigger signal on each field. Resistors R404, R405, and R406 attenuate and level shift the output of U453C to produce levels suitable for the A Sweep Trigger Generator.

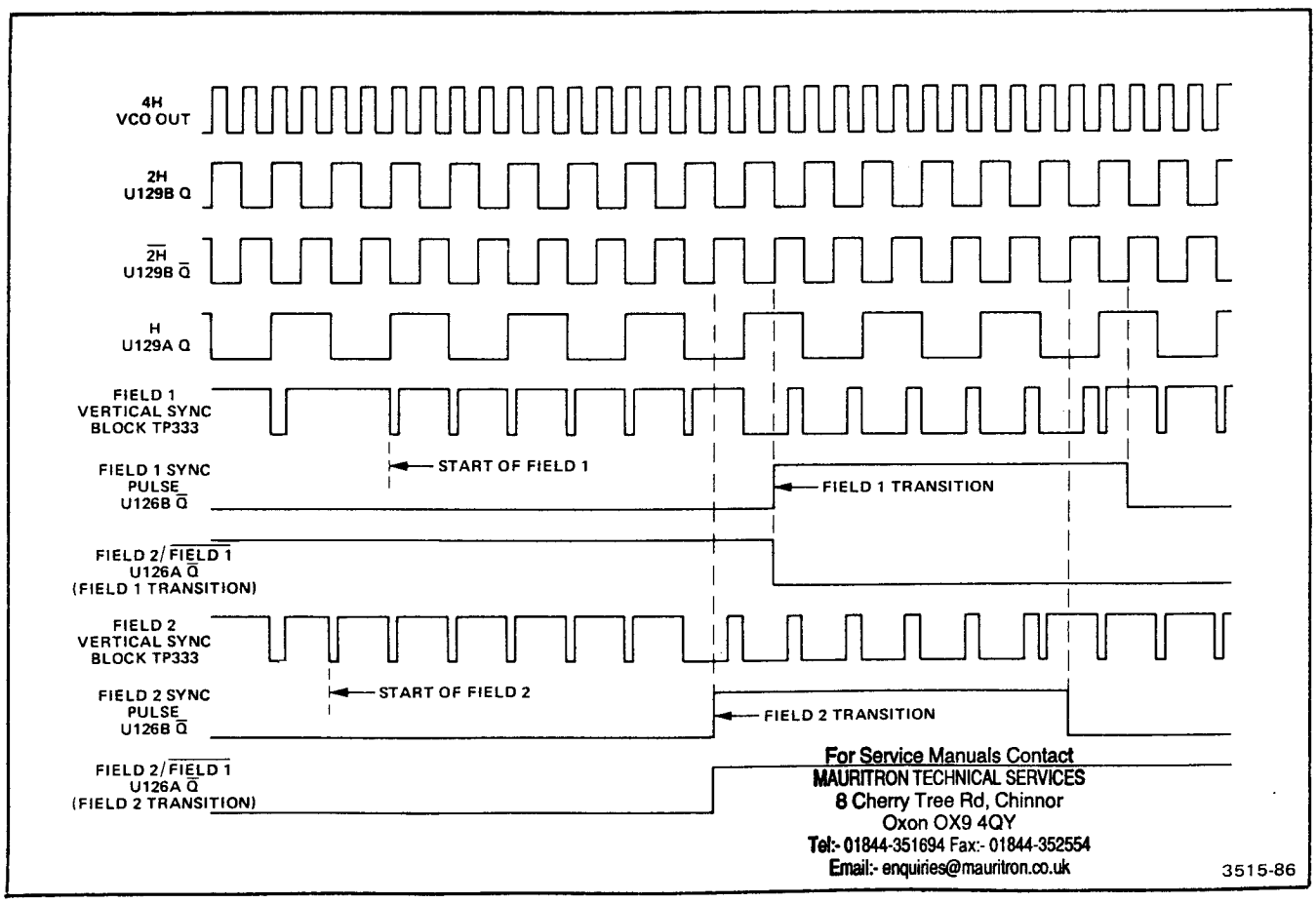

Figure 6-8. Field selection timing diagram.

OPTION 11—ANALOG X-Y OUTPUT

INTRODUCTION AND SPECIFICATION

This Option enables the 468 to convert the digital data stored in the storage display memory into analog X and Y outputs for driving an external X-Y Plotter. The analog outputs will conform to most currently produced X-Y Plotters. Electrical specifications for Option 11 are given in Table 6-5. All other specifications given in Volume I of this manual remain unchanged.

Table 6-5

Electrical Characteristics

Characteristics	Performance Requirement	Supplemental Information
X and Y Output		
Sensitivity	200 mV per division.	Within ±3%, measured with respect to on-screen cursors.
Range	0 to 2.048 V.	0 to 10.24 divisions.
Resolution		
Y-Axis		8 bit.
X-Axis		8 or 9 bit.
PEN LIFT	For Service Manuals Contact MAURITRON TECHNICAL SERVICES 8 Cherry Tree Rd, Chinnor Oxon OX9 4QY Tel:- 01844-351694 Fax:- 01844-352554 Email:- enquiries@mauritron.co.uk	Relay contact closure to ground, polarity switchable. Maximum relay current is 200 mA, fused at 250 mA. Maximum applied voltage is 30 V peak. A 10-kilohm pull-up resistor to the +5-V supply is switchable to provide TTL pen-lift levels.
PLOT SPEED		Switch selectable between fast and slow.
Switch Open	Fast plot.	40 ms ±10% per data point.
Switch Closed	Slow plot.	320 ms ±10% per data point.

OPERATING INSTRUCTIONS

SETTING UP THE OPTION

Operation of the Analog X-Y Output Option is largely automatic. Only a few switch settings are required before pressing the PLOT switch to start the operation. Refer to the Operators information of the X-Y Plotter in use for set-up and operation procedures required for using it. Information required for the correct setup of the Analog X-Y Output Option switches on the 468 rear panel should also be obtained from the instructions for the X-Y Plotter in use.

The required switch settings of the Analog X-Y Output switches shown in Figure 6-9 are as follows:

1. The PLOT SPEED switch must be set to match the X-Y Plotter characteristics. Choices of plot speed are 40 ms per data point (fast plot) and 320 ms per data point (slow plot).

2. The PEN POLARITY switch must be set to match the X-Y Plotter pen-lift signal requirements. When the switch is OPEN, the pen control relay will be open when the plotting pen should be down on the paper. When the switch is CLOSED, the pen control relay will be closed when the plotting pen should be down on the paper.

3. The PEN PULL-UP switch must be set to provide the proper level pen-lift signal for the plotter pen. The pen-lift voltage may be set either for no pull-up to the +5-V supply or for pull-up through a 10-kΩ resistor. The pen-lift voltage is pulled up when the switch is CLOSED and not pulled up when the switch is OPEN.

4. The RESET switch must be set to the OPEN (off) position for normal operation.

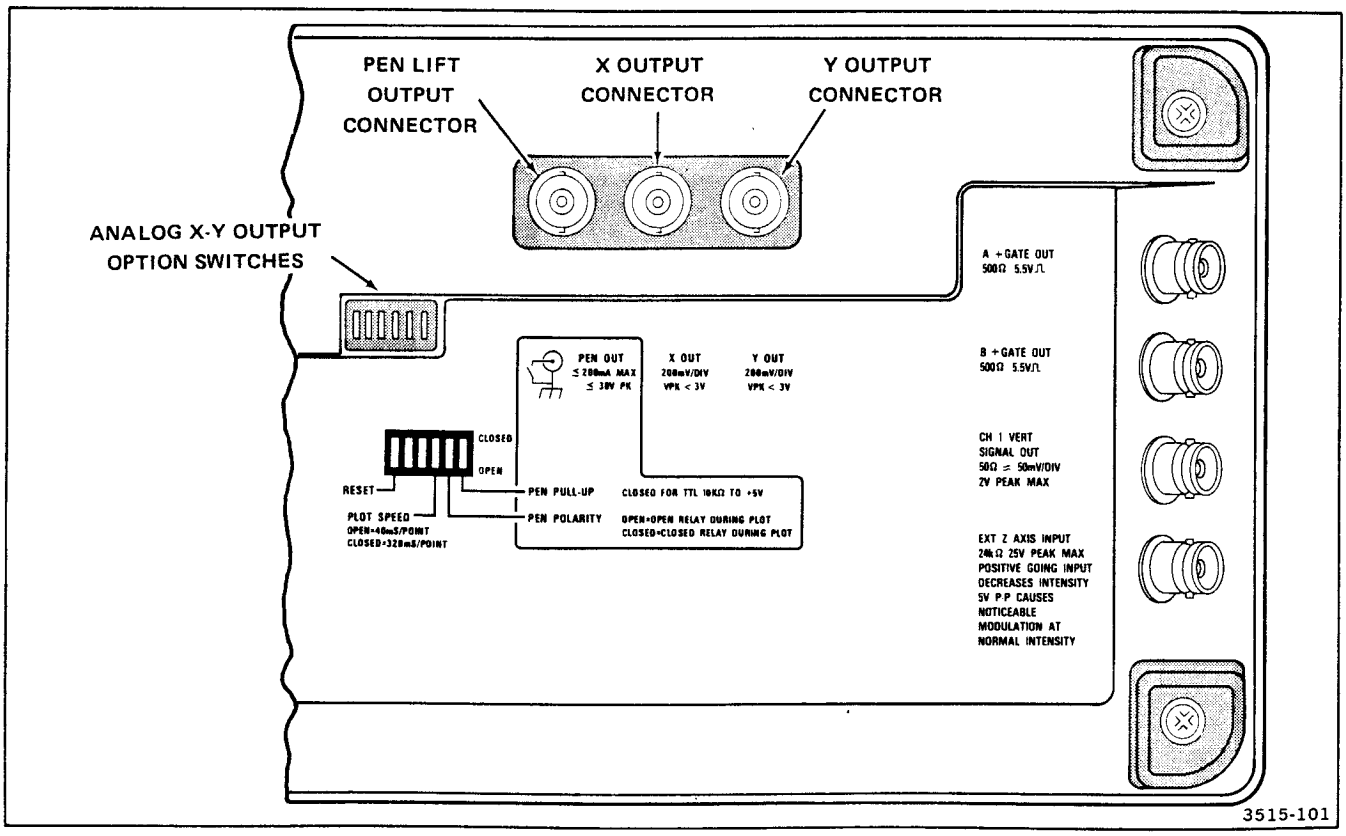

Figure 6-9. Location of Analog X-Y Output Option switches and output connectors.

NOTE

The RESET switch is maintenance only. If the switch is inadvertently closed while a waveform plot is occurring, the switch must remain closed until the remaining waveform data is dumped. Returning the switch to the OPEN position before the waveform data has finished dumping will cause a state control malfunction. If this should occur, cycle the POWER switch OFF; then ON again to clear the malfunction.

In addition to the external switch settings required, section 8 of the internal OPTIONS/SERVICE switch must be in the CLOSED position when power is applied to the instrument for the Analog X-Y Output Option to be enabled. If the PLOT switch is inoperable, refer the instrument to a qualified service person to check the switch position. Refer to Figure 5-6 in the "Maintenance" section of Volume I for the location of the OPTIONS/SERVICE switch.

Refer to Figure 6-9 for the location of the Analog X-Y Output switches and the PEN OUT, X OUT, and Y OUT BNC connectors.

After the Analog X-Y Output switches are set for the X-Y Plotter to be used, no further setting of the switches is required. Connect the X OUT, Y OUT, and PEN OUT connectors to the X-Y Plotter, and set up the X-Y Plotter by following the operating instructions of the plotter in use.

USING THE OPTION

Acquire a storage mode waveform to be plotted as per the operating instructions given both in this manual and in the 468 Operators manual, then press in the PLOT push button. The 468 will go into the SAVE Storage Mode, and the stored waveform will be plotted. If you wish to do more than one plot of the same waveform, press in the SAVE Storage Mode push button either prior to pressing in the PLOT push button or during the time the waveform is being plotted. The waveform will be saved for as long as the SAVE Storage Mode remains selected. At the completion of the plot, the 468 will return to the operating mode selected by the front-panel controls. If SAVE Storage Mode has not been selected, new waveform data will be acquired.

Only the actual waveform data points are output to the X OUT and Y OUT connectors. No scale factors or interpolated data are sent. When the PLOT push button is pressed, the plotter pen will move to the first data point after about two seconds. The pen will stay at the first data point for five seconds. After 2.5 seconds, the plotter pen will be lowered to the plot paper. The remaining data points will be plotted at the rate selected by the PLOT SPEED switch. On the last data point plotted, the pen again remains for five seconds, with the pen lifting at about 2.5 seconds into the delay. The five-second delay at the first and last data points allows the operator time to manually control the pen position on some X-Y Plotters. For multiple waveforms to be plotted, the sequence just described is repeated for each waveform, including a two-second wait in the home position before going to the first data point of the next waveform to be plotted. When all the waveform data has been sent, the 468 returns to front-panel control.

THEORY OF OPERATION

INTRODUCTION

The following text begins with a general description of the Analog X-Y Output Option circuitry and its relationship to the 468 Digital Oscilloscope. It then continues with a detailed description of the Option circuitry. Refer to Figure 6-10 for a block diagram and to Diagram 26 in the foldout section of Volume II of this manual for a schematic representation of the circuitry.

GENERAL DESCRIPTION

The Analog X-Y Output Option provides the 468 user with a hard-copy output that is compatible with a large number of currently available X-Y Plotters. The Option 11 circuit board is designed to physically replace the GPIB Option circuit board, and it uses the GPIB Option firmware for data communications between the 468 and the Analog X-Y Output Option circuitry.

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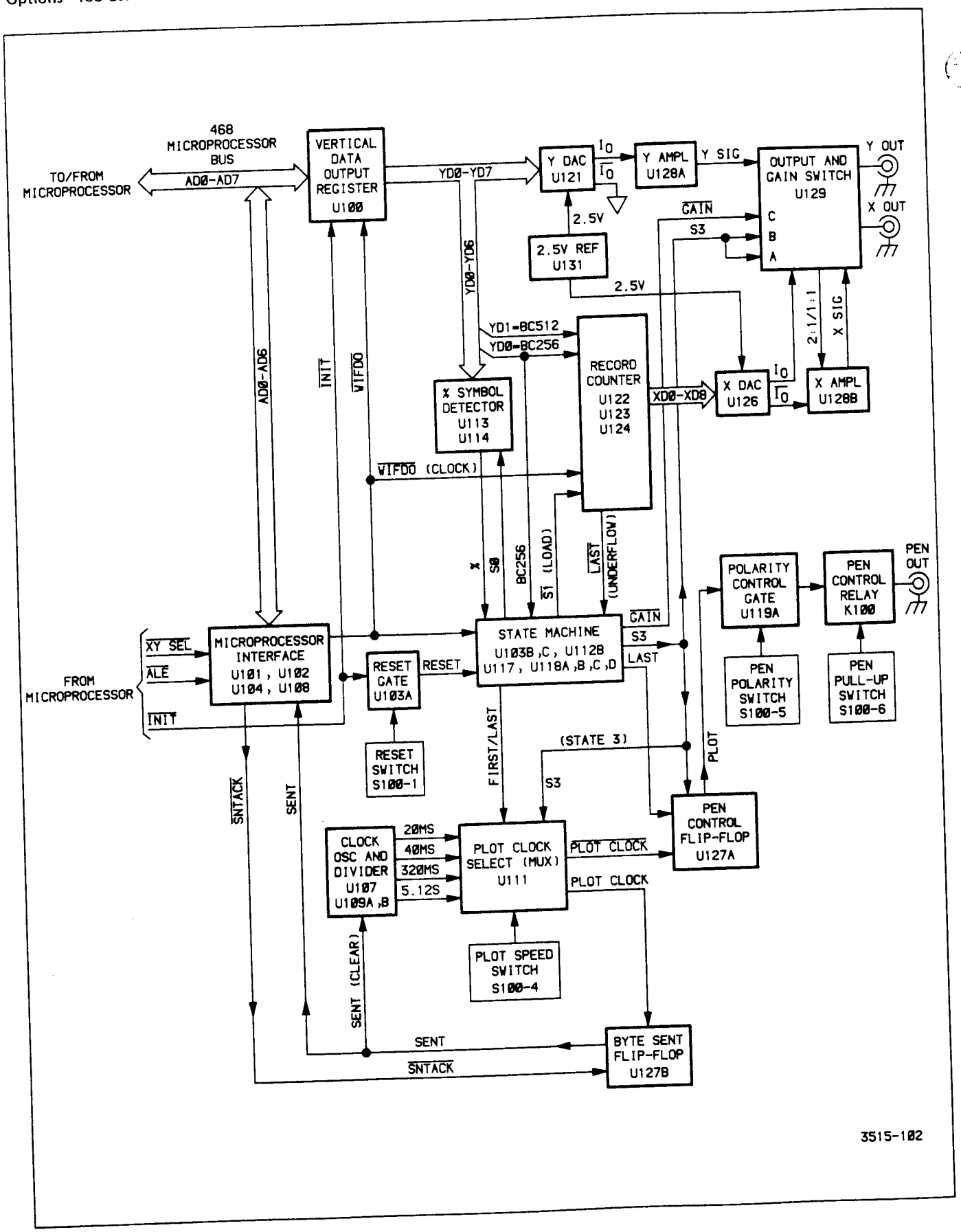

Figure 6-10. Block diagram of Analog X-Y Output Option.

When the user presses the PLOT push button on the 468 left-side panel, the 468 Microprocessor begins to transmit the stored waveform data to the Analog X-Y Output Option board. This transmission includes a preamble, scale-factor information, byte-count information, and the waveform data. (Refer to the GPIB information in the 468 Operators manual for a detailed description of the transmission format.) The entire transmission would be used by the GPIB Option. The Analog X-Y Output Option, however, requires only the byte count and waveform data portion of the transmission. It thus waits for the ASCII % (percent) character that precedes the byte count in the transmission before it commences to process the data. All of the preamble and scale-factor information that comes before the % character is ignored.

Upon detection of the % character, the Analog X-Y Output Option loads the first byte-count byte into the Record Counters, discards the second byte-count byte, and prepares to receive the waveform data points that follow.

The waveform data points are then processed through a digital-to-analog converter (DAC) to provide the Y-Axis output to the X-Y Plotter attached. A second DAC uses the count contained in the Record Counters to generate the X-Axis signal to the X-Y Plotter. At the end of the current waveform plot, the Analog X-Y Output Option returns to the mode of searching for the % symbol.

Detailed control of the circuit operations is provided by a State Machine. Other circuits provide for interfacing with the 468 Microprocessor and for timing the operation of the Option circuitry.

DETAILED CIRCUIT DESCRIPTION

MICROPROCESSOR INTERFACE CIRCUITS

The Microprocessor Interface Circuits consist of Talk Register U102, Address Demultiplexer Register U104, Address Decoder U108, and Status Buffer U101. These circuits accomplish the address communication and basic timing functions that occur between the Analog X-Y Output Option and the 468 Microprocessor.

Talk Register U102 forces the 468 GPIB firmware into a talk-only mode whenever power is applied to the 468.

NOTE

Section 8 of the 468 OPTIONS/SERVICE switch must be closed when power is applied to the 468 to enable the Analog X-Y Output Option.

At power on, the $\overline{\text{TALKREG}}$ strobe is generated by the Address Decoder, and the Microprocessor reads the data on the AD0 through AD4 bus lines and the AD7 bus line placed there by U102. All of these bus lines have a zero, due to the hardwired ground on all of the U102 input pins. The Microprocessor interprets the data as the GPIB Talk-Only Mode and sets up to transmit waveform data whenever the PLOT push button is pressed.

Adress Demultiplexer Register U104 receives the address information from the bidirectional Microprocessor bus lines AD0, AD1, and AD2. On the rising edge of the $\overline{\text{ALE}}$ (Address Latch Enable) signal from the Microprocessor, the address bits at the input pins of U104 are transferred to the output pins of U104. From U104, the three-bit address demultiplexed from the bus lines is applied to Address Decoder U108 (a 1-in-8 decoder). When enabled by the $\overline{\text{XYSEL}}$ (X-Y Select) signal, the Address Decoder produces one of four possible output strobe signals. The $\overline{\text{XYSEL}}$ signal is decoded from the high-order Microprocessor address bits and is timed to be active (LO) during the data portion of the Microprocessor cycle. Refer to the Microprocessor portion of the 468 Theory of Operation for the decoding description.

NOTE

On GPIB Option schematic diagrams and in the circuit descriptions, $\overline{\text{XYSEL}}$ is termed $\overline{\text{GPIBSEL}}$. Since the Analog X-Y Output Option replaces the GPIB Option, the signal name is also changed.

Possible control strobes decoded by U108 are:

1. $\overline{\text{TALKREG}}$–used at power on to force the 468 GPIB firmware into the talk-only mode.

2. $\overline{\text{SNTACK}}$–used to reset the Sent Flip-flop and acknowledge that the SENT signal has been received by the Microprocessor.

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3. $\overline{\text{RIFSTAT}}$–used to enable the Status Buffer so the Microprocessor can read the status of the Analog X-Y Output Option. The Microprocessor is checking the SENT bit to determine if the current data byte has been sent. If not, the Microprocessor does not place a new data byte on the bus, but waits until the SENT bit goes HI.

4. $\overline{\text{WIFDO}}$–used to enable the Vertical Data Output Register to transfer the data byte at the input pins to the output pins. This control strobe also clocks the Record Counter, which keeps a count of the number of bytes sent, and the State Machine, which determines the operation that the Analog X-Y Output Option performs.

When the Analog X-Y Output Option is to be addressed to start processing waveform data, the Microprocessor puts the Option address (binary 100) on the AD0, AD1, and AD2 bus lines and places address bits on the high-order address lines that will be decoded to cause the $\overline{\text{XYSEL}}$ signal to be LO during the data portion of the Microprocessor cycle. The Microprocessor then applies a byte of data to the AD0 through AD7 bus lines, and $\overline{\text{XYSEL}}$ enables Address Decoder U108. The Address Decoder produces the $\overline{\text{WIFDO}}$ strobe to Vertical Data Output Register U100, and on the strobe's rising edge, U100 latches the data byte in. That data byte remains on the output pins of U100 until the next data byte is latched in.

Status Buffer U101 is read by the Microprocessor to determine if the Analog X-Y Output Option is ready to receive another data byte. At the end of processing each data byte, the Sent Flip-flop (U127B) is clocked to make SENT HI at U127B, pin 9. When the Microprocessor polls the Option Status Buffer, a HI on the SENT line tells the Microprocessor that the next data byte can be transmitted. The Microprocessor places the address to produce the $\overline{\text{SNTACK}}$ strobe on the AD0 through AD2 bus lines and enables the Address Decoder to decode the address and reset the Sent Flip-flop.

VERTICAL DATA OUTPUT REGISTER

The Vertical Data Output Register consists of eight-bit register U100 which accepts data from the Microprocessor bus lines and holds that data for one byte count. The waveform data is loaded into U100 on the rising edge of the $\overline{\text{WIFDO}}$ strobe produced by the Microprocessor from Address Decoder U108, pin 11. From the output pins of U100, data bytes are supplied to the Percent Symbol Detector and to the Y-Output circuits.

Y-OUTPUT CIRCUITS

The Y-Output circuits consist of Y Digital-to-Analog Converter (DAC) U121, Operational Amplifier U128A, and one section of Field-Effect Transistor (FET) Switch U129. These circuits convert the eight-bit digital output of the Vertical Data Output Register into the analog voltage required for providing Y-Axis deflection for plotting the waveform by an external X-Y Plotter.

Y-DAC U121 is a 10-bit current output converter with the two most significant bits hardwired to ground. The eight-bit data bytes are converted into a current signal output at pin 4 of U121. Operational Amplifier U128A transforms the current signal into a voltage signal for use by the external X-Y Plotter. One section of FET switch U129 is used to turn the Y-output on during the plot. When off, FET switch U129 isolates the plot pen from any data transmitted by the Microprocessor during nonplotting times and holds the plot pen at the home position. The Y-output is turned on when the S3 signal is HI (State Three of the State Machine).

PERCENT SYMBOL DETECTOR

The Percent Symbol Detector circuit consists of comparators U113 and U114 which compare each byte of the input data with a fixed reference byte. Input lines B0 through B3 of U113 and U114 are hardwired to HI and LO levels in the configuration of the ASCII % symbol. When the % symbol occurs in the data transmission from the Microprocessor, the comparators output the % signal to the State Machine to tell it that the next byte is the first byte-count byte at the beginning of the waveform block. Bytes that precede the % symbol are the GPIB waveform preamble and scale factor information and are not needed by the Analog X-Y Output Option. The % signal causes the State Machine to move to State One, and the comparators are disabled from searching for a % symbol.

STATE MACHINE

The State Machine consists of register U117 (a quad-D flip-flop), First Flip-flop U112, and associated AND, NAND, and exclusive-OR gating composed of U103, U118, and U119 respectively. These circuits produce the state signals that control the detailed operation of the Analog X-Y Output Option. Inputs to the State Machine include the % symbol from the Percent Symbol Detector, the $\overline{\text{WIFDO}}$ clocking signal from Address Decoder U108, the Byte Count 256 (BC256) signal from the Microprocessor bus via Vertical Data Output Register U100, and the $\overline{\text{LAST}}$ signal from U122 in the Record Counter. Outputs from the State Machine include the $\overline{\text{GAIN}}$ signal, the

State signals (S0, S1, S2, and S3), the LAST signal, and the combined FIRST/LAST signal.

State conditions for the states are described in the following paragraphs. The overall flow sequence of the states is illustrated in Figure 6-11.

State Zero is established when the $\overline{S1}$, $\overline{S2}$, and $\overline{S3}$ state signals are all HI at the input of AND-gate U103C. The HI S0 state signal from U103C pin 8 is applied to pin 3 of comparator U114 in the Percent Symbol Detector to enable the circuit to compare the incoming waveform data from the Microprocessor bus with the fixed ASCII % symbol configuration hardwired on the B input pins. When the % symbol is detected, pin 6 of U113 is switched HI and applied to pin 5 of register U117.

On the next rising edge of the $\overline{WIFDO}$ strobe at U117 pin 9, S1 is clocked HI at U117 pin 7, and State One is established. At this time $\overline{S1}$ goes LO and the byte count (256 or 512) is loaded into the Record Counters. The BC256 signal logic level at pin 4 of U118B is used to determine the gain setting of X-Output Amplifier U128B during this state, through the gating of U118A, U118B, and U103B. S1 will remain HI for the first byte count only, because the S0 signal goes LO at the output of U103C during State One. This action causes the % signal at the output of U113 at pin 6 to also go LO, and on the next $\overline{WIFDO}$ strobe rising edge, S1 is clocked LO.

On the same clocking pulse that clocks S1 LO, the HI present on U117 pin 12 (S1 before being clocked LO) is gated through to U117 pin 10 to set up State Two. The HI S2 signal is applied to the D input of U112B, pin 12, in preparation for the next clocking signal to generate the FIRST signal, and pin 13 of U117 goes HI through the gating of U118C and U118D. No action is taken with the second byte-count byte that is sent prior to the waveform data points.

The next clocking pulse clocks both S3 and the FIRST signal (at pin 9 of U112B) HI to set up State Three of the State Machine. State Three will remain in effect until the $\overline{LAST}$ signal from the Record Counter signals that the last waveform data byte is being processed. The FIRST signal is gated through exclusive-OR gate U119B, in combination with the LAST signal, to select the timing for the first waveform data point. Both the first and last data points have a five-second delay to allow for manual pen control on some X-Y Plotters. See the "Plot Timing Circuits" discussion for an explanation of the timing. On the next clocking pulse, the FIRST signal becomes LO, and the remaining data points are plotted at the speed established by the PLOT SPEED switch.

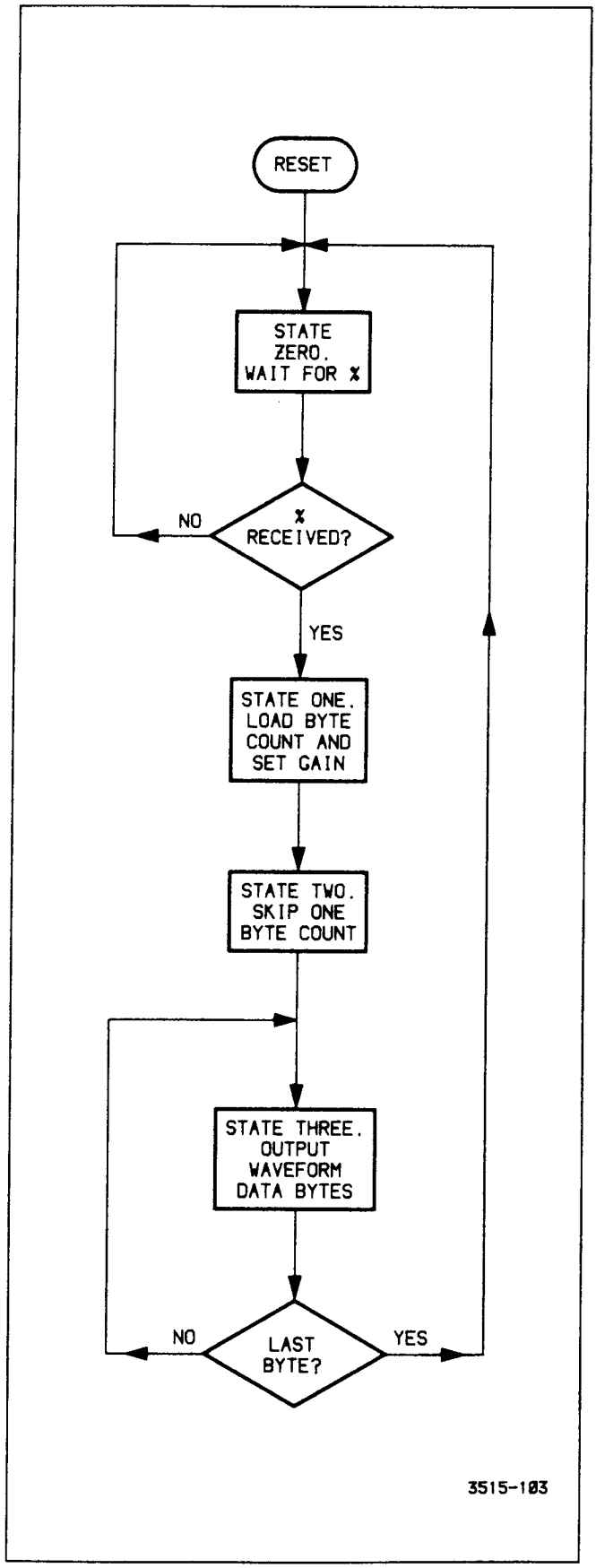

Figure 6-11. Analog X-Y Output Option stste flow chart.

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RECORD COUNTER

The Record Counter consists of hexadecimal counters U122, U123, and U124. These counters count either 512 or 256 bytes, depending on the byte count loaded during State One. In State One, the LO $\overline{S1}$ signal from the State Machine enables the counters to be set to the maximum count (either 512 for single and alternate storage acquisitions or 256 for chopped acquisitions). The maximum count, except for the BC512 and BC256 inputs, is hardwired into the counters. When BC256 is HI, the counters are loaded with 010000000000_2 or 256_{10}. The $\overline{WIFDO}$ strobe that sets up State Two also decrements the counters to either 511 or 255, as appropriate, for the start of the waveform plot.

As the waveform is plotted, the counters are continually decremented one count for each plot point (data byte) until the underflow output from U122 pin 12 (the $\overline{LAST}$ signal) goes LO. This indicates to the State Machine that the last byte plot is being processed and causes the State Machine to return to State Zero. The $\overline{LAST}$ signal is also applied through exclusive-OR gate U119B to allow Pen Control flip-flop U127A to be reset at the end of the last plot.

During State Three, the byte count contained in the Record Counter is applied via nine lines to the X-Output circuits for processing into the analog X-Axis signal for the external X-Y Plotter.

X-OUTPUT CIRCUITS

The X-Output circuits consist of X Digital-to-Analog Converter (DAC) U126, Operational Amplifier U128B, and two sections of Field-Effect Transistor (FET) switch U129. These circuits convert the nine-bit hexadecimal byte count from the Record Counter into the analog voltage required for time base (X-Axis) of the wavefrom plotted by the external X-Y Plotter.

X-DAC U126 is a current output type converter as is the Y-DAC. Signal currents at output pins 2 and 4 increase or decrease differentially according to the digital input. Operational Amplifier U128B transforms the DAC output current into a voltage signal for use by the external Plotter. Configured as an inverting amplifier, U128B, in combination with the gain-switching section of U129, provides either a 2:1 gain (for 256-point waveforms) or a 1:1 gain (for 512-point waveforms).

For chopped-mode signal acquisitions, 256 data points define the full waveform. Therefore, the gain of U128B must be changed to still accomplish full-scale deflection of the X-Y Plotter X-Axis. Amplifier gain is controlled by switching pin 5 of U128B either to ground for a signal gain of one or to pin 4 of U126 and R135 for a signal gain of two. The $\overline{GAIN}$ signal from the State Machine controls the gain-switching section of U129. When $\overline{GAIN}$ is LO, pin 5 of U129 connects to pin 4 of U129, and the gain of U128B is two. $\overline{GAIN}$ is HI for a 512-point waveform, and pin 3 of U129 (ground) is connected to pin 4 of U129 for a gain of one.

Another section of FET switch U129 is used to turn the X-Output to the Plotter on or off and is controlled by the S3 (State 3) signal from the State Machine. The X-Output switch section is turned on when S3 is HI. When off, this switch holds the X-Y Plotter plot pen at the home position by effectively isolating the Plotter from the data transmitted by the Microprocessor during nonplotting times.

PLOT TIMING CIRCUITS

The Plot Timing circuits consist of Oscillator U107, Clock Divider U109, Plot-Clock Select Multiplexer U111, Byte-Sent Flip-flop U127B, and Pen Control Flip-flop U127A. These circuits control the pen-lift timing of the external X-Y Plotter and signal to the Microprocessor when the current waveform data point has been plotted.

The basic clocking frequency is produced by Oscillator U107 which free runs at a frequency of 50 Hz. The 50-Hz output from U107 pin 3 is applied to both Clock Divider U109 and Plot-Clock Select Multiplexer U111. In the Clock Divider circuitry, the 50-Hz frequency is divided down to provide three additional clocking frequency outputs. (For ease of description, the clocking signals will be defined by cycle period, not frequency.) Since the 50-Hz input signal period is 20 ms; the cycle period at U109 pin 3 is 40 ms (divided by two), the cycle period at U109 pin 6 is 320 ms (pin 3 output divided by eight), and the cycle period at U109 pin 8 is 5.12 s (pin 6 output divided by 16). These four clocking frequencies (the basic 50 Hz plus the three divided down signals) are all applied to the input pins of Plot-Clock Select Multiplexer U111, where they are available for selection according to the output state of the State Machine and the setting of the PLOT SPEED switch. See Table 6-6 for Multiplexer U111 switching logic.

From Table 6-6, it can be seen that during nonplot periods when S3 is LO, the clock period is 20 ms. This clocking period is used to transfer the data as rapidly as possible from the Microprocessor while the Percent Symbol

Table 6-6

Multiplexer U111 Switching Logic

Select Inputs			Clock Period Selected	Function
C Plot Speed	B S3	A First/ Last		
0	0	0	20 ms	Fast Data Xfer
0	0	1	20 ms	Fast Data Xfer
0	1	0	320 ms	Slow Plot
0	1	1	5.12 s	First or Last
1	0	0	20 ms	Fast Data Xfer
1	0	1	20 ms	Fast Data Xfer
1	1	0	40 ms	Fast Plot
1	1	1	5.12 s	First or Last

Detector is looking for the beginning of the waveform data block. 20-ms clocking signals to Byte-Sent Flip-flop U127B are continuous, and the SENT output signal from U127B will become HI on the first clock rising edge that occurs after being reset by the $\overline{\text{SNTACK}}$ strobe. Since the Microprocessor responds quickly during data transfer, the transfer byte rate is nearly 50 Hz for the preamble and scale-factor data bytes.

When the % symbol is detected, the State Machine switches to State One, and the byte count is loaded into the Record Counter. State Two is entered for one data byte, and First Flip-flop U112B is clocked to make the FIRST signal HI for the first waveform data byte; then State Three is entered, and S3 becomes HI.

From Table 6-6, when S3 and FIRST/LAST are both HI with either PLOT SPEED chosen, the clock period selected is 5.12 seconds. At the output pins of U111, $\overline{\text{PLOT CLOCK}}$ from pin 6 is applied to the clock input of Pen Control Flip-flop U127A, the PLOT CLOCK (the complement of $\overline{\text{PLOT CLOCK}}$) from pin 5 is applied to the clock input of Byte-Sent Flip-flop U127B.

The rising edge of the PLOT CLOCK signal on pin 13 of U127B causes the SENT signal to switch HI. A HI on the SENT line clears the Clock Dividers and signals the Microprocessor, via Status Buffer U101, that the current data byte has been sent. When the Microprocessor acknowledges with the $\overline{\text{SNTACK}}$ strobe, Byte-Sent Flip-flop U127B is reset to make SENT LO. The clear on the Clock Dividers is thereby released, and they start dividing to produce the next clock cycle.

At about 2.5 seconds into the 5.12-second period of the first waveform data byte (one-half of the period), the rising edge of the $\overline{\text{PLOT CLOCK}}$ clocks Pen Control Flip-flop U127A to switch U127A pin 6 LO. The 2.5-second delay allows the plot pen time to reach the first data point to be plotted and settle down before the pen is lowered.

The output of U127A is applied to Polarity Control Gate U119A, an exclusive-OR gating circuit, on pin 1. PEN POLARITY switch S100-5 controls the logic level on pin 2 of the gate. Polarity Control Gate U119A acts as a switchable inverter to allow the use of external X-Y Plotters that require either open-contact or closed-contact pen control signals. If the PEN POLARITY switch is closed, Pen Control Relay K100 will have closed contacts when the plot pen should be down. The opposite is true when the PEN POLARITY switch is open.

The plot pen remains down until the last byte is indicated by the Record Counters. At that time, the LAST signal going HI at pin 2 of U127A enables the Pen Control Flip-flop to be reset by the next clock rising edge. On the last data byte, the reset occurs again at about 2.5 seconds into the 5.12-second clock period. The delay on the last data byte prevents a retrace from being drawn.

Between the first and last waveform data bytes, S3 remains HI, but the FIRST/LAST signal is LO. From Table 6-6, the clock period chosen with these logic levels on the select inputs of U111 is either 40 ms or 320 ms, depending on the setting of PLOT SPEED switch S100-4. When the switch is open, the plot speed is 40 ms (fast plot); when closed it is 320 ms (slow plot).

When each byte is loaded into the Vertical Data Output Register U100, the Microprocessor begins polling the Status Buffer, waiting to find the SENT bit HI. When the clock cycle is completed, SENT goes HI, and as soon as the Microprocessor acknowledges with $\overline{\text{SNTACK}}$, the next clock cycle is started.

If RESET switch S100-1 is closed while waveform data is being plotted, the RESET signal is produced from U103A and applied to U117 at pin 1 and to U112B (the First Flip-flop) at pin 13. The RESET signal returns the State Machine to State Zero and resets First Flip-flop U112B. Any remaining waveform data is then transferred at the 20-ms clock rate, while the X- and Y-Outputs are held off by U129.

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PERFORMANCE CHECK

PURPOSE

This performance check is used to verify the Performance Requirements of the Analog X-Y Output Option as listed in Table 6-5. Introductory information contained at the beginning of the 468 Performance Check in this volume is applicable for preparing to complete this procedure.

TEST EQUIPMENT REQUIRED

The following equipment is required to perform the complete Performance Check procedure. The numbers preceding equipment types correspond to the items listed in Table 4-1 is this volume.

Equipment Required:

4. Test Oscilloscope
8. Low-Frequency Sine-Wave Generator
12. 42-in, 50-Ω BNC Cable (4 required)

CHECK PROCEDURE

NOTE

Section 8 of the 468 internal OPTIONS/SERVICE switch must be closed when the instrument is powered up to enable the Analog X-Y Output Option. Refer to Figure 5-6 in the "Maintenance" section of this manual for the switch location if necessary to set this switch.

468 CONTROL SETTINGS

POWER	ON (button in)

CRT

INTENSITY	As required for visible display
FOCUS	Best focused display
SCALE ILLUM	As desired

Vertical (Both Channels if Applicable)

VERT MODE	CH 1
POSITION	Midrange
VOLTS/DIV	5 mV
VOLTS/DIV VAR	Calibrated detent
AC-GND-DC	DC
INVERT	Normal (button out)
20 MHz BW LIMIT	Full Bandwidth (button out)

Trigger

COUPLING	AC
LEVEL	Midrange
SLOPE	+
A SOURCE	CH 1
TRIG MODE	AUTO
A TRIGGER HOLDOFF	NORM

Sweep

HORIZ DISPLAY	A
TIME/DIV	5 μs
TIME/DIV VAR	Calibrated detent
X10 MAG	Off (button out)
POSITION (horizontal)	Midrange

Digital Storage

STORAGE MODE	NORM
SAVE REF	Off (button out)
CURSOR FUNCTION	Off (both out)

Analog X-Y Output

RESET	Open (RESET off)
PLOT SPEED	Closed (Slow Plot)
PEN POLARITY	Closed (relay closed)
PEN PULL-UP	Closed (10 kΩ pull-up)

1. Check Analog X-Y Option Operation

a. Connect the Analog X-Y Output Option to the test oscilloscope as follows, using 50-Ω BNC coaxial cables. Use no terminations.

X OUT to CH 1 OR X

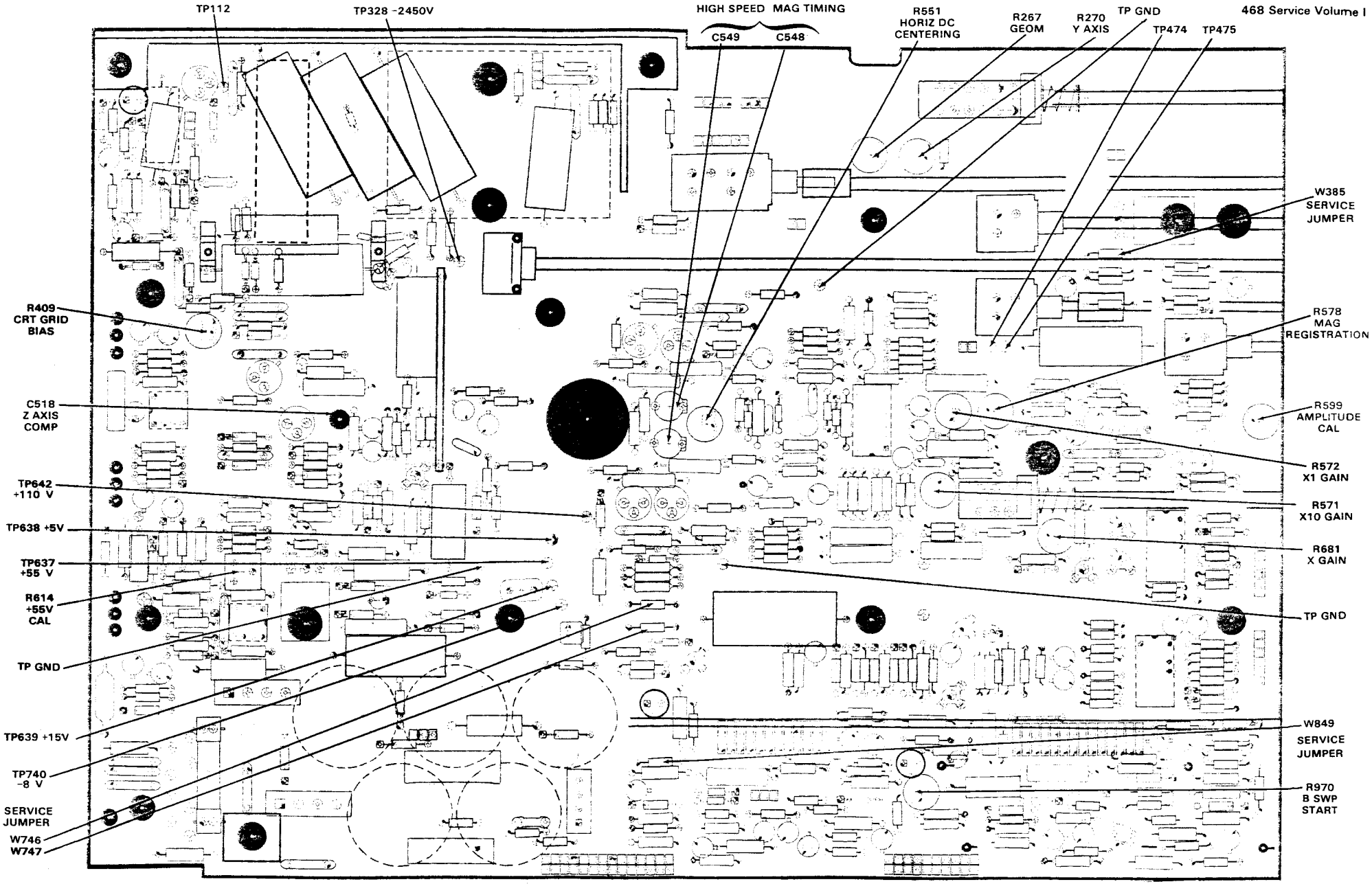
Y OUT to CH 2 OR Y

PEN OUT to EXT Z-AXIS
(on test oscilloscope rear panel)

b. Set the test oscilloscope controls:

Volts/Div (Ch 1 and Ch 2)	0.2 V
A and B Time/Div	X-Y
Ac-Gnd-Dc (Ch 1 and Ch 2)	Dc
Vert Mode	As required for X-Y display

c. Use the test oscilloscope Position controls to place the X-Y display spot at the lower left-hand corner of the crt graticule and adjust the Intensity control for a spot that is just visible.



Interface circuit board adjustment locations.

A15 INTERFACE BOARD

3515-73

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d. Connect the low-frequency sine-wave generator via a 50-Ω unterminated cable to the 468 CH 1 OR X input connector.

e. Set the generator controls for a frequency of 50 kHz and adjust the output amplitude for a vertical display of 6 divisions.

f. Use the 468 CH 1 Vertical POSITION control to align the negative peaks of the sine-wave signal with the bottom horizontal graticule line.

g. Set the 468 VERT MODE switches for a CHOP display of CH 1, CH 2, and ADD.

h. Use the 468 CH 2 POSITION control to superimpose the ADD waveform over the CH 1 waveform. Do not move the CH 1 waveform from the position set in part f.

i. Press in the PLOT push button (located on the 468 upper right side panel).

j. CHECK—Waveform freezes (468 enters SAVE Storage Mode; if this does not occur, see note at beginning of this procedure). Immediately observe the test oscilloscope display.

k. CHECK—Spot becomes intensified and plots a sine-wave trace having 6 divisions of amplitude. Watch the entire waveform to determine if all the data points are plotted correctly (none either missing or away from the sine-wave trace).

l. Set PEN POLARITY switch to OPEN.

m. CHECK—Spot intensity on test oscilloscope decreases.

n. Set PEN PULL-UP switch to OPEN.

o. CHECK—Spot intensity on test oscilloscope increases.

p. Set PEN POLARITY and PEN PULL-UP switches back to CLOSED.

q. Set PLOT SPEED switch to OPEN (Fast Plot).

r. CHECK—Plot speed on test oscilloscope increases (by eight times; from 320 ms per data point to 40 ms per data point).

s. CHECK—All three traces saved on the 468 display (two sine-wave traces and one baseline trace) are plotted, and the 468 exits the SAVE Storage Mode and returns to NORM Storage Mode at the completion of the last plot.

t. Disconnect all test equipment from the 468.

MAINTENANCE

The information contained here pertains to specific troubleshooting of the Analog X-Y Output Option. General maintenance information and specific information pertaining to Service Test and Signature Analysis testing contained in the "Maintenance" section of this manual also apply to the Analog X-Y Output Option.

Signatures for the option circuitry consist of the Microprocessor Trap Test signatures (located in Table 5-10 in the "Maintenance" section of this volume) and the Analog X-Y Output Data Test signatures (found in Table 6-7). Analyzer and 468 setups required to perform the signature tests are also included in the signature tables.

CORRECTIVE MAINTENANCE

Troubleshooting procedures for the Analog X-Y Output Option are detailed in the troubleshooting chart (Figure 6-12) and associated notes. Illustrated in the specific notes are pertinent waveforms generated in the option circuitry under normal operating conditions.

The Option 11 schematic diagram and circuit board illustration are located in Volume II of this manual. Figure 6-13 indicates the location of test points on the Option 11 circuit board.

TROUBLESHOOTING CHART NOTES

The following text is divided into General and Specific notes. General notes pertain to information that must be observed when doing any troubleshooting or maintenance on the instrument. Specific notes are associated with certain steps in the troubleshooting chart. The note number corresponds to the number called out in the troubleshooting chart.

GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

SPECIFIC NOTES

1. Analog X-Y Output Option setup.

   a. Set OPTIONS/SERVICE switch section 8 to CLOSED position. (Refer to Figure 5-6 in the "Maintenance" section of this volume for switch location.) This switch must be closed when the 468 is powered on to enable the Analog X-Y Output Option.

   b. Set rear panel X-Y Option switches as follows:

RESET	Open (reset off)
PLOT SPEED	Open (fast plot)
PEN POLARITY	Closed (relay contact closed)
PEN PULL-UP	Closed (10 k pull-up)

   c. Check X-Y Output Options power supplies at the following points (refer to Figure 6-10 for test point locations):

+5 V	TP101
-12 V	TP103
+2.5 V	U131-2

   d. Verify that clock frequency is approximately 50 Hz at U107-3.

2. Microprocessor Interface Test.

   a. Perform Microprocessor Trap Test. Refer to Table 5-10 for signatures and test setup.

      (1) Start Trap Test by momentarily removing P262, then replacing it. (Refer to Figure 5-7 in the "Maintenance" section of this volume for jumper location.)

      (2) Verify +5-V Check Signature at TP101 (on the Analog X-Y Output circuit board).

      (3) If +5-V signature is OK, then verify remaining Trap Test signatures given in Table 5-10.

   b. Perform Analog X-Y Output Data Test. Refer to Table 6-7 for signatures and test setup.

      (1) Turn off the 468. Remove ROM U565 and install the Service Test ROM in its place.

      (2) Set the OPTIONS/SERVICE switch to 11111000 (see Figure 5-6 for switch location).

      (3) Turn 468 power on (Record Counters will free run for checking X-Axis output).

      (4) Verify +5-V Check Signature at TP101.

      (5) If +5 V signature is OK, then verify remaining Output Data Test signatures given in Table 6-7.

3. Pen Lift Test.

   a. Turn 468 power off.

   b. Check pen-lift fuse F100 on Analog X-Y Output Option board.

   c. Turn 468 power on.

   d. Check voltage at relay K100-8. Voltage should be +5 V.

   e. Set rear panel PEN POLARITY swtich to OPEN.

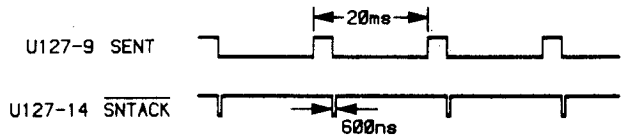
   f. Check voltage at relay K100-8 again. Voltage should be 0 V.

4. Byte Send Handshake Test.

   a. Set rear panel RESET switch to CLOSED.

   b. Connect test oscilloscope or logic analyzer probes to U127-9 (SENT signal) and U127-15 (SNTACK signal).

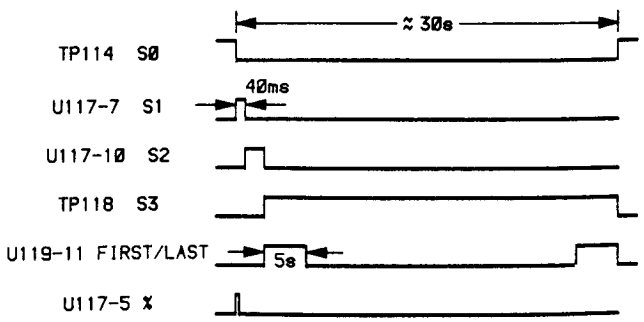
   c. Press in PLOT push button and check for waveforms as shown:



5. State Machine Test.

   a. Connect logic analyzer probes to the following points:
   TP114-SO signal
   U117-7-S1 signal
   U117-10-S2 signal
   TP118-S3 signal
   U119-11-FIRST/LAST signal
   U117-5-% signal

   b. Press in PLOT push button and check for waveforms as shown:



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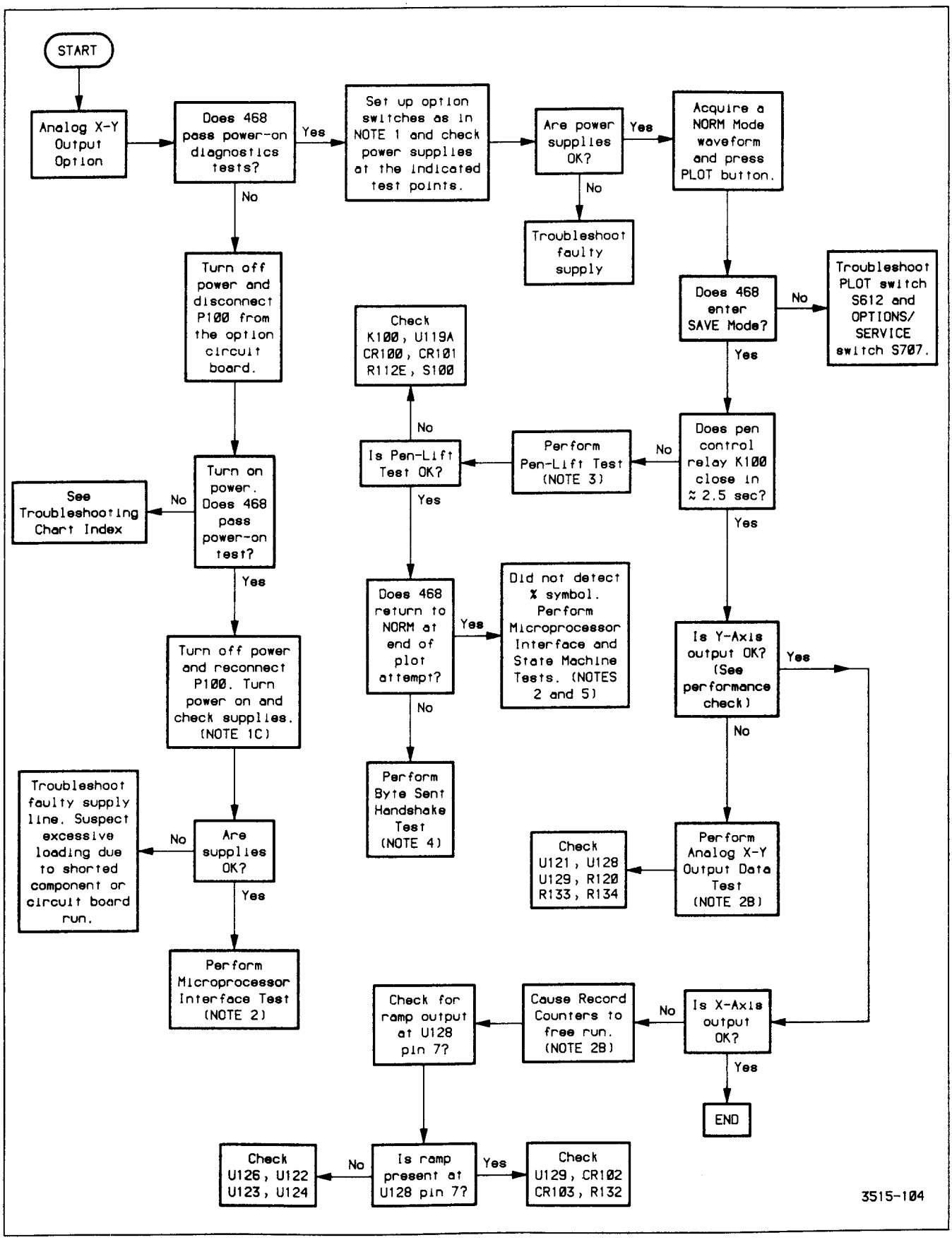

Figure 6-12. Analog X-Y Output Option troubleshooting chart.

Table 6-7

Version 2.0

Analog X-Y Output Data Test Signatures

Assy Number	Board Name	Part Number	Board Illustration	Schematic Diagram
A27	Analog X-Y Output	670-7551-00	8-27	26

Analyzer Setup

	Analyzer Setting	Probe Connect	Assy
Clock	↑	TP102	A27
Start	↑	TP358	A21
Stop	↓	TP358	A21

468 Setup

468 in Servicing Setup (see "Maintenance" section of this volume). Service Test ROM installed in U565 socket on A21. OPTIONS/SERVICE switch set to 11111000. Analog X-Y Output switches (on 468 rear panel) all OPEN. LED readout at completion of power-on should be 9211. To start or restart routine with POWER ON, move P182 on A21 to RESET position momentarily; then return it to RUN position.

+5 V Check Signature—5456

Component	Pin	Signature
U101	1	75C4
	2	5456
	4	5456
	6	5456
	14	0000
	16	0000
	18	0000
	19	75C4
U102	1	54H7
	2	0000
	4	0000
	6	0000
	10	0000
	12	0000
	14	0000
	15	54H7
U104	1	5456
	2	3396
	7	62UP
	15	54A7

Component	Pin	Signature
U108	1	3396
	2	62UP
	3	54A7
	5	0000
	6	5456
	7	75C4
	9	177A
	10	4672
	11	701C
	12	5446
	13	5476
	14	5416
	15	54H7
U100	1	5456
	2	7CUP
	5	PUU4
	6	CUHU
	9	1PUF
	11	701C
	12	HF17
	15	U706
	16	UHF2
	19	UU73

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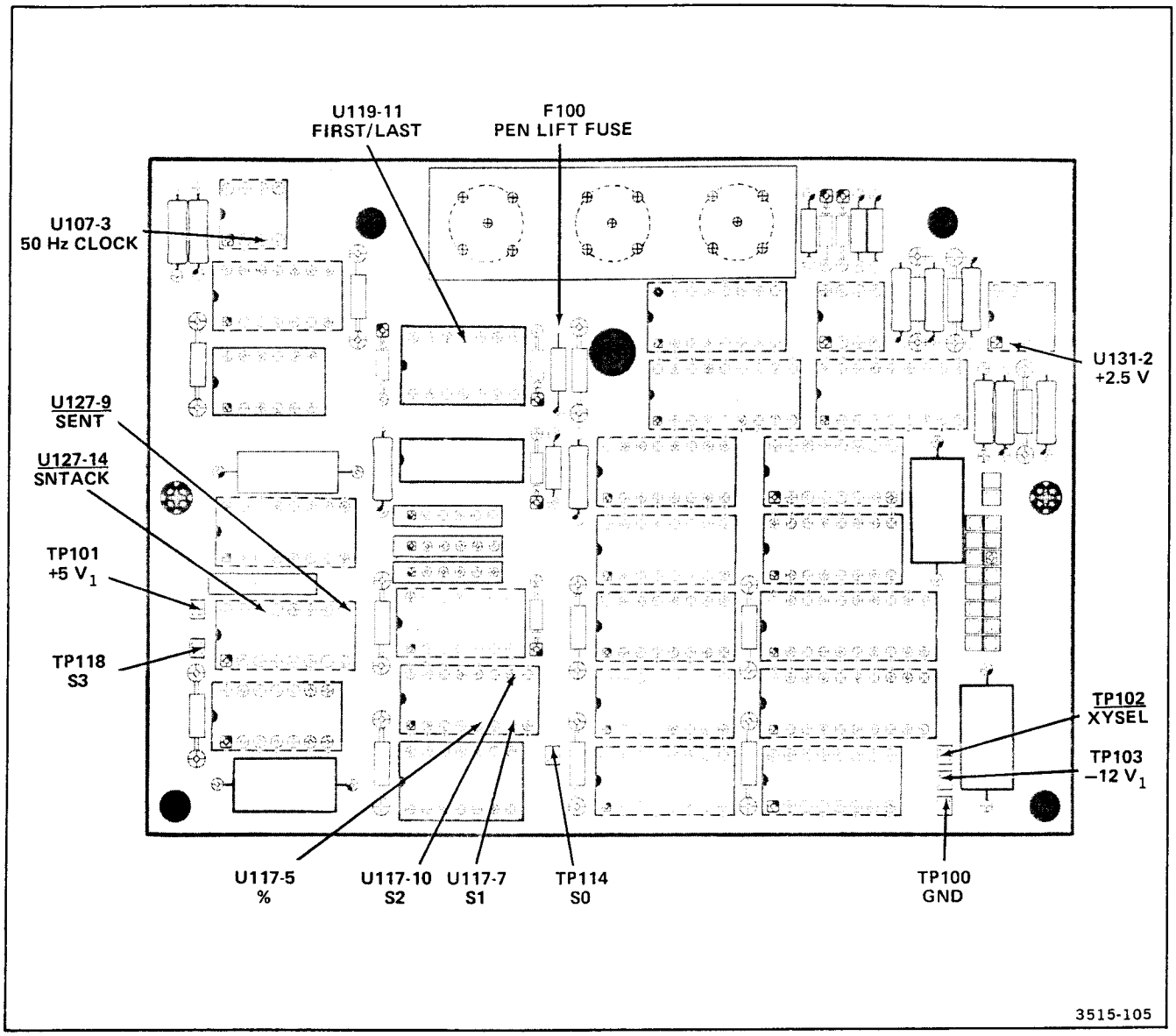
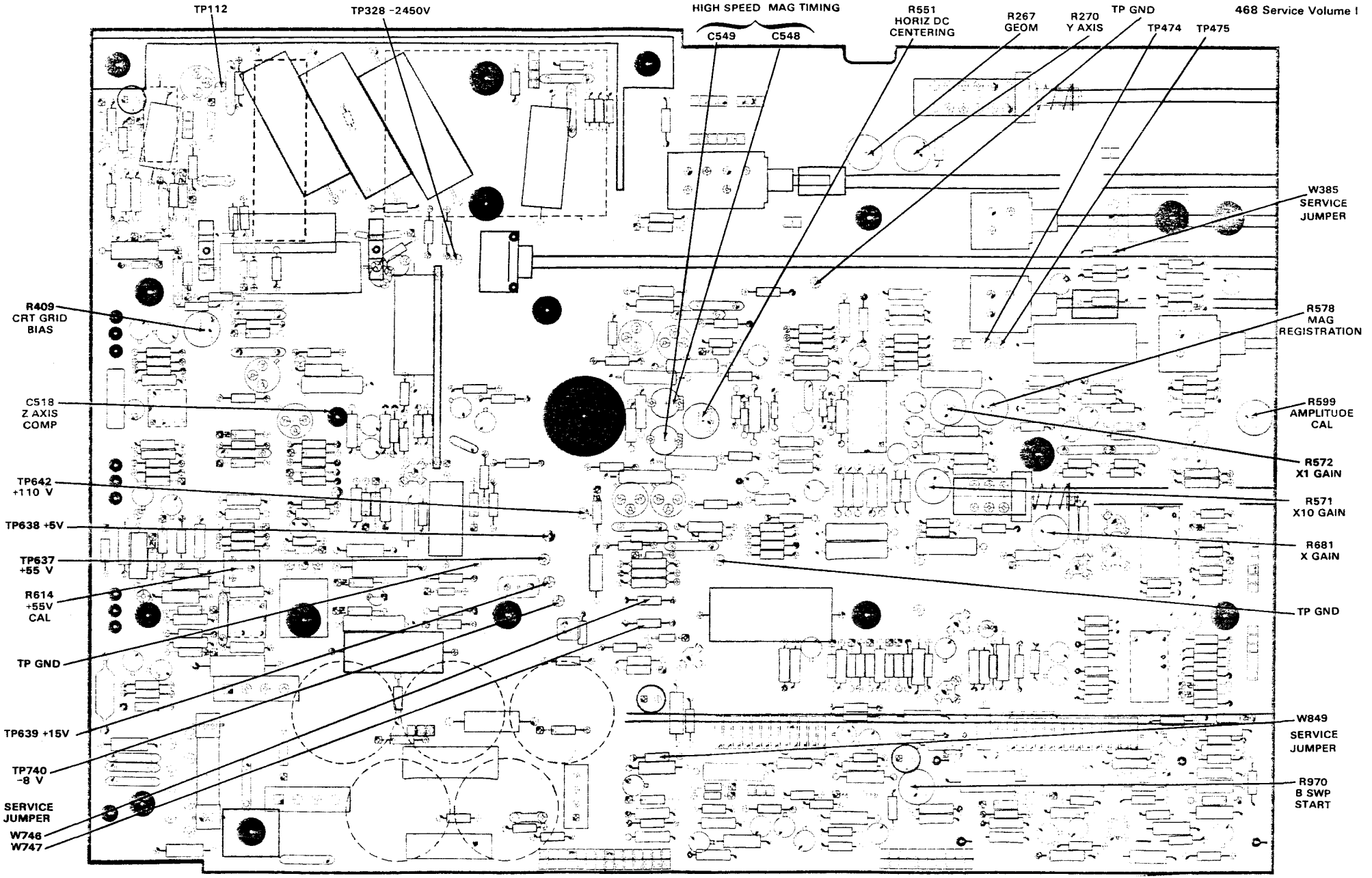


Figure 6-13. Analog X-Y Output Option test point locations.



Interface circuit board adjustment locations.

A15 INTERFACE BOARD

3515-73

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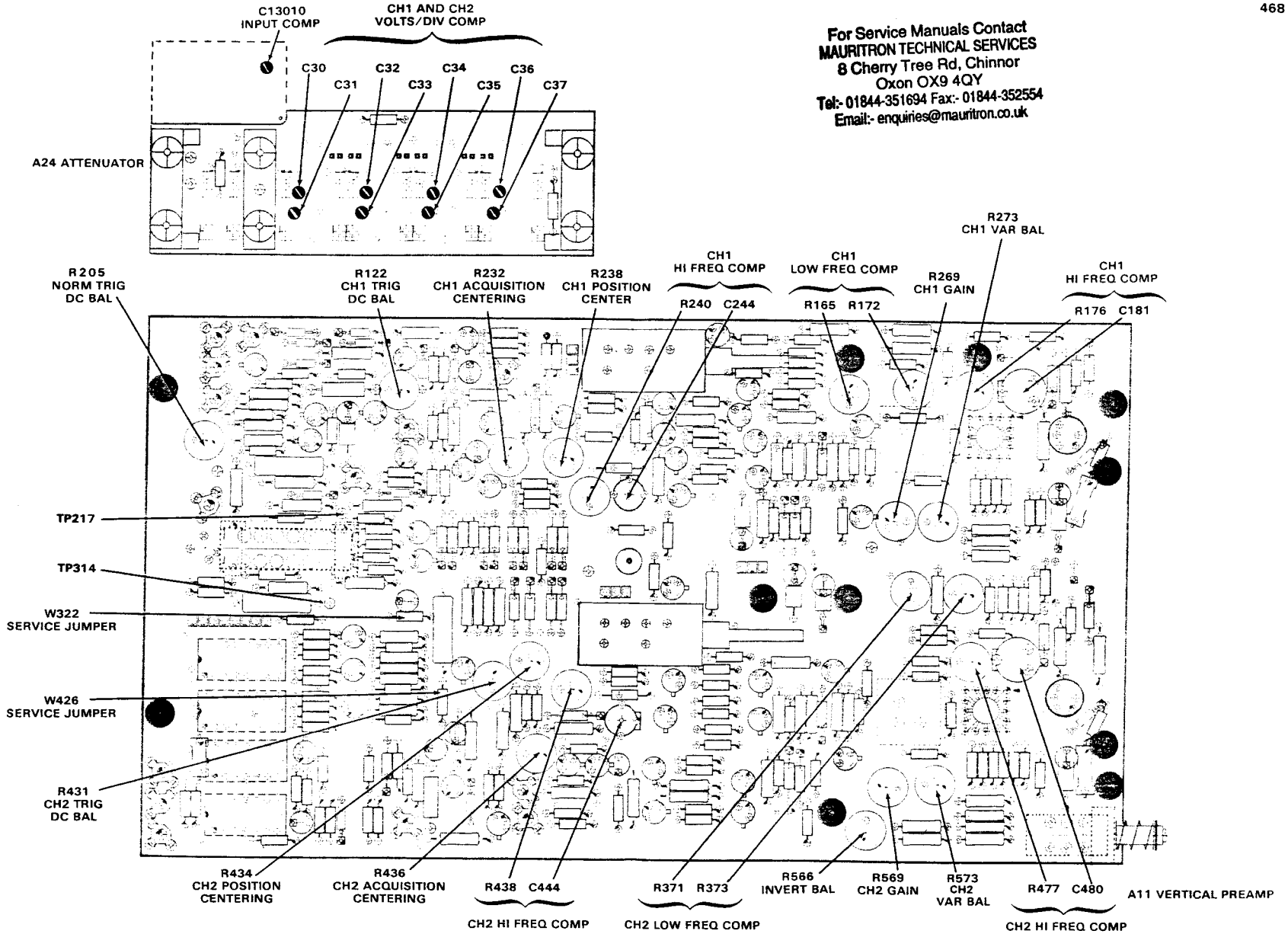

Vertical Preamplifier circuit board adjustment locations.

3515-74A

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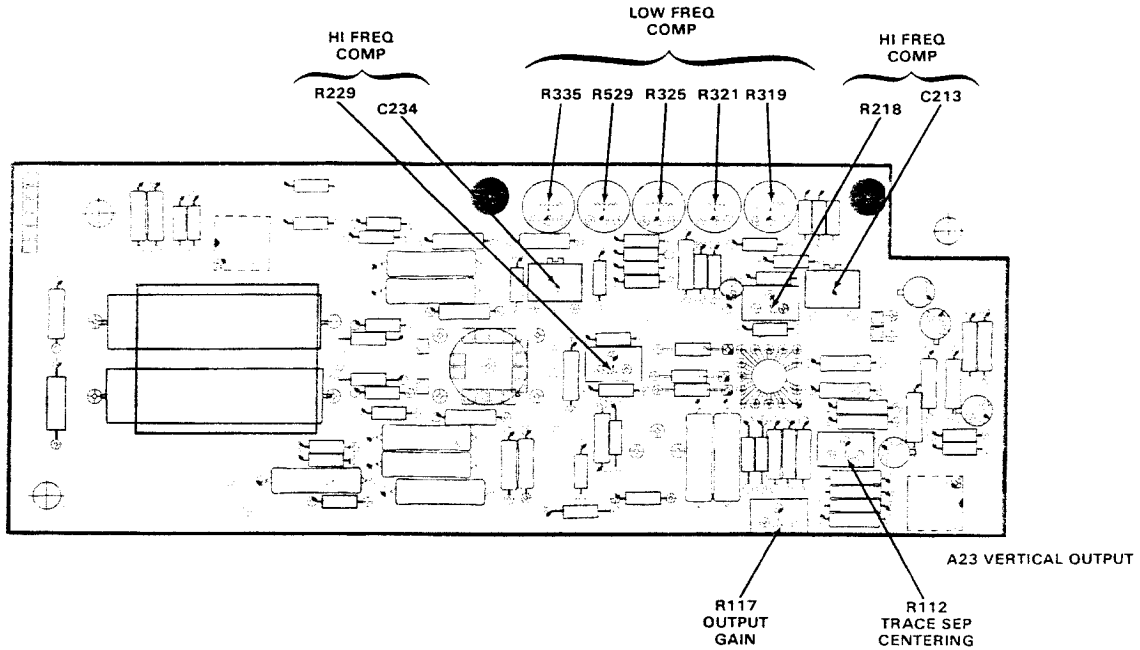

3515-75

Vertical Output board adjustment locations.

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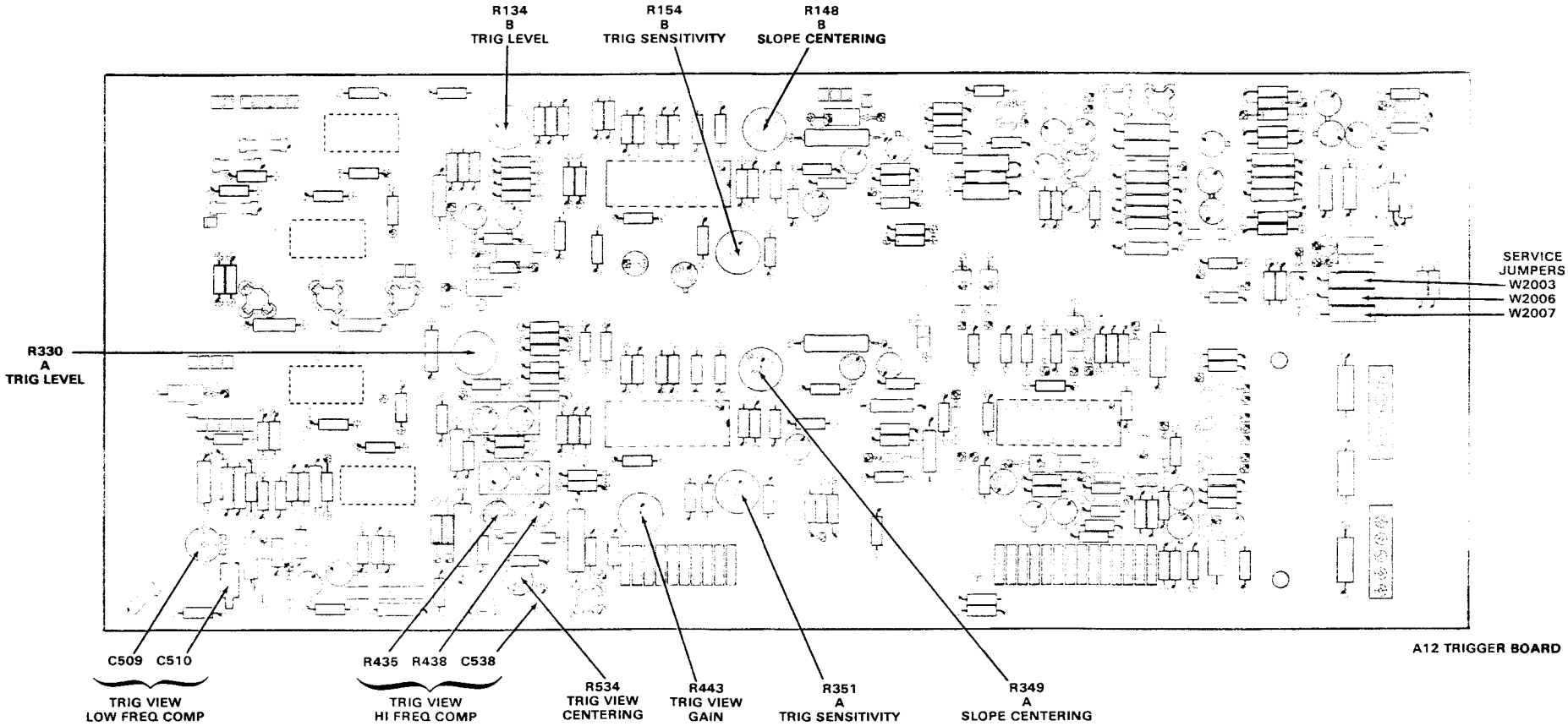
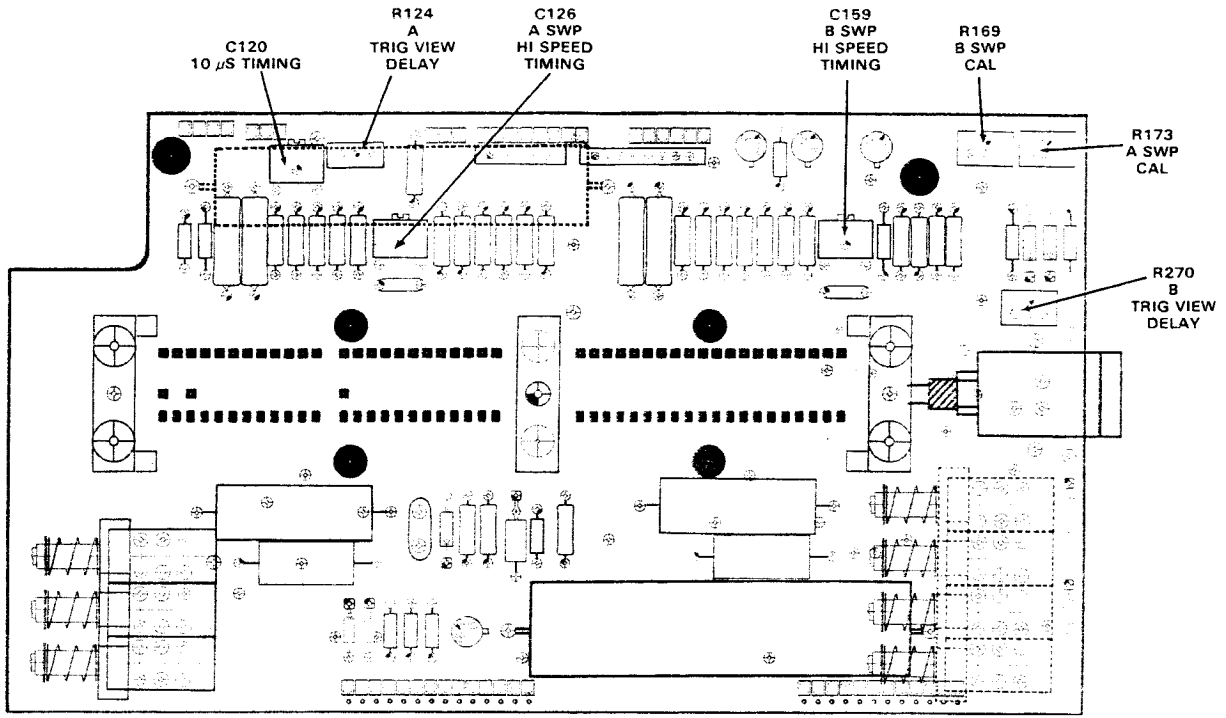


Trigger Generator and Sweep Logic circuit board adjustment locations.



Timing board adjustment locations.

3515-77

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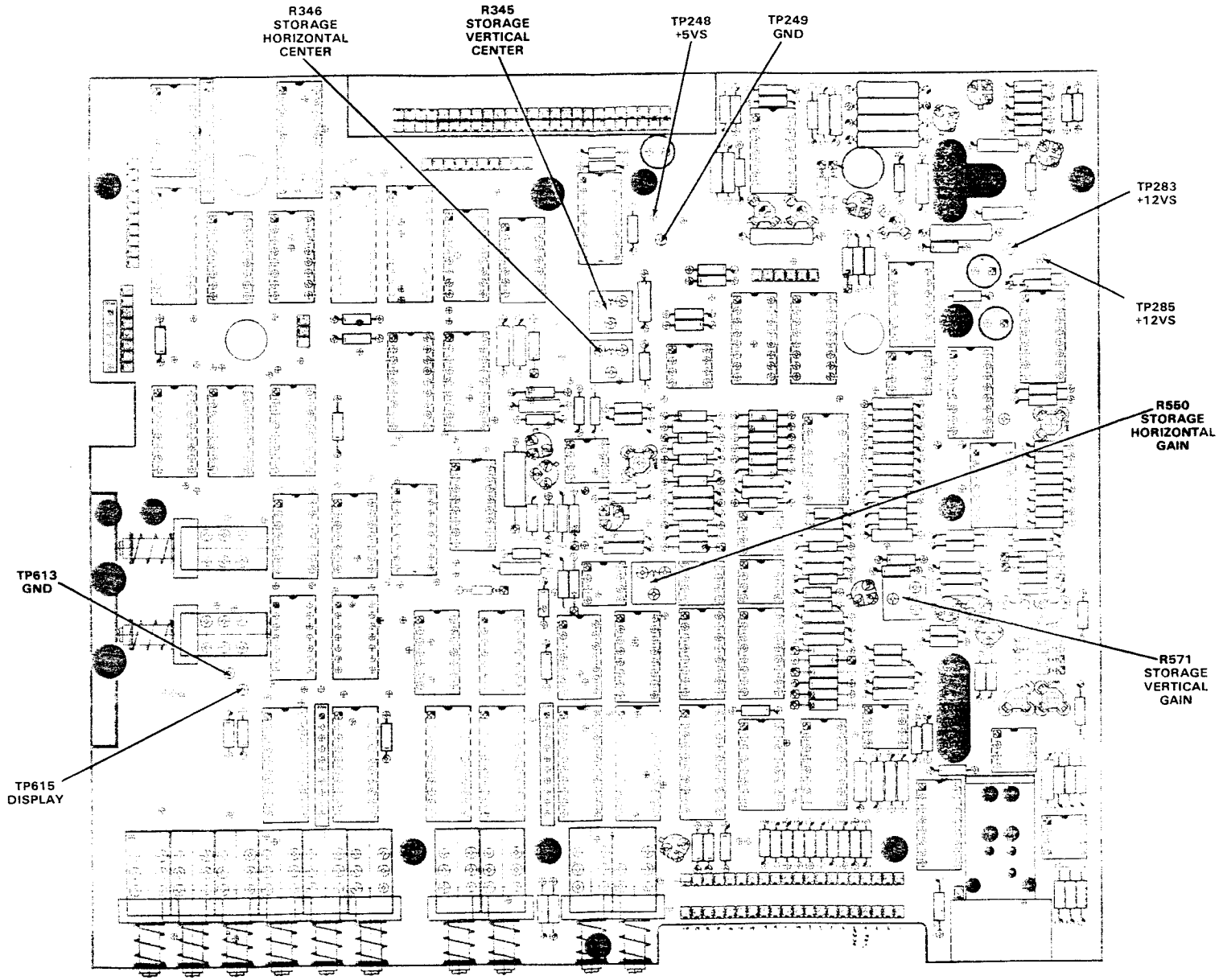

Storage Display board adjustment locations.

A16 STORAGE DISPLAY BOARD

3515-78

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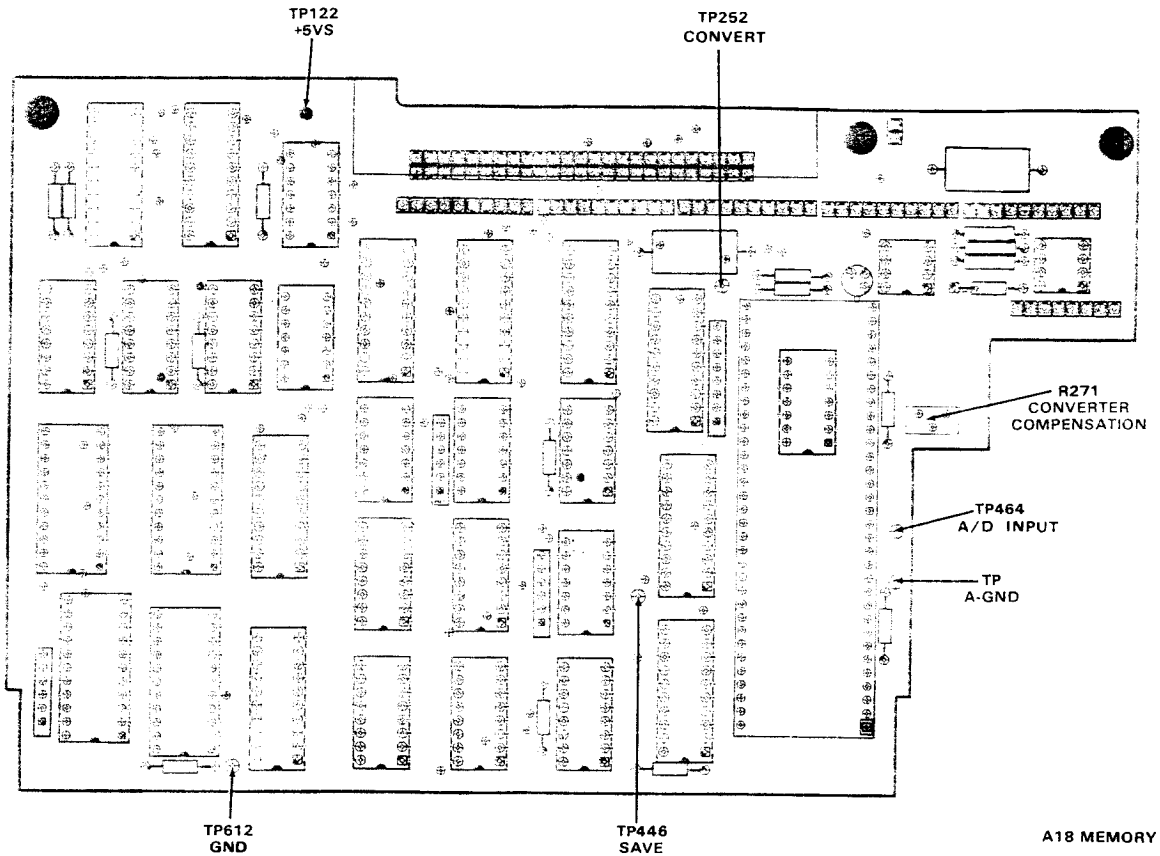
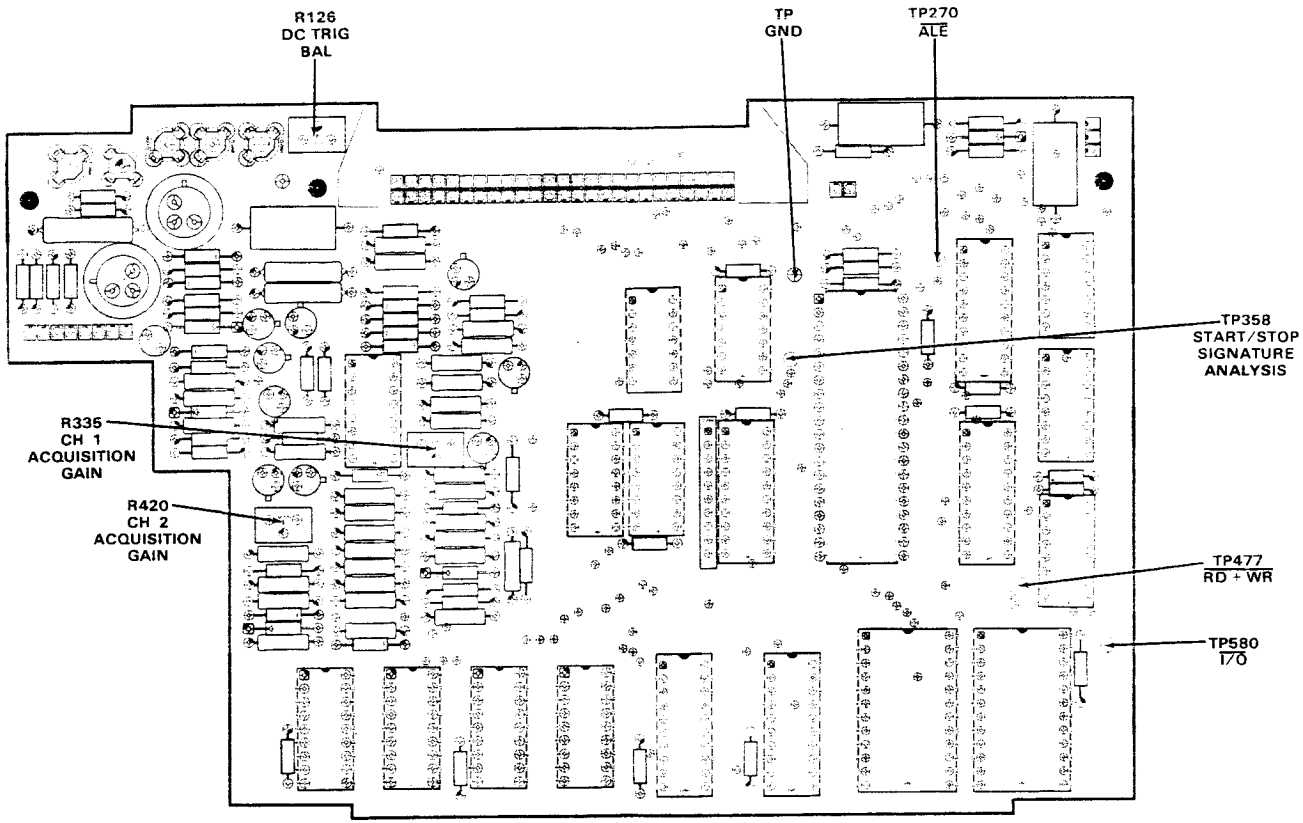


Memory board adjustment locations.

3515-79



Microprocessor board adjustment locations.

3515-80

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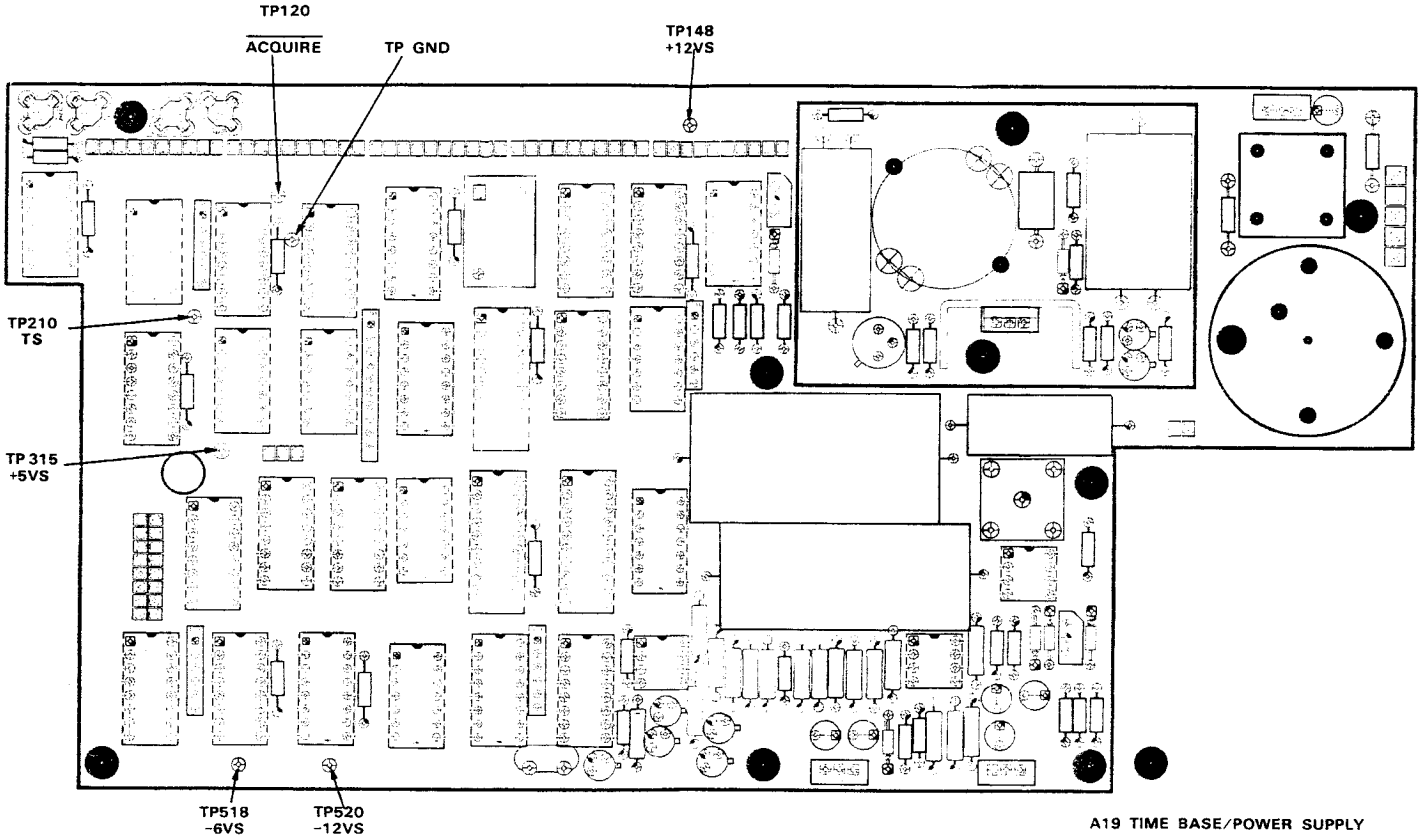

A19 TIME BASE/POWER SUPPLY

Time Base/Power Supply test point locations.

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SPECIFIC NOTES

1. Initial control settings and connections:

NON STORE	On (button in)
TRIG MODE	AUTO
A and B TIME/DIV	1 ms
HORIZ DISPLAY	A
CH 1 VOLTS/DIV	.1 V
CH 1 AC-GND-DC	DC
VERT MODE	CH 1
CH 1 Signal Input	Calibrator square wave via 10X probe
Service/Options Switch	X1000000

2. Isolate the nonstorage circuitry from the digital storage circuitry to allow checkout of conventional oscilloscope functions:
   a. Disconnect power and remove the oscilloscope cabinet (see "Maintenance", Secction 5).
   b. Disconnect P3008 from the A12 Trigger Generator Sweep Logic board (see Figure 8-17).
   c. Disconnect P483 from the A12 circuit board and connect a jumper between the two square-pin connectors on the board.
   d. Move P307 (at the rear of A14 Vertical Mode Switch board) to the Test Mode position (see Figure 8-15).
   e. Reapply power. This procedure enables the 468 to function as a conventional oscilloscope set up to chop between CH 1 and CH 2 inputs.
3. Perform the following sequence to check 468 operation:
   a. Verify operation in NON STORE mode (Troubleshooting Chart 3).
   b. Verify Microprocessor Kernel and AD0-AD7 Bus (Troubleshooting Chart 1).
   c. Perform the following Service Routines (see "SERVICE TEST", Section 5): Basic Display System, Switch Closure, Lamp Test.
   d. Remove the IC from U456 socket on A18 Memory board and insert Service Counter U356 in test socket. Verify digital data path (Troubleshooting Chart 4.3, NOTE 4).
   e. Reinstall U456.
4. If any Service Routine fails or if front panel controls have no effect or if any +5 V Check Signature fails, verify Microprocessor Kernel and AD0-AD7 Bus (Troubleshooting Chart 1).

GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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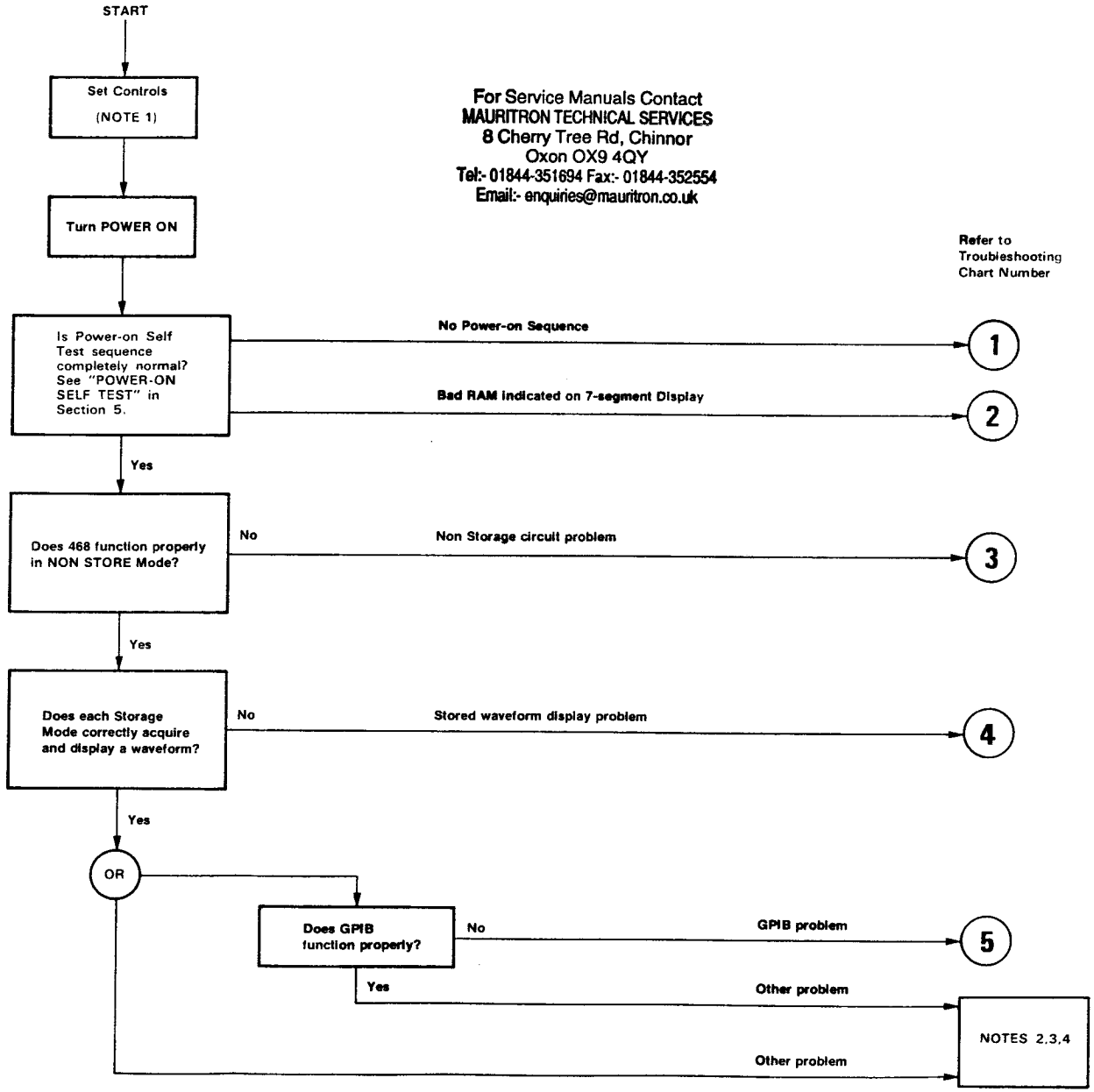

TROUBLESHOOTING CHART INDEX

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3515-61

SPECIFIC NOTES

1. Digital Storage Power Supplies.

   +4.8 V to +5.2 V at TP 248 (Diagram 17 and Figure 8-22).

   +11.4 V to +12.6 V at TP285 (Diagram 16 and Figure 8-22).

   -11.4 V to -12.6 V at TP283 (Diagram 16 and Figure 8-22).

   -5.8 V to -6.2 V at TP518 (Diagram 19 and Figure 8-23).

2. Kernel Test Procedure.

   a. Set POWER switch OFF.

   b. Remove U452 and U558.

   c. Set POWER switch ON.

   d. Move P182 momentarily to the RESET position, then return it to the RUN position.

   e. Verify presence of the following signals and signatures in the order listed. See waveform illustrations on Diagram 18 in Volume II (numbers in parentheses).

      (1) +5 V on U364-40

      (2) 5-MHz Clock on U272-15 and U364-1 (135 and 136)

      (3) 2.5-MHz Clock on U364-37 (137)

      (4) 50 kHz on U440-1 (138)

      (5) 500 Hz on U364-7 (139)

      (6) PRDONE on U472-16 (140)

      (7) $\overline{\text{ALE}}$ on TP270 (141)

      (8) Waveform on TP477 (142)

      (9) $\overline{\text{RD}}$ on U364-32 (143)

      (10) $\overline{\text{WR}}$ on U364-31 (144)

      (11) Signal on U255-5 (145)

      (12) All Signatures of Kernel Test 1 and Kernel Test 2

      (13) All Signatures of ROML and ROMH (ensure that correct ROMs are installed)

      (14) U255-9 is not stuck either HI or LO

   f. SET POWER switch OFF.

   g. Reinstall U452 and U558.

3. Trap Test Procedure.

   a. Remove P262 momentarily, then reinstall it to cause a TRAP Interrupt to U364-6.

   b. Verify the +5-V signature.

   c. If +5-V signature is OK, then verify remaining Trap Test signatures on A21, A14, or A19, as applicable.

4. Service ROM Checksum Test.

   a. Set POWER switch OFF.

   b. Remove U464 (ROML) and install Service ROM at U565 socket.

   c. Set Service ROM switch to 00000000 (all OPEN).

   d. Set POWER switch ON.

   e. Observe Readout Display for any one of the following indications:

      0000 (Test OK)
      8888 (Test Failed)
      No readout or any other readout (Test Failed)

5. Other service routines can be run at this time to verify other areas of the instrument. Service Switch 7 is ON for normal operation, and 8 is ON for GPIB. All others are "don't care".

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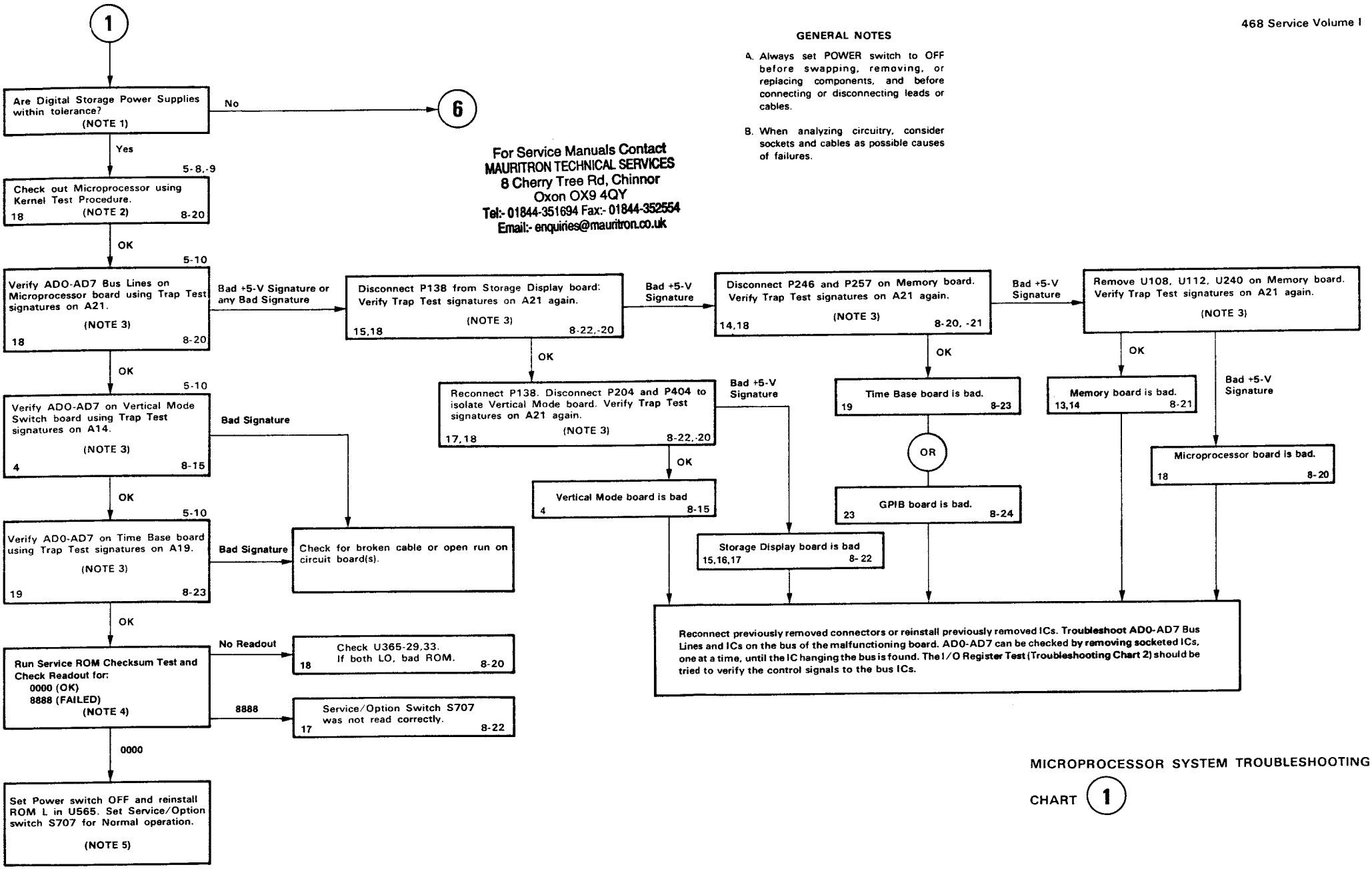
GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.



MICROPROCESSOR SYSTEM TROUBLESHOOTING CHART 1

SPECIFIC NOTES

1. The procedures for running all Service Routine tests (using the Service ROM) are contained under "SERVICE TEST" in Section 5 of this volume.

GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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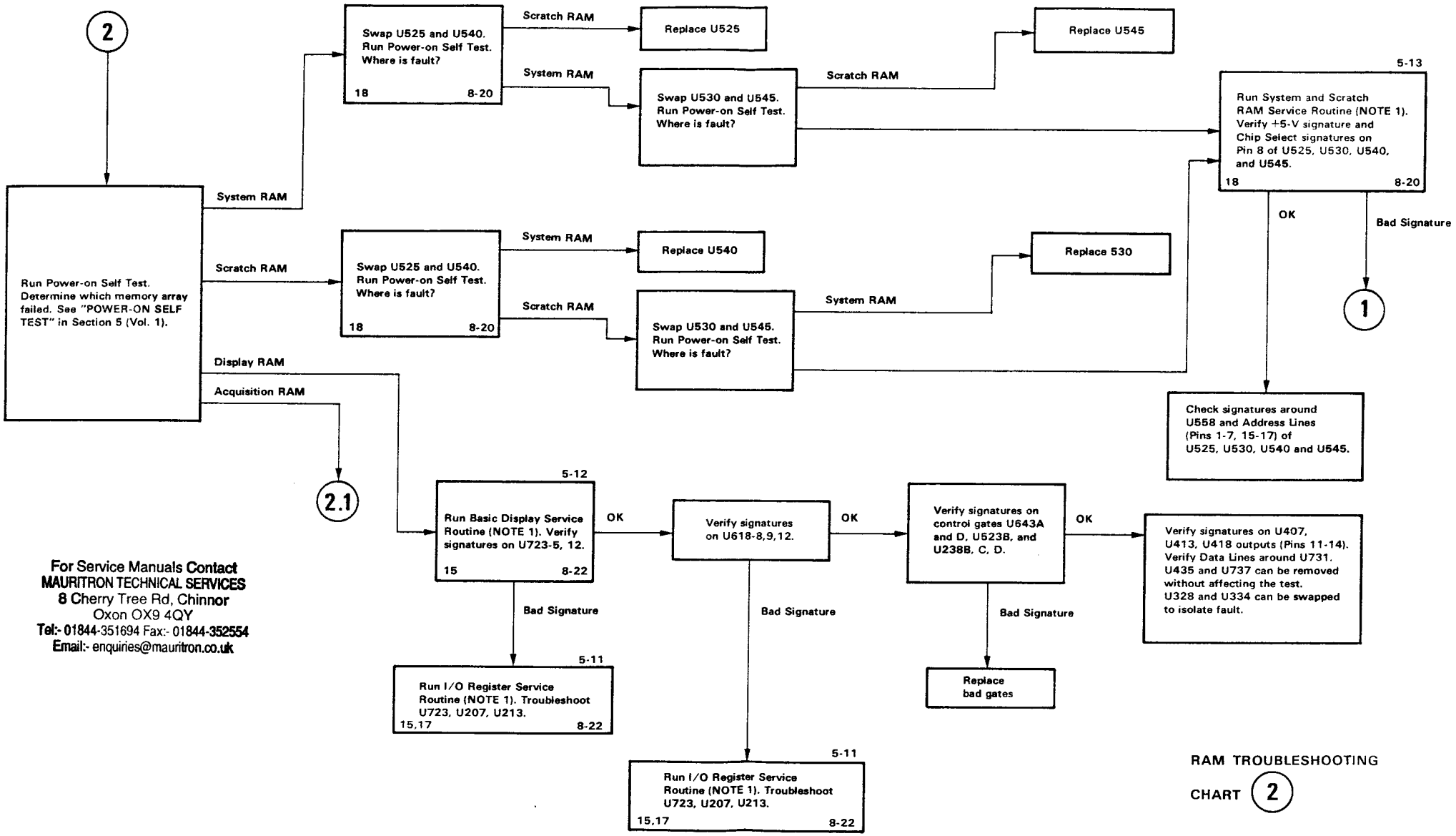

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RAM TROUBLESHOOTING CHART 2

SPECIFIC NOTES

1. The procedures for running all Service Routine tests (using the Service ROM) are contained under "SERVICE TEST" in Section 5 of this volume.

GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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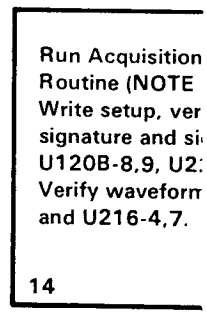

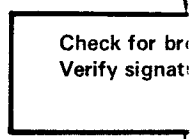

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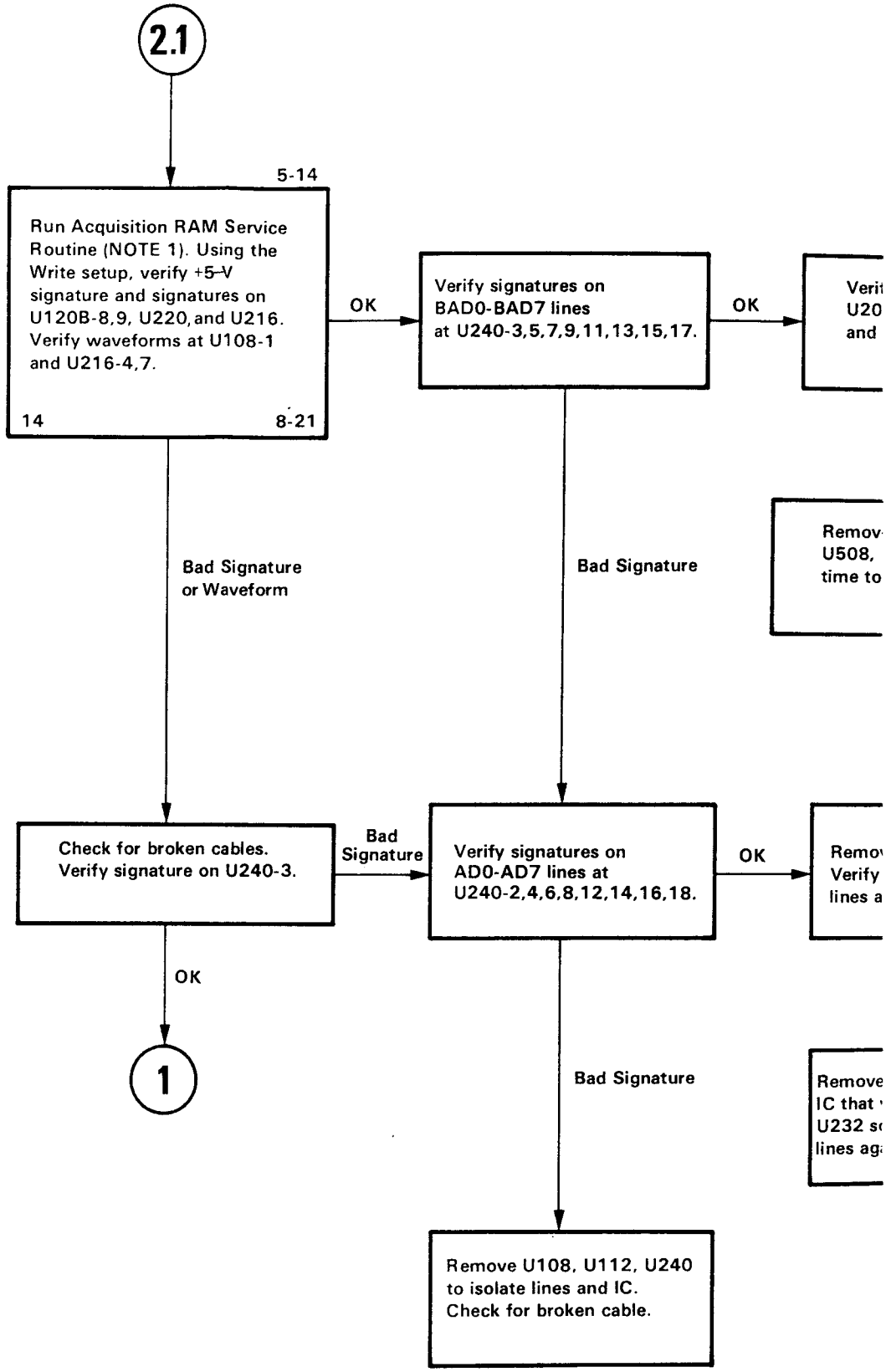

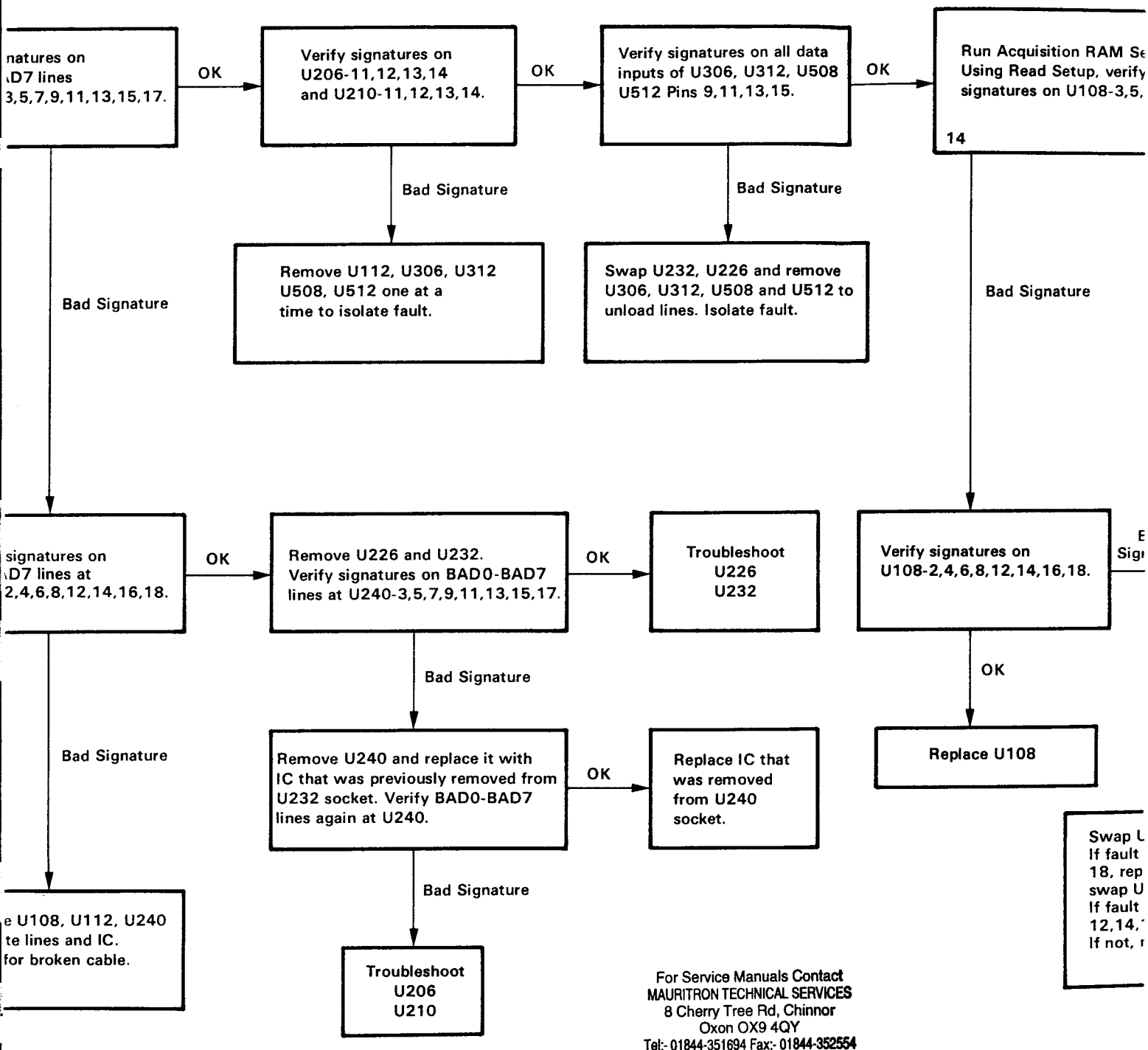

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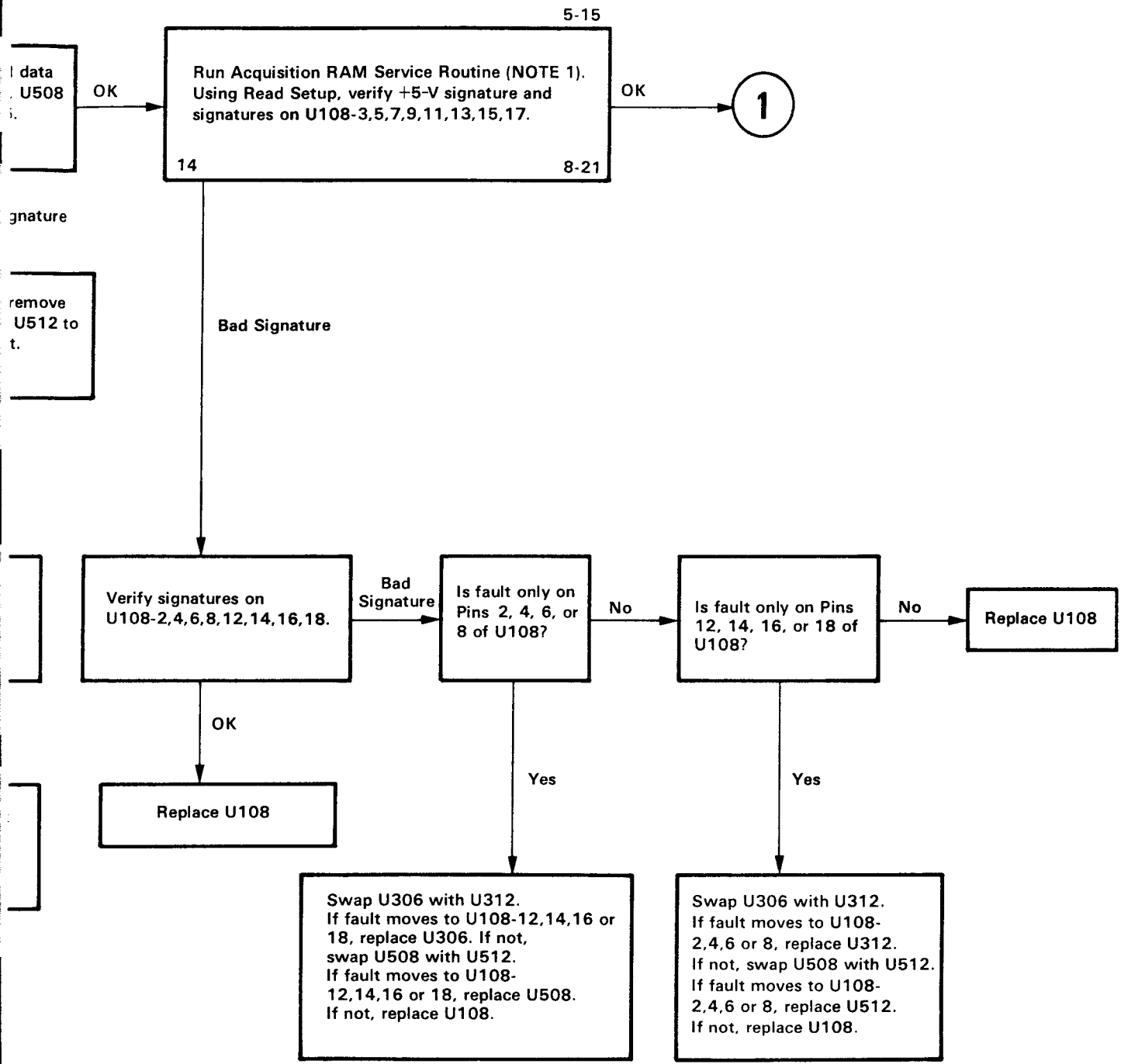

RAM TROUBLESHOOTING

CHART 2.1

SPECIFIC NOTES

1. Isolate the nonstorage circuitry from the digital storage circuitry to allow checkout of conventional oscilloscope functions:
   a. Disconnect power and remove the oscilloscope cabinet (see "Maintenance", Section 5, Vol. I).
   b. Disconnect P3008 from the A12 Trigger Generator Sweep Logic board (see Figure 8-17).
   c. Disconnect P483 from the A12 circuit board and connect a jumper between the two square-pin connectors on the board.
   d. Move P307 (at the rear of A14 Vertical Mode Switch board) to the Test Mode position (see Figure 8-15).
   e. Reapply power. This procedure enables the 468 to function as a conventional oscilloscope set up to chop between CH1 and CH2 inputs.

2. Verify the following voltages at A15 Interface board (Diagram 20 and Figure 8-18):

   a. −8 V at TP740
   b. +5 V at TP638
   c. +15 V at TP639
   d. +55 V at TP637
   e. +110 V at TP642.
   f. -2450V at TP328.

GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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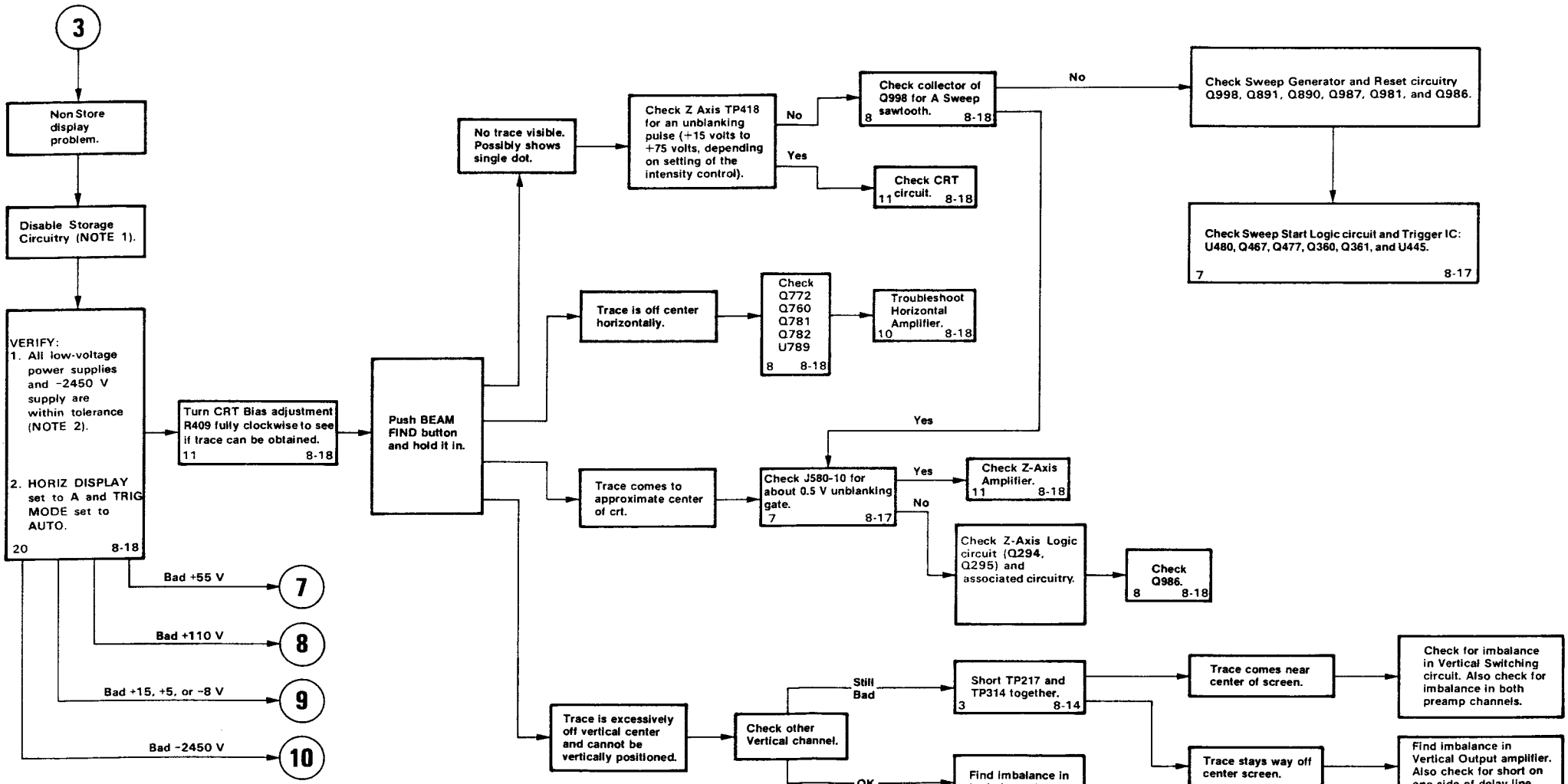


NONSTORAGE FUNCTIONS TROUBLESHOOTING

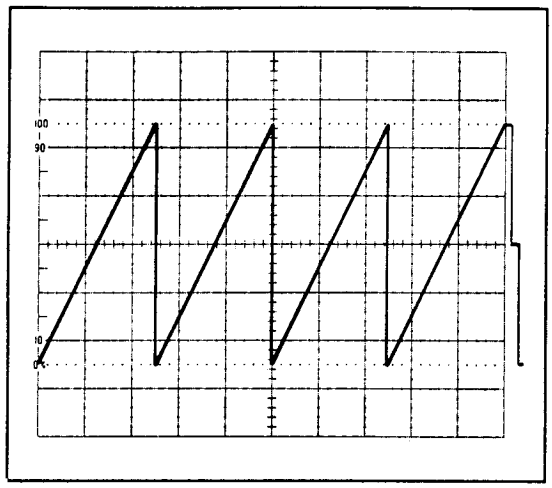
CHART 3

(2757-52) 3515-58

SPECIFIC NOTES

1. The procedures for running all Service Routine tests (using the Service ROM) are contained under "SERVICE TEST" in Section 5 of this volume.

2.

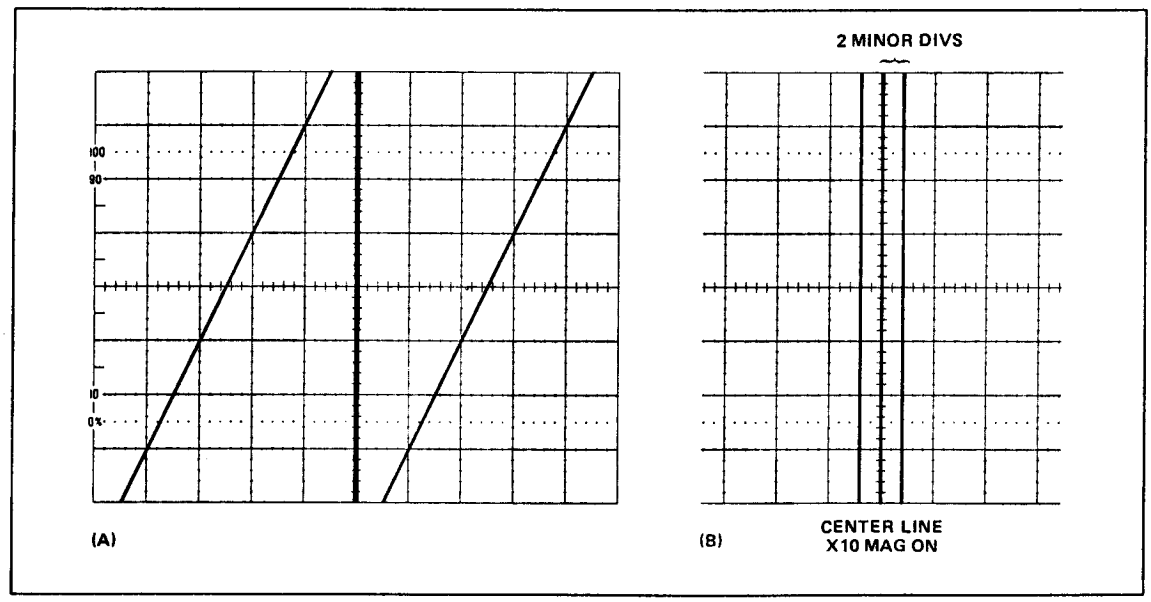


GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

3.



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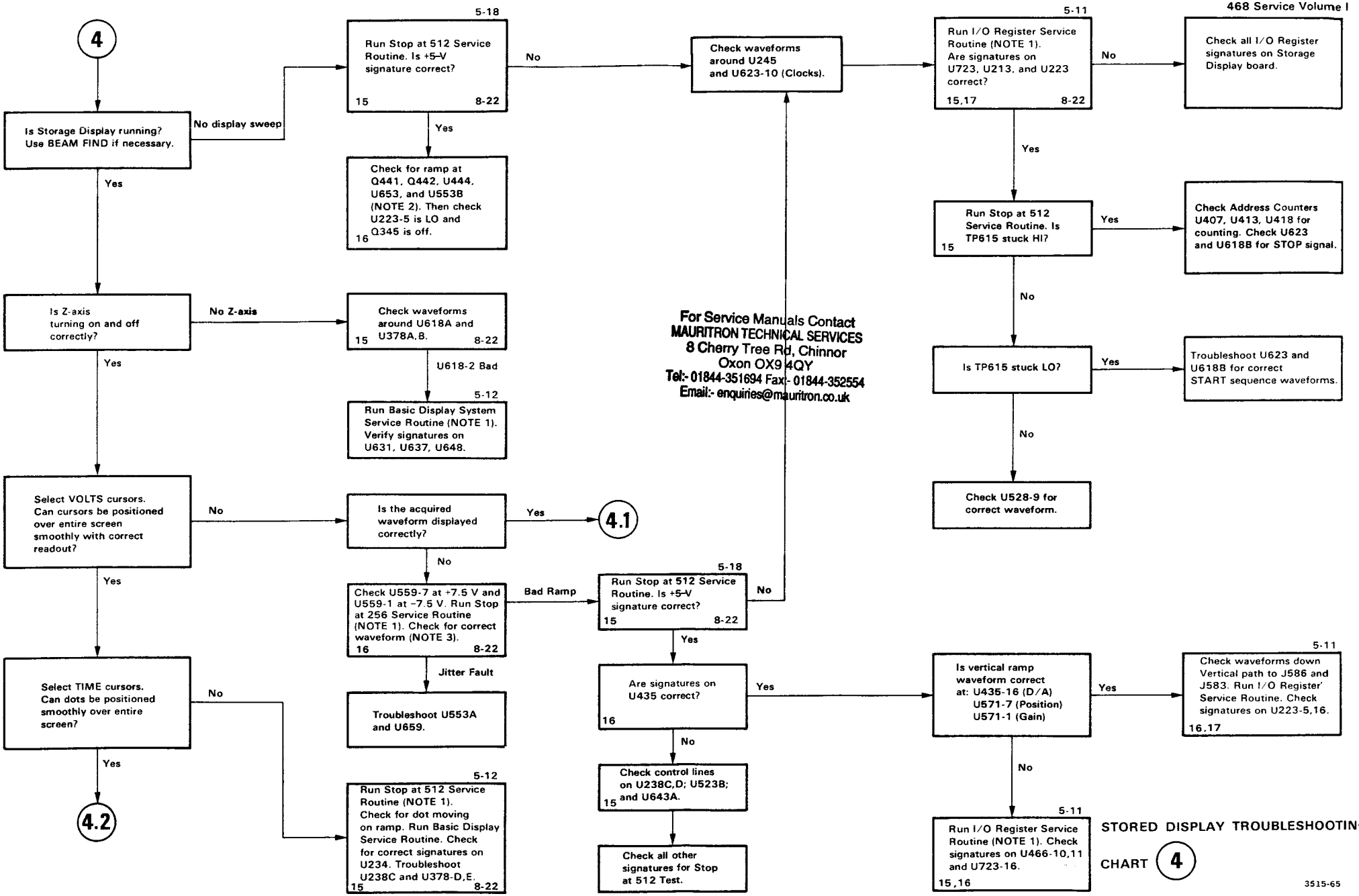

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STORED DISPLAY TROUBLESHOOTING

CHART 4

3515-65

SPECIFIC NOTES

1. The procedures for running all Service Routine tests (using the Service ROM) are contained under "SERVICE TEST" in Section 5 of this volume.

2. Adjust R345 on Storage Display board (Diagram 16) to vertically center trace.

GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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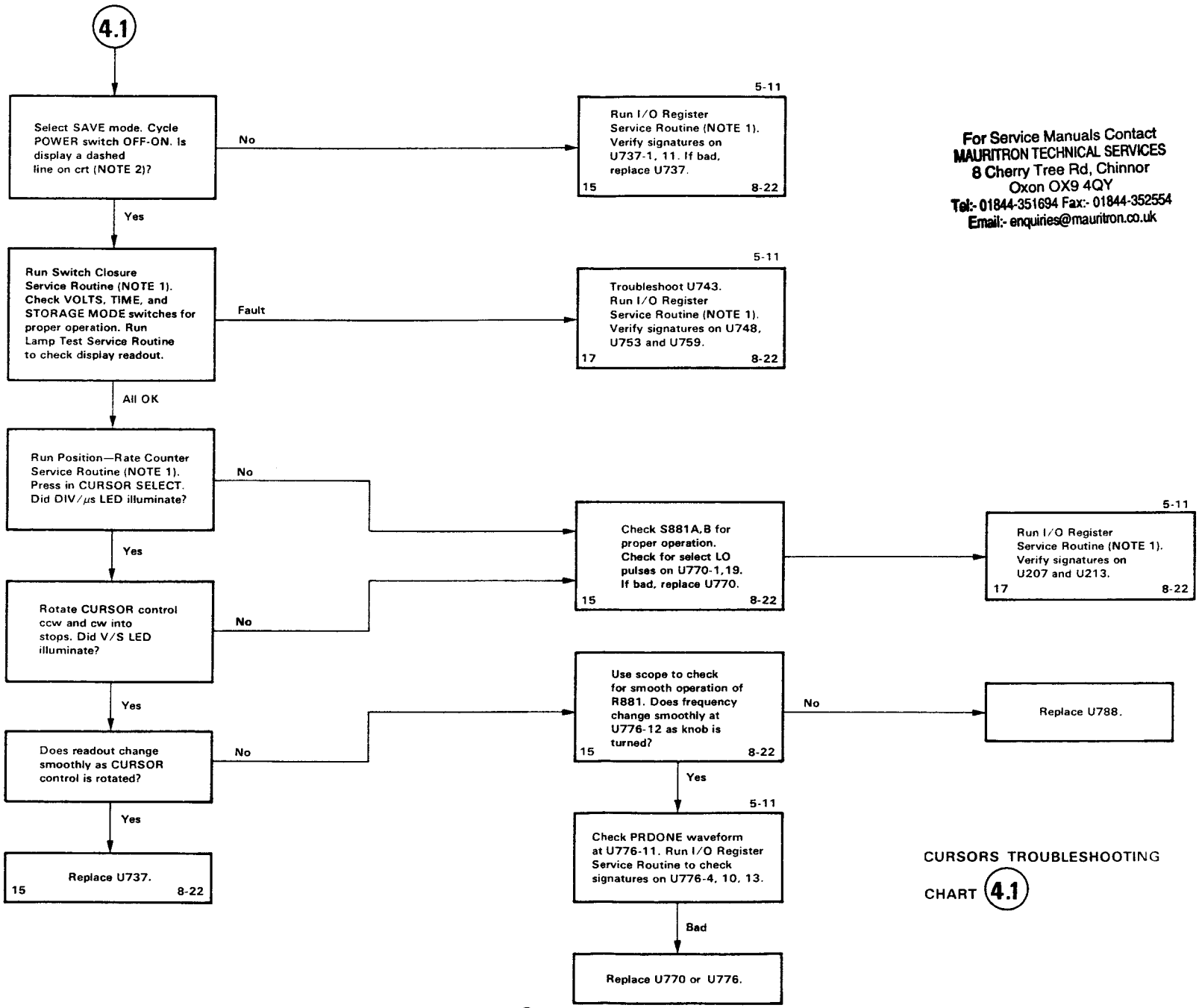
CHART (4:1)



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CURSORS TROUBLESHOOTING CHART 4.1

3515-66

SPECIFIC NOTES

1. The procedures for running all Service Routine tests (using the Service ROM) are contained under "SERVICE TEST" in Section 5, Volume 1.

2. Use the following table to determine Sample Clock periods at TP446 TP210 and U120-13.

3. Use the following table to determine Sa periods and frequencies at U120-10, 11 an

Table A

TIME/DIV Switch Setting	Sample Clock Periods		
	TP446 (Diagram 14)	TP210 (Diagram 19)	U120-13 (Diagram 19)
0.02—2 μs	40 ns	40 ns	Not Running
5 μs	100 ns	100 ns	Not Running
10 μs	200 ns	200 ns	Not Running
20 μs	400 ns	40 ns	Not Running
50 μs	1 μs	100 ns	Not Running
0.1 ms	2 μs	200 ns	Not Running
0.2 ms	4 μs	400 ns	400 ns
0.5 ms	10 μs	1 μs	1 μs
1 ms	20 μs	2 μs	2 μs
2 ms	40 μs	4 μs	4 μs
5 ms	100 μs	10 μs	10 μs
10 ms	200 μs	20 μs	20 μs
20 ms	400 μs	40 μs	40 μs
50 ms	1 ms	100 μs	100 μs
0.1 s	2 ms	200 μs	200 μs
0.2 s	4 ms	400 μs	400 μs
0.5 s	10 ms	1 ms	1 ms
1 s	20 ms	2 ms	2 ms
2 s	40 ms	4 ms	4 ms
5 s	100 ms	10 ms	10 ms

Table B

Test Point	Sample Clocks	
	Period	Frequen
U120-10	40 ns	25 MH:
U120-11	100 ns	10 MH:
U120-12	200 ns	5 MH:

4. Use the following table to determine Divider Cl periods. When observing waveforms, disregarc characteristic glitch associated with synchrono

Table C

Test Point	Period	Duty Cycle ('
U430-15	400 ns	50
U424-15	4 μs	10
U418-15	40 μs	10
U510-15	400 μs	10
U518-15	4 ms	10

GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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TP446

3. Use the following table to determine Sample Clock periods and frequencies at U120-10, 11 and 12.

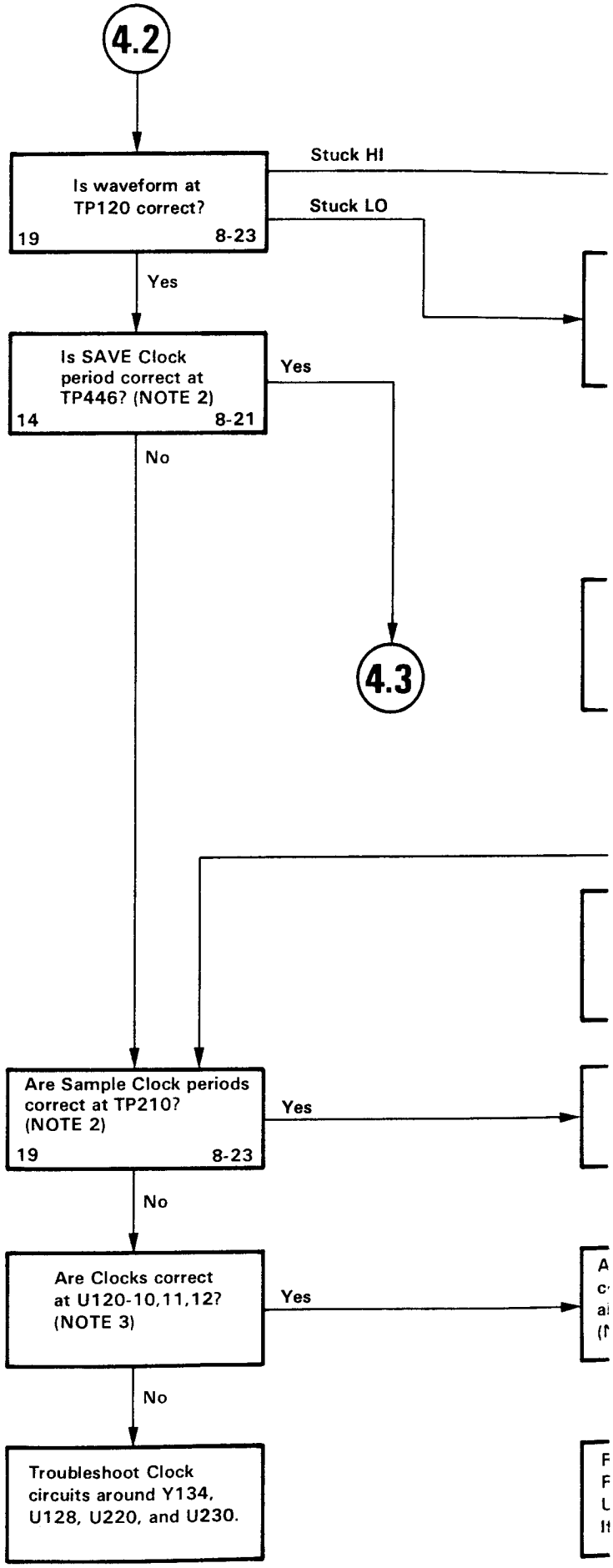
Table B

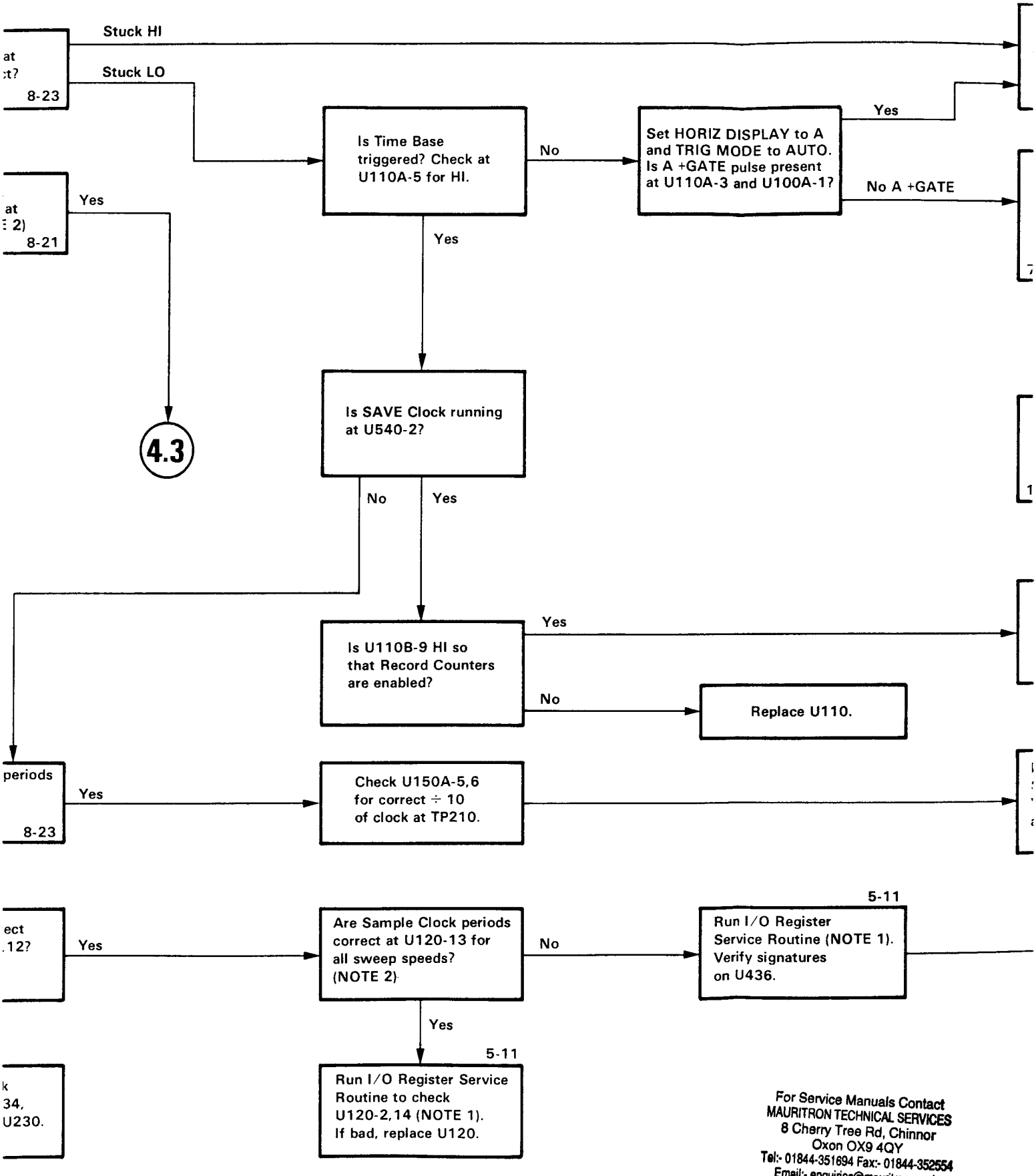
Test Point	Sample Clocks	
	Period	Frequency
U120-10	40 ns	25 MHz
U120-11	100 ns	10 MHz
U120-12	200 ns	5 MHz

4. Use the following table to determine Divider Chain output periods. When observing waveforms, disregard the characteristic glitch associated with synchronous counters.

Table C

Test Point	Period	Duty Cycle (%)
U430-15	400 ns	50
U424-15	4 μs	10
U418-15	40 μs	10
U510-15	400 μs	10
U518-15	4 ms	10





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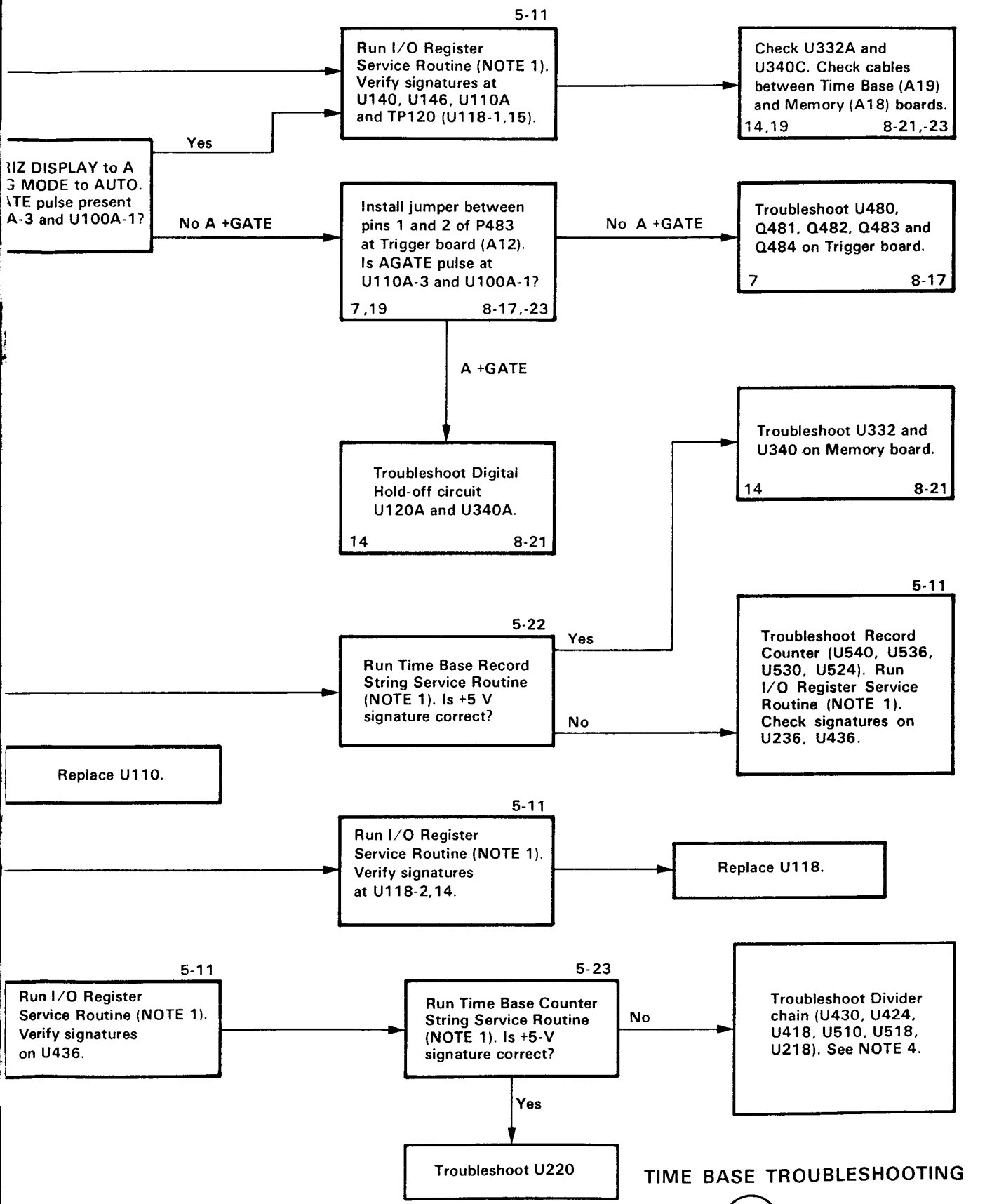

TIME BASE TROUBLESHOOTING

CHART 4.2

3515-67

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SPECIFIC NOTES

1. The procedures for running all Service Routine tests (using the Service ROM) are contained under "SERVICE TEST" in Section 5 of this volume.

2. Jitter Correction Check. Perform the following procedure to check jitter correction:

   a. Set controls:

VERT MODE	CH 1
A TIME/DIV	20 μs
CH 1 VOLTS/DIV	5 mV
STORAGE MODE	NORM
HORIZ DISPLAY	A
X10 MAG	On (button in)
TRIGGER LEVEL	As necessary for a stable, triggered display.

   b. Connect a sine-wave generator to the CH 1 input via a 50 Ω bnc cable and a 50 Ω bnc termination. Set the generator for a 50 kHz, 6-division display.

   c. Observe display jitter. Is the display stable, or is it shifting continually over 0.4 of a division?

   d. Change the A TIME/DIV switch to 0.02 μs and turn off the X10 MAG function (button out).

   e. Set the generator for a 5 MHz, 6-division display.

   f. Observe the display jitter. Is the display stable, or is it shifting continually over 4-divisions? (An occasional shift should be expected, see Theory of Operation.)

3. Vertical Signal Path Check. Perform the following procedure to check the vertical Signal path.

   a. Set controls:

VERT MODE	CH 1
VOLTS/DIV (both)	5 mV

   b. Connect a sine-wave generator to the CH 1 input via a 50 Ω bnc cable and a 50 Ω bnc termination. Set the generator for a 50 kHz, 6-division display.

   c. Check signal at TP 464 for ≈1.2 V p-p, centered at −1 V.

   d. Move the test signal to CH 2 and set VERT MODE switch to CH 2 only.

   e. Check signal at TP464 for ≈1.2 V p-p, centered at −1 V.

4. After Service Counter is installed at U456, obtain Test Ramp display as follows:

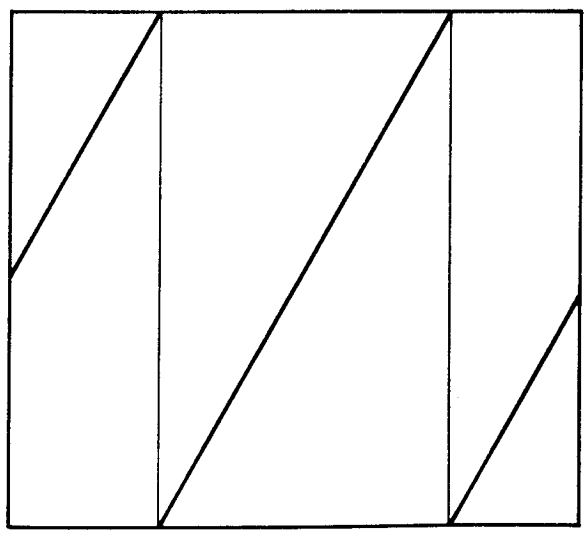
   a. Set controls:

STORAGE MODE	NORM
TIME/DIV	10 μs
TRIGGER SOURCE	LINE

   b. Set POWER switch to ON.

   c. Press and release SINGL SWP push button.

   d. Observe Test Ramp. Test Ramp display consists of two complete ramps. To shift ramp through the display, press in and release SINGL SWP push button.



GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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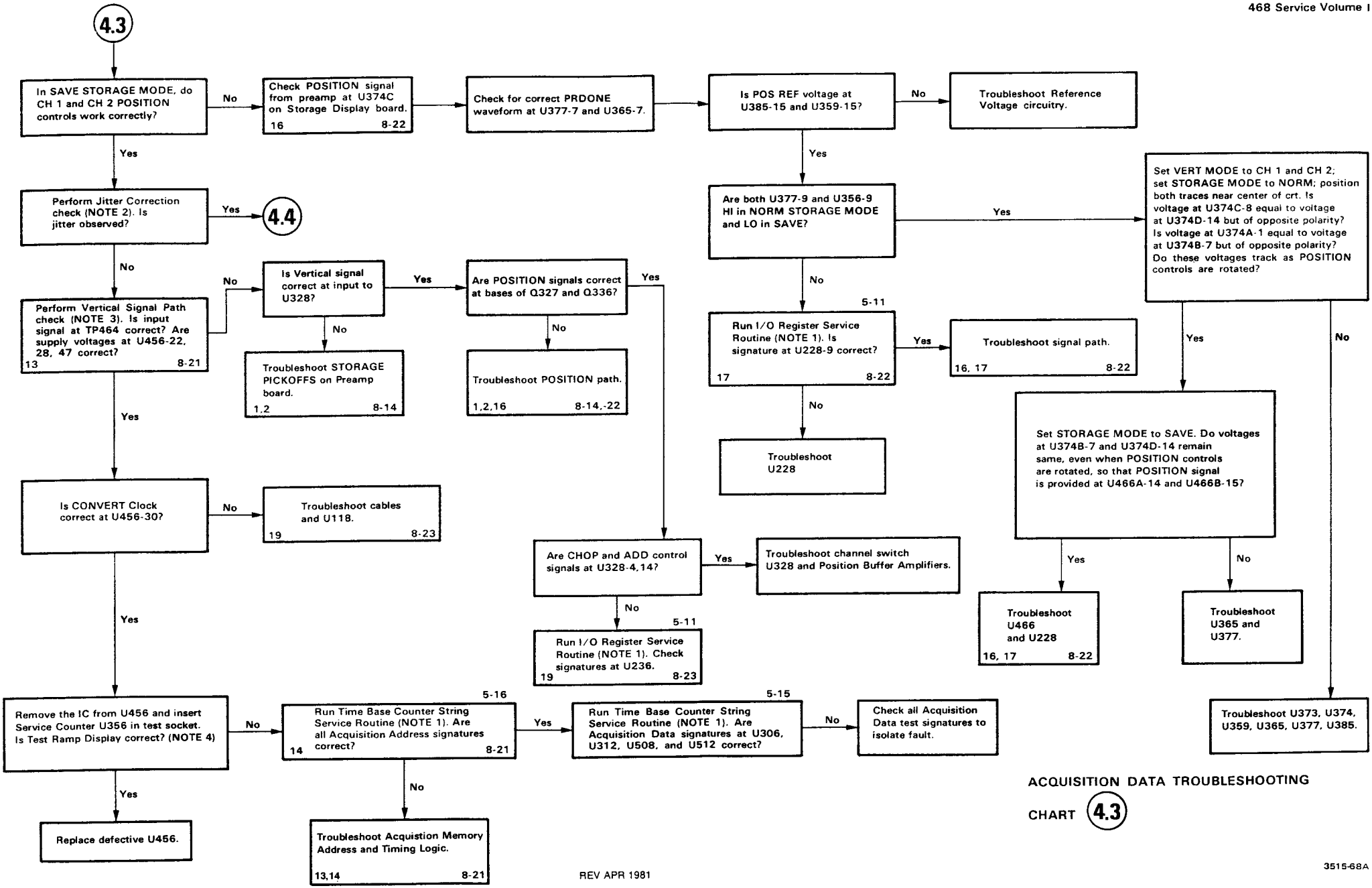
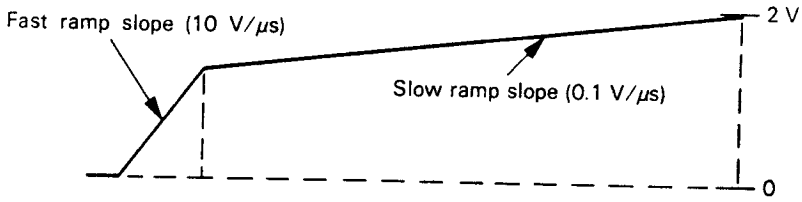


ACQUISITION DATA TROUBLESHOOTING

CHART 4.3

SPECIFIC NOTES

1. The procedures for running all Service Routine tests (using the Service ROM) are contained under "SERVICE TEST" in Section 5, Volume 1.
2. Signal at U546-3 should ramp fast then slow (up to 2 V in about 20 μs). Outputs of U446 should be counting during slow ramp. When ramp reaches 2 V, U546-7 switches to turn off clock at U218A.



GENERAL NOTES

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B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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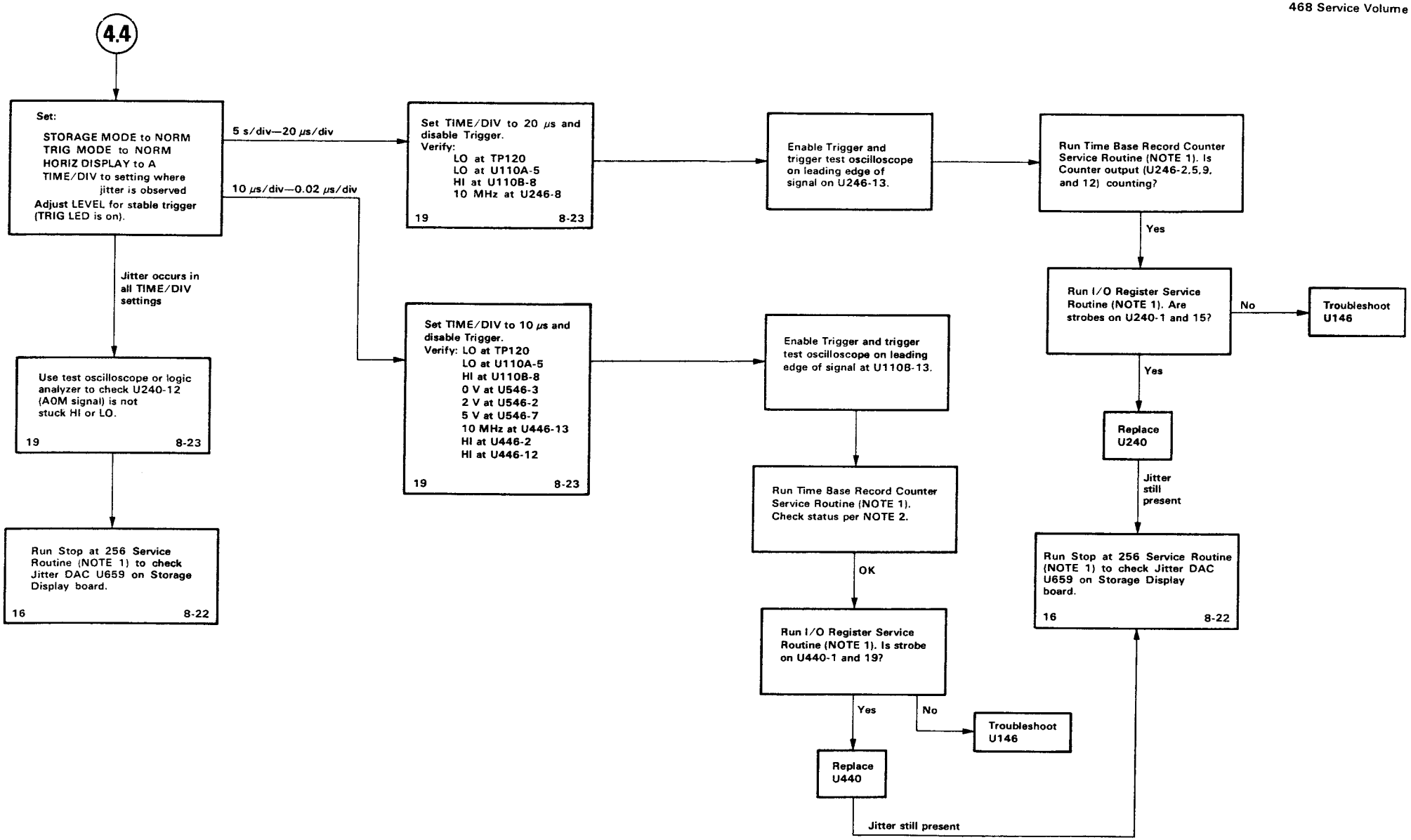


JITTER CORRECTION TROUBLESHOOTING CHART 4.4

3515-69

SPECIFIC NOTES

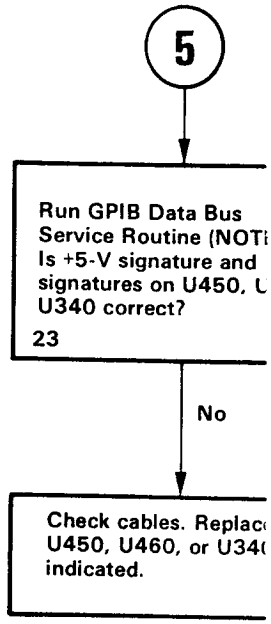
1. The procedures for running all Service Routine tests (using the Service ROM) are contained under "SERVICE TEST" in Section 5 of this volume.

2. 7-SEGMENT LED READOUT

4	3	2	1
DATA BUS	STATUS BUFFER	ADDRESS SWITCH	TADS SIGNAL

0 = Tested OK 1—9 = Fault

3. A fault is detected if Digit 1 of the Readout is any number except 0. If digits 2, 3, and 4 are not 0, the Service Routine is not running correctly.



GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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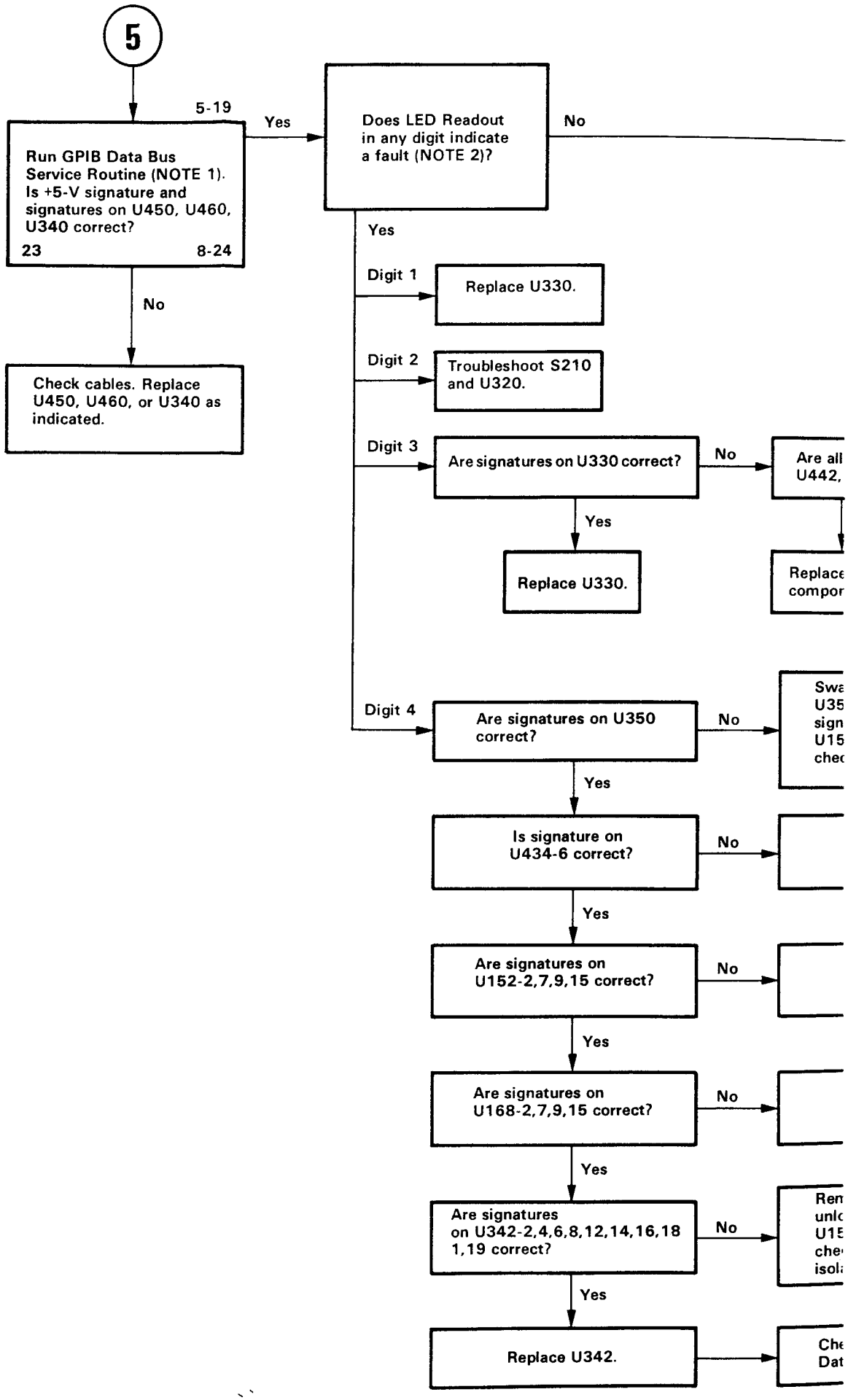
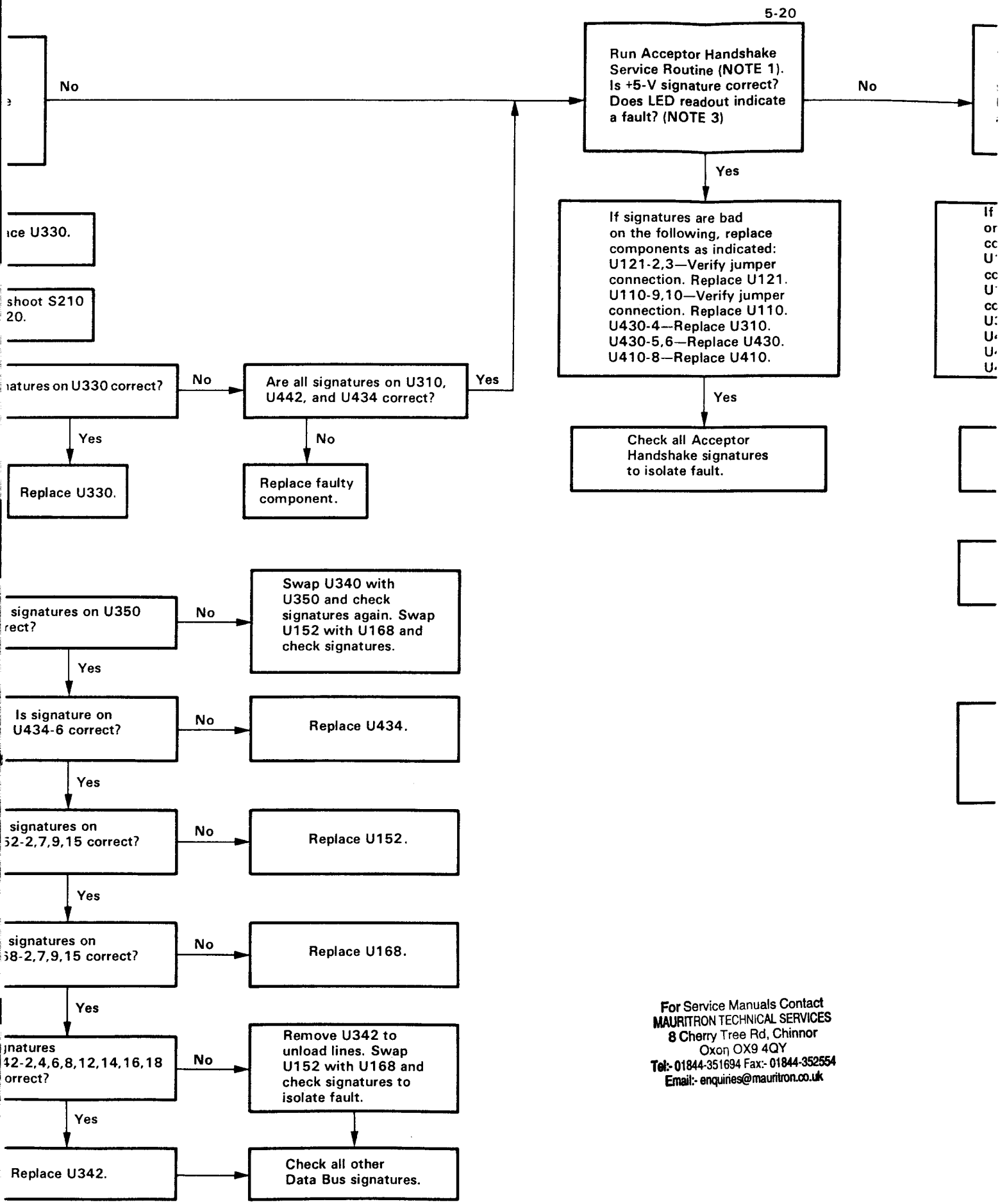

5
5-19
Run GPIB Data Bus Service Routine (NOTE 1). Is +5-V signature and signatures on U450, U460, U340 correct?
23
8-24
Yes
No
Check cables. Replace U450, U460, or U340 as indicated.
Does LED Readout in any digit indicate a fault (NOTE 2)?
Yes
No
Digit 1
Replace U330.
Digit 2
Troubleshoot S210 and U320.
Digit 3
Are signatures on U330 correct?
No
Yes
Replace U330.
Digit 4
Are signatures on U350 correct?
No
Yes
Is signature on U434-6 correct?
No
Yes
Are signatures on U152-2,7,9,15 correct?
No
Yes
Are signatures on U168-2,7,9,15 correct?
No
Yes
Are signatures on U342-2,4,6,8,12,14,16,18 1,19 correct?
No
Yes
Replace U342.



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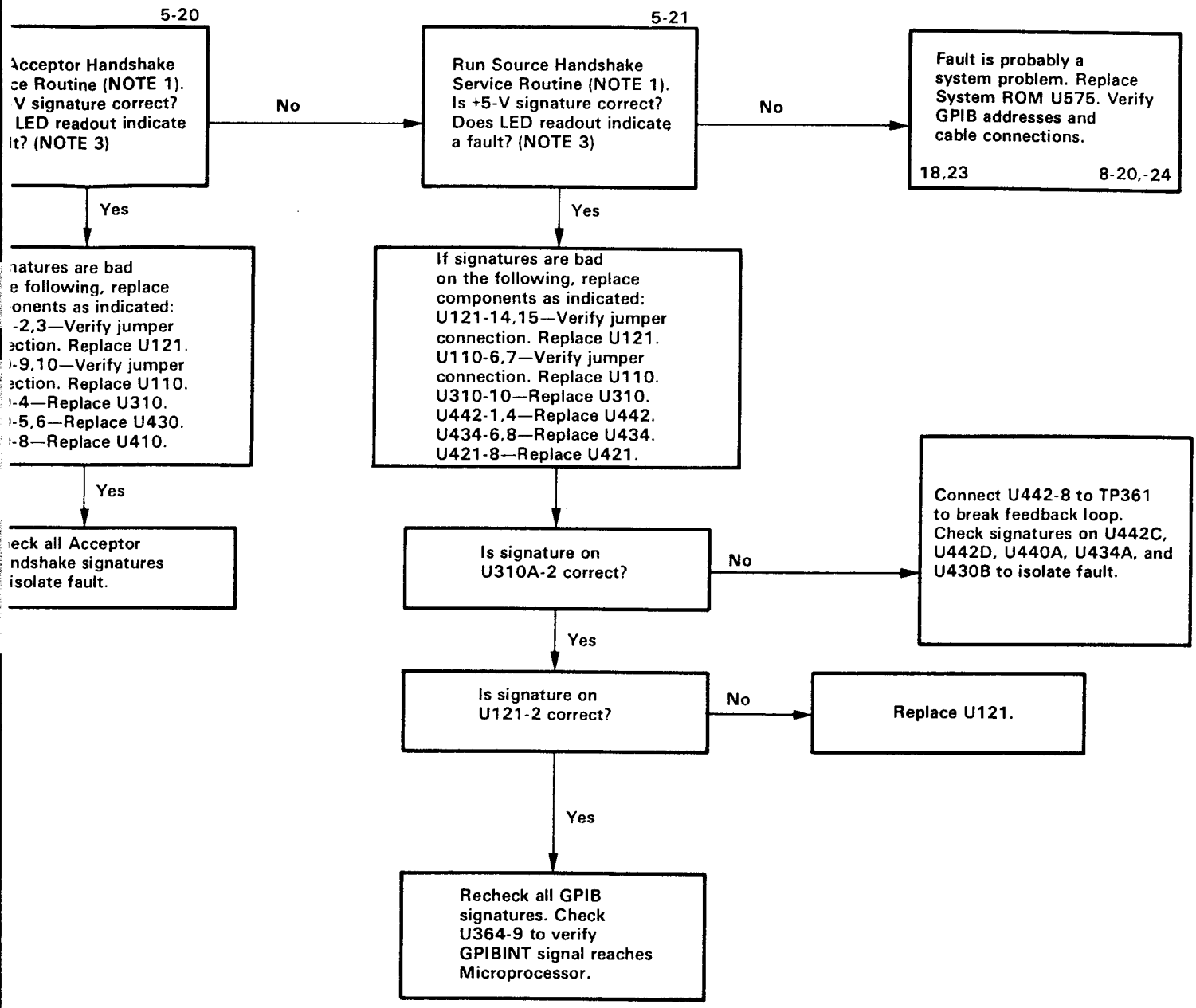

GPIB TROUBLESHOOTING

CHART 5

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3515-70

SPECIFIC NOTES

1. Digital Storage Power Supplies.

   +4.8 V to +5.2 V at TP248 (Diagram 17 and Figure 8-22).

   +11.4 V to +12.6 V at TP285 (Diagram 16 and Figure 8-22).

   -11.4 V to -12.6 V at TP283 (Diagram 16 and Figure 8-22).

   -5.8 V to -6.2 V at TP518 (Diagram 19 and Figure 8-23).

2. The following nominal values of dc resistance to ground with the 468 POWER Switch OFF should be measured with a TEKTRONIX DM 501 Digital Multimeter or equivalent.

Supply	Dc Resistance to Ground (nominal)	Measured at
+5 V	80 Ω	TP315
-6 V	500 Ω	TP518
+12 V	250 Ω	TP148
-12 V	350 Ω	TP520

GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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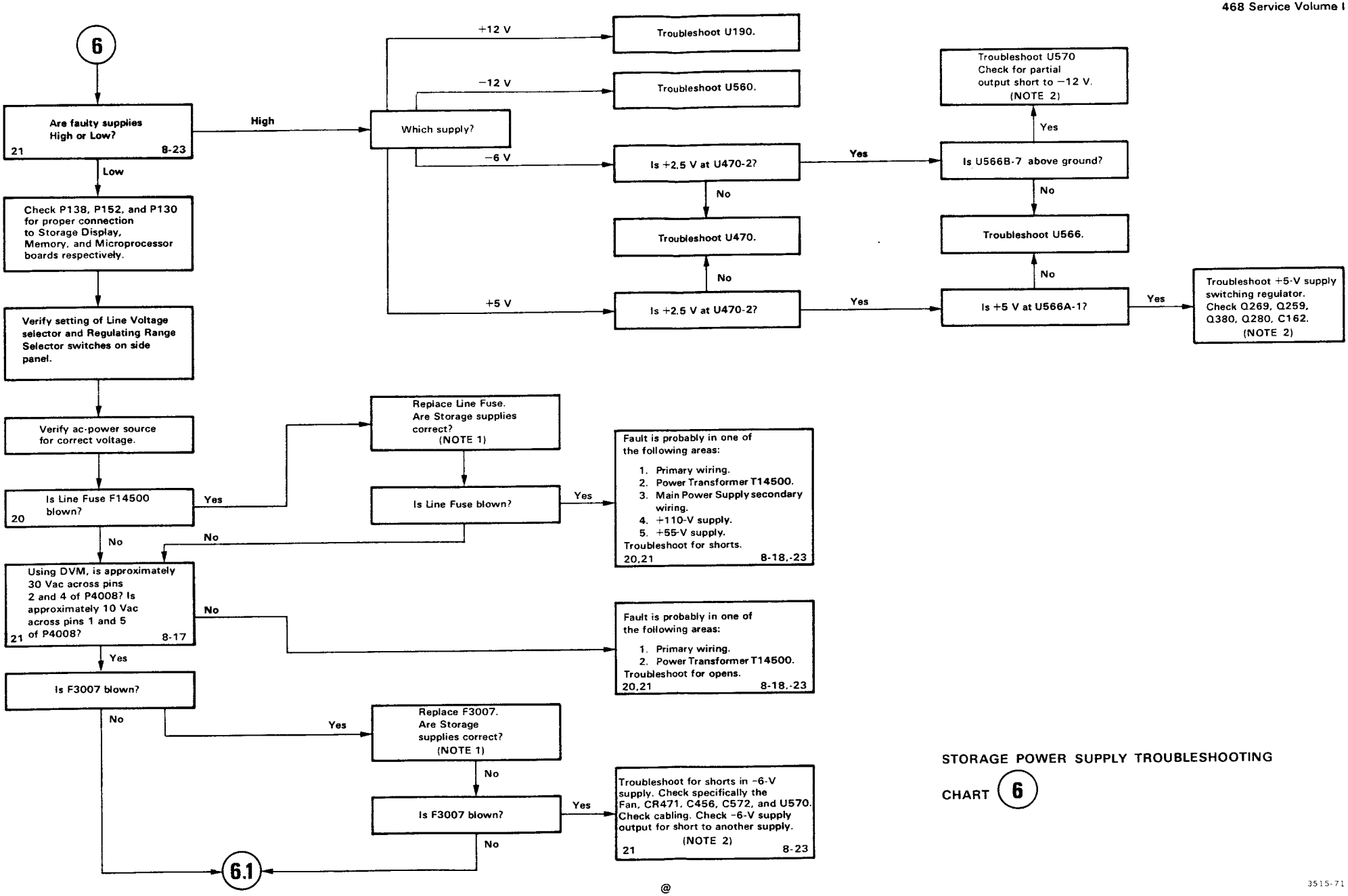

STORAGE POWER SUPPLY TROUBLESHOOTING

CHART 6

3515-71

SPECIFIC NOTES

1. Digital Storage Power Supplies.

   +4.8 V to +5.2 V at TP248 (Diagram 17 and Figure 8-22).

   +11.4 V to +12.6 V at TP285 (Diagram 16 and Figure 8-22).

   -11.4 V to -12.6 V at TP283 (Diagram 16 and Figure 8-22).

   -5.8 V to -6.2 V at TP518 (Diagram 19 and Figure 8-23).

GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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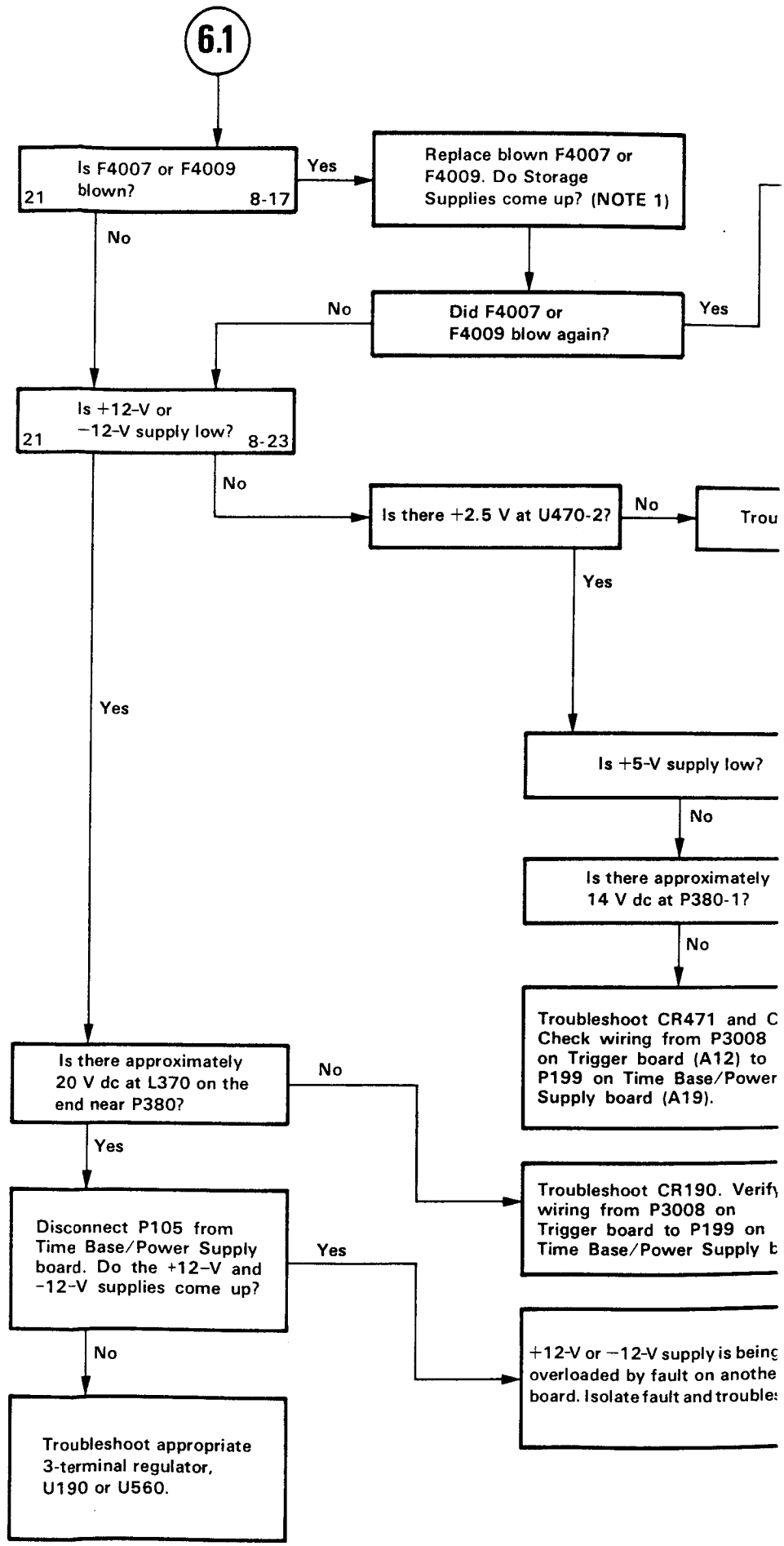

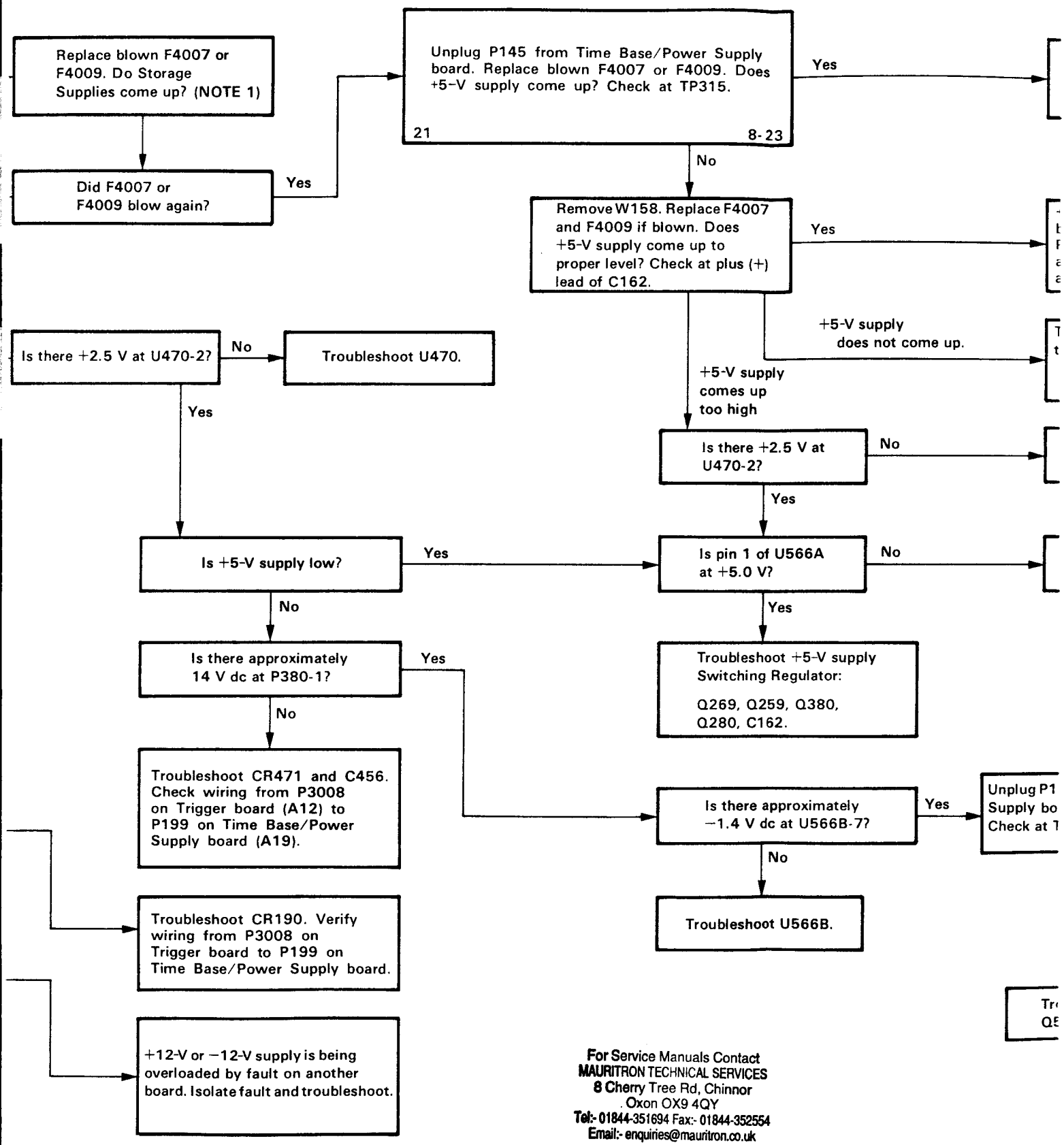

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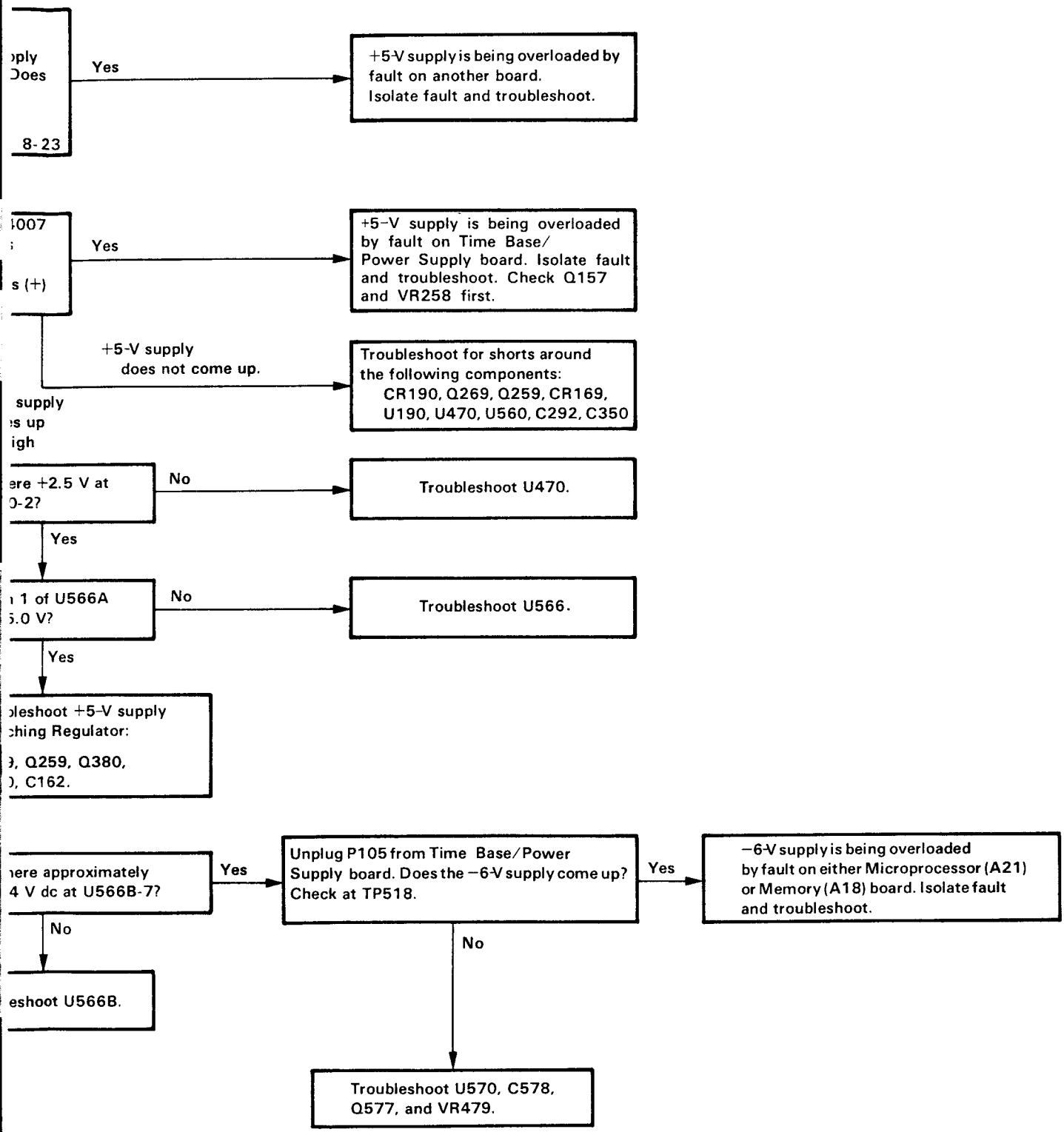

STORAGE POWER SUPPLY TROUBLESHOOTING CHART 6.1

POWER SUPPLY ISOLATION PROCEDURE

The following procedure is used as an aid in localizing the area in which loading of a power supply occurs. If the power supply comes up after isolating a circuit, it is very probable the problem is in that circuit. This can sometimes, however, lead to erroneous conclusions as a supply may pass through one circuit to another circuit. For instance, the +5 volt supply enters the Timing Board through P555-4. It then passes through the timing switch (in the X-Y position only) and J885-9 to CR486 in the Horizontal Amplifier circuit. From P885-9 it also passes through P970-4 to the sweep control IC on the Trigger board. Watch for these types of conditions when trying to localize a loading problem.

+55-V Supply

1. Unsolder service jumper W880 from the Interface board (see Figure 8-18). This isolates the Timing board and the Holdoff potentiometer.
2. Pull P252 from the Interface board. This isolates the Vertical Output Amplifier board.
3. To isolate the Trigger board from the +55-V supply, it is necessary to remove the Trigger board from the instrument. The +55-V supply connects to the Trigger board through P970-9.
4. Unsolder one end of R877 and R850 on the Interface board (see Figure 8-18). This isolates the A & B Sweep Generator circuitry.
5. Unsolder one end of R387 and R391 from the Interface board (see Figure 8-18). This isolates the Calibrator circuitry.
6. If the +55-V supply is still loaded, suspect the CRT circuitry, or the Horizontal Amplifier circuitry. Refer to Diagram 10 to locate +55-V connections to the Horizontal Amplifier circuitry and to Diagram 11 to locate +55-V connections to the CRT circuity.

GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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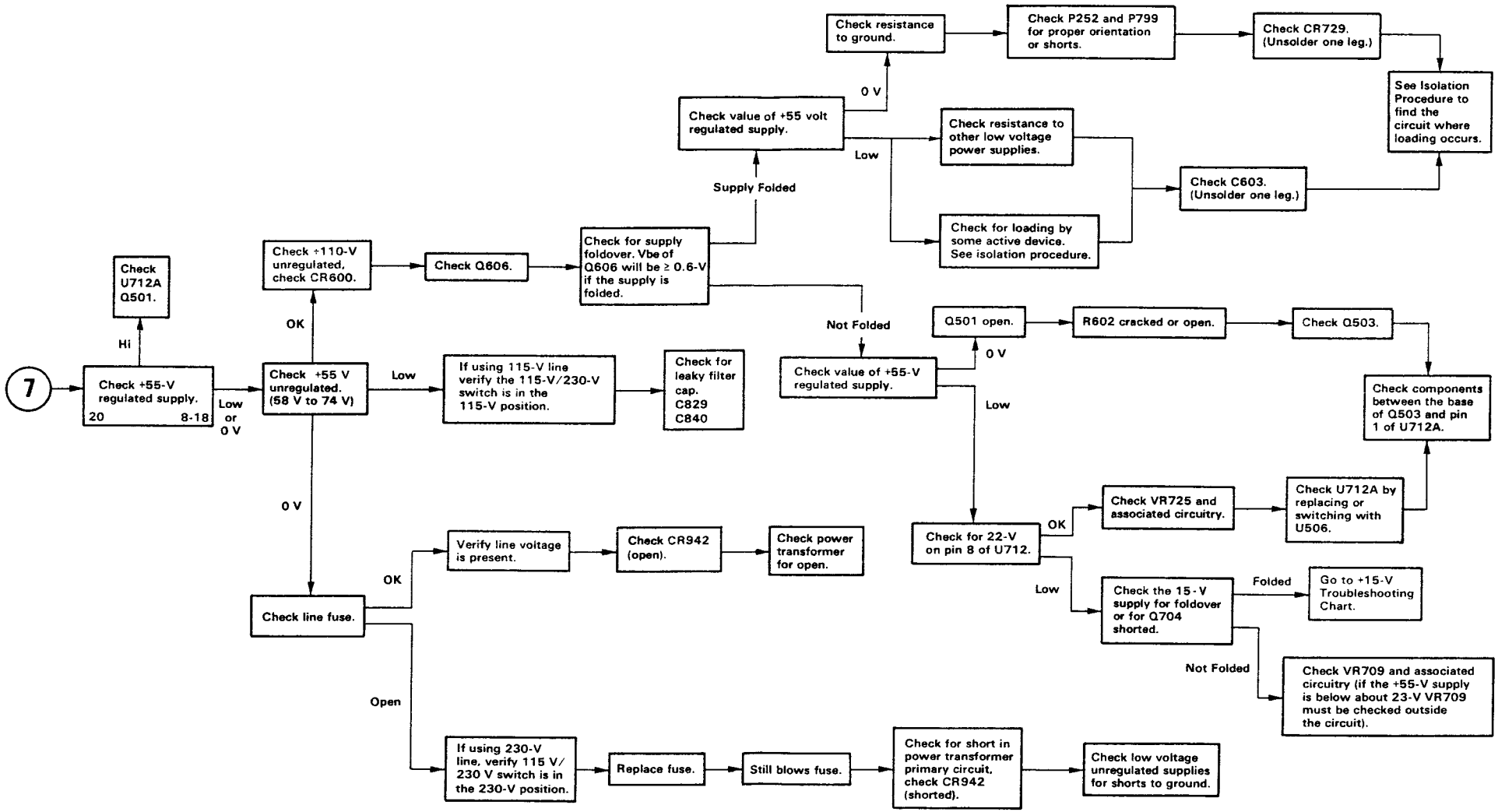

+55 V SUPPLY TROUBLESHOOTING CHART 7

(2757-67) 3515-57

POWER SUPPLY ISOLATION PROCEDURE

The following procedure is used as an aid in localizing the area in which loading of a power supply occurs. If the power supply comes up after isolating a circuit, it is very probable the problem is in that circuit. This can sometimes, however, lead to erroneous conclusions as a supply may pass through one circuit to another circuit. For instance, the +5 volt supply enters the Timing Board through P555-4. It then passes through the timing switch (in the X-Y position only) and J885-9 to CR486 in the Horizontal Amplifier circuit. From P885-9 it also passes through P970-4 to the sweep control IC on the Trigger board. Watch for these types of conditions when trying to localize a loading problem.

+110-V Supply

1. Unsolder one end of VR643, R438, and R647 (see Figure 8-18). This isolates the Horizontal Amplifier circuit.
2. Unsolder one end of CR727 and R633 (see Figure 8-18). If loading still exists, check adjustment of R267 (Geometry) and R377 (ASTIG). If either does not adjust and an internal short is suspected, it will be necessary to remove R267 and R377 to isolate the CRT circuitry (Z-Axis Amplifier).

GENERAL NOTES

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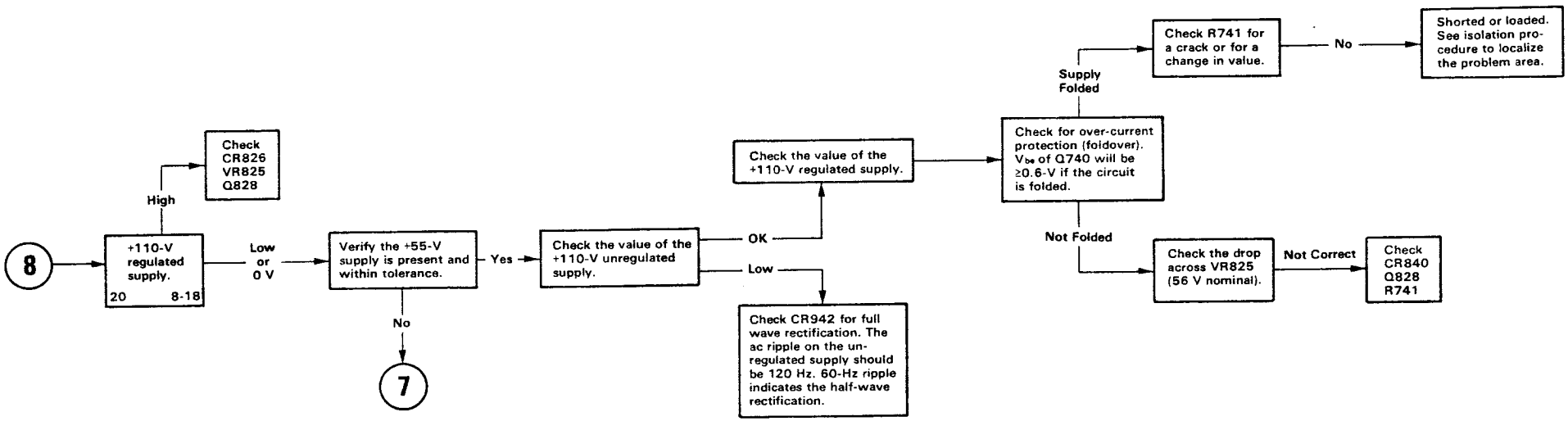

+110 V SUPPLY TROUBLESHOOTING

CHART 8

POWER SUPPLY ISOLATION PROCEDURE

The following procedure is used as an aid in localizing the area in which loading of a power supply occurs. If the power supply comes up after isolating a circuit, it is very probable the problem is in that circuit. This can sometimes, however, lead to erroneous conclusions as a supply may pass through one circuit to another circuit. For instance, the +5-V supply enters the Timing Board through P555-4. It then passes through the timing switch (in the X-Y position only) and J885-9 to CR486 in the Horizontal Amplifier circuit. From P885-9 it also passes through P970-4 to the sweep control IC on the Trigger board. Watch for these types of conditions when trying to localize a loading problem.

+15-V Supply

1. Pull P154 from the Interface board. This isolates the Vertical Preamplifier board.
2. Pull P151 from the Interface board. This isolates the Vertical Mode board.
3. Pull P252 from the Interface board. This isolates the Vertical Output board.
4. Pull P699 from the Interface board. This isolates the Horizontal POSITION potentiometers.
5. Unsolder service jumper W2006 on the Trigger board (see Figure 8-17). This isolates the Trigger board.
6. Unsolder service jumper W780 from the Interface board (see Figure 8-18). This isolates the Timing board.
7. Unsolder service jumper W747 on the Interface board (see Figure 8-18). This isolates the A & B Sweep Generator circuitry and the Horizontal Amplifier circuitry.
8. If the +15-V supply is still loaded, suspect the CRT circuitry (Z-Axis Amplifier). Refer to Diagram 11 to locate the +15-V connection to the CRT circuity.

+5-V Supply

1. Pull P154 from the Interface board. This isolates the Vertical Preamplifier board.
2. Pull P151 from the Interface board. This isolates the Vertical Mode board.
3. Pull P252 from the Interface board. This isolates the Vertical Output board.
4. Pull P799 from the Interface board. This isolates the HOLDOFF potentiometer.
5. Unsolder service jumper W866 from the Interface board (see Figure 8-18). This isolates the Timing board.
6. Unsolder service jumper W2003 from the Trigger board (see figure 8-17). This isolates the A & B Sweep Generator circuitry and part of the Horizontal Amplifier circuitry.
7. Unsolder service jumper W746 from the Interface board (see Figure 8-18). This isolates the A & B Sweep Generator circuitry and part of the Horizontal Amplifier circuitry.
8. Unsolder one end of R453 and R554 from the Interface board (see Figure 8-18). This isolates the rest of the Horizontal Amplifier circuity.
9. Unsolder L494 from the Interface board (see Figure 8-18). This isolates the Calibrator circuitry.
10. If the +5-V supply is still loaded, the CRT circuitry should be suspected. Refer to Diagram 11 to locate the +5-V connections to the CRT circuitry.

-8-V Supply

1. Pull P154 from the Interface board. This isolates the Vertical Preamplifier board.
2. Pull P151 from the Interface board. This isolates the Vertical Mode board.
3. Pull P252 from the Interface board. This isolates the Vertical Output Amplifier board.
4. Pull P699 from the Interface board. This isolates the Horizontal POSITION and B INTENSITY potentiometers.
5. Unsolder service jumper W2007 from the Trigger board to isolate part of the Trigger board. Unsolder one end of R509 from the Trigger board to isolate the rest of the Trigger board (see Figure 8-17).
6. Unsolder service jumper W849 from the Interface board (see Figure 8-18). This isolates the Timing board, A & B Sweep Generator circuitry, and part of the Horizontal Amplifier circuitry. It will also completely remove the -8-V from the Trigger board if step 5 is not done.
7. Check C848 on the Interface board for a short or leakage (see Figure 8-18).
8. If the -8-V supply is still loaded, suspect the CRT circuitry (Z-Axis Amplifer), or the Horizontal Amplifier circuitry. Refer to Diagram 10 for the -8-V connections to the Horizontal Amplifier and to Diagram 11 for the -8-V connections to the CRT circuitry.

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GENERAL NOTES

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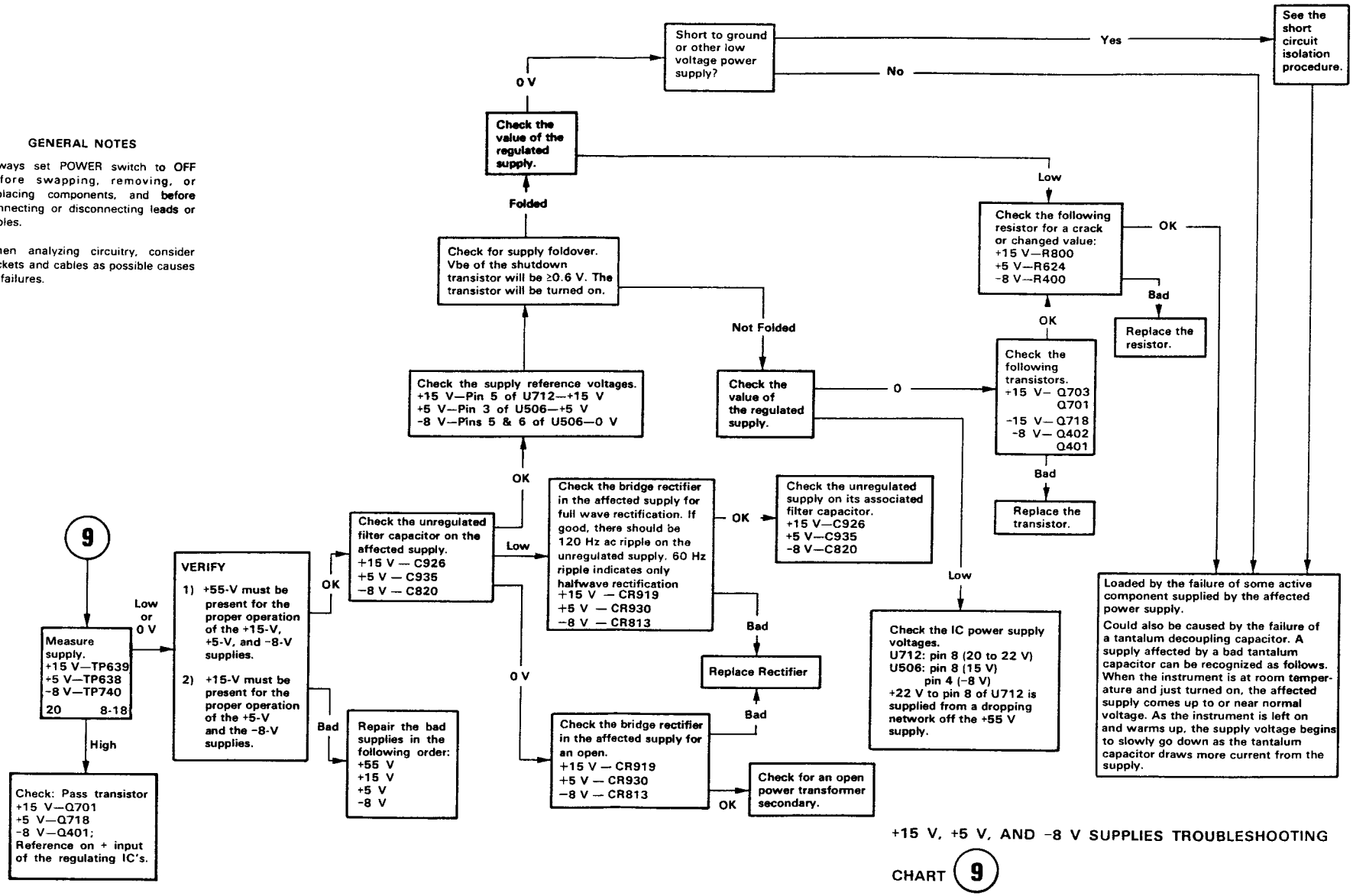
B. When analyzing circuitry, consider sockets and cables as possible causes of failures.



+15 V, +5 V, AND −8 V SUPPLIES TROUBLESHOOTING

CHART 9

GENERAL NOTES

A. Always set POWER switch to OFF before swapping, removing, or replacing components, and before connecting or disconnecting leads or cables.

B. When analyzing circuitry, consider sockets and cables as possible causes of failures.

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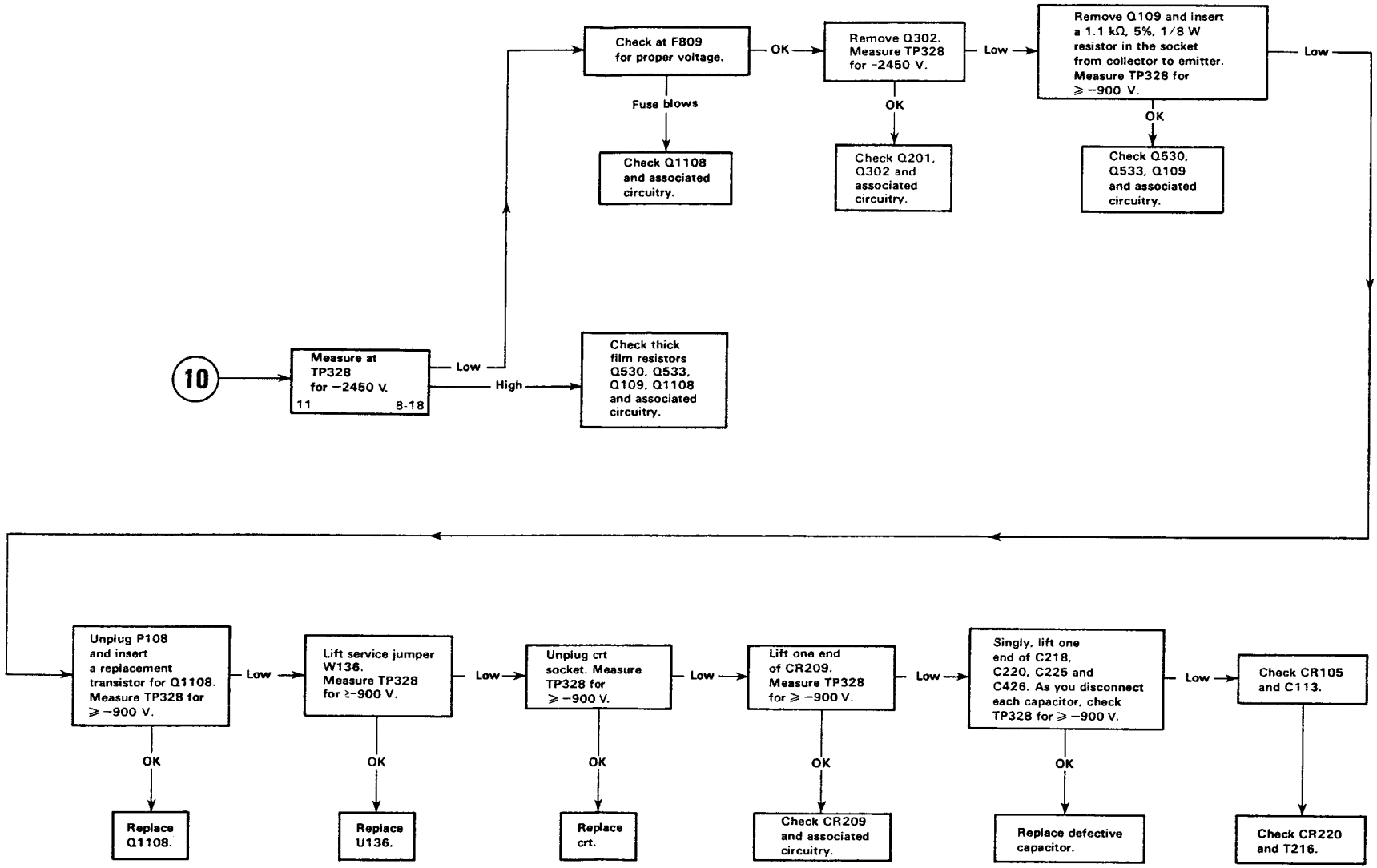
Oxon OX9 4QY
Tel:- 01844-351694 Fax:- 01844-352554
Email:- enquiries@mauritron.co.uk



-2450 V SUPPLY TROUBLESHOOTING CHART 10

-2450 V SUPPLY TROUBLESHOOTING CHART (10)

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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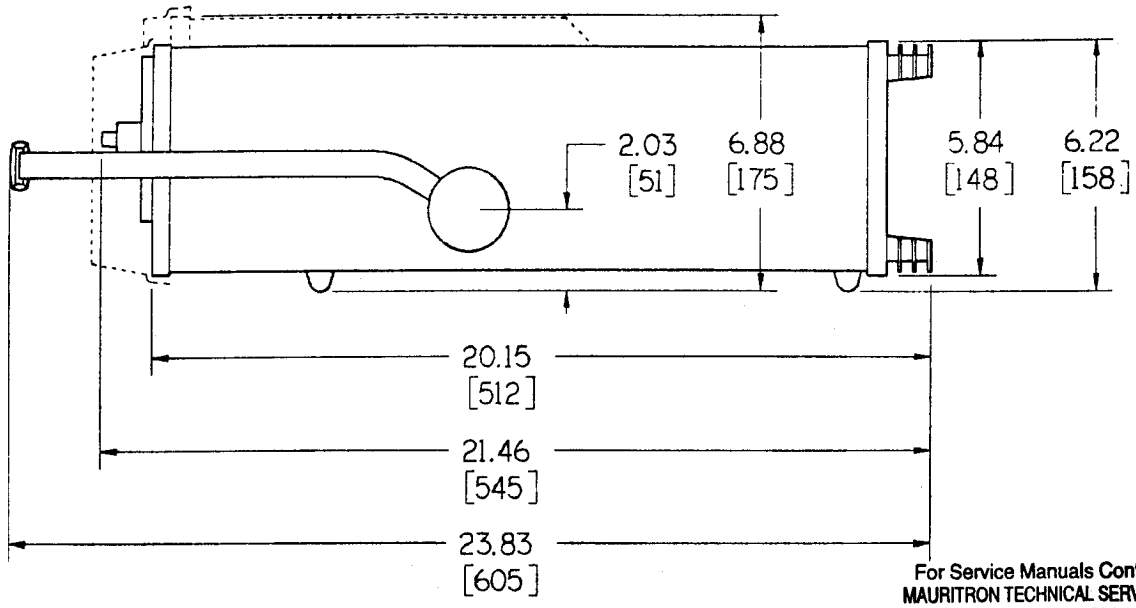
DIMENSIONAL DRAWING OF THE 468



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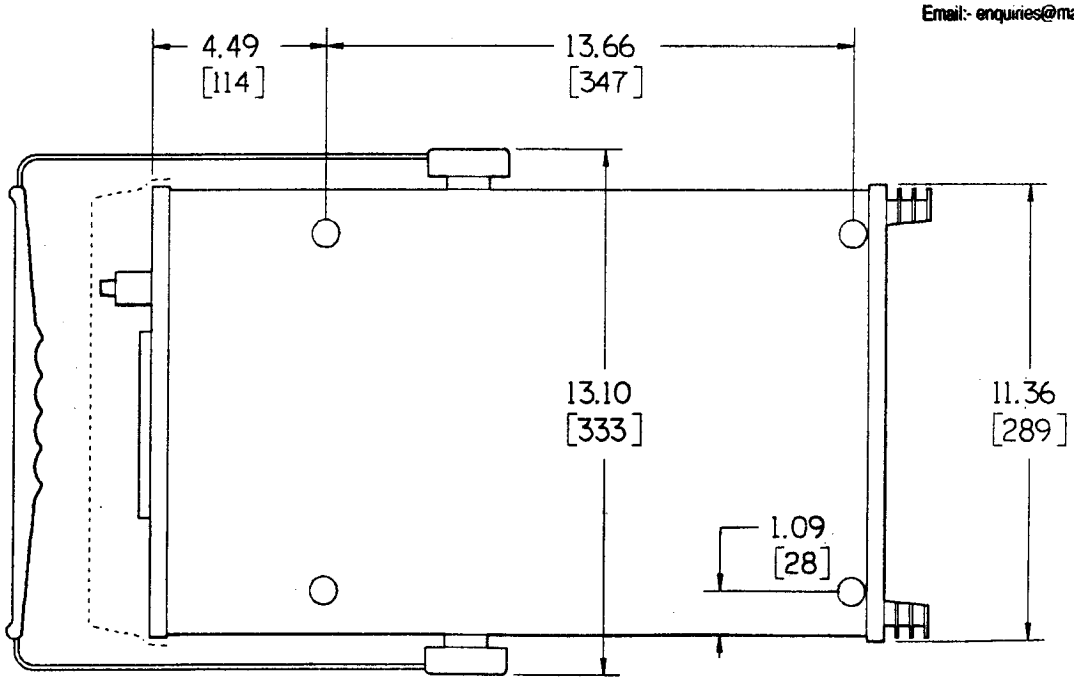

Dimensions are in inches [mm]

Tektronix®

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WARNING

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

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

468
DIGITAL STORAGE OSCILLOSCOPE
SERVICE
VOLUME II

INSTRUCTION MANUAL

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

070-3516-00
Product Group 40

Serial Number 706739

First Printing AUG 1980
Revised NOV 1984

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

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

Symbols as Marked on Equipment

DANGER – High voltage.

Protective ground (earth) terminal.

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 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 connecting 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 insulating) 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 2-2.

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.

Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product 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 product without the covers and panels properly installed.

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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 conductor in the power cord is essential for safe operation.

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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.

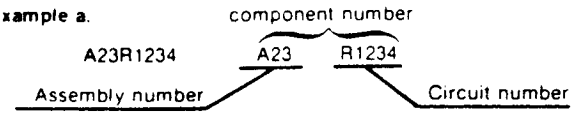
ABBREVIATIONS

Abbreviations conform to American National Standard Y1.1.

COMPONENT NUMBER (column one of the Electrical Parts List)

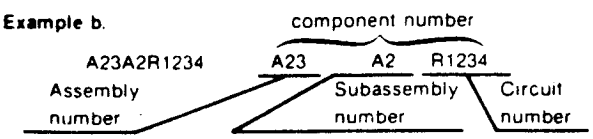
A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:

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.

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CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
000FJ	MARCOM SWITCHES INC.	67 ALBANY STREET	CAZENOVIA, N.Y. 13035
000HX	SAN-O INDUSTRIAL CORP.	170 WILBUR PLACE	BAHEMIA LONG ISLAND, NY 11716
000LH	ELECTRONIC COMPONENTS INTERNATIONAL	121 SHELDON STREET	EL SEGUNDO, CA 90245
00779	AMP, INC.	P.O. BOX 3608	HARRISBURG, PA 17105
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P.O. BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01281	TRW ELECTRONIC COMPONENTS, SEMICONDUCTOR OPERATIONS	14520 AVIATION BLVD.	LAWNDALE,CA 90260
01295	TEXAS INSTRUMENTS, INC. SEMICONDUCTOR GROUP	P.O. BOX 5012	DALLAS, TX 75222
01537	MOTOROLA COMMUNICATIONS AND ELECTRONICS INC.	2553 N. EDGINGTON ST.	FRANKLIN PARK, IL 60131
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 91745
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
02777	HOPKINS ENGINEERING COMPANY	12900 FOOTHILL BLVD.	SAN FERNANDO, CA 91342
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
05397	UNION CARBIDE CORPORATION, MATERIALS SYSTEMS DIVISION	11901 MADISON AVENUE	CLEVELAND, OH 44101
05828	GENERAL INSTRUMENT CORP ELECTRONIC SYSTEMS DIV.	600 W JOHN ST.	HICKSVILLE LI, NY 11802
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
07716	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, BURLINGTON DIV.	2850 MT. PLEASANT	BURLINGTON, IA 52601
08806	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPARTMENT	NELA PARK	CLEVELAND, OH 44112
09023	CORNELL-DUBILIER ELECTRONIC DIVISION FEDERAL PACIFIC ELECTRIC CO.	2652 DALRYMPLE ST.	SANFORD, NC 27330
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON STREET	DOVER, NH 03820
12954	SIEMENS CORPORATION, COMPONENTS GROUP	8700 E THOMAS RD, P O BOX 1390	SCOTTSDALE, AZ 85252
12969	UNITRODE CORPORATION	580 PLEASANT STREET	WATERTOWN, MA 02172
14193	CAL-R, INC.	1601 OLYMPIC BLVD.	SANTA MONICA, CA 90404
14298	AMERICAN COMPONENTS, INC., AN INSILCO COMPANY	8TH AVE. AT HARRY STREET	CONSHOHOCKEN, PA 19428
14433	ITT SEMICONDUCTORS	3301 ELECTRONICS WAY P O BOX 3049	WEST PALM BEACH, FL 33402
14552	MICRO SEMICONDUCTOR CORP.	2830 E FAIRVIEW ST.	SANTA ANA, CA 92704
14752	ELECTRO CUBE INC.	1710 S. DEL MAR AVE.	SAN GABRIEL, CA 91776
15238	ITT SEMICONDUCTORS, A DIVISION OF INTER NATIONAL TELEPHONE AND TELEGRAPH CORP.	P.O. BOX 168, 500 BROADWAY	LAWRENCE, MA 01841
15454	RODAN INDUSTRIES, INC.	2905 BLUE STAR ST.	ANAHEIM, CA 92806
17856	SILICONIX, INC.	2201 LAURELWOOD DRIVE	SANTA CLARA, CA 95054
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
18518	MSI ELLCTRONICS INC.	34-32 57TH ST	WOODSIDE, NY 11377
19701	ELECTRA-MIDLAND CORP., MEPCO ELECTRA INC.	P O BOX 760	MINERAL WELLS, TX 76067
22229	SOLITRON DEVICES, INC., SEMICONDUCTOR GROUP	8808 BALBOA AVENUE	SAN DIEGO OPERS, CA 92123
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
24355	ANALOG DEVICES INC.	RT 1 INDUSTRIAL PK,P O BOX 280	NORWOOD, MA 02062
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
28480	HEWLETT-PACKARD CO., CORPORATE HQ.	1501 PAGE MILL RD.	PALO ALTO, CA 94304
31918	IEE/SCHADOW INC.	8081 WALLACE ROAD	EDEN PRAIRIE, MN 55343
32293	INTERSIL, INC.	10900 N. TANTAU AVE.	CUPERTINO, CA 95014
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
33095	SPECTRUM CONTROL, INC.	152 E MAIN STREET	FAIRVIEW, PA 16415
34335	ADVANCED MICRO DEVICES	901 THOMPSON PL.	SUNNYVALE, CA 94086
34649	INTEL CORP.	3065 BOWERS AVE.	SANTA CLARA, CA 95051
50157	MIDWEST COMPONENTS INC.	P. O. BOX 787 1981 PORT CITY BLVD.	MUSKEGON, MI 49443
50434	HEWLETT-PACKARD COMPANY	640 PAGE MILL ROAD	PALO ALTO, CA 94304
50437	RELIANCE STEEL PRODUCTS COMPANY	3700 WALNUT STREET	MCKEESPORT, PA 15132
51642	CENTRE ENGINEERING INC.	2820 E COLLEGE AVENUE	STATE COLLEGE, PA 16801

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Mfr. Code	Manufacturer	Address	City, State, Zip
51984	NEC AMERICA INC. RADIO AND TRANSMISSION DIV.	2990 TELESTAR CT. SUITE 212	FALLS CHURCH, VA 22042
52306	HIGH VOLTAGE DEVICES, INC.	7485 AVENUE 304	VISALIA, CA 93277
52763	STETTNER-TRUSH, INC.	67 ALBANY STREET	CAZENOVIA, NY 13035
52769	SPRAGUE GOODMAN ELEC., INC.	134 FULTON AVENUE	GARDEN CITY PARK, NY 11040
53184	XCITON CORPORATION	5 HEMLOCK STREET	LATHAM, NY 12110
55680	NICHICON/AMERICA/CORP.	6435 N PROESEL AVENUE	CHICAGO, IL 60645
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
57668	R-OHM CORP.	16931 MILLIKEN AVE.	IRVINE, CA 92713
58361	GENERAL INSTRUMENT CORP OPTO ELECTRONICS DIV.	3400 HILLVIEW AVE	PALO ALTO, CA 94304
59660	TUSONIX INC.	2155 N FORBES BLVD	TUCSON, AZ 85705
59821	CENTRALAB INC SUB NORTH AMERICAN PHILIPS CORP	7158 MERCHANT AVE	EL PASO, TX 79915
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
72619	DIALIGHT, DIV. AMPEREX ELECTRONIC	203 HARRISON PLACE	BROOKLYN, NY 11237
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
73899	JFD ELECTRONICS COMPONENTS CORP.	PINETREE ROAD	OXFORD, NC 27565
74276	SIGNALITE DIV., GENERAL INSTRUMENT CORP.	1933 HECK AVE.	NEPTUNE, NJ 07753
74970	JOHNSON, E. F., CO.	299 10TH AVE. S. W.	WASECA, MN 56093
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
76493	BELL INDUSTRIES, INC., MILLER, J. W., DIV.	19070 REYES AVE., P O BOX 5825	COMPTON, CA 90224
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80031	ELECTRA-MIDLAND CORP., MEPCO DIV.	22 COLUMBIA ROAD	MORRISTOWN, NJ 07960
82389	SWITCHCRAFT, INC.	5555 N. ELSTON AVE.	CHICAGO, IL 60630
83003	VARO, INC.	P O BOX 411, 2203 WALNUT STREET	GARLAND, TX 75040
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E. WASHINGTON STREET P. O. BOX 372	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601
93410	ESSEX INTERNATIONAL, INC., CONTROLS DIV. LEXINGTON PLANT	P. O. BOX 1007	MANSFIELD, OH 44903
95348	GORDOS CORPORATION	250 GLENWOOD AVENUE	BLOOMFIELD, NJ 07003
96733	SAN FERNANDO ELECTRIC MFG CO	1501 FIRST ST	SAN FERNANDO, CA 91341
T0058	NEC ELECTRON INC.	252 HUMBOLT COURT	SUNNYVALE, CA 94086
T0900	UNITED CHEMI-CON	9801 W. HIGGINS ROAD	ROSEMONT,IL 60018

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A11	670-6372-00	B010100	B039999	CKT BOARD ASSY:VERTICAL PREAMPLIFIER	80009	670-6372-00
A11	670-6372-01	B040000		CKT BOARD ASSY:VERTICAL PREAMPLIFIER	80009	670-6372-01
A11C111	281-0798-00			CAP.,FXD,CER DI:51PF,1%,100V	96733	R2928
A11C117	290-0517-00	B010100	B039999	CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A11C117	281-0775-00	B040000		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A11C119	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A11C124	281-0815-00	B010100	B039999	CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C128	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A11C135	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C139	281-0775-00	B040000		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A11C144	281-0819-00			CAP.,FXD,CER DI:33PF,5%,50V	72982	8035BC0G330
A11C156	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A11C160	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	04222	MA106A569D
A11C161	283-0114-00			CAP.,FXD,CER DI:0.0015UF,5%,200V	59660	805534Y5DO152J
A11C163	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A11C166	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A11C181	281-0205-00			CAP.,VAR,PLSTC:5.5-65PF,100V	80031	2810C5R565QJ02F0
A11C183	281-0773-00	B010100	B039999	CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A11C183	281-0775-00	B040000		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A11C186	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C220	281-0823-00			CAP.,FXD,CER DI:470PF,10%,50V	04222	MA105A471KAA
A11C221	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A11C229	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A11C235	281-0823-00			CAP.,FXD,CER DI:470PF,10%,50V	04222	MA105A471KAA
A11C241	281-0757-00	B040000		CAP.,FXD,CER DI:10PF,20%,100V	04222	GC101A100M
A11C244	281-0204-00			CAP.,VAR,PLSTC:2-22PF,100V	80031	2807C00222MJ02
A11C252	281-0809-00			CAP.,FXD,CER DI:200PF,5%,100V	04222	GC101A201J
A11C253	281-0809-00			CAP.,FXD,CER DI:200PF,5%,100V	04222	GC101A201J
A11C254	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A11C274	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C277	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C279	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C285	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A11C287	281-0547-00			CAP.,FXD,CER DI:2.7PF,10%,500V	04222	7001--COJ-2R7C
A11C304	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A11C306	281-0589-00			CAP.,FXD,CER DI:170PF,5%,500V	72982	301000Z5D0171J
A11C311	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A11C312	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A11C314	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A11C316	281-0579-00			CAP.,FXD,CER DI:21PF,5%,500V	04222	7001-NPO-210J
A11C320	281-0823-00			CAP.,FXD,CER DI:470PF,10%,50V	04222	MA105A471KAA
A11C322	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
A11C335	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C347	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A11C360	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A11C363	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A11C372	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A11C373	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A11C381	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	04222	MA106A569D
A11C382	283-0114-00			CAP.,FXD,CER DI:0.0015UF,5%,200V	59660	805534Y5DO152J

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A11C384	281-0773-00	B010100	B039999	CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A11C384	281-0775-00	B040000		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A11C386	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C414	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A11C415	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A11C420	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A11C421	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A11C422	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A11C426	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
A11C434	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C436	281-0775-00	B040000		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A11C444	281-0204-00			CAP.,VAR,PLSTC:2-22PF,100V	80031	2807C00222MJ02
A11C446	281-0757-00	B040000		CAP.,FXD,CER DI:10PF,20%,100V	04222	GC101A100M
A11C451	281-0809-00			CAP.,FXD,CER DI:200PF,5%,100V	04222	GC101A201J
A11C452	281-0809-00			CAP.,FXD,CER DI:200PF,5%,100V	04222	GC101A201J
A11C456	281-0775-00	B040000		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A11C476	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C480	281-0205-00			CAP.,VAR,PLSTC:5.5-65PF,100V	80031	2810C5R565QJ02F0
A11C504	281-0630-00			CAP.,FXD,CER DI:390PF,5%,500V	72982	630000Y5D391J
A11C509	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A11C511	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A11C512	281-0809-00			CAP.,FXD,CER DI:200PF,5%,100V	04222	GC101A201J
A11C518	281-0763-00			CAP.,FXD,CER DI:47PF,10%,100V	04222	GA101A470KAA
A11C523	281-0798-00			CAP.,FXD,CER DI:51PF,1%,100V	96733	R2928
A11C524	281-0775-00	B040000		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A11C525	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A11C531	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C539	281-0823-00			CAP.,FXD,CER DI:470PF,10%,50V	04222	MA105A471KAA
A11C543	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A11C544	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	96733	R2735
A11C574	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C579	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A11C587	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A11C588	281-0547-00			CAP.,FXD,CER DI:2.7PF,10%,500V	04222	7001--COJ-2R7C
A11CR112	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR114	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR115	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR118	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR119	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR120	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR127	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR135	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR184	152-0153-00			SEMICOND DVC,DI:SW,SI,10V,50MA,D0-7	07263	FD7003
A11CR215	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR223	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR258	152-0612-00			SEMICOND DEVICE:V VAR CAP.,4V,17.5PF	18518	152-0612-00
A11CR259	152-0612-00			SEMICOND DEVICE:V VAR CAP.,4V,17.5PF	18518	152-0612-00
A11CR288	152-0323-00			SEMICOND DEVICE:SILICON,35V,0.1A	80009	152-0323-00
A11CR295	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR325	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A11CR326	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A11CR330	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A11CR331	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A11CR332	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A11CR333	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A11CR334	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A11CR335	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A11CR336	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A11CR337	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A11CR338	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A11CR339	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A11CR383	152-0153-00			SEMICOND DVC,DI:SW,SI,10V,50MA,D0-7	07263	FD7003
A11CR438	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR487	152-0323-00			SEMICOND DEVICE:SILICON,35V,0.1A	80009	152-0323-00
A11CR516	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR529	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A11CR559	152-0612-00			SEMICOND DEVICE:V VAR CAP.,4V,17.5PF	18518	152-0612-00
A11CR561	152-0612-00			SEMICOND DEVICE:V VAR CAP.,4V,17.5PF	18518	152-0612-00
A11L213	108-0182-00			COIL,RF:FIXED,285NH	80009	108-0182-00
A11L243	108-0433-00			COIL,RF:0.09UH	80009	108-0433-00
A11L310	108-0182-00			COIL,RF:FIXED,285NH	80009	108-0182-00
A11L445	108-0433-00	B010100	B039999	COIL,RF:0.09UH	80009	108-0433-00
A11Q108	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A11Q114	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q119	151-0221-00	B010100	B039999	TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q119	151-0221-02	B040000		TRANSISTOR:SILICON,PNP	07263	S42530
A11Q121	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A11Q123	151-0220-00	B010100	B039999	TRANSISTOR:PNP,SI,TO-92	07263	S036228
A11Q123	151-0221-00	B040000		TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q132	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q137	151-0434-00			TRANSISTOR:SILICON,PNP	04713	SS7144
A11Q147	151-0434-00			TRANSISTOR:SILICON,PNP	04713	SS7144
A11Q148	151-0434-00			TRANSISTOR:SILICON,PNP	04713	SS7144
A11Q151	151-0190-00	B010100	B039999	TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A11Q151	151-0341-00	B040000		TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A11Q153	151-0341-00	B040000		TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A11Q154	151-0221-00	B010100	B039999	TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q154	151-0333-00	B040000		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
A11Q155	151-0221-00	B010100	B039999	TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q155	151-0333-00	B040000		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
A11Q167	151-0198-00			TRANSISTOR:SELECTED	04713	SPS8802-1
A11Q214	151-0198-00			TRANSISTOR:SELECTED	04713	SPS8802-1
A11Q222	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q228	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q231	151-0434-00			TRANSISTOR:SILICON,PNP	04713	SS7144
A11Q247	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q248	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q255	151-0434-00			TRANSISTOR:SILICON,PNP	04713	SS7144
A11Q256	151-0434-00			TRANSISTOR:SILICON,PNP	04713	SS7144
A11Q264	151-0341-00	B040000		TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A11Q266	151-0198-00			TRANSISTOR:SELECTED	04713	SPS8802-1
A11Q285	151-1090-00	B010100	B039999	TRANSISTOR:SILICON,DUAL,N CHANNEL,FET	32293	ITS30929
A11Q285	151-1032-00	B040000		TRANSISTOR:SILICON,FET,DUAL	17856	DN399
A11Q318	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A11Q323	151-0472-00			TRANSISTOR:SILICON,NPN	51984	NE41632B
A11Q324	151-0472-00			TRANSISTOR:SILICON,NPN	51984	NE41632B
A11Q348	151-0190-00	B010100	B039999	TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A11Q348	151-0341-00	B040000		TRANSISTOR:NPN,SI,TO-106	07263	S040065

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A11Q350	151-0341-00	B040000		TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A11Q418	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A11Q419	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A11Q428	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	04713	SPS 8811
A11Q447	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q448	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q455	151-0434-00			TRANSISTOR:SILICON,PNP	04713	SS7144
A11Q456	151-0434-00			TRANSISTOR:SILICON,PNP	04713	SS7144
A11Q463	151-0341-00	B040000		TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A11Q465	151-0198-00			TRANSISTOR:SELECTED	04713	SPS8802-1
A11Q485	151-1090-00	B010100	B039999	TRANSISTOR:SILICON,DUAL,N CHANNEL,FET	32293	ITS30929
A11Q485	151-1032-00	B040000		TRANSISTOR:SILICON,FET,DUAL	17856	DN399
A11Q512	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A11Q527	151-0221-00	B010100	B039999	TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q527	151-0221-02	B040000		TRANSISTOR:SILICON,PNP	07263	S42530
A11Q532	151-0434-00			TRANSISTOR:SILICON,PNP	04713	SS7144
A11Q538	151-0434-00			TRANSISTOR:SILICON,PNP	04713	SS7144
A11Q542	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q546	151-0434-00			TRANSISTOR:SILICON,PNP	04713	SS7144
A11Q547	151-0434-00			TRANSISTOR:SILICON,PNP	04713	SS7144
A11Q554	151-0221-00	B010100	B039999	TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q554	151-0333-00	B040000		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
A11Q555	151-0221-00	B010100	B039999	TRANSISTOR:SILICON,PNP	04713	SPS246
A11Q555	151-0333-00	B040000		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
A11Q565	151-0198-00			TRANSISTOR:SELECTED	04713	SPS8802-1
A11R107	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A11R109	321-0206-00			RES.,FXD,FILM:1.37K OHM,1%,0.125W	91637	MFF1816G13700F
A11R110	321-0064-00			RES.,FXD,FILM:45.3 OHM,1%,0.125W	91637	MFF1816G45R30F
A11R111	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	91637	MFF1816G49R90F
A11R113	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A11R116	321-0064-00			RES.,FXD,FILM:45.3 OHM,1%,0.125W	91637	MFF1816G45R30F
A11R117	315-0751-00	B010100	B039999	RES.,FXD,CMPSN:750 OHM,5%,0.25W	57668	NTR25J-E750E
A11R117	315-0331-00	B040000		RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A11R118	301-0151-00	B010100	B039999	RES.,FXD,CMPSN:150 OHM,5%,0.5W	01121	EB1515
A11R118	301-0121-00	B040000		RES.,FXD,CMPSN:120 OHM,5%,0.5W	57668	R50J 120 OHM
A11R119	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A11R122	311-1564-00			RES.,VAR,NONWIR:TRMR,500 OHM,0.5W	32997	3352T-CK5-501
A11R124	321-0201-00	B010100	B039999	RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	MFF1816G12100F
A11R124	321-0188-00	B040000		RES.,FXD,FILM:887 OHM,1%,0.125W	91637	MFF1816G887R0F
A11R125	315-0430-00			RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
A11R126	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A11R127	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
A11R128	321-0196-00	B010100	B039999	RES.,FXD,FILM:1.07K OHM,1%,0.125W	91637	MFF1816G10700F
A11R128	321-0169-00	B040000		RES.,FXD,FILM:562 OHM,1%,0.125W	91637	MFF1816G562R0F
A11R129	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A11R130	315-0301-00	B010100	B039999	RES.,FXD,CMPSN:300 OHM,5%,0.25W	57668	NTR25J-E300E
A11R131	321-0064-00	B010100	B039999	RES.,FXD,FILM:45.3 OHM,1%,0.125W	91637	MFF1816G45R30F
A11R132	315-0681-00	B010100	B039999	RES.,FXD,CMPSN:680 OHM,5%,0.25W	57668	NTR25J-E680E
A11R132	315-0122-00	B040000		RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A11R134	321-0201-00	B010100	B039999	RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	MFF1816G12100F
A11R134	321-0190-00	B040000		RES.,FXD,FILM:931 OHM,1%,0.125W	91637	MFF1816G931R0F
A11R134	315-0271-00	.700001		RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
A11R136	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A11R137	321-0260-00	B040000		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
A11R138	321-0196-00	B010100	B039999	RES.,FXD,FILM:1.07K OHM,1%,0.125W	91637	MFF1816G10700F
A11R138	321-0165-00	B040000		RES.,FXD,FILM:511 OHM,1%,0.125W	91637	MFF1816G511R0F

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A11R139	321-0280-00	B040000		RES.,FXD,FILM:8.06K OHM,1%,0.125W	91637	MFF1816G80600F
A11R140	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A11R141	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A11R142	321-0280-00	B040000		RES.,FXD,FILM:8.06K OHM,1%,0.125W	91637	MFF1816G80600F
A11R143	321-0260-00	B040000		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
A11R144	321-0153-00	B040000		RES.,FXD,FILM:383 OHM,1%,0.125W	91637	MFF1816G383R0F
A11R145	311-2075-00	B010100	B039999	RES.,VAR,NONWIR:PNL,1/10K OHM,20%,0.25W	01121	21M172
A11R145	311-1311-00	B040000		RES.,VAR,NONWIR:1K OHM,20%,0.5W	01121	73M4G048L102M
A11R146	321-0126-00	B010100	B039999	RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A11R146	321-0097-00	B040000		RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
A11R150	321-0192-00	B010100	B039999	RES.,FXD,FILM:976 OHM,1%,0.125W	91637	MFF1816G976R0F
A11R150	321-0193-00	B040000		RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A11R151	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	57668	NTR25J-E39E0
A11R152	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	57668	NTR25J-E39E0
A11R153	315-0102-00	B040000		RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A11R154	315-0121-00	B040000		RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
A11R155	315-0101-00	B010100	B039999	RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A11R155	315-0471-00	B040000		RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A11R156	315-0121-00	B040000		RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
A11R157	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A11R158	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A11R159	321-0170-00			RES.,FXD,FILM:576 OHM,1%,0.125W	91637	MFF1816G576R0F
A11R160	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
A11R161	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A11R163	321-0190-00	B010100	B039999	RES.,FXD,FILM:931 OHM,1%,0.125W	91637	MFF1816G931R0F
A11R163	321-0173-00	B040000		RES.,FXD,FILM:619 OHM,1%,0.125W	91637	MFF1816G619R0F
A11R165	311-1560-00			RES.,VAR,NONWIR:TRMR,5K OHM,0.5W	32997	3352T-1-502
A11R170	321-0218-00	B010100	B039999	RES.,FXD,FILM:1.82K OHM,1%,0.125W	91637	MFF1816G18200F
A11R170	321-0201-00	B040000		RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	MFF1816G12100F
A11R171	321-0239-00	B010100	B039999	RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
A11R171	321-0201-00	B040000		RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	MFF1816G12100F
A11R172	311-1560-00			RES.,VAR,NONWIR:TRMR,5K OHM,0.5W	32997	3352T-1-502
A11R174	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A11R176	311-1567-00			RES.,VAR,NONWIR:TRMR,100 OHM,0.50W	73138	91-89-0
A11R177	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A11R185	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	CMF55116G20R00F
A11R187	315-0241-00	.700001		RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A11R205	311-1564-00			RES.,VAR,NONWIR:TRMR,500 OHM,0.5W	32997	3352T-CK5-501
A11R206	321-0064-00			RES.,FXD,FILM:45.3 OHM,1%,0.125W	91637	MFF1816G45R30F
A11R207	321-0177-00			RES.,FXD,FILM:681 OHM,1%,0.125W	01121	ORD BY DESCR
A11R208	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
A11R211	323-0156-00			RES.,FXD,FILM:412 OHM,1%,0.50W	75042	CECT0-4120F
A11R212	321-0049-00			RES.,FXD,FILM:31.6 OHM,1%,0.125W	91637	MFF1816G31R60F
A11R214	321-0065-00			RES.,FXD,FILM:46.4 OHM,1%,0.125W	91637	MFF1816G46R40F
A11R219	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	57668	NTR25J-E75E0
A11R220	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A11R221	315-0430-00			RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
A11R225	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	57668	NTR25J-E 820E
A11R226	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	57668	NTR25J-E 820E
A11R228	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A11R229	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A11R232	311-1564-00			RES.,VAR,NONWIR:TRMR,500 OHM,0.5W	32997	3352T-CK5-501
A11R236	315-0331-00	B010100	B039999	RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A11R236	315-0241-00	B040000		RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A11R237	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A11R237	315-0271-00	.700001		RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
A11R238	311-1558-00			RES.,VAR,NONWIR:TRMR,20K OHM,0.5W	32997	3352T-1-203
A11R240	311-1563-00	B010100	B039999	RES.,VAR,NONWIR:1K OHM,20%,0.50W	73138	91-85-0
A11R240	311-1565-00	B040000		RES.,VAR,NONWIR:250 OHM,20%,0.50W	73138	91-87-0
A11R241	315-0331-00	B010100	B039999	RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A11R241	315-0241-00	B040000		RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A11R246	321-0192-00	B010100	B039999	RES.,FXD,FILM:976 OHM,1%,0.125W	91637	MFF1816G976R0F
A11R246	321-0193-00	B040000		RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A11R247	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	57668	NTR25J-E750E
A11R248	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A11R251	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A11R252	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A11R256	321-0170-00			RES.,FXD,FILM:576 OHM,1%,0.125W	91637	MFF1816G576R0F
A11R257	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A11R258	321-0089-00			RES.,FXD,FILM:82.5 OHM,1%,0.125W	91637	MFF1816G82R50F
A11R259	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A11R260	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A11R261	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
A11R262	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A11R263	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
A11R264	315-0301-00	B010100	B039999	RES.,FXD,CMPSN:300 OHM,5%,0.25W	57668	NTR25J-E300E
A11R264	315-0201-00	B040000		RES.,FXD,CMPSN:200 OHM,5%,0.25W	57668	NTR25J-E200E
A11R265	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
A11R266	315-0301-00	B010100	B039999	RES.,FXD,CMPSN:300 OHM,5%,0.25W	57668	NTR25J-E300E
A11R266	315-0201-00	B040000		RES.,FXD,CMPSN:200 OHM,5%,0.25W	57668	NTR25J-E200E
A11R267	321-0192-00	B040000		RES.,FXD,FILM:976 OHM,1%,0.125W	91637	MFF1816G976R0F
A11R268	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A11R269	311-1561-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	73138	91-83-0
A11R270	311-1403-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	01121	18M651
A11R270	----- -----			(REPL AS A SET WITH CHASSIS S270)		
A11R271	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A11R272	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A11R273	311-1559-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	73138	91-81-0
A11R274	321-0166-00	B040000		RES.,FXD,FILM:523 OHM,1%,0.125W	91637	MFF1816G523R0F
A11R277	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A11R278	321-0307-00			RES.,FXD,FILM:15.4K OHM,1%,0.125W	91637	MFF1816G15401F
A11R279	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A11R282	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A11R283	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	CMF55116G20R00F
A11R284	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A11R289	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A11R304	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A11R310	323-0161-00			RES.,FXD,FILM:464 OHM,1%,0.50W	75042	CECT0-4640F
A11R311	321-0065-00			RES.,FXD,FILM:46.4 OHM,1%,0.125W	91637	MFF1816G46R40F
A11R319	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A11R321	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	57668	NTR25J-E75E0
A11R325	323-0106-00			RES.,FXD,FILM:124 OHM,1%,0.50W	91637	MFF1226G124R0F
A11R328	321-0186-00			RES.,FXD,FILM:845 OHM,1%,0.125W	91637	MFF1816G845R0F
A11R330	321-0186-00			RES.,FXD,FILM:845 OHM,1%,0.125W	91637	MFF1816G845R0F
A11R331	321-0133-00			RES.,FXD,FILM:237 OHM,1%,0.125W	91637	MFF1816G237R0F
A11R332	321-0133-00			RES.,FXD,FILM:237 OHM,1%,0.125W	91637	MFF1816G237R0F
A11R343	321-0280-00	B040000		RES.,FXD,FILM:8.06K OHM,1%,0.125W	91637	MFF1816G80600F
A11R344	321-0260-00	B040000		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
A11R345	311-2075-00	B010100	B039999	RES.,VAR,NONWIR:PNL,1/10K OHM,20%,0.25W	01121	21M172
A11R345	311-1311-00	B040000		RES.,VAR,NONWIR:1K OHM,20%,0.5W	01121	73M4G048L102M

For Service Manuals Contact
MAURITRON TECHNICAL SERVICES
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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A11R349	315-0102-00	B040000		RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A11R352	321-0190-00	B010100	B039999	RES.,FXD,FILM:931 OHM,1%,0.125W	91637	MFF1816G931R0F
A11R352	321-0173-00	B040000		RES.,FXD,FILM:619 OHM,1%,0.125W	91637	MFF1816G619R0F
A11R371	311-1560-00			RES.,VAR,NONWIR:TRMR,5K OHM,0.5W	32997	3352T-1-502
A11R372	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
A11R373	311-1560-00			RES.,VAR,NONWIR:TRMR,5K OHM,0.5W	32997	3352T-1-502
A11R374	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
A11R375	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
A11R376	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
A11R377	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A11R378	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A11R383	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
A11R388	315-0241-00	.700001		RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A11R414	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
A11R415	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A11R416	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
A11R417	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A11R418	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
A11R419	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A11R420	321-0151-00			RES.,FXD,FILM:365 OHM,1%,0.125W	91637	MFF1816G365R0F
A11R421	321-0145-00			RES.,FXD,FILM:316 OHM,1%,0.125W	91637	MFF1816G316R0F
A11R422	321-0151-00			RES.,FXD,FILM:365 OHM,1%,0.125W	91637	MFF1816G365R0F
A11R423	321-0145-00			RES.,FXD,FILM:316 OHM,1%,0.125W	91637	MFF1816G316R0F
A11R424	321-0145-00			RES.,FXD,FILM:316 OHM,1%,0.125W	91637	MFF1816G316R0F
A11R425	321-0151-00			RES.,FXD,FILM:365 OHM,1%,0.125W	91637	MFF1816G365R0F
A11R429	321-0201-00	B010100	B039999	RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	MFF1816G12100F
A11R429	321-0188-00	B040000		RES.,FXD,FILM:887 OHM,1%,0.125W	91637	MFF1816G887R0F
A11R431	311-1564-00			RES.,VAR,NONWIR:TRMR,500 OHM,0.5W	32997	3352T-CK5-501
A11R432	321-0064-00			RES.,FXD,FILM:45.3 OHM,1%,0.125W	91637	MFF1816G45R30F
A11R433	321-0196-00	B010100	B039999	RES.,FXD,FILM:1.07K OHM,1%,0.125W	91637	MFF1816G10700F
A11R433	321-0165-00	B040000		RES.,FXD,FILM:511 OHM,1%,0.125W	91637	MFF1816G511R0F
A11R434	311-1558-00			RES.,VAR,NONWIR:TRMR,20K OHM,0.5W	32997	3352T-1-203
A11R435	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A11R435	315-0271-00	.700001		RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
A11R436	311-1564-00			RES.,VAR,NONWIR:TRMR,500 OHM,0.5W	32997	3352T-CK5-501
A11R438	311-1563-00	B010100	B039999	RES.,VAR,NONWIR:1K OHM,20%,0.50W	73138	91-85-0
A11R438	311-1565-00	B040000		RES.,VAR,NONWIR:250 OHM,20%,0.50W	73138	91-87-0
A11R439	321-0201-00	B010100	B039999	RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	MFF1816G12100F
A11R439	321-0190-00	B040000		RES.,FXD,FILM:931 OHM,1%,0.125W	91637	MFF1816G931R0F
A11R440	315-0331-00	B010100	B039999	RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A11R440	315-0241-00	B040000		RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A11R441	321-0280-00	B040000		RES.,FXD,FILM:8.06K OHM,1%,0.125W	91637	MFF1816G80600F
A11R442	321-0260-00	B040000		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
A11R443	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A11R444	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A11R446	321-0153-00	B040000		RES.,FXD,FILM:383 OHM,1%,0.125W	91637	MFF1816G383R0F
A11R451	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A11R452	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A11R453	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	57668	NTR25J-E750E
A11R454	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A11R455	315-0101-00	B010100	B039999	RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A11R455	315-0471-00	B040000		RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A11R456	315-0121-00	B040000		RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
A11R457	321-0089-00			RES.,FXD,FILM:82.5 OHM,1%,0.125W	91637	MFF1816G82R50F
A11R458	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A11R459	321-0170-00			RES.,FXD,FILM:576 OHM,1%,0.125W	91637	MFF1816G576R0F

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A11R461	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A11R462	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A11R463	321-0166-00	B040000		RES.,FXD,FILM:523 OHM,1%,0.125W	91637	MFF1816G523R0F
A11R464	321-0192-00	B040000		RES.,FXD,FILM:976 OHM,1%,0.125W	91637	MFF1816G976R0F
A11R465	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
A11R466	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
A11R467	315-0301-00	B010100	B039999	RES.,FXD,CMPSN:300 OHM,5%,0.25W	57668	NTR25J-E300E
A11R467	315-0201-00	B040000		RES.,FXD,CMPSN:200 OHM,5%,0.25W	57668	NTR25J-E200E
A11R468	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A11R470	311-1403-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	01121	18M651
A11R470	----- -----			(REPL AS A SET WITH CHASSIS S470)		
A11R471	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A11R472	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A11R477	311-1567-00			RES.,VAR,NONWIR:TRMR,100 OHM,0.50W	73138	91-89-0
A11R485	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	CMF55116G20R00F
A11R488	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A11R489	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	CMF55116G20R00F
A11R503	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
A11R504	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	57668	NTR25J-E220E
A11R512	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A11R513	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A11R514	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A11R515	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A11R519	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A11R521	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A11R523	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A11R524	321-0064-00			RES.,FXD,FILM:45.3 OHM,1%,0.125W	91637	MFF1816G45R30F
A11R525	301-0151-00	B010100	B039999	RES.,FXD,CMPSN:150 OHM,5%,0.5W	01121	EB1515
A11R525	301-0121-00	B040000		RES.,FXD,CMPSN:120 OHM,5%,0.5W	57668	R50J 120 OHM
A11R527	321-0196-00	B010100	B039999	RES.,FXD,FILM:1:07K OHM,1%,0.125W	91637	MFF1816G10700F
A11R527	321-0169-00	B040000		RES.,FXD,FILM:562 OHM,1%,0.125W	91637	MFF1816G562R0F
A11R532	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A11R532	315-0271-00	.700001		RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
A11R536	315-0301-00	B010100	B039999	RES.,FXD,CMPSN:300 OHM,5%,0.25W	57668	NTR25J-E300E
A11R536	301-0121-00	B040000		RES.,FXD,CMPSN:120 OHM,5%,0.5W	57668	R50J 120 OHM
A11R538	321-0064-00	B040000		RES.,FXD,FILM:45.3 OHM,1%,0.125W	91637	MFF1816G45R30F
A11R539	315-0331-00	B010100	B039999	RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A11R539	315-0241-00	B040000		RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A11R545	321-0126-00	B010100	B039999	RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A11R545	321-0097-00	B040000		RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
A11R550	321-0192-00	B010100	B039999	RES.,FXD,FILM:976 OHM,1%,0.125W	91637	MFF1816G976R0F
A11R550	321-0193-00	B040000		RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A11R551	321-0192-00	B010100	B039999	RES.,FXD,FILM:976 OHM,1%,0.125W	91637	MFF1816G976R0F
A11R551	321-0193-00	B040000		RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A11R552	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A11R553	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	57668	NTR25J-E39E0
A11R554	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	57668	NTR25J-E39E0
A11R555	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A11R556	315-0121-00	B040000		RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
A11R557	321-0170-00			RES.,FXD,FILM:576 OHM,1%,0.125W	91637	MFF1816G576R0F
A11R558	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A11R562	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
A11R563	315-0301-00	B010100	B039999	RES.,FXD,CMPSN:300 OHM,5%,0.25W	57668	NTR25J-E300E
A11R563	315-0201-00	B040000		RES.,FXD,CMPSN:200 OHM,5%,0.25W	57668	NTR25J-E200E
A11R566	311-1559-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	73138	91-81-0

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A11R569	311-1561-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	73138	91-83-0
A11R570	321-0307-00			RES.,FXD,FILM:15.4K OHM,1%,0.125W	91637	MFF1816G15401F
A11R571	321-0307-00			RES.,FXD,FILM:15.4K OHM,1%,0.125W	91637	MFF1816G15401F
A11R572	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A11R573	311-1559-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	73138	91-81-0
A11R574	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A11R575	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A11R576	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
A11R577	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
A11R578	321-0253-00	B010100	B039999	RES.,FXD,FILM:4.22K OHM,1%,0.125W	91637	MFF1816G42200F
A11R578	321-0260-00	B040000		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
A11R579	321-0253-00	B010100	B039999	RES.,FXD,FILM:4.22K OHM,1%,0.125W	91637	MFF1816G42200F
A11R579	321-0260-00	B040000		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
A11R581	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A11R582	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A11R584	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A11RT362	307-0181-00			RES.,THERMAL:100K OHM,10%,4MW/DEG C	15454	1DE104-K-220EC
A11RT559	307-0181-00			RES.,THERMAL:100K OHM,10%,4MW/DEG C	15454	1DE104-K-220EC
A11S310	260-1486-00			SWITCH,PUSH:1 BUTTON,PB1,4P,PUSH-PUSH	59821	EKAB001000562
A11S586	260-1208-00			SWITCH,PUSH:DPDT,28VDC,PUSH-PUSH	31918	ORDER BY DESCR
A11U278	155-0078-10			MICROCIRCUIT,LI:ML,VERTICAL AMPLIFIER	80009	155-0078-10
A11U141	156-0158-03	B040000		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
A11U341	156-0158-03	B040000		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
A11U408	160-0204-01			MICROCIRCUIT,DI:256 X 4 ROM,SCRN	80009	160-0204-01
A11U409	156-0392-01			MICROCIRCUIT,DI:QUAD LATCH W/CLEAR	34335	AM25LS175
A11U479	155-0078-10			MICROCIRCUIT,LI:ML,VERTICAL AMPLIFIER	80009	155-0078-10
A11U508	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A11U509	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A11VR120	152-0757-00	B040000		SEMICOND DEVICE:ZENER,SI,6.2V,5%,1W	04713	1N4735A
A11VR187	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738RL
A11VR187	---- ----			(NOT USED HEERENVEEN INSTRUMENTS)		
A11VR189	152-0217-00	.700001		SEMICOND DVC,DI:ZEN,SI,8.2V,5%,0.4W	04713	SZG20
A11VR263	152-0166-00	B010100	B039999	SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738RL
A11VR388	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738RL
A11VR388	---- ----			(NOT USED HEERENVEEN INSTRUMENTS)		
A11VR389	152-0217-00	.700001		SEMICOND DVC,DI:ZEN,SI,8.2V,5%,0.4W	04713	SZG20
A11VR463	152-0166-00	B010100	B039999	SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738RL
A11VR522	152-0306-00			SEMICOND DEVICE:ZENER,0.4W,9.1V,5%	15238	Z5409
A11VR530	152-0757-00	B040000		SEMICOND DEVICE:ZENER,SI,6.2V,5%,1W	04713	1N4735A
A11W322	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A11W426	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A11W445	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A12	670-6373-00	B010100	B010219	CKT BOARD ASSY:TRIGGER GEN & SWEEP LOGIC (STANDARD)	80009	670-6373-00
A12	----- -----					
A12	670-6373-02	B010220		CKT BOARD ASSY:TRIGGER GEN & SWEEP LOGIC (STANDARD)	80009	670-6373-02
A12	----- -----					
A12	670-6373-01	B010100	B010219	CKT BOARD ASSY:TRIGGER GEN & SWEEP LOGIC (OPTION 5)	80009	670-6373-01
A12	----- -----					
A12	670-6373-03	B010220		CKT BOARD ASSY:TRIGGER GEN & SWEEP LOGIC (OPTION 5)	80009	670-6373-03
A12	----- -----					
A12C110	281-0603-00			CAP.,FXD,CER DI:39PF,5%,500V	59660	0301080C0G0390
A12C111	281-0579-00			CAP.,FXD,CER DI:21PF,5%,500V	04222	7001-NPO-210J
A12C121	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A12C129	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	96733	R2735
A12C133	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A12C134	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A12C138	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A12C150	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12C158	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12C160	290-0183-00			CAP.,FXD,ELCTLT:1UF,10%,35V	90201	TAC105K035P02
A12C189	281-0786-00	B010220		CAP.,FXD,CER DI:150PF,10%,100V	04222	MA106A569D
A12C211	281-0592-00			CAP.,FXD,CER DI:4.7PF,+/-0.5PF,500V (OPTION 05 ONLY)	59660	0301080COH0479 D
A12C211	----- -----					
A12C212	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A12C222	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A12C230	290-0808-00			CAP.,FXD,ELCTLT:2.7UF,10%,20V	05397	T3228275K020AS
A12C244	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12C248	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
A12C250	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12C270	290-0808-00			CAP.,FXD,ELCTLT:2.7UF,10%,20V	05397	T3228275K020AS
A12C272	290-0808-00			CAP.,FXD,ELCTLT:2.7UF,10%,20V	05397	T3228275K020AS
A12C284	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	04222	MA106A569D
A12C291	281-0547-00			CAP.,FXD,CER DI:2.7PF,10%,500V	04222	7001-COJ-2R7C
A12C309	290-0808-00			CAP.,FXD,ELCTLT:2.7UF,10%,20V	05397	T3228275K020AS
A12C315	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A12C327	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A12C330	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A12C332	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A12C333	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A12C347	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12C351	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12C352	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12C360	290-0808-00			CAP.,FXD,ELCTLT:2.7UF,10%,20V	05397	T3228275K020AS
A12C361	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12C362	281-0797-00			CAP.,FXD,CER DI:15PF,10%,100V	04222	MA 106A 150KAA
A12C380	290-0183-00			CAP.,FXD,ELCTLT:1UF,10%,35V	90201	TAC105K035P02
A12C381	281-0797-00			CAP.,FXD,CER DI:15PF,10%,100V	04222	MA 106A 150KAA
A12C413	281-0579-00			CAP.,FXD,CER DI:21PF,5%,500V	04222	7001-NPO-210J
A12C415	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A12C423	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A12C423	281-0772-00			CAP.,FXD,CER DI:0.0047UF,10%,100V (OPTION 05 ONLY)	04222	GC701C472K
A12C423	----- -----					
A12C438	281-0158-00			CAP.,VAR,CER D1:7-45PF,25V	73899	DVJ-5006
A12C457	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A12C461	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A12C478	290-0301-00			CAP.,FXD,ELCTLT:10UF,10%,20V	56289	150D106X9020B2

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A12C480	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A12C481	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	04222	MA106A569D
A12C482	290-0808-00			CAP.,FXD,ELCTLT:2.7UF,10%,20V	05397	T3228275K020AS
A12C505	281-0592-00			CAP.,FXD,CER DI:4.7PF,+/-0.5PF,500V	59660	0301080COH0479 D
A12C505	----- -----			(OPTION 05 ONLY)		
A12C509	281-0207-00			CAP.,VAR,PLSTC:2-18PF,100V	52769	GXA 18000
A12C510	281-0217-00			CAP.,VAR,CER DI:0.5-3.5PF,400V	52763	311908141
A12C515	290-0808-00			CAP.,FXD,ELCTLT:2.7UF,10%,20V	05397	T3228275K020AS
A12C516	281-0811-00			CAP.,FXD,CER DI:10PF,10%,100V	96733	R2911
A12C519	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A12C519	----- -----			(OPTION 05 ONLY)		
A12C525	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	96733	R2735
A12C527	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A12C538	281-0122-00			CAP.,VAR,CER DI:2.5-9PF,100V	59660	518-000A2.5-9
A12C541	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12C570	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12C593	290-0183-00			CAP.,FXD,ELCTLT:1UF,10%,35V	90201	TAC105K035P02
A12C2002	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12C2003	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
A12C2004	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
A12C2006	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12C2007	281-0547-00			CAP.,FXD,CER DI:2.7PF,10%,500V	04222	7001--COJ-2R7C
A12C2008	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
A12C2102	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A12CR180	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR181	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR189	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR228	152-0246-00			SEMICOND DEVICE:SW,SI,40V,200MA	03508	DE140
A12CR262	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR295	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR296	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR330	152-0246-00			SEMICOND DEVICE:SW,SI,40V,200MA	03508	DE140
A12CR380	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR385	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR390	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR391	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR392	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR463	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR470	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR471	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR474	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR475	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR478	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR480	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR488	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR493	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR494	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR495	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR496	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR497	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR519	152-0246-00			SEMICOND DEVICE:SW,SI,40V,200MA	03508	DE140
A12CR519	----- -----			(OPTION 05 ONLY)		
A12CR530	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR541	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	01295	1N4152R

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A12CR1000	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR1001	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR1100	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR1101	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12CR1102	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A12F3007	159-0059-00			FUSE,WIRE LEAD:5A,FAST-BLOW	000HX	SPI-5A
A12F4007	159-0059-00			FUSE,WIRE LEAD:5A,FAST-BLOW	000HX	SPI-5A
A12F4009	159-0059-00			FUSE,WIRE LEAD:5A,FAST-BLOW	000HX	SPI-5A
A12L389	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
A12L532	108-0655-00			COIL,RF:FIXED,75NH	80009	108-0655-00
A12Q160	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A12Q161	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A12Q177	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	07263	SP12141
A12Q180	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A12Q181	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A12Q182	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A12Q183	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A12Q195	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A12Q266	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A12Q294	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A12Q295	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A12Q360	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A12Q361	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A12Q432	151-0441-00			TRANSISTOR:SILICON,NPN	04713	SRF501
A12Q433	151-0441-00			TRANSISTOR:SILICON,NPN	04713	SRF501
A12Q467	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A12Q477	151-0223-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8026
A12Q481	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A12Q482	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A12Q483	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A12Q484	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A12Q520	151-1005-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	27014	F55037
A12Q520	----- -----			(OPTION 05 ONLY)		
A12Q521	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A12Q521	----- -----			(OPTION 05 ONLY)		
A12Q598	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A12Q1005	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A12Q1006	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A12Q1007	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A12Q2008	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A12Q230	151-1042-00			SEMICOND DVC SE:MATCHED PAIR FET	22229	S2089
A12Q430	151-1042-00			SEMICOND DVC SE:MATCHED PAIR FET	22229	S2089
A12R112	315-0334-00			RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
A12R120	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	57668	NTR25J-E100K
A12R130	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R132	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R133	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R134	311-1558-00			RES.,VAR,NONWIR:TRMR,20K OHM,0.5W	32997	3352T-1-203
A12R135	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R139	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	57668	NTR25J-E680E
A12R140	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	57668	NTR25J-E100K
A12R141	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	57668	NTR25J-E02K0
A12R142	315-0560-00			RES.,FXD,CMPSN:56 OHM,5%,0.25W	57668	NTR25J-E56E0
A12R143	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025

For Service Manuals Contact
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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A12R144	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A12R145	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	57668	NTR25J-E1K8
A12R148	311-1558-00			RES.,VAR,NONWIR:TRMR,20K OHM,0.5W	32997	3352T-1-203
A12R150	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A12R152	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	57668	NTR25J-E02K0
A12R153	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A12R154	311-1560-00			RES.,VAR,NONWIR:TRMR,5K OHM,0.5W	32997	3352T-1-502
A12R158	307-0113-00			RES.,FXD,CMPSN:5.1 OHM,5%,0.25W	01121	CB51G5
A12R161	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	57668	NTR25J-E39E0
A12R162	322-0189-00			RES.,FXD,FILM:909 OHM,1%,0.25W	75042	CEBT0-9090F
A12R163	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A12R165	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A12R166	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A12R171	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R172	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	57668	NTR25J-E680E
A12R173	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
A12R174	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	57668	NTR25J-E680E
A12R175	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R176	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	57668	NTR25J-E05K6
A12R177	301-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.50W	57668	TR50J-E8K2
A12R178	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A12R191	321-0155-00			RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402R0F
A12R210	315-0754-00			RES.,FXD,CMPSN:750K OHM,5%,0.25W	01121	CB7545
A12R211	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R219	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
A12R229	321-0481-00			RES.,FXD,FILM:1M OHM,1%,0.125W	91637	CMF55116G10003F
A12R232	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
A12R233	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	57668	NTR25J-E20K0
A12R234	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
A12R240	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A12R250	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
A12R260	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A12R261	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
A12R264	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	57668	NTR25J-E680E
A12R266	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	57668	NTR25J-E680E
A12R267	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A12R270	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A12R272	301-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.50W	57668	TR50J-E 5K6
A12R280	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
A12R281	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A12R290	321-0155-00			RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402R0F
A12R291	321-0209-00			RES.,FXD,FILM:1.47K OHM,1%,0.125W	91637	MFF1816G14700F
A12R292	321-0171-00			RES.,FXD,FILM:590 OHM,1%,0.125W	91637	MFF1816G590R0F
A12R293	321-0192-00			RES.,FXD,FILM:976 OHM,1%,0.125W	91637	MFF1816G976R0F
A12R294	321-0227-00			RES.,FXD,FILM:2.26K OHM,1%,0.125W	91637	MFF1816G22600F
A12R295	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A12R296	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
A12R310	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	91637	MFF1816G49R90F
A12R320	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	91637	MFF1816G49R90F
A12R328	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	91637	MFF1816G49R90F
A12R330	311-1558-00			RES.,VAR,NONWIR:TRMR,20K OHM,0.5W	32997	3352T-1-203
A12R332	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	57668	NTR25J-E02K0
A12R333	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	57668	NTR25J-E680E
A12R334	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A12R335	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
A12R340	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	57668	NTR25J-E100K
A12R341	315-0560-00			RES.,FXD,CMPSN:56 OHM,5%,0.25W	57668	NTR25J-E56E0
A12R342	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	57668	NTR25J-E1K8
A12R344	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A12R346	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A12R347	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A12R349	311-1558-00			RES.,VAR,NONWIR:TRMR,20K OHM,0.5W	32997	3352T-1-203
A12R350	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	57668	NTR25J-E02K0
A12R351	311-1560-00			RES.,VAR,NONWIR:TRMR,5K OHM,0.5W	32997	3352T-1-502
A12R352	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A12R360	307-0113-00			RES.,FXD,CMPSN:5.1 OHM,5%,0.25W	01121	CB51G5
A12R361	322-0184-00			RES.,FXD,FILM:806 OHM,1%,0.25W	75042	CEBT0-8060F
A12R362	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	57668	NTR25J-E39E0
A12R365	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A12R366	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
A12R370	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A12R378	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A12R379	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A12R380	315-0334-00			RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
A12R381	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A12R382	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A12R383	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A12R390	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
A12R391	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
A12R410	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	57668	NTR25J-E51E0
A12R411	321-0790-00			RES.,FXD,FILM:990K OHM,1%,0.125W	14298	AME55D9903F
A12R412	315-0820-00			RES.,FXD,CMPSN:82 OHM,5%,0.25W	57668	NTR25J-E82E0
A12R413	321-0450-00			RES.,FXD,FILM:475K OHM,1%,0.125W	91637	CMF55116G47502F
A12R414	321-0381-00			RES.,FXD,FILM:90.9K OHM,1%,0.125W	91637	MFF1816G90901F
A12R416	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A12R417	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A12R418	315-0241-00	B010100 B040000	B03999	RES.,FXD,CMPSN:240 OHM,5%,0.25W (TEST SELECTABLE)	01121	CB2415
A12R418	---- ----					
A12R420	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W (OPTION 05 ONLY)	57668	NTR25J-E47E0
A12R420	---- ----					
A12R421	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W (OPTION 05 ONLY)	01121	CB1535
A12R421	---- ----					
A12R422	321-0496-00			RES.,FXD,FILM:1.43M OHM,1%,0.125W (OPTION 05 ONLY)	91637	HFF1813G14303F
A12R422	---- ----					
A12R423	315-0106-00			RES.,FXD,CMPSN:10M OHM,5%,0.25W (OPTION 05 ONLY)	01121	CB1065
A12R423	---- ----					
A12R424	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
A12R428	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R430	321-0481-00			RES.,FXD,FILM:1M OHM,1%,0.125W	91637	CMF55116G10003F
A12R430	315-0475-00			RES.,FXD,CMPSN:4.7M OHM,5%,0.25W (OPTION 05 ONLY)	01121	CB4755
A12R430	---- ----					
A12R431	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R432	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
A12R433	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R435	311-1260-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	32997	3329P-L58-251
A12R440	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R443	311-1567-00			RES.,VAR,NONWIR:TRMR,100 OHM,0.50W	73138	91-89-0
A12R444	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A12R445	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	57668	NTR25J-E20K0
A12R446	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R460	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A12R463	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A12R466	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A12R467	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A12R470	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A12R471	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A12R472	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
A12R473	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A12R476	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
A12R477	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A12R479	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A12R480	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
A12R481	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	57668	NTR25J-E27K0
A12R482	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	57668	NTR25J-E100K
A12R483	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A12R484	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	57668	NTR25J-E02K0
A12R485	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A12R486	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A12R487	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	57668	NTR25J-E20K0
A12R495	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A12R496	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A12R497	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A12R504	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A12R514	325-0245-00			RES.,FXD,FILM:3.32M OHM,1%,0.125W	91637	CMF55116G33203F
A12R523	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A12R523	----- -----			(OPTION 05 ONLY)		
A12R524	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	57668	NTR25J-E100K
A12R526	321-0178-00			RES.,FXD,FILM:698 OHM,1%,0.125W	91637	MFF1816G698R0F
A12R531	322-0194-00			RES.,FXD,FILM:1.02K OHM,1%,0.25W	75042	CEBTO-1021F
A12R533	315-0124-00			RES.,FXD,CMPSN:120K OHM,5%,0.25W	01121	CB1245
A12R534	311-0622-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	32997	3329H-G48-101
A12R538	315-0430-00			RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
A12R540	322-0194-00			RES.,FXD,FILM:1.02K OHM,1%,0.25W	75042	CEBTO-1021F
A12R541	315-0430-00			RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
A12R542	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
A12R570	315-0274-00			RES.,FXD,CMPSN:270K OHM,5%,0.25W	57668	NTR25J-E270K
A12R591	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	57668	NTR25J-E39K0
A12R592	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	57668	NTR25J-E02K0
A12R593	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A12R599	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A12R1000	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	57668	NTR25J-E910E
A12R1002	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	57668	NTR25J-E220E
A12R1003	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	57668	NTR25J-E220E
A12R1004	321-0155-00			RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402R0F
A12R1005	321-0215-00			RES.,FXD,FILM:1.69K OHM,1%,0.125W	91637	MFF1816G16900F
A12R1100	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A12R1101	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	57668	NTR25J-E910E
A12R2001	321-0171-00			RES.,FXD,FILM:590 OHM,1%,0.125W	91637	MFF1816G590R0F
A12R2002	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A12R2005	321-0264-00			RES.,FXD,FILM:5.49K OHM,1%,0.125W	91637	MFF1816G54900F
A12R2006	321-0192-00			RES.,FXD,FILM:976 OHM,1%,0.125W	91637	MFF1816G976R0F
A12R2008	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A12R2009	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
A12R2100	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	57668	NTR25J-E1K8
A12R2101	321-0155-00			RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402R0F
A12R2102	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A12S120	263-0065-00			SW SL ACTR ASSY:B COUPLING,4 OF 5 POSITION	80009	263-0065-00
A12S220	263-0066-00			SW SL ACTR ASSY:B SOURCE,5 OF 6 POSITION	80009	263-0066-00
A12S220	263-0070-00			SW SL ACTR ASSY:A COUPLING,6 OF 6 POSITION	80009	263-0070-00
A12S220	----- -----			(OPTION 05 ONLY)		
A12S320	263-0068-00			SW SL ACTR ASSY:A SOURCE,6 OF 6 POSITION	80009	263-0068-00
A12S420	263-0067-00			SW SL ACTR ASSY:A COUPLING,4 OF 6 POSITION	80009	263-0067-00
A12S420	263-0070-00			SW SL ACTR ASSY:A COUPLING,6 OF 6 POSITION	80009	263-0070-00
A12S420	----- -----			(OPTION 05 ONLY)		
A12U240	155-0196-00			MICROCKT,INTFC:TRIGGER	80009	155-0196-00
A12U250	156-1150-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR,NEGATIVE	04713	MC79L05ACP
A12U445	155-0196-00			MICROCKT,INTFC:TRIGGER	80009	155-0196-00
A12U480	155-0049-02			MICROCIRCUIT,DI:SWEEP CONTROL,W/LOCKOUT	80009	155-0049-02
A12VR366	152-0227-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ13903
A12VR383	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
A12VR526	152-0195-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	04713	SZ11755
A12W189	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A12W190	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A12W2003	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A12W2006	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A12W2007	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A13	670-6374-00	B010100	B010899	CKT BOARD ASSY:TIMING	80009	670-6374-00
A13	670-6374-01	B010900		CKT BOARD ASSY:TIMING	80009	670-6374-01
A13C112	281-0763-00			CAP.,FXD,CER DI:47PF,10%,100V	04222	GA101A470KAA
A13C120	281-0096-00			CAP.,VAR,AIR DI:5.5-18PF,350V	33095	53-717-029A5.5
A13C126	281-0089-00			CAP.,VAR,CER DI:2-8PF,350V	59660	538-006-A2-8
A13C126	281-0096-00	.700001		CAP.,VAR,AIR DI:5.5-18PF,350V	33095	53-717-029A5.5
A13C130	295-0175-00			CAP.,SET,MTCHD:0.1UF,9.95UF,985PF,0.2%	80009	295-0175-00
A13C152	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A13C159	281-0089-00			CAP.,VAR,CER DI:2-8PF,350V	59660	538-006-A2-8
A13C228	283-0331-00	B010100	B010899	CAP.,FXD,CER DI:43PF,2%,100V	59660	0805536C0G0-430G
A13C228	283-0784-00	B010900		CAP.,FXD,MICA D:40 PF,2%,500V	09023	CD15ED400G03
A13C228	283-0333-00	.700001		CAP.,FXD,CER DI:35PF,5%,1000V	72982	838-534 A 350>
A13C258	283-0331-00			CAP.,FXD,CER DI:43PF,2%,100V	59660	0805536C0G0-430G
A13C318	295-0175-00			CAP.,SET,MTCHD:0.1UF,9.95UF,985PF,0.2%	80009	295-0175-00
A13C345	295-0157-00			CAP.,SET,MTCHD:0.1UF,1UF,998PF	80009	295-0157-00
A13C418	295-0175-00			CAP.,SET,MTCHD:0.1UF,9.95UF,985PF,0.2%	80009	295-0175-00
A13C429	283-0645-00			CAP.,FXD,MICA D:790PF,1%,100V	00853	D153F791F0
A13C435	290-0245-00			CAP.,FXD,ELCTLT:1.5UF,10%,10V	56289	150D155X9010A2
A13C437	283-0239-00			CAP.,FXD,CER DI:0.022UF,10%,50V	72982	8121N083X7R0223K
A13C446	295-0157-00			CAP.,SET,MTCHD:0.1UF,1UF,998PF	80009	295-0157-00
A13C449	295-0157-00			CAP.,SET,MTCHD:0.1UF,1UF,998PF	80009	295-0157-00
A13CR374	152-0075-00			SEMICOND DEVICE:SW,GE,22V,40MA	14433	G866
A13CR423	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A13CR425	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A13CR430	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A13CR471	152-0075-00			SEMICOND DEVICE:SW,GE,22V,40MA	14433	G866
A13Q151	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A13Q158	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A13Q161	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A13Q432	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A13R113	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A13R114	323-0498-04			RES.,FXD,FILM:1.5M OHM,0.1%,0.50W	91637	HFF129D15003B
A13R115	323-0481-04			RES.,FXD,FILM:1M OHM,0.1%,0.50W	91637	MFF1226D10003B
A13R116	321-0648-04			RES.,FXD,FILM:500K OHM,0.1%,0.125W	91637	CMF110216D50002B
A13R120	321-0618-04			RES.,FXD,FILM:250K OHM,0.1%,0.125W	07716	OBD
A13R121	321-0414-04			RES.,FXD,FILM:200K OHM,0.1%,0.125W	91637	CMF55116D20002B
A13R122	321-0385-04			RES.,FXD,FILM:100K OHM,0.1%,0.125W	91637	MFF1816D10002B
A13R123	321-0756-04			RES.,FXD,FILM:50K OHM,0.1%,0.125W	91637	MFF1816D50001B
A13R124	311-1915-00			RES.,VAR,NONWIR:20K OHM,10%,0.50W	73138	72-196-0
A13R129	321-0169-00			RES.,FXD,FILM:562 OHM,1%,0.125W	91637	MFF1816G562R0F
A13R130	321-0986-07			RES.,FXD,FILM:25K OHM,0.1%,0.125W	91637	MFF1816C25001B
A13R131	321-0380-00			RES.,FXD,FILM:88.7K OHM,1%,0.125W	91637	MFF1816G88701F
A13R132	321-0156-00			RES.,FXD,FILM:412 OHM,1%,0.125W	91637	MFF1816G412R0F
A13R133	321-0463-00			RES.,FXD,FILM:649K OHM,1%,0.125W	91637	MFF1816G64902F
A13R135	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A13R137	315-0305-00			RES.,FXD,CMPSN:3M OHM,5%,0.25W	01121	CB3055
A13R138	321-0296-00			RES.,FXD,FILM:11.8K OHM,1%,0.125W	91637	MFF1816G11801F
A13R143	323-0498-04			RES.,FXD,FILM:1.5M OHM,0.1%,0.50W	91637	HFF129D15003B
A13R144	323-0481-04			RES.,FXD,FILM:1M OHM,0.1%,0.50W	91637	MFF1226D10003B
A13R145	307-0595-00			RES NTWK,FXD FI:7,5.6K OHM,2%,1.0W	32997	4308R-101-562
A13R147	321-0648-04			RES.,FXD,FILM:500K OHM,0.1%,0.125W	91637	CMF110216D50002B
A13R148	321-0618-04			RES.,FXD,FILM:250K OHM,0.1%,0.125W	07716	OBD
A13R150	321-0414-04			RES.,FXD,FILM:200K OHM,0.1%,0.125W	91637	CMF55116D20002B
A13R153	321-0385-04			RES.,FXD,FILM:100K OHM,0.1%,0.125W	91637	MFF1816D10002B
A13R154	321-0756-04			RES.,FXD,FILM:50K OHM,0.1%,0.125W	91637	MFF1816D50001B
A13R156	321-0986-07			RES.,FXD,FILM:25K OHM,0.1%,0.125W	91637	MFF1816C25001B

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A13R157	321-0383-00			RES.,FXD,FILM:95.3K OHM,1%,0.125W	91637	MFF1816G95301F
A13R160	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	57668	NTR25J-E47K0
A13R161	321-0262-00			RES.,FXD,FILM:5.23K OHM,1%,0.125W	91637	MFF1816G52300F
A13R162	315-0914-00			RES.,FXD,CMPSN:910K OHM,5%,0.25W	01121	CB9145
A13R163	321-0414-00			RES.,FXD,FILM:200K OHM,1%,0.125W	91637	MFF1816G20002F
A13R164	321-0451-00			RES.,FXD,FILM:487K OHM,1%,0.125W	91637	CMF55116G48702F
A13R169	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
A13R170	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A13R173	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
A13R178	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A13R270	311-1238-00			RES.,VAR,NONWIR:5K OHM,10%,0.50W	73138	72-27-0
A13R272	311-1701-00			RES.,VAR,NONWIR:PNL,50K OHM,1W,W/SW	01121	18M655
A13R428	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
A13R429	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A13R430	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
A13R431	321-0338-00			RES.,FXD,FILM:32.4K OHM,1%,0.125W	91637	MFF1816G32401F
A13R432	321-0429-00			RES.,FXD,FILM:287K OHM,1%,0.125W	91637	MFF1816G28702F
A13R439	321-0463-00			RES.,FXD,FILM:649K OHM,1%,0.125W	91637	MFF1816G64902F
A13S249	263-1186-00			SW CAM ACTR AS:TIME/CM	80009	263-1186-00
A13S410	260-1422-00			SWITCH,PUSH:3 STA,INTERLOCK	59821	EKBC030000594
A13S469	260-1423-00			SWITCH,PUSH:4 STA,INTERLOCK,NON-SHORT	59821	2KBC040000593
A13VR173	152-0395-00			SEMICOND DEVICE:ZENER,0.4W,4.3V,5%	14552	TD332317
A13VR174	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738RL

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A14	670-6375-00			CKT BOARD ASSY:VERTICAL MODE	80009	670-6375-00
A14C203	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A14C358	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A14C399	290-0135-00			CAP.,FXD,ELCTLT:15UF,20%,20V	56289	150D156X0020B2
A14Q115	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A14Q208	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A14Q209	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A14Q366	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A14Q369	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A14Q1308	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A14Q1309	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A14R101	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A14R102	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A14R103	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	57668	NTR25J-E02K0
A14R104	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A14R202	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A14R203	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A14R204	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A14R265	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A14R266	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A14R267	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A14R358	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A14R370	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A14R398	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A14R472	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A14R1106	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A14R1107	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A14R1112	315-0111-00			RES.,FXD,CMPSN:110 OHM,5%,0.25W	57668	NTR25J-E110E
A14R1311	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A14R1312	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	57668	NTR25J-E47K0
A14R1313	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A14R1314	315-0111-00			RES.,FXD,CMPSN:110 OHM,5%,0.25W	57668	NTR25J-E110E
A14R1315	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A14R1316	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	57668	NTR25J-E47K0
A14R1317	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A14S272	260-1944-00			SWITCH,PUSH:5 BTN,2 POLE,VERTICAL MODE	59821	2KBB0500001219
A14S295	263-1185-00			SW CAM ACTR AS:ATTENUATOR	80009	263-1185-00
A14S495	263-1185-00			SW CAM ACTR AS:ATTENUATOR	80009	263-1185-00
A14U310	156-0913-02			MICROCIRCUIT,DI:OCTAL D FF,BURN-IN	04713	SN74LS377NDS
A14U320	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A14U326	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A14U336	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A14U346	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A14U358	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3
A14U458	156-0948-02			MICROCIRCUIT,DI:QUAD D F-F,BURN-IN	01295	SN74S175J4
A14U466	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A15	670-6376-00	B010100	B039999	CKT BOARD ASSY:INTERFACE	80009	670-6376-00
A15	670-6376-02	B040000		CKT BOARD ASSY:INTERFACE	80009	670-6376-02
A15	670-6376-01	B010100	B039999	CKT BOARD ASSY:INTERFACE	80009	670-6376-01
A15	----- -----			(OPTION 04 ONLY)		
A15	670-6376-03	B040000		CKT BOARD ASSY:INTERFACE	80009	670-6376-03
A15	----- -----			(OPTION 04 ONLY)		
A15C104	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
A15C108	290-0316-00			CAP.,FXD,ELCTLT:47UF,20%,35V	56289	150D476X0035S2
A15C113	283-0203-00			CAP.,FXD,CER DI:0.47UF,20%,50V	04222	5R305SE474MAA
A15C141	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
A15C142	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
A15C143	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A15C146	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A15C162	290-0047-00	.700001		CAP.,FXD,ELCTLT:150UF,250V W/COVER & PLATE	80009	290-0047-00
A15C205	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	59821	SDDH69L103Z
A15C210	281-0622-00			CAP.,FXD,CER DI:47PF,1%,500V	59660	0301080C0G0470F
A15C218	285-0509-01			CAP.,FXD,PPR DI:0.0068UF,20%,5000V	56289	430P507
A15C220	285-0509-01			CAP.,FXD,PPR DI:0.0068UF,20%,5000V	56289	430P507
A15C225	285-0509-01			CAP.,FXD,PPR DI:0.0068UF,20%,5000V	56289	430P507
A15C239	285-1040-00			CAP.,FXD,PLSTC:0.0012UF,10%,4000V	56289	430P522
A15C303	290-0164-00			CAP.,FXD,ELCTLT:1UF,+50-10%,150V	56289	500D105F150BA7
A15C307	283-0178-00			CAP.,FXD,CER DI:0.1UF,+80-20%,100V	72982	8131N145651 104Z
A15C314	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	59821	SDDH69L103Z
A15C318	285-1040-00			CAP.,FXD,PLSTC:0.0012UF,10%,4000V	56289	430P522
A15C319	285-0507-01			CAP.,FXD,PPR DI:0.0047UF,20%,6000V	56289	430P472060
A15C353	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
A15C391	281-0767-00			CAP.,FXD,CER DI:330PF,20%,100V	12969	CGB331MEN
A15C404	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A15C414	283-0057-00			CAP.,FXD,CER DI:0.1UF,+80-20%,200V	56289	2C20Z5U104Z200B
A15C416	283-0057-00			CAP.,FXD,CER DI:0.1UF,+80-20%,200V	56289	2C20Z5U104Z200B
A15C426	285-1040-00			CAP.,FXD,PLSTC:0.0012UF,10%,4000V	56289	430P522
A15C450	283-0328-00			CAP.,FXD,CER DI:0.03UF,+80-20%,200V	72982	8131N225Z5U0303Z
A15C453	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A15C460	281-0816-00			CAP.,FXD,CER DI:82PF,5%,100V	96733	R3247
A15C461	281-0772-00			CAP.,FXD,CER DI:0.0047UF,10%,100V	04222	GC701C472K
A15C467	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A15C468	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A15C485	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A15C486	285-0686-00			CAP.,FXD,PLSTC:0.068UF,10%,100V	56289	192P68392M465
A15C502	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
A15C513	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	59821	SDDH69L103Z
A15C518	281-0064-00			CAP.,VAR,PLSTC:0.25-1.5PF,600V	74970	273-0001-101
A15C519	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A15C525	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	96733	R3015
A15C531	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	56289	1C10Z5U223M050B
A15C548	281-0168-00			CAP.,VAR,AIR DI:1.3-5.4PF,250V	74970	187-0103-035
A15C549	281-0168-00			CAP.,VAR,AIR DI:1.3-5.4PF,250V	74970	187-0103-035
A15C555	283-0024-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	72982	8121N083Z5U0104Z
A15C570	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
A15C582	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
A15C589	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
A15C594	290-0532-00			CAP.,FXD,ELCTLT:150UF,20%,6V	90201	TDC157M006WLC
A15C595	281-0762-00			CAP.,FXD,CER DI:27PF,20%,100V	04222	GC101A270M
A15C603	290-0305-00			CAP.,FXD,ELCTLT:3UF,20%,150V	56289	109D305X0150C2
A15C607	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A15C609	281-0783-00			CAP.,FXD,CER DI:0.1UF,20%,100V	96733	ADVISE
A15C629	290-0149-00			CAP.,FXD,ELCTLT:5UF,+75-10%,15OV	56289	30D505G150CCAS
A15C634	290-0529-00			CAP.,FXD,ELCTLT:47UF,20%,20V	05397	T362C476M020AS
A15C644	283-0328-00			CAP.,FXD,CER DI:0.03UF,+80-20%,200V	72982	8131N225Z5U0303Z
A15C650	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
A15C652	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A15C657	281-0816-00			CAP.,FXD,CER DI:82PF,5%,100V	96733	R3247
A15C658	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A15C672	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A15C690	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A15C698	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A15C705	281-0774-00			CAP.,FXD,CER DI:0.022UF,20%,100V	12969	CGE223MEZ
A15C707	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A15C725	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
A15C756	290-0807-00			CAP.,FXD,ELCTLT:1000UF,+100-10%,10VDC	90201	TT102N010E1C3P
A15C770	281-0767-00			CAP.,FXD,CER DI:330PF,20%,100V	12969	CGB331MEN
A15C776	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
A15C777	281-0756-00			CAP.,FXD,CER DI:2.2PF,0.5%,200V	12969	CGB2R2DFN
A15C803	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
A15C803	---- ----			(OPTION 04 ONLY)		
A15C804	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
A15C804	---- ----			(OPTION 04 ONLY)		
A15C805	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
A15C805	---- ----			(OPTION 04 ONLY)		
A15C820	290-0571-00			CAP.,FXD,ELCTLT:5000UF,+100-0%,25V	90201	PFP20-36043
A15C829	290-0638-00			CAP.,FXD,ELCTLT:1200UF,+75-10%,100V	56289	68D10529
A15C840	290-0670-00			CAP.,FXD,ELCTLT:550UF,+75-10%,100V	56289	68D10512
A15C848	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
A15C849	281-0783-00			CAP.,FXD,CER DI:0.1UF,20%,100V	96733	ADVISE
A15C869	290-0512-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	196D226X0015KA1
A15C870	281-0774-00			CAP.,FXD,CER DI:0.022UF,20%,100V	12969	CGE223MEZ
A15C874	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
A15C876	281-0783-00			CAP.,FXD,CER DI:0.1UF,20%,100V	96733	ADVISE
A15C885	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	96733	R3015
A15C894	281-0774-00			CAP.,FXD,CER DI:0.022UF,20%,100V	12969	CGE223MEZ
A15C913	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
A15C913	---- ----			(OPTION 04 ONLY)		
A15C917	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
A15C917	---- ----			(OPTION 04 ONLY)		
A15C926	290-0584-00			CAP.,FXD,ELCTLT:5500UF,+100-10%,30V	90201	PFP552GN4A3P2
A15C935	290-0571-00			CAP.,FXD,ELCTLT:5000UF,+100-0%,25V	90201	PFP20-36043
A15C938	281-0580-00			CAP.,FXD,CER DI:470PF,10%,500V	04222	7001-1374
A15C939	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A15C956	281-0760-00			CAP.,FXD,CER DI:22PF,10%,500V	72982	0314021 C0G0220K
A15C959	281-0785-00			CAP.,FXD,CER DI:68PF,10%,100V	04222	GC101A680K
A15C964	281-0762-00			CAP.,FXD,CER DI:27PF,20%,100V	04222	GC101A270M
A15C965	281-0787-00			CAP.,FXD,CER DI:15PF,5%,500V	72982	0314021COG0150J
A15C966	281-0774-00			CAP.,FXD,CER DI:0.022UF,20%,100V	12969	CGE223MEZ
A15C985	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	96733	R2735
A15C988	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A15C989	281-0774-00			CAP.,FXD,CER DI:0.022UF,20%,100V	12969	CGE223MEZ
A15C992	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A15C996	281-0771-00			CAP.,FXD,CER DI:0.0022UF,20%,200V	56289	292C Z5U222M200B
A15C997	281-0760-00			CAP.,FXD,CER DI:22PF,10%,500V	72982	0314021 C0G0220K

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A15CR101	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR104	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR105	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR110	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR209	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	12969	G727
A15CR220	152-0409-00			SEMICOND DEVICE:SILICON,12,000V,5MA	83003	VG12X-1
A15CR304	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR305	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR313	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
A15CR314	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
A15CR323	152-0242-00			SEMICOND DVC:SIG,SI,225V,0.2A,D0-7	07263	FDH5004
A15CR324	152-0242-00			SEMICOND DVC:SIG,SI,225V,0.2A,D0-7	07263	FDH5004
A15CR347	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR414	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR453	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR486	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR494	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR508	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR513	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
A15CR517	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR519	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
A15CR553	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR556	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR560	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A15CR561	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A15CR587	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR600	152-0066-00			SEMICOND DVC DI:RECT,SI,400V,1A,D0-41	05828	GP10G-020
A15CR605	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
A15CR611	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR617	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR622	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR623	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR631	152-0333-00			SEMICOND DVC DI:SW,SI,55V,200MA,D0-35	03508	DJ2011
A15CR645	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR679	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR696	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR706	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR727	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
A15CR728	152-0066-00			SEMICOND DVC DI:RECT,SI,400V,1A,D0-41	05828	GP10G-020
A15CR729	152-0066-00			SEMICOND DVC DI:RECT,SI,400V,1A,D0-41	05828	GP10G-020
A15CR746	152-0153-00			SEMICOND DVC,DI:SW,SI,10V,50MA,D0-7	07263	FD7003
A15CR749	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR761	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR763	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR765	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR767	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR768	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR804	152-0066-00			SEMICOND DVC DI:RECT,SI,400V,1A,D0-41	05828	GP10G-020
A15CR813	152-0556-00			SEMICOND DEVICE:BRIDGE,50V,2.5A	05828	KBL005-8
A15CR815	152-0066-00			SEMICOND DVC DI:RECT,SI,400V,1A,D0-41	05828	GP10G-020
A15CR826	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	12969	G727
A15CR840	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	12969	G727
A15CR889	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR919	152-0556-00			SEMICOND DEVICE:BRIDGE,50V,2.5A	05828	KBL005-8

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A15CR930	152-0556-00			SEMICOND DEVICE:BRIDGE,50V,2.5A	05828	KBL005-8
A15CR942	152-0488-00			SEMICOND DEVICE:SILICON,200V,1500MA	04713	SDA317
A15CR947	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR953	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR954	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR965	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR975	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR980	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR984	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15CR996	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A15DS323	150-0002-00			LAMP,GLOW:0.5 MA 60/125V	74276	NE-2T(T2)
A15DS324	150-0002-00			LAMP,GLOW:0.5 MA 60/125V	74276	NE-2T(T2)
A15F802	159-0059-00			FUSE,WIRE LEAD:5A,FAST-BLOW	000HX	SPI-5A
A15F809	159-0016-00			FUSE,CARTRIDGE:3AG,1.5A,250V,FAST-BLOW	71400	AGC 1 1/2
A15F909	159-0059-00			FUSE,WIRE LEAD:5A,FAST-BLOW	000HX	SPI-5A
A15L107	108-0422-00			COIL,RF:FIXED,82UH	80009	108-0422-00
A15L494	108-0245-00			COIL,RF:3.9UH	76493	B6310-1
A15L991	108-0328-00			COIL,RF:0.3UH	80009	108-0328-00
A15Q109	151-0136-00			TRANSISTOR:SILICON,NPN	02735	35495
A15Q201	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A15Q302	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A15Q380	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
A15Q396	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
A15Q402	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A15Q406	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A15Q416	151-0406-00			TRANSISTOR:SILICON,PNP	04713	OBD
A15Q446	151-0406-00			TRANSISTOR:SILICON,PNP	04713	OBD
A15Q449	151-0407-00			TRANSISTOR:SILICON,NPN	04713	SS2456
A15Q456	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A15Q465	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A15Q503	151-0347-00			TRANSISTOR:SILICON,NPN	56289	T7916
A15Q516	151-0407-00			TRANSISTOR:SILICON,NPN	04713	SS2456
A15Q522	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A15Q523	151-0223-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS8026
A15Q530	151-0126-00			TRANSISTOR:SILICON,NPN	04713	ST1046
A15Q533	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
A15Q555	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
A15Q559	151-0342-00			TRANSISTOR:SILICON,PNP	07263	S035928
A15Q560	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A15Q569	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A15Q570	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A15Q571	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A15Q582	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A15Q583	151-0216-00			TRANSISTOR:SILICON,PNP	04713	SPS8803
A15Q595	151-0164-00			TRANSISTOR:PNP,SI,TO-92	04713	2N2907A
A15Q606	151-0347-00			TRANSISTOR:SILICON,NPN	56289	T7916
A15Q617	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A15Q646	151-0406-00			TRANSISTOR:SILICON,PNP	04713	OBD
A15Q649	151-0407-00			TRANSISTOR:SILICON,NPN	04713	SS2456
A15Q703	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A15Q704	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
A15Q740	151-0347-00			TRANSISTOR:SILICON,NPN	56289	T7916
A15Q760	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A15Q772	151-0188-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS6868

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A15Q781	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A15Q782	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A15Q790	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A15Q791	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A15Q828	151-0311-01			TRANSISTOR:SILICON,NPN	04713	SJE908
A15Q864	151-0283-00			TRANSISTOR:SILICON,NPN	07263	S032790
A15Q867	151-1025-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	01295	SFB8129
A15Q890	151-0283-00			TRANSISTOR:SILICON,NPN	07263	S032790
A15Q891	151-1025-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	01295	SFB8129
A15Q946	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A15Q952	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A15Q956	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A15Q958	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A15Q960	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A15Q967	151-0127-00			TRANSISTOR:SILICON,NPN	07263	S006075
A15Q981	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A15Q986	151-0220-03			TRANSISTOR:SILICON,PNP,SEL	04713	SPS6915
A15Q987	151-0354-00			TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
A15Q998	151-0127-00			TRANSISTOR:SILICON,NPN	07263	S006075
A15R101	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A15R103	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A15R114	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	57668	NTR25J-E100K
A15R144	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A15R145	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	57668	NTR25J-E 22K
A15R148	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
A15R203	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
A15R204	321-0329-00			RES.,FXD,FILM:26.1K OHM,1%,0.125W	91637	MFF1816G26101F
A15R206	315-0106-00			RES.,FXD,CMPSN:10M OHM,5%,0.25W	01121	CB1065
A15R209	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	57668	NTR25J-E1K8
A15R252	311-1538-00			RES.,VAR,NONWIR:5K OHM X 2.5M OHM,10%	01121	18M683
A15R267	311-1555-00			RES.,VAR,NONWIR:TRMR,100K OHM,0.5W	32997	3352T-1-104
A15R270	311-1560-00			RES.,VAR,NONWIR:TRMR,5K OHM,0.5W	32997	3352T-1-502
A15R273	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A15R302	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A15R309	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A15R310	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A15R312	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A15R313	315-0394-00			RES.,FXD,CMPSN:390K OHM,5%,0.25W	57668	NTR25J-E390K
A15R316	315-0102-03			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A15R324	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A15R325	315-0226-00			RES.,FXD,CMPSN:22M OHM,5%,0.25W	01121	CB2265
A15R327	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A15R328	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A15R335	311-0075-00			RES.,VAR,NONWIR:5M OHM,20%	12697	381-CM16993
A15R346	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A15R348	321-0189-00			RES.,FXD,FILM:909 OHM,1%,0.125W	91637	MFF1816G909R0F
A15R349	301-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.5W	57668	TR50J-E 39K
A15R358	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	57668	NTR25J-E680E
A15R368	321-0287-00			RES.,FXD,FILM:9.53K OHM,1%,0.125W	91637	MFF1816G95300F
A15R369	321-0138-00			RES.,FXD,FILM:267 OHM,1%,0.125W	91637	MFF1816G267R0F
A15R377	311-1372-00			RES.,VAR,NONWIR:100K OHM,20%,1W	01121	73M1G040L104M
A15R378	311-1313-00			RES.,VAR,NONWIR:2K OHM,20%,0.5W	01121	73M4G048L202M
A15R385	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
A15R386	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB1925

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A15R387	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	57668	NTR25J-E47K0
A15R391	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	57668	NTR25J-E51K0
A15R392	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A15R400	308-0459-00			RES.,FXD,WW:1.1 OHM,5%,3W	91637	CW2B-1R100J TR
A15R403	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A15R404	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A15R405	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	CMF55116G69800F
A15R409	311-1557-00			RES.,VAR,NONWIR:25K OHM,20%,0.50W	73138	91-79-0
A15R414	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	57668	NTR25J-E910E
A15R415	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
A15R417	315-0221-03			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A15R418	302-0393-00			RES.,FXD,CMPSN:39K OHM,10%,0.50W	01121	EB3931
A15R419	323-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.50W	75042	CECT0-2212F
A15R425	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A15R429	307-0290-04			RES.,FXD,FILM:	80009	307-0290-04
A15R432	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A15R435	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A15R444	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A15R445	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A15R447	322-0289-00			RES.,FXD,FILM:10K OHM,1%,0.25W	75042	CEBT0-1002F
A15R450	322-0289-00			RES.,FXD,FILM:10K OHM,1%,0.25W	75042	CEBT0-1002F
A15R453	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A15R454	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	57668	NTR25J-E 22K
A15R460	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	57668	NTR25J-E1K8
A15R461	315-0330-00			RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
A15R462	321-0142-00			RES.,FXD,FILM:294 OHM,1%,0.125W	91637	MFF1816G294R0F
A15R463	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A15R464	321-0245-00			RES.,FXD,FILM:3.48K OHM,1%,0.125W	91637	MFF1816G34800F
A15R465	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	57668	NTR25J-E220E
A15R466	321-0206-00			RES.,FXD,FILM:1.37K OHM,1%,0.125W	91637	MFF1816G13700F
A15R467	321-0138-00			RES.,FXD,FILM:267 OHM,1%,0.125W	91637	MFF1816G267R0F
A15R468	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	57668	NTR25J-E620E
A15R469	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	57668	NTR25J-E620E
A15R472	323-0289-00			RES.,FXD,FILM:10K OHM,1%,0.50W	75042	CECT0-1002F
A15R480	321-0164-00			RES.,FXD,FILM:499 OHM,1%,0.125W	91637	MFF1816G499R0F
A15R481	321-0205-00			RES.,FXD,FILM:1.33K OHM,1%,0.125W	91637	MFF1816G13300F
A15R486	321-0174-00			RES.,FXD,FILM:634 OHM,1%,0.125W	91637	MFF1816G634R0F
A15R492	311-1393-00			RES.,VAR,NONWIR:PNL,5K X 5M OHM,0.5W	12697	CM39702
A15R493	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
A15R505	321-0775-03			RES.,FXD,FILM:45K OHM,0.25%,0.125W	91637	MFF1816D45001C
A15R506	321-0774-03			RES.,FXD,FILM:4.5K OHM,0.25%,0.125W	91637	MFF1816D45000C
A15R507	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
A15R508	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A15R512	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	57668	NTR25J-E27K0
A15R517	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A15R518	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	57668	NTR25J-E390E
A15R521	321-0249-00			RES.,FXD,FILM:3.83K OHM,1%,0.125W	91637	MFF1816G38300F
A15R523	321-0168-00			RES.,FXD,FILM:549 OHM,1%,0.125W	91637	MFF1816G549R0F
A15R524	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	57668	NTR25J-E200E
A15R526	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	57668	NTR25J-E220E
A15R527	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A15R533	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	57668	NTR25J-E27K0
A15R536	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	57668	NTR25J-E68K0
A15R542	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A15R543	321-0414-00			RES.,FXD,FILM:200K OHM,1%,0.125W	91637	MFF1816G20002F
A15R544	321-0414-00			RES.,FXD,FILM:200K OHM,1%,0.125W	91637	MFF1816G20002F
A15R547	322-0289-00			RES.,FXD,FILM:10K OHM,1%,0.25W	75042	CEBT0-1002F
A15R550	322-0289-00			RES.,FXD,FILM:10K OHM,1%,0.25W	75042	CEBT0-1002F
A15R551	311-1556-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	73138	91-78-0
A15R553	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	57668	NTR25J-E 22K
A15R554	301-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.5W	57668	TR50J-E180E
A15R557	321-0359-00			RES.,FXD,FILM:53.6K OHM,1%,0.125W	91637	MFF1816G53601F
A15R558	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
A15R559	321-0142-00			RES.,FXD,FILM:294 OHM,1%,0.125W	91637	MFF1816G294R0F
A15R561	321-0300-00			RES.,FXD,FILM:13K OHM,1%,0.125W	91637	MFF1816G13001F
A15R562	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
A15R563	321-0173-00			RES.,FXD,FILM:619 OHM,1%,0.125W	91637	MFF1816G619R0F
A15R564	321-0184-00			RES.,FXD,FILM:806 OHM,1%,0.125W	91637	MFF1816G806R0F
A15R565	321-0184-00			RES.,FXD,FILM:806 OHM,1%,0.125W	91637	MFF1816G806R0F
A15R566	321-0173-00			RES.,FXD,FILM:619 OHM,1%,0.125W	91637	MFF1816G619R0F
A15R567	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A15R571	311-1567-00			RES.,VAR,NONWIR:TRMR,100 OHM,0.50W	73138	91-89-0
A15R572	311-1563-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	73138	91-85-0
A15R573	323-0289-00			RES.,FXD,FILM:10K OHM,1%,0.50W	75042	CECT0-1002F
A15R574	321-0210-00			RES.,FXD,FILM:1.5K OHM,1%,0.125W	91637	MFF1816G15000F
A15R577	321-0110-00			RES.,FXD,FILM:137 OHM,1%,0.125W	91637	MFF1816G137R0F
A15R578	311-1561-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	73138	91-83-0
A15R580	321-0253-00	B010100	B039999	RES.,FXD,FILM:4.22K OHM,1%,0.125W	91637	MFF1816G42200F
A15R580	321-0248-00	B040000		RES.,FXD,FILM:3.74K OHM,1%,0.125W	91637	MFF1816G37400F
A15R581	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	57668	NTR25J-E33K0
A15R582	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A15R586	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A15R587	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
A15R588	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	57668	NTR25J-E20K0
A15R589	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	57668	NTR25J-E02K0
A15R595	321-0107-00			RES.,FXD,FILM:127 OHM,1%,0.125W	91637	MFF1816G127R0F
A15R596	321-0001-00			RES.,FXD,FILM:10 OHM,1%,0.125W	75042	CEAT0-10R00F
A15R599	311-1568-00			RES.,VAR,NONWIR:50 OHM,20%,0.50W	73138	91-90-0
A15R602	307-0052-00			RES.,FXD,CMPSN:3 OHM,5%,0.50W	01121	EB30G5
A15R608	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A15R609	321-0366-00			RES.,FXD,FILM:63.4K OHM,1%,0.125W	91637	CMF55116G63401F
A15R610	321-0962-03			RES.,FXD,FILM:8K OHM,0.25%,0.125W	91637	MFF1816D80000C
A15R611	321-0967-03			RES.,FXD,FILM:55K OHM,0.25%,0.125W	91637	MFF1816D55001C
A15R612	315-0512-00	B010100	B039999	RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
A15R612	315-0392-00	B040000		RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A15R613	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
A15R614	311-1226-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	32997	3386F-T04-252
A15R617	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A15R618	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A15R619	321-0201-00			RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	MFF1816G12100F
A15R621	321-0307-00			RES.,FXD,FILM:15.4K OHM,1%,0.125W	91637	MFF1816G15401F
A15R624	307-0093-00			RES.,FXD,CMPSN:1.2 OHM,5%,0.50W	01121	EB12G5
A15R625	321-0220-00			RES.,FXD,FILM:1.91K OHM,1%,0.125W	91637	MFF1816G19100F
A15R626	303-0223-00			RES.,FXD,CMPSN:22K OHM,5%,1W	01121	GB2235
A15R627	301-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.5W	57668	TR50J-E24K
A15R628	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A15R629	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A15R633	315-0224-00			RES.,FXD,CMPSN:220K OHM,5%,0.25W	01121	CB2245

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A15R643	302-0273-00			RES.,FXD,CMPSN:27K OHM,10%,0.50W	01121	EB2731
A15R644	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A15R645	301-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.5W	57668	TR50J-E 39K
A15R646	321-0268-00			RES.,FXD,FILM:6.04K OHM,1%,0.125W	91637	MFF1816G60400F
A15R647	321-0189-00			RES.,FXD,FILM:909 OHM,1%,0.125W	91637	MFF1816G909R0F
A15R648	321-0034-00			RES.,FXD,FILM:22.1 OHM,1%,0.125W	91637	CMF55116G22R10F
A15R651	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
A15R652	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
A15R655	321-0245-00			RES.,FXD,FILM:3.48K OHM,1%,0.125W	91637	MFF1816G34800F
A15R656	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
A15R657	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A15R659	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	57668	NTR25J-E390E
A15R664	323-0248-00			RES.,FXD,FILM:3.74K OHM,1%,0.50W	19701	5053RD3K740F
A15R665	323-0248-00			RES.,FXD,FILM:3.74K OHM,1%,0.50W	19701	5053RD3K740F
A15R671	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A15R673	323-0191-00			RES.,FXD,FILM:953 OHM,1%,0.50W	75042	CECT0-9530F
A15R676	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A15R679	321-0116-00			RES.,FXD,FILM:158 OHM,1%,0.125W	91637	MFF1816G158R0F
A15R681	311-1567-00			RES.,VAR,NONWIR:TRMR,100 OHM,0.50W	73138	91-89-0
A15R682	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A15R683	321-0147-00			RES.,FXD,FILM:332 OHM,1%,0.125W	91637	MFF1816G332R0F
A15R693	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A15R694	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	57668	NTR25J-E 820E
A15R695	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A15R697	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A15R706	321-0296-00			RES.,FXD,FILM:11.8K OHM,1%,0.125W	91637	MFF1816G11801F
A15R708	321-0603-00			RES.,FXD,FILM:15K OHM,0.25%,0.125W	91637	MFF1816D15001C
A15R713	321-0292-00			RES.,FXD,FILM:10.7K OHM,1%,0.125W	91637	MFF1816G10701F
A15R714	321-0966-03			RES.,FXD,FILM:40K OHM,0.25%,0.125W	91637	MFF1816D40001C
A15R715	303-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,1W	01121	GB4725
A15R726	323-0269-00			RES.,FXD,FILM:6.19K OHM,1%,0.50W	75042	CECT0-6191F
A15R728	308-0644-00			RES.,FXD,WW:25 OHM,1%,5W	91637	RS5111-25R00F
A15R740	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A15R741	315-0200-02			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A15R743	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A15R746	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A15R758	321-0229-00			RES.,FXD,FILM:2.37K OHM,1%,0.125W	91637	MFF1816G23700F
A15R759	321-0251-01			RES.,FXD,FILM:4.02K OHM,0.5%,0.125W	91637	MFF1816G40200D
A15R762	321-0401-00			RES.,FXD,FILM:147K OHM,1%,0.125W	91637	CMF55116G14702F
A15R764	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
A15R766	321-0446-00			RES.,FXD,FILM:432K OHM,1%,0.125W	91637	MFF1816G43202F
A15R769	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
A15R771	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	57668	NTR25J-E220E
A15R774	321-0228-00			RES.,FXD,FILM:2.32K OHM,1%,0.125W	91637	MFF1816G23200F
A15R775	321-0251-01			RES.,FXD,FILM:4.02K OHM,0.5%,0.125W	91637	MFF1816G40200D
A15R776	315-0184-00			RES.,FXD,CMPSN:180K OHM,5%,0.25W	01121	CB1845
A15R778	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A15R785	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
A15R786	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
A15R787	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
A15R788	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A15R790	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
A15R793	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A15R794	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A15R795	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A15R796	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	57668	NTR25J-E 820E
A15R797	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A15R798	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A15R800	308-0459-00			RES.,FXD,WW:1.1 OHM,5%,3W	91637	CW2B-1R100J TR
A15R803	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A15R804	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A15R830	308-0363-00			RES.,FXD,WW:3K OHM,5%,8W	14193	SAV96-3001J
A15R834	303-0203-00			RES.,FXD,CMPSN:20K OHM,5%,1W	01121	GB2035
A15R849	301-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.5W	57668	TR50J-E 4K3
A15R850	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A15R854	308-0421-00			RES.,FXD,WW:3K OHM,5%,3W	91637	CW-2B B30000J
A15R858	321-0165-00			RES.,FXD,FILM:511 OHM,1%,0.125W	91637	MFF1816G511R0F
A15R860	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A15R866	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A15R867	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A15R868	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A15R871	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A15R873	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
A15R877	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A15R883	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
A15R884	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A15R885	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
A15R888	321-0165-00			RES.,FXD,FILM:511 OHM,1%,0.125W	91637	MFF1816G511R0F
A15R889	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A15R891	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A15R893	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A15R894	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
A15R895	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A15R896	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A15R932	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A15R938	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A15R947	321-0228-00			RES.,FXD,FILM:2.32K OHM,1%,0.125W	91637	MFF1816G23200F
A15R948	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A15R949	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A15R953	315-0360-00			RES.,FXD,CMPSN:36 OHM,5%,0.25W	01121	CB3605
A15R954	321-0250-00			RES.,FXD,FILM:3.92K OHM,1%,0.125W	91637	MFF1816G39200F
A15R955	321-0195-00			RES.,FXD,FILM:1.05K OHM,1%,0.125W	91637	MFF1816G10500F
A15R957	315-0360-00			RES.,FXD,CMPSN:36 OHM,5%,0.25W	01121	CB3605
A15R960	315-0330-00			RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
A15R964	315-0330-00			RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
A15R968	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A15R970	311-1567-00			RES.,VAR,NONWIR:TRMR,100 OHM,0.50W	73138	91-89-0
A15R971	321-0154-00			RES.,FXD,FILM:392 OHM,1%,0.125W	91637	MFF1816G392R0F
A15R972	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
A15R974	303-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,1W	01121	GB4325
A15R976	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A15R977	321-0228-00			RES.,FXD,FILM:2.32K OHM,1%,0.125W	91637	MFF1816G23200F
A15R978	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A15R982	308-0421-00			RES.,FXD,WW:3K OHM,5%,3W	91637	CW-2B B30000J
A15R983	321-0250-00			RES.,FXD,FILM:3.92K OHM,1%,0.125W	91637	MFF1816G39200F
A15R984	321-0195-00			RES.,FXD,FILM:1.05K OHM,1%,0.125W	91637	MFF1816G10500F
A15R985	315-0360-00			RES.,FXD,CMPSN:36 OHM,5%,0.25W	01121	CB3605
A15R988	315-0360-00			RES.,FXD,CMPSN:36 OHM,5%,0.25W	01121	CB3605

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A15R990	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
A15R995	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	57668	NTR25J-E180E
A15R998	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A15RT672	307-0122-00			RES.,THERMAL:50 OHM,10%	50157	3D1515
A15S175	260-1310-01			SWITCH,PUSH:4PDT MOMENTARY,NON-SHORTING	59821	2KAA001000549
A15S678	260-1208-00			SWITCH,PUSH:DPDT,28VDC,PUSH-PUSH	31918	ORDER BY DESCR
A15T216	120-0800-01			XFMR,PWR,SDN&SU:MOLDED	80009	120-0800-01
A15U136	152-0552-00			SEMICOND DEVICE:V MULTR,5KV IN,15KV OUT	52306	CMX315
A15U506	156-0158-03			MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
A15U564	156-0048-03			MICROCIRCUIT,LI:5 XSTR ARRAY,SEL	04713	SC77161B
A15U690	156-0383-02			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74LS02
A15U712	156-0158-03			MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
A15U789	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A15VR207	152-0289-00			SEMICOND DEVICE:ZENER,0.4W,180V,5%	04713	SZ12484KRL
A15VR308	152-0286-00			SEMICOND DEVICE:ZENER,0.4W,75V,5%	80009	152-0286-00
A15VR392	152-0127-00			SEMICOND DEVICE:ZENER,0.4W,7.5V,5%	04713	SZG35009K2
A15VR512	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738RL
A15VR604	152-0283-00			SEMICOND DEVICE:ZENER,0.4W,43V,5%	12954	DZ750903B1N976B
A15VR624	152-0304-00			SEMICOND DEVICE:ZENER,0.4W,20V,5%	15238	Z5411
A15VR643	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ11738RL
A15VR695	152-0306-00			SEMICOND DEVICE:ZENER,0.4W,9.1V,5%	15238	Z5409
A15VR709	152-0281-00			SEMICOND DEVICE:ZENER,0.4W,22V,5%	12954	1N969B
A15VR725	152-0411-00			SEMICOND DEVICE:ZENER,0.25W,9V,5%	04713	SZ12483KRL
A15VR797	152-0306-00			SEMICOND DEVICE:ZENER,0.4W,9.1V,5%	15238	Z5409
A15VR798	152-0306-00			SEMICOND DEVICE:ZENER,0.4W,9.1V,5%	15238	Z5409
A15VR825	152-0268-00			SEMICOND DEVICE:ZENER,0.4W,56V,5%	80009	152-0268-00
A15VR896	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
A15W136	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A15W385	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A15W552	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A15W580	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A15W746	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A15W747	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A15W780	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A15W849	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A15W866	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A15W880	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A16	672-0878-00	B010100	B029999	CKT BOARD ASSY:TOP	80009	672-0878-00
A16	672-0878-02	B030000	B039999	CKT BOARD ASSY:TOP	80009	672-0878-02
A16	672-0878-06	B040000		CKT BOARD ASSY:TOP	80009	672-0878-06
A16	----- -----			(STANDARD)		
A16	672-0878-01	B010100	B029999	CKT BOARD ASSY:TOP	80009	672-0878-01
A16	----- -----			(OPTION 02 ONLY)		
A16	672-0878-03	B030000	B039999	CKT BOARD ASSY:TOP	80009	672-0878-00
A16	----- -----			(OPTION 02 ONLY)		
A16	672-0878-07	B040000		CKT BOARD ASSY:TOP	80009	672-0878-07
A16	----- -----			(OPTION 02 ONLY)		
A16	672-0878-04	B030000	B039999	CKT BOARD ASSY:TOP	80009	672-0878-04
A16	----- -----			(OPTION 11 ONLY)		
A16	672-0878-08	B040000		CKT BOARD ASSY:TOP	80009	672-0878-08
A16	----- -----			(OPTION 11 ONLY)		
A16	672-0878-00	B010100	B029999	CKT BOARD ASSY:TOP	80009	672-0878-00
A16	----- -----			(OPTION 12 ONLY)		
A16C145	281-0809-00			CAP.,FXD,CER DI:200PF,5%,100V	04222	GC101A201J
A16C151	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
A16C155	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C163	281-0809-00			CAP.,FXD,CER DI:200PF,5%,100V	04222	GC101A201J
A16C182	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C248	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C266	281-0809-00			CAP.,FXD,CER DI:200PF,5%,100V	04222	GC101A201J
A16C268	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C269	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C279	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
A16C282	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C285	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C321	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
A16C348	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	96733	R3015
A16C349	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C378	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C407	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C418	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C437	285-0808-00			CAP.,FXD,PLSTC:0.1UF,10%,50V	56289	LP66A1A104K004
A16C441	290-0246-00			CAP.,FXD,ELCTLT:3.3UF,10%,15V	56289	173D335X9015V
A16C442	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C444	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C447	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C448	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	96733	R2735
A16C450	281-0865-00			CAP.,FXD,CER DI:1000PF,5%,100V	04222	MA201A102JAA
A16C451	281-0865-00			CAP.,FXD,CER DI:1000PF,5%,100V	04222	MA201A102JAA
A16C452	281-0863-00			CAP.,FXD CER DI:240PF,5%,100V	04222	GC101A241J
A16C460	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C461	281-0864-00			CAP.,FXD,CER DI:430PF,5%,100V	12969	CGD431JEN
A16C465	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A16C466	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A16C486	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C541	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C553	281-0863-00			CAP.,FXD CER DI:240PF,5%,100V	04222	GC101A241J
A16C568	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C569	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C570	281-0811-00			CAP.,FXD,CER DI:10PF,10%,100V	96733	R2911
A16C571	281-0810-00			CAP.,FXD,CER DI:5.6PF,0.5%,100V	04222	GC10-1A5R6D
A16C572	281-0865-00			CAP.,FXD,CER DI:1000PF,5%,100V	04222	MA201A102JAA

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A16C653	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C670	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C671	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C676	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A16C683	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C688	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A16C717	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C768	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C770	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C771	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C786	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16C888	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A16CR173	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR174	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR267	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A16CR285	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A16CR336	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR443	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A16CR553	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A16CR566	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A16CR584	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR585	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR586	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR587	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR635	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR666	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR667	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR670	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A16CR684	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR685	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR686	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16CR687	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A16L155	108-0509-00			COIL,RF:2.45UH	80009	108-0509-00
A16Q174	151-0271-00			TRANSISTOR:SILICON,PNP	04713	SPS8236
A16Q184	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A16Q185	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A16Q187	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A16Q345	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A16Q441	151-0276-00			TRANSISTOR:SILICON,PNP	04713	2N5087
A16Q442	151-1121-00			TRANSISTOR:FE,N CHANNEL,SI,T0-92	T0768	N01003N3
A16Q570	151-1097-00			TRANSISTOR:SILICON,FE	04713	SPF713
A16Q578	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A16Q580	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A16Q680	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A16Q850	151-0188-00			TRANSISTOR:PNP,SI,TO-92	T0058	2N3906
A16R145	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	57668	NTR25J-E75E0
A16R159	322-0193-00			RES.,FXD,FILM:1K OHM,1%,0.25W	75042	CEBT0-1001F
A16R160	322-0193-00			RES.,FXD,FILM:1K OHM,1%,0.25W	75042	CEBT0-1001F
A16R163	321-0069-00			RES.,FXD,FILM:51.1 OHM,1%,0.125W	91637	CMF55116G51R10F
A16R164	321-0033-00			RES.,FXD,FILM:21.5 OHM,1%,0.125W	91637	CMF55116G21R50F
A16R168	315-0240-00			RES.,FXD,CMPSN:24 OHM,5%,0.25W	57668	NTR25J-E24E0
A16R169	315-0240-00			RES.,FXD,CMPSN:24 OHM,5%,0.25W	57668	NTR25J-E24E0
A16R180	322-0154-00			RES.,FXD,FILM:392 OHM,1%,0.25W	91637	MFF1421G392R0F
A16R182	321-0155-00			RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402R0F
A16R183	321-0216-00			RES.,FXD,FILM:1.74K OHM,1%,0.125W	91637	MFF1816G17400F

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A16R186	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A16R187	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A16R188	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	57668	NTR25J-E1K8
A16R189	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A16R251	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A16R252	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A16R259	322-0193-00			RES.,FXD,FILM:1K OHM,1%,0.25W	75042	CEBT0-1001F
A16R260	322-0193-00			RES.,FXD,FILM:1K OHM,1%,0.25W	75042	CEBT0-1001F
A16R264	321-0069-00			RES.,FXD,FILM:51.1 OHM,1%,0.125W	91637	CMF55116G51R10F
A16R265	321-0033-00			RES.,FXD,FILM:21.5 OHM,1%,0.125W	91637	CMF55116G21R50F
A16R272	322-0193-00			RES.,FXD,FILM:1K OHM,1%,0.25W	75042	CEBT0-1001F
A16R274	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A16R282	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A16R283	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A16R284	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A16R285	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A16R287	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A16R330	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
A16R332	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	57668	NTR25J-E200E
A16R335	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	91637	MFF1816G32400F
A16R336	321-0284-00			RES.,FXD,FILM:8.87K OHM,1%,0.125W	91637	MFF1816G88700F
A16R344	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A16R345	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
A16R346	311-1223-00			RES.,VAR,NONWIR:TRMR,250 OHM,0.5W	73138	72-5-0
A16R347	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A16R348	321-0339-00			RES.,FXD,FILM:33.2K OHM,1%,0.125W	91637	MFF1816G33201F
A16R349	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A16R350	321-0218-00			RES.,FXD,FILM:1.82K OHM,1%,0.125W	91637	MFF1816G18200F
A16R351	321-0170-00			RES.,FXD,FILM:576 OHM,1%,0.125W	91637	MFF1816G576R0F
A16R352	321-0185-00			RES.,FXD,FILM:825 OHM,1%,0.125W	91637	MFF1816G825R0F
A16R353	321-0185-00			RES.,FXD,FILM:825 OHM,1%,0.125W	91637	MFF1816G825R0F
A16R385	315-0124-00			RES.,FXD,CMPSN:120K OHM,5%,0.25W	01121	CB1245
A16R386	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	57668	NTR25J-E47K0
A16R403	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A16R437	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A16R438	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A16R439	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A16R440	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
A16R441	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	57668	NTR25J-E33K0
A16R443	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A16R448	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A16R450	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A16R451	321-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.125W	91637	MFF1816G21500F
A16R452	321-0283-00			RES.,FXD,FILM:8.66K OHM,1%,0.125W	91637	CMF55116G86600F
A16R453	321-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.125W	91637	MFF1816G21500F
A16R454	321-0283-00			RES.,FXD,FILM:8.66K OHM,1%,0.125W	91637	CMF55116G86600F
A16R455	321-0341-00			RES.,FXD,FILM:34.8K OHM,1%,0.125W	91637	CMF55116G34801F
A16R456	321-0283-00			RES.,FXD,FILM:8.66K OHM,1%,0.125W	91637	CMF55116G86600F
A16R460	315-0124-00			RES.,FXD,CMPSN:120K OHM,5%,0.25W	01121	CB1245
A16R461	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	57668	NTR25J-E47K0
A16R462	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A16R463	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	57668	NTR25J-E680E
A16R464	321-0271-00			RES.,FXD,FILM:6.49K OHM,1%,0.125W	91637	MFF1816G64900F
A16R465	321-0271-00			RES.,FXD,FILM:6.49K OHM,1%,0.125W	91637	MFF1816G64900F
A16R470	321-0319-00			RES.,FXD,FILM:20.5K OHM,1%,0.125W	91637	MFF1816G20501F
A16R471	321-0319-00			RES.,FXD,FILM:20.5K OHM,1%,0.125W	91637	MFF1816G20501F

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A16R472	321-0217-00			RES.,FXD,FILM:1.78K OHM,1%,0.125W	91637	MFF1816G17800F
A16R473	321-0217-00			RES.,FXD,FILM:1.78K OHM,1%,0.125W	91637	MFF1816G17800F
A16R474	321-0319-00			RES.,FXD,FILM:20.5K OHM,1%,0.125W	91637	MFF1816G20501F
A16R475	321-0319-00			RES.,FXD,FILM:20.5K OHM,1%,0.125W	91637	MFF1816G20501F
A16R476	321-0217-00			RES.,FXD,FILM:1.78K OHM,1%,0.125W	91637	MFF1816G17800F
A16R477	321-0217-00			RES.,FXD,FILM:1.78K OHM,1%,0.125W	91637	MFF1816G17800F
A16R478	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	57668	NTR25J-E 22K
A16R479	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	57668	NTR25J-E750E
A16R480	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
A16R483	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A16R484	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A16R485	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
A16R486	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	57668	NTR25J-E09K1
A16R487	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	57668	NTR25J-E04K3
A16R550	311-1225-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	32997	3386F-T04-102
A16R553	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
A16R560	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
A16R561	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A16R563	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	57668	NTR25J-E680E
A16R564	321-0185-00			RES.,FXD,FILM:825 OHM,1%,0.125W	91637	MFF1816G825R0F
A16R565	321-0289-00	B010100	B039999	RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
A11R565	321-0306-00	B040000		RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
A16R566	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A16R567	321-0289-00	B010100	B039999	RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
A16R567	321-0306-00	B040000		RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
A16R568	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A16R569	321-0318-00	B010100	B039999	RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A16R569	321-0335-00	B040000		RES.,FXD,FILM:30.1K OHM,1%,0.125W	91637	CMF55116G30101F
A16R570	321-0185-00			RES.,FXD,FILM:825 OHM,1%,0.125W	91637	MFF1816G825R0F
A16R571	311-1466-00			RES.,VAR,NONWW:TRMR,2K OHM,0.5W	02111	63M202T602
A16R572	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
A16R577	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A16R578	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	57668	NTR25J-E09K1
A16R579	321-0123-00			RES.,FXD,FILM:187 OHM,1%,0.125W	91637	MFF1816G187R0F
A16R580	321-0206-00			RES.,FXD,FILM:1.37K OHM,1%,0.125W	91637	MFF1816G13700F
A16R581	321-0127-00			RES.,FXD,FILM:205 OHM,1%,0.125W	91637	MFF1816G205R0F
A16R583	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A16R584	321-0177-00			RES.,FXD,FILM:681 OHM,1%,0.125W	01121	ORD BY DESCR
A16R585	321-0177-00			RES.,FXD,FILM:681 OHM,1%,0.125W	01121	ORD BY DESCR
A16R586	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	57668	NTR25J-E01K3
A16R640	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
A16R660	315-0131-00			RES.,FXD,CMPSN:130 OHM,5%,0.25W	01121	CB1315
A16R661	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A16R662	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A16R663	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A16R664	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A16R665	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A16R666	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A16R667	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A16R668	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	57668	NTR25J-E620E
A16R669	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	57668	NTR25J-E200E
A16R670	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A16R673	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
A16R674	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
A16R675	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A16R676	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
A16R677	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A16R678	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A16R709	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A16R717	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A16R720	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A16R723	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A16R740	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A16R753	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A16R754	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A16R773	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A16R785	321-0303-00			RES.,FXD,FILM:14K OHM,1%,0.125W	91637	MFF1816G14001F
A16R787	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	57668	NTR25J-E100K
A16R788	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
A16R839	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A16R840	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A16R874	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A16R881	----- -----			(REPLACEABLE AS A UNIT WITH A16S881)		
A16R886	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
A16R887	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	57668	NTR25J-E100K
A16S512	260-1211-00			SWITCH,PUSH:1A,28VDC	31918	601348
A16S612	260-1994-00			SWITCH,PUSH:1 BUTTON,2 POLE,TRANSMIT	80009	260-1994-00
A16S612	----- -----			(OPTION 02 ONLY)		
A16S707	260-1721-00			SWITCH,ROCKER:8,SPST,125MA,30VDC	00779	435166-5
A16S813	260-1990-00	B010100	B029999	SWITCH,PUSH:5 BUTTON,2 POLE,CONTROL	71590	2KBM0500001300
A16S813	260-1991-00	B030000		SWITCH,PUSH:6 BUTTON,2 POLE,CONTROL	59821	2KBM0600001301
A16S831	260-1353-02			SWITCH,PUSH:2 BTN,2 POLE,STORAGE/DISPLA	59821	2KBB0200001332
A16S844	260-1353-02			SWITCH,PUSH:2 BTN,2 POLE,STORAGE/DISPLA	59821	2KBB0200001332
A16S881	263-0072-00			SW-VAR RES ASSY:	80009	263-0072-00
A16S881	----- -----			(REPLACEABLE AS A UNIT WITH A16R881)		
A16U158	156-0048-03			MICROCIRCUIT,LI:5 XSTR ARRAY,SEL	04713	SC77161B
A16U207	156-0913-02	B010100	B010949	MICROCIRCUIT,DI:OCTAL D FF,BURN-IN	04713	SN74LS377NDS
A16U207	156-0982-03	B010950		MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	01295	SN74LS374 N3
A16U213	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3
A16U218	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3
A16U223	156-0913-02	B010100	B010949	MICROCIRCUIT,DI:OCTAL D FF,BURN-IN	04713	SN74LS377NDS
A16U223	156-0982-03	B010950		MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	01295	SN74LS374 N3
A16U228	156-0913-02	B010100	B010949	MICROCIRCUIT,DI:OCTAL D FF,BURN-IN	04713	SN74LS377NDS
A16U228	156-0982-03	B010950		MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	01295	SN74LS374 N3
A16U234	156-1278-00			MICROCIRCUIT,LI:1024 X 1 STATIC RAM	80009	156-1278-00
A16U238	156-0383-02			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74LS02
A16U245	156-0910-02			MICROCIRCUIT,DI:DUAL DECADE COUNTER	01295	SN74LS390
A16U328	156-1127-01			MICROCIRCUIT,DI:1024 X 4 STATIC RAM	80009	156-1127-01
A16U334	156-1127-01			MICROCIRCUIT,DI:1024 X 4 STATIC RAM	80009	156-1127-01
A16U352	156-1149-01			MICROCIRCUIT,LI:OPER AMPL,JFET,BURN-IN	27014	GLEA134/A+
A16U359	156-1366-00			MICROCIRCUIT,LI:8 BIT MULT D/A CONVERTER	24355	AD11/296
A16U365	156-0583-02			MICROCIRCUIT,DI:SUCCESSIVE APPROX RGTR,SEL	04713	MC14559
A16U373	156-1225-01			MICROCIRCUIT,LI:DUAL COMPARATOR,SCREENED	27014	LM393N/A+
A16U374	156-0495-02			MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	01295	LM324J4
A16U377	156-0583-02			MICROCIRCUIT,DI:SUCCESSIVE APPROX RGTR,SEL	04713	MC14559
A16U378	156-0197-01			MICROCIRCUIT,LI:5-TRANSISTOR ARRAY	80009	156-0197-01
A16U385	156-1366-00			MICROCIRCUIT,LI:8 BIT MULT D/A CONVERTER	24355	AD11/296
A16U407	156-0844-02			MICROCIRCUIT,DI:SYN 4 BIT CNTR,SCRN	01295	SN74LS161A
A16U413	156-0844-02			MICROCIRCUIT,DI:SYN 4 BIT CNTR,SCRN	01295	SN74LS161A
A16U418	156-0844-02			MICROCIRCUIT,DI:SYN 4 BIT CNTR,SCRN	01295	SN74LS161A
A16U435	156-0719-01			MICROCIRCUIT,LI:10 BIT MULTIPLYING D/A	27014	DAC1020LCD/A+

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A16U444	156-0067-12			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	UA741CJG
A16U466	156-0515-02			MICROCIRCUIT,DI:TRIPLE 3-CHAN MUX,SEL	80009	156-0515-02
A16U523	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A16U528	156-0798-02			MICROCIRCUIT,DI:DUAL 14 TO 1 LINE SEL/MUX	01295	SN74LS153
A16U545	156-1149-01			MICROCIRCUIT,LI:OPER AMPL,JFET,BURN-IN	27014	GLEA134/A+
A16U553	156-0158-03			MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
A16U558	156-0742-02			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,SEL	01295	LM318JG
A16U559	156-0158-03			MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
A16U571	156-1272-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	NE5532 FE-B
A16U618	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A16U623	156-0452-02			MICROCIRCUIT,DI:4-WIDE,2-INP AOI,SCREENED	07263	74LS54
A16U631	156-0478-02			MICROCIRCUIT,DI:DUAL 4 INP & GATE,BURN-IN	01295	SN74LS21NP3
A16U637	156-0985-01			MICROCIRCUIT,DI:DUAL 5 INPUT NOR GATE,SCRN	04713	SN74LS260
A16U643	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A16U648	156-0452-02			MICROCIRCUIT,DI:4-WIDE,2-INP AOI,SCREENED	07263	74LS54
A16U653	156-1367-00			MICROCIRCUIT,LI:8 BIT BUFF,MULT D/A CONV	24355	AD11/297
A16U659	156-1367-00			MICROCIRCUIT,LI:8 BIT BUFF,MULT D/A CONV	24355	AD11/297
A16U713	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A16U717	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A16U723	156-0913-02	B010100	B010949	MICROCIRCUIT,DI:OCTAL D FF,BURN-IN	04713	SN74LS377NDS
A16U723	156-0982-03	B010950		MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	01295	SN74LS374 N3
A16U731	156-1111-02			MICROCIRCUIT,DI:OCTAL BUS TRANSCEIVERS	01295	SN74LS245 N3ORJ4
A16U737	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	01295	SN74LS374 N3
A16U743	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A16U748	156-0913-02	B010100	B010949	MICROCIRCUIT,DI:OCTAL D FF,BURN-IN	04713	SN74LS377NDS
A16U748	156-0982-03	B010950		MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	01295	SN74LS374 N3
A16U753	156-0888-02			MICROCIRCUIT,DI:HEX DIGIT DRIVER,SCREENED	80009	156-0888-02
A16U759	156-0795-01			MICROCIRCUIT,DI:BCD 7-SEG LCH DCDR	07263	4511BDCQR
A16U766	156-1367-00			MICROCIRCUIT,LI:8 BIT BUFF,MULT D/A CONV	24355	AD11/297
A16U770	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A16U776	156-0896-01			MICROCIRCUIT,DI:3-DIGIT BCD COUNTER,SCRN	80009	156-0896-01
A16U783	156-1173-00			MICROCIRCUIT,LI:VOLTAGE REFERENCE	04713	MC1403UDS
A16U788	156-1362-00			MICROCIRCUIT,LI:V-TO-FREQUENCY CONVERTER	80009	156-1362-00
A16VR664	152-0744-00			SEMICOND DEVICE:ZEN,SI,3.6V,5%,0.4W	04713	1N747A
A16VR665	152-0744-00			SEMICOND DEVICE:ZEN,SI,3.6V,5%,0.4W	04713	1N747A
A16W250	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0

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A17	670-6378-01			CKT BOARD ASSY:GPIB	80009	670-6378-01
A17	----- -----			(OPTION 02 ONLY)		
A17C121	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A17C168	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A17C330	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A17C350	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A17C361	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	T0900	SL25T10(T)TP
A17C410	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A17C430	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A17C440	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A17C450	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A17C460	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A17R310	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A17R330	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A17R442	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A17S210	260-1589-00			SWITCH,PUSH:(6)SPST,0.1A,5V	00779	435166-4
A17U110	156-1219-01			MICROCIRCUIT,DI:GPIB XCVR	80009	156-1219-01
A17U121	156-0600-01			MICROCIRCUIT,DI:QUAD BUS XSVR,CHK	80009	156-0600-01
A17U152	156-0600-01			MICROCIRCUIT,DI:QUAD BUS XSVR,CHK	80009	156-0600-01
A17U168	156-0600-01			MICROCIRCUIT,DI:QUAD BUS XSVR,CHK	80009	156-0600-01
A17U310	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A17U320	156-0720-02			MICROCIRCUIT,DI:HEX DRVR,4 TO 2 LINE	01295	SN74LS368
A17U330	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A17U340	156-0865-02			MICROCIRCUIT,DI:OCTAL D-TYPE FF W/CLEAR	01295	SN74LS273NP3
A17U342	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A17U350	156-0865-02			MICROCIRCUIT,DI:OCTAL D-TYPE FF W/CLEAR	01295	SN74LS273NP3
A17U410	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A17U421	156-0481-02			MICROCIRCUIT,DI:TRIPLE 3 INP & GATE	27014	DM74LS11NA+
A17U430	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A17U434	156-0386-02			MICROCIRCUIT,DI:TRIPLE 3-INP NAND GATE	27014	DM74LS10N
A17U440	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A17U442	156-0383-02			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74LS02
A17U450	156-0391-02			MICROCIRCUIT,DI:HEX LATCH W/CLEAR	01295	SN74LS174
A17U460	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A18	670-6379-00	B010100	B010639	CKT BOARD ASSY:MEMORY	80009	670-6379-00
A18	670-6379-01	B010640		CKT BOARD ASSY:MEMORY	80009	670-6379-01
A18C172	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	T0900	SL25T10(T)TP
A18C210	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18C216	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18C250	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	T0900	SL25T10(T)TP
A18C255	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18C266	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18C340	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18C414	281-0775-00	B010100	B010639	CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18C540	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18C547	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18C556	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18C612	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A18CR174	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A18Q260	151-0220-00			TRANSISTOR:PNP,SI,TO-92	07263	S036228
A18R104	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A18R106	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A18R118	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A18R252	307-0541-00			RES,NTWK,THK FI:(7)1K OHM,10%,1W	91637	MSP08A01-102G
A18R255	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A18R265	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
A18R266	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
A18R267	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
A18R271	311-1936-00			RES.,VAR,NONWIR:CKT BD,50 OHM,20%,0.5W	73138	72XR50-232A
A18R332	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A18R440	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A18R502	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A18U108	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A18U112	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	01295	SN74LS374 N3
A18U120	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A18U206	156-1198-01			MICROCIRCUIT,DI:SYNCHRONOUS 4 BIT CNTR	01295	SN74S163J4
A18U210	156-1198-01			MICROCIRCUIT,DI:SYNCHRONOUS 4 BIT CNTR	01295	SN74S163J4
A18U216	156-1064-02			MICROCIRCUIT,DI:QUAD 2/1 LINE TRUE DATA	01295	SN74S157JP4
A18U220	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A18U226	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A18U232	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A18U240	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A18U248	156-1046-02			MICROCIRCUIT,DI:OCTAL D TYPE EDGE TRIG FF	01295	SN74S374N3/J4
A18U264	156-0067-12			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	UA741CJG
A18U266	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A18U274	156-1173-00			MICROCIRCUIT,LI:VOLTAGE REFERENCE	04713	MC1403UDS
A18U306	156-1360-01			MICROCIRCUIT,DI:256 X 4 STATIC RAM	80009	156-1360-01
A18U312	156-1360-01			MICROCIRCUIT,DI:256 X 4 STATIC RAM	80009	156-1360-01
A18U320	156-1046-02			MICROCIRCUIT,DI:OCTAL D TYPE EDGE TRIG FF	01295	SN74S374N3/J4
A18U326	156-0331-03			MICROCIRCUIT,DI:DUAL D TYPE POS EDGE TRIG	80009	156-0331-03
A18U332	156-0331-03			MICROCIRCUIT,DI:DUAL D TYPE POS EDGE TRIG	80009	156-0331-03
A18U340	156-0459-02			MICROCIRCUIT,DI:QUAD 2 INPUT & GATE,BURN	01295	SN74S08
A18U426	156-0953-02			MICROCIRCUIT,DI:4 BIT MAGNITUDE CMPRTR	01295	SN74LS85
A18U432	156-0953-02			MICROCIRCUIT,DI:4 BIT MAGNITUDE CMPRTR	01295	SN74LS85
A18U440	156-0331-03			MICROCIRCUIT,DI:DUAL D TYPE POS EDGE TRIG	80009	156-0331-03
A18U448	156-1046-02			MICROCIRCUIT,DI:OCTAL D TYPE EDGE TRIG FF	01295	SN74S374N3/J4
A18U456	156-1345-00			MICROCIRCUIT,LI:A/D CONV ML VIDEO	01281	TDS5180/1007J1C5
A18U508	156-1360-01			MICROCIRCUIT,DI:256 X 4 STATIC RAM	80009	156-1360-01

For Service Manuals Contact
MAURITRON TECHNICAL SERVICES
8 Cherry Tree Rd, Chinnor
Oxon OX9 4QY
Tel:- 01844-351694 Fax:- 01844-352554
Email:- enquiries@mauritron.co.uk

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A18U512	156-1360-01			MICROCIRCUIT,DI:256 X 4 STATIC RAM	80009	156-1360-01
A18U520	156-1046-02			MICROCIRCUIT,DI:OCTAL D TYPE EDGE TRIG FF	01295	SN74S374N3/J4
A18U526	156-0953-02			MICROCIRCUIT,DI:4 BIT MAGNITUDE CMPRTR	01295	SN74LS85
A18U532	156-0953-02			MICROCIRCUIT,DI:4 BIT MAGNITUDE CMPRTR	01295	SN74LS85
A18U540	156-0325-02			MICROCIRCUIT,DI:DUAL 4-1 LINE DATA,BURN-IN	01295	SN74S153JP3
A18U548	156-1046-02			MICROCIRCUIT,DI:OCTAL D TYPE EDGE TRIG FF	01295	SN74S374N3/J4

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8 Cherry Tree Rd, Chinnor
Oxon OX9 4QY
Tel:- 01844-351694 Fax:- 01844-352554
Email:- enquiries@mauritron.co.uk

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A19	670-6380-02			CKT BOARD ASSY:TIME BASE/POWER SUPPLY	80009	670-6380-02
A19C108	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C119	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C130	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C148	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C162	290-0932-00			CAP.,FXD ELECT:390UF,+ 100-10%,15VDC	90201	VPR391N01E1A3J
A19C171	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
A19C175	290-0931-00			CAP.,FXD ELECT:540UF,+ 100-10%,25 VDC	90201	VPR541N025J1C3J
A19C188	281-0775-00	B010100	B010219	CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C188	----- -----			(OPTION 04 ONLY)		
A19C188	283-0212-00	B010220		CAP.,FXD,CER DI:2UF,20%,50V	51642	400-050-Z5U205M
A19C188	----- -----			(OPTION 04 ONLY)		
A19C190	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
A19C197	281-0775-00	B010100	B010219	CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C197	----- -----			(OPTION 04 ONLY)		
A19C197	283-0212-00	B010220		CAP.,FXD,CER DI:2UF,20%,50V	51642	400-050-Z5U205M
A19C197	----- -----			(OPTION 04 ONLY)		
A19C212	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C238	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C256	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C279	281-0772-00			CAP.,FXD,CER DI:0.0047UF,10%,100V	04222	GC701C472K
A19C292	290-0636-00			CAP.,FXD,ELCTLT:7500UF,+100-10%,25V	56289	68D10501
A19C356	290-0760-00			CAP.,FXD,ELCTLT:2200UF,+50-10%,25V	56289	53D187
A19C438	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C456	290-0751-00			CAP.,FXD,ELCTLT:2200UF,+50-10%,16V	56289	D76245
A19C475	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C518	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C522	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C538	283-0594-00			CAP.,FXD,MICA D:0.001UF,1%,100V	00853	D151F102F0
A19C556	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C558	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
A19C560	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
A19C567	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C568	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C571	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
A19C572	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
A19C573	290-0804-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	ULA1E100TEA
A19C577	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A19C579	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A19CR169	152-0754-00			SEMICOND DEVICE:RECT,SI,SCHOTTKY,40V,8A	80009	152-0754-00
A19CR170	152-0333-00			SEMICOND DVC DI:SW,SI,55V,200MA,DO-35	03508	DJ2011
A19CR190	152-0668-00			SEMICOND DEVICE:RECT BRIDGE,SI,200V,6A	80009	152-0668-00
A19CR471	152-0406-00			SEMICOND DEVICE:SILICON,200V,3A	80009	152-0406-00
A19CR472	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A19CR473	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A19CR567	152-0066-00			SEMICOND DVC DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
A19L370	108-0337-00			COIL,RF:25UH	80009	108-0337-00
A19Q157	151-0506-00	B010100	B010859	SCR:SILICON	03508	C106B2X283
A19Q157	151-0521-01	B010860		TRANSISTOR:200V,8.0A	03508	C122B
A19Q259	151-0208-00			TRANSISTOR:SILICON,PNP	80009	151-0208-00
A19Q269	151-0625-00			TRANSISTOR:SILICON,PNP	03508	D45H11
A19Q280	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A19Q380	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A19Q544	151-1121-00			TRANSISTOR:FE,N CHANNEL,SI,VN 3	17856	V10206

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A19Q546	151-0220-00			TRANSISTOR:PNP,SI,TO-92	07263	S036228
A19Q547	151-0220-00			TRANSISTOR:PNP,SI,TO-92	07263	S036228
A19Q552	151-0220-00			TRANSISTOR:PNP,SI,TO-92	07263	S036228
A19Q554	151-0220-00			TRANSISTOR:PNP,SI,TO-92	07263	S036228
A19Q577	151-0506-00			SCR:SILICON	03508	C106B2X283
A19R101	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A19R103	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A19R110	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A19R170	315-0111-00			RES.,FXD,CMPSN:110 OHM,5%,0.25W	57668	NTR25J-E110E
A19R188	307-0113-00	B010220		RES.,FXD,CMPSN:5.1 OHM,5%,0.25W	01121	CB51G5
A19R188	----- -----			(OPTION 04 ONLY)		
A19R197	307-0113-00	B010220		RES.,FXD,CMPSN:5.1 OHM,5%,0.25W	01121	CB51G5
A19R197	----- -----			(OPT 04 ONLY)		
A19R224	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A19R248	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A19R250	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A19R252	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	57668	NTR25J-E470E
A19R254	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
A19R261	315-0820-00			RES.,FXD,CMPSN:82 OHM,5%,0.25W	57668	NTR25J-E82E0
A19R262	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	57668	NTR25J-E200E
A19R278	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	57668	NTR25J-E680E
A19R282	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	57668	NTR25J-E390E
A19R469	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
A19R470	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
A19R471	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A19R515	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A19R538	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A19R544	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A19R545	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A19R546	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A19R547	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
A19R548	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
A19R550	321-0189-00			RES.,FXD,FILM:909 OHM,1%,0.125W	91637	MFF1816G909R0F
A19R552	321-0154-00			RES.,FXD,FILM:392 OHM,1%,0.125W	91637	MFF1816G392R0F
A19R554	321-0381-00			RES.,FXD,FILM:90.9K OHM,1%,0.125W	91637	MFF1816G90901F
A19R556	321-0214-00			RES.,FXD,FILM:1.65K OHM,1%,0.125W	91637	MFF1816G16500F
A19R558	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
A19R559	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A19R560	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A19R562	321-0293-00			RES.,FXD,FILM:11K OHM,1%,0.125W	91637	MFF1816G11001F
A19R564	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
A19R566	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
A19R570	321-0216-00			RES.,FXD,FILM:1.74K OHM,1%,0.125W	91637	MFF1816G17400F
A19R571	321-0268-00			RES.,FXD,FILM:6.04K OHM,1%,0.125W	91637	MFF1816G60400F
A19R572	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
A19R579	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A19T160	120-1301-00			TRANSFORMER,RF:POT CORE	80009	120-1301-00
A19U100	156-0413-02			MICROCIRCUIT,DI:QUAD 2-INP SCHMITT TRIG	80009	156-0413-02
A19U110	156-0331-03			MICROCIRCUIT,DI:DUAL D TYPE POS EDGE TRIG	80009	156-0331-03
A19U118	156-0325-02			MICROCIRCUIT,DI:DUAL 4-1 LINE DATA,BURN-IN	01295	SN74S153JP3
A19U120	156-0325-02			MICROCIRCUIT,DI:DUAL 4-1 LINE DATA,BURN-IN	01295	SN74S153JP3
A19U128	156-0118-03			MICROCIRCUIT,DI:1 DUAL J-K FF,BURN-IN	01295	SN74S112JP3
A19U140	156-0391-02			MICROCIRCUIT,DI:HEX LATCH W/CLEAR	01295	SN74LS174
A19U146	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A19U150	156-0331-03			MICROCIRCUIT,DI:DUAL D TYPE POS EDGE TRIG	80009	156-0331-03
A19U210	156-1198-01			MICROCIRCUIT,DI:SYNCHRONOUS 4 BIT CNTR	01295	SN74S163J4
A19U218	156-0180-04			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74S00NP3
A19U220	156-0331-03			MICROCIRCUIT,DI:DUAL D TYPE POS EDGE TRIG	80009	156-0331-03
A19U230	156-0118-03			MICROCIRCUIT,DI:1 DUAL J-K FF,BURN-IN	01295	SN74S112JP3
A19U236	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	01295	SN74LS374 N3
A19U240	156-0852-02			MICROCIRCUIT,DI:HEX DRVR W/3 STATE INP	01295	SN74LS367NP3
A19U246	156-0629-01			MICROCIRCUIT,DI:30 MHZ PRESETTABLE BIN	01295	SN74LS197
A19U418	156-0788-01			MICROCIRCUIT,DI:SYN 4-BIT CNTR,W/SYN CLEAR	01295	SN74LS162
A19U424	156-0788-01			MICROCIRCUIT,DI:SYN 4-BIT CNTR,W/SYN CLEAR	01295	SN74LS162
A19U430	156-0788-01			MICROCIRCUIT,DI:SYN 4-BIT CNTR,W/SYN CLEAR	01295	SN74LS162
A19U434	156-0323-02			MICROCIRCUIT,DI:HEX INVERTER,BURN-IN	01295	SN74S04
A19U436	156-0982-03			MICROCIRCUIT,DI:OCTAL-D-EDGE FF,SCRN	01295	SN74LS374 N3
A19U440	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A19U446	156-1172-01			MICROCIRCUIT,DI:DUAL 4 BIT CNTR	01295	SN74LS393
A19U470	156-1173-00			MICROCIRCUIT,LI:VOLTAGE REFERENCE	04713	MC1403UDS
A19U510	156-0788-01			MICROCIRCUIT,DI:SYN 4-BIT CNTR,W/SYN CLEAR	01295	SN74LS162
A19U518	156-0788-01			MICROCIRCUIT,DI:SYN 4-BIT CNTR,W/SYN CLEAR	01295	SN74LS162
A19U524	156-1198-01			MICROCIRCUIT,DI:SYNCHRONOUS 4 BIT CNTR	01295	SN74S163J4
A19U530	156-0320-03			MICROCIRCUIT,DI:TRIPLE 3 INP NAND GATE	01295	SN74S11NP3
A19U536	156-1198-01			MICROCIRCUIT,DI:SYNCHRONOUS 4 BIT CNTR	01295	SN74S163J4
A19U540	156-1198-01			MICROCIRCUIT,DI:SYNCHRONOUS 4 BIT CNTR	01295	SN74S163J4
A19U546	156-1126-01			MICROCIRCUIT,LI:VOLTAGE COMPARATOR,SEL	01295	LM311JG4
A19U566	156-0158-03			MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
A19VR258	152-0175-00			SEMICOND DEVICE:ZENER,0.4W,5.6V,5%	04713	SZG35008
A19VR479	152-0760-00			SEMICOND DEVICE:ZEN,SI,6.2V,2%,400MW	04713	SZ630205
A19W158	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
A19Y134	119-1186-00			OSCILLATOR,RF:50MHZ,CLOCK	01537	K1100A-50:MHZ

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A20	670-6381-00			CKT BOARD ASSY:READOUT	80009	670-6381-00
A20DS120	150-1049-00			LT EMITTING DIO:RED/GREEN	000LH	QEC552CRG
A20DS122	150-1049-00			LT EMITTING DIO:RED/GREEN	000LH	QEC552CRG
A20DS124	150-1049-00			LT EMITTING DIO:RED/GREEN	000LH	QEC552CRG
A20U106	150-1011-01			LAMP,LED,RDOUT:RED SINGLE DIGIT	58361	FND-357
A20U110	150-1011-01			LAMP,LED,RDOUT:RED SINGLE DIGIT	58361	FND-357
A20U112	150-1011-01			LAMP,LED,RDOUT:RED SINGLE DIGIT	58361	FND-357
A20U114	150-1011-01			LAMP,LED,RDOUT:RED SINGLE DIGIT	58361	FND-357

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A21	670-6382-00	B010100	B019999	CKT BOARD ASSY:PROCESSOR	80009	670-6382-00
A21	670-6382-01	B020000	B039999	CKT BOARD ASSY:PROCESSOR	80009	670-6382-01
A21	670-6382-02	B040000		CKT BOARD ASSY:PROCESSOR	80009	670-6382-02
A21C128	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	T0900	SL25T10(T)TP
A21C161	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	T0900	SL25T10(T)TP
A21C165	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C174	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	T0900	SL25T10(T)TP
A21C203	290-0246-00	B010100	B039999	CAP.,FXD,ELCTLT:3.3UF,10%,15V	56289	173D335X9015V
A21C204	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C205	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C206	281-0762-00			CAP.,FXD,CER DI:27PF,20%,100V	04222	GC101A270M
A21C215	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C235	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	96733	R2735
A21C236	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C237	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C262	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C315	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A21C316	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C318	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C325	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	96733	R2735
A21C346	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C352	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C371	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C372	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C378	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C424	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C426	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C428	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C440	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C521	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C525	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C540	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C550	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C558	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21C578	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A21CR172	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A21CR218	152-0153-00			SEMICOND DVC,DI:SW,SI,10V,50MA,D0-7	07263	FD7003
A21CR219	152-0536-00			SEMICOND DEVICE:SILICON,HOT CARRIER,4V	80009	152-0536-00
A21CR315	152-0457-00			SEMICOND DEVICE:SILICON,25V	28480	5082-2068
A21CR425	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A21CR434	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A21L219	108-0333-00			COIL,RF:0.9UH	80009	108-0333-00
A21Q115	151-0134-00			TRANSISTOR:SILICON,PNP	80009	151-0134-00
A21Q210	151-0450-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N5583	80009	151-0450-00
A21Q221	151-0271-00			TRANSISTOR:SILICON,PNP	04713	SPS8236
A21Q224	151-0271-00			TRANSISTOR:SILICON,PNP	04713	SPS8236
A21Q225	151-0271-00			TRANSISTOR:SILICON,PNP	04713	SPS8236
A21Q236	151-0220-00			TRANSISTOR:PNP,SI,TO-92	07263	S036228
A21Q324	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
A21Q326	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
A21Q327	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
A21Q333	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
A21Q336	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
A21R107	323-0060-00			RES.,FXD,FILM:41.2 OHM,1%,0.50W	91637	CMF65116G41R20F

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A21R126	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
A21R172	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A21R173	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A21R205	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A21R208	315-0820-00			RES.,FXD,CMPSN:82 OHM,5%,0.25W	57668	NTR25J-E82E0
A21R215	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	57668	NTR25J-E680E
A21R216	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A21R217	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A21R218	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A21R219	321-0132-00			RES.,FXD,FILM:232 OHM,1%,0.125W	91637	MFF1816G232R0F
A21R220	321-0132-00			RES.,FXD,FILM:232 OHM,1%,0.125W	91637	MFF1816G232R0F
A21R221	322-0127-00			RES.,FXD,FILM:	91637	CMF1842G205R0F
A21R222	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A21R223	322-0136-00			RES.,FXD,FILM:	91637	CMF1842G255R0F
A21R225	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A21R230	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A21R231	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
A21R232	321-0116-00			RES.,FXD,FILM:158 OHM,1%,0.125W	91637	MFF1816G158R0F
A21R233	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
A21R234	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	57668	NTR25J-E75E0
A21R235	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	57668	NTR25J-E75E0
A21R236	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A21R237	321-0206-00			RES.,FXD,FILM:1.37K OHM,1%,0.125W	91637	MFF1816G13700F
A21R238	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A21R253	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A21R262	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A21R263	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A21R266	317-0511-00	B020000		RES.,FXD,CMPSN:510 OHM,5%,0.125W	01121	BB5115
A21R315	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	57668	NTR25J-E20K0
A21R317	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
A21R319	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A21R325	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	57668	NTR25J-E75E0
A21R326	321-0069-00			RES.,FXD,FILM:51.1 OHM,1%,0.125W	91637	CMF55116G51R10F
A21R327	321-0069-00			RES.,FXD,FILM:51.1 OHM,1%,0.125W	91637	CMF55116G51R10F
A21R328	321-0080-00			RES.,FXD,FILM:66.5 OHM,1%,0.125W	91637	MFF1816G66R50F
A21R331	321-0069-00			RES.,FXD,FILM:51.1 OHM,1%,0.125W	91637	CMF55116G51R10F
A21R332	321-0069-00			RES.,FXD,FILM:51.1 OHM,1%,0.125W	91637	CMF55116G51R10F
A21R333	321-0080-00			RES.,FXD,FILM:66.5 OHM,1%,0.125W	91637	MFF1816G66R50F
A21R334	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A21R335	311-1244-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	32997	3386X-T07-101
A21R336	321-0131-00	B010100	B039999	RES.,FXD,FILM:226 OHM,1%,0.125W	91637	MFF1816G226R0F
A21R336	321-0111-00	B040000		RES.,FXD,FILM:140 OHM,1%,0.125W	91637	MFF1816G140R0F
A21R338	321-0145-00			RES.,FXD,FILM:316 OHM,1%,0.125W	91637	MFF1816G316R0F
A21R368	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A21R378	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A21R412	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A21R413	321-0262-00	B010100	B039999	RES.,FXD,FILM:5.23K OHM,1%,0.125W	91637	MFF1816G52300F
A21R413	321-0247-00	B040000		RES.,FXD,FILM:3.65K OHM,1%,0.125W	91637	MFF1816G36500F
A21R420	311-1244-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	32997	3386X-T07-101
A21R421	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A21R422	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	57668	NTR25J-E150E
A21R423	321-0131-00	B010100	B039999	RES.,FXD,FILM:226 OHM,1%,0.125W	91637	MFF1816G226R0F
A21R423	321-0111-00	B040000		RES.,FXD,FILM:140 OHM,1%,0.125W	91637	MFF1816G140R0F
A21R424	321-0145-00			RES.,FXD,FILM:316 OHM,1%,0.125W	91637	MFF1816G316R0F

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A21R425	321-0258-00	B010100	B039999	RES.,FXD,FILM:4.75K OHM,1%,0.125W	91637	MFF1816G47500F
A21R425	321-0293-00	B040000		RES.,FXD,FILM:11K OHM,1%,0.125W	91637	MFF1816G11001F
A21R426	321-0243-00			RES.,FXD,FILM:3.32K OHM,1%,0.125W	91637	MFF1816G33200F
A21R429	321-0233-00			RES.,FXD,FILM:2.61K OHM,1%,0.125W	91637	MFF1816G26100F
A21R430	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A21R432	321-0233-00			RES.,FXD,FILM:2.61K OHM,1%,0.125W	91637	MFF1816G26100F
A21R433	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	91637	MFF1816G32400F
A21R434	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A21R436	321-0243-00			RES.,FXD,FILM:3.32K OHM,1%,0.125W	91637	MFF1816G33200F
A21R437	321-0262-00	B010100	B039999	RES.,FXD,FILM:5.23K OHM,1%,0.125W	91637	MFF1816G52300F
A11R437	321-0247-00	B040000		RES.,FXD,FILM:3.65K OHM,1%,0.125W	91637	MFF1816G36500F
A21R438	321-0258-00	B010100	B039999	RES.,FXD,FILM:4.75K OHM,1%,0.125W	91637	MFF1816G47500F
A21R438	321-0293-00	B040000		RES.,FXD,FILM:11K OHM,1%,0.125W	91637	MFF1816G11001F
A21R441	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	91637	MFF1816G32400F
A21R442	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A21R450	307-0445-00			RES NTWK,FXD,FI:4.7K OHM,20%,(9) RES	91637	MSP10A01-472M
A21U246	156-0386-02			MICROCIRCUIT,DI:TRIPLE 3-INP NAND GATE	27014	DM74LS10N
A21U255	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A21U272	156-0914-02			MICROCIRCUIT,DI:OCT ST BFR W/3 STATE OUT	01295	SN74LS240
A21U278	156-0383-02			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74LS02
A21U328	155-0022-00			MICROCIRCUIT,DI:ML,CHANNEL SWITCH	80009	155-0022-00
A21U364	156-1088-00			MICROCIRCUIT,DI:8 BIT MICROPROCESSOR	34649	D8085AH
A21U378	156-0541-02			MICROCIRCUIT,DI:DUAL 2 TO 4 LINE DCDR	01295	SN74LS139NP3
A21U440	156-0910-02			MICROCIRCUIT,DI:DUAL DECADE COUNTER	01295	SN74LS390
A21U446	156-0910-02			MICROCIRCUIT,DI:DUAL DECADE COUNTER	01295	SN74LS390
A21U452	156-1111-02			MICROCIRCUIT,DI:OCTAL BUS TRANSCEIVERS	01295	SN74LS245 N3ORJ4
A21U472	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95
A21U478	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3
A21U525	156-1127-01			MICROCIRCUIT,DI:1024 X 4 STATIC RAM	80009	156-1127-01
A21U530	156-1127-01			MICROCIRCUIT,DI:1024 X 4 STATIC RAM	80009	156-1127-01
A21U540	156-1127-01			MICROCIRCUIT,DI:1024 X 4 STATIC RAM	80009	156-1127-01
A21U545	156-1127-01			MICROCIRCUIT,DI:1024 X 4 STATIC RAM	80009	156-1127-01
A21U550	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A21U558	156-1111-02			MICROCIRCUIT,DI:OCTAL BUS TRANSCEIVERS	01295	SN74LS245 N3ORJ4
A21U565	160-0459-00	B010100	B019999	MICROCIRCUIT,DI:8192 X 8 ROM,PRGM	80009	160-0459-00
A21U565	160-0459-01	B020000		MICROCIRCUIT,DI:8192 X 8 MROM,PRGM	80009	160-0459-01
A21U575	160-0759-00	B010100	B019999	MICROCIRCUIT,DI:8192 X 8 ROM CUSTOM MASK	80009	160-0759-00
A21U575	160-0759-01	B020000		MICROCIRCUIT,DI:8192 X 8 MROM,PRGM	80009	160-0759-01

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A22	670-6386-00			CKT BOARD ASSY:LINE SELECTOR SWITCH	80009	670-6386-00
A22J108	131-2427-00			TERM,QIK DISC:CKT BD,BRASS	00779	G2409-1
A22J110	131-2427-00			TERM,QIK DISC:CKT BD,BRASS	00779	G2409-1
A22J214	131-2427-00			TERM,QIK DISC:CKT BD,BRASS	00779	G2409-1
A22J224	131-2427-00			TERM,QIK DISC:CKT BD,BRASS	00779	G2409-1
A22S108	260-1849-00			SWITCH,PUSH:DPDT,4A,250VAC	31918	NE15/F2U103EE
A22S216	260-1980-00			SWITCH,SLIDE:DPDT,10A,125V,HI/LOW	82389	EPS2-PC1
A22S226	260-1980-01			SWITCH,SLIDE:DPDT,10A,125V,MKD 115V/230V	000FJ	4021.1913

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A23	670-6470-00	B010100	B039999	CKT BOARD ASSY:VERTICAL OUTPUT	80009	670-6470-00
A23	670-6470-01	B040000		CKT BOARD ASSY:VERTICAL OUTPUT	80009	670-6470-01
A23C116	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A23C125	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	96733	R3015
A23C129	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A23C148	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A23C167	281-0783-00			CAP.,FXD,CER DI:0.1UF,20%,100V	96733	ADVISE
A23C213	281-0089-00			CAP.,VAR,CER DI:2-8PF,350V	59660	538-006-A2-8
A23C220	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A23C224	281-0797-00			CAP.,FXD,CER DI:15PF,10%,100V	04222	MA 106A 150KAA
A23C225	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A23C226	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A23C234	281-0096-00			CAP.,VAR,AIR DI:5.5-18PF,350V	33095	53-717-029A5.5
A23C312	290-0246-00			CAP.,FXD,ELCTLT:3.3UF,10%,15V	56289	173D335X9015V
A23C315	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A23C318	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	96733	R3015
A23C326	281-0772-00			CAP.,FXD,CER DI:0.0047UF,10%,100V	04222	GC701C472K
A23C358	290-0246-00			CAP.,FXD,ELCTLT:3.3UF,10%,15V	56289	173D335X9015V
A23C359	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A23L245	108-0328-00			COIL,RF:0.3UH	80009	108-0328-00
A23L246	108-0328-00			COIL,RF:0.3UH	80009	108-0328-00
A23L267	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
A23L361	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
A23L362	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
A23Q108	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A23Q202	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A23Q205	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A23Q206	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A23R100	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A23R101	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A23R103	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	57668	NTR25J-E75E0
A23R104	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
A23R105	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
A23R106	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
A23R107	321-0250-00			RES.,FXD,FILM:3.92K OHM,1%,0.125W	91637	MFF1816G39200F
A23R108	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A23R109	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	01121	ORD BY DESCR
A23R112	311-1236-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	72-22-0
A23R113	321-0183-00			RES.,FXD,FILM:787 OHM,1%,0.125W	91637	MFF1816G787R0F
A23R114	321-0223-00			RES.,FXD,FILM:2.05K OHM,1%,0.125W	91637	MFF1816G20500F
A23R115	321-0198-00			RES.,FXD,FILM:1.13K OHM,1%,0.125W	91637	MFF1816G11300F
A23R117	311-1238-00			RES.,VAR,NONWIR:5K OHM,10%,0.50W	73138	72-27-0
A23R118	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A23R119	323-0140-00			RES.,FXD,FILM:280 OHM,1%,0.50W	75042	CECT0-2800F
A23R121	323-0140-00			RES.,FXD,FILM:280 OHM,1%,0.50W	75042	CECT0-2800F
A23R127	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
A23R128	321-0061-00			RES.,FXD,FILM:42.2 OHM,1%,0.125W	91637	MFF1816G42R20F
A23R129	315-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
A23R133	321-0080-00			RES.,FXD,FILM:66.5 OHM,1%,0.125W	91637	MFF1816G66R50F
A23R134	321-0175-00			RES.,FXD,FILM:649 OHM,1%,0.125W	91637	CMF55116G649R0F
A23R136	321-0052-00			RES.,FXD,FILM:34 OHM,1%,0.125W	91637	MFF1816G34R00F
A23R140	323-0127-00			RES.,FXD,FILM:205 OHM,1%,0.50W	91637	MFF1226G205R0F
A23R141	323-0155-00			RES.,FXD,FILM:402 OHM,1%,0.50W	75042	CECT0-4020F
A23R142	323-0155-00			RES.,FXD,FILM:402 OHM,1%,0.50W	75042	CECT0-4020F

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A23R143	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A23R144	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A23R145	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	57668	NTR25J-E47K0
A23R146	323-0055-00			RES.,FXD,FILM:36.5 OHM,1%,0.5W	75042	CECT0-35R50F
A23R147	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	57668	NTR25J-E47K0
A23R156	308-0758-00			RES.,FXD,WW:430 OHM,1%,7W	14193	SP1151S-430R0F
A23R201	321-0147-00			RES.,FXD,FILM:332 OHM,1%,0.125W	91637	MFF1816G332R0F
A23R202	321-0147-00			RES.,FXD,FILM:332 OHM,1%,0.125W	91637	MFF1816G332R0F
A23R203	321-0001-00			RES.,FXD,FILM:10 OHM,1%,0.125W	75042	CEAT0-10R00F
A23R205	321-0001-00			RES.,FXD,FILM:10 OHM,1%,0.125W	75042	CEAT0-10R00F
A23R210	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	91637	MFF1816G49R90F
A23R211	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	91637	MFF1816G49R90F
A23R214	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A23R215	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A23R216	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
A23R218	311-1236-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	72-22-0
A23R221	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
A23R222	321-0061-00			RES.,FXD,FILM:42.2 OHM,1%,0.125W	91637	MFF1816G42R20F
A23R226	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A23R227	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A23R228	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A23R229	311-1236-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	72-22-0
A23R230	321-0139-00			RES.,FXD,FILM:274 OHM,1%,0.125W	91637	MFF1816G274R0F
A23R234	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A23R236	321-0052-00			RES.,FXD,FILM:34 OHM,1%,0.125W	91637	MFF1816G34R00F
A23R240	323-0155-00			RES.,FXD,FILM:402 OHM,1%,0.50W	75042	CECT0-4020F
A23R241	323-0155-00			RES.,FXD,FILM:402 OHM,1%,0.50W	75042	CECT0-4020F
A23R244	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A23R256	308-0758-00			RES.,FXD,WW:430 OHM,1%,7W	14193	SP1151S-430R0F
A23R313	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	57668	NTR25J-E330E
A23R319	311-1564-00			RES.,VAR,NONWIR:TRMR,500 OHM,0.5W	32997	3352T-CK5-501
A23R321	311-1560-00			RES.,VAR,NONWIR:TRMR,5K OHM,0.5W	32997	3352T-1-502
A23R325	311-1559-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	73138	91-81-0
A23R329	311-1559-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	73138	91-81-0
A23R333	321-0178-00			RES.,FXD,FILM:698 OHM,1%,0.125W	91637	MFF1816G698R0F
A23R335	311-1556-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	73138	91-78-0
A23R339	321-0178-00			RES.,FXD,FILM:698 OHM,1%,0.125W	91637	MFF1816G698R0F
A23R344	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	57668	NTR25J-E47K0
A23R345	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	57668	NTR25J-E47K0
A23R348	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	57668	NTR25J-E02K0
A23R349	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	57668	NTR25J-E 820E
A23RT219	307-0125-00	B010100	B039999	RES.,THERMAL:500 OHM,10%,25 DEG C	50157	2D1595
A23RT219	307-0127-00	B040000		RES.,THERMAL:1K OHM,10%	50157	2D1596
A23U105	156-0067-12			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	UA741CJG
A23U218	155-0078-10			MICROCIRCUIT,LI:ML,VERTICAL AMPLIFIER	80009	155-0078-10
A23U239	155-0115-00			MICROCIRCUIT,LI:CRT VERT DEFLECTION DRIVER	80009	155-0115-00
A23U356	156-0067-12			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	UA741CJG
A23VR222	152-0195-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	04713	SZ11755
A23VR223	152-0195-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	04713	SZ11755
A23VR224	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20

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A24	670-6003-00	B010100	B039999	CKT BOARD ASSY:ATTENUATOR	80009	670-6003-00
A24	670-6003-03	B040000		CKT BOARD ASSY:ATTENUATOR	80009	670-6003-03
A24C30	307-1014-05			ATTENUATOR,FXD:100X	80009	307-1014-05
A24C31	307-1014-05			ATTENUATOR,FXD:100X	80009	307-1014-05
A24C32	307-1013-05			ATTENUATOR,FXD:10X	80009	307-1013-05
A24C33	307-1013-05			ATTENUATOR,FXD:10X	80009	307-1013-05
A24C34	307-1011-01			ATTENUATOR,FXD:4X	80009	307-1011-01
A24C35	307-1011-01			ATTENUATOR,FXD:4X	80009	307-1011-01
A24C36	307-1010-02			ATTENUATOR,FXD:2X	80009	307-1010-02
A24C37	307-1010-02			ATTENUATOR,FXD:2X	80009	307-1010-02
A24C3042	283-0156-00			CAP.,FXD,CER DI:1000PF,+100-0%,200V	96733	R2670
A24C15101	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
A24C15103	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
A24R3014	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
A24R3015	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
A24R3030	317-0100-00	B010100	B039999	RES.,FXD,CMPSN:10 OHM,5%,0.125W	01121	BB1005
A24R3030	317-0150-00	B040000		RES.,FXD,CMPSN:15 OHM,5%,0.125W	01121	BB1505
A24R3032	315-0360-00			RES.,FXD,CMPSN:36 OHM,5%,0.25W	01121	CB3605
A24R3033	317-0220-00	B010100	B039999	RES.,FXD,CMPSN:22 OHM,5%,0.125W	01121	BB2205
A24R3033	317-0100-00	B040000		RES.,FXD,CMPSN:10 OHM,5%,0.125W	01121	BB1005
A24R3036	317-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.125W	01121	BB1005
A24R3039	321-0481-00			RES.,FXD,FILM:1M OHM,1%,0.125W	91637	CMF55116G10003F
A24R3042	315-0300-00			RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
A24R3045	317-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.125W	01121	BB4745
A24R15103	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A25	670-6004-00			CKT BOARD ASSY:PROBE CODING	80009	670-6004-00
A25DS9040	150-1063-00			LT EMITTING DIO:YELLOW,585 NM,40 MA	72619	550-0305-804
A25DS9060	150-1063-00			LT EMITTING DIO:YELLOW,585 NM,40 MA	72619	550-0305-804
A26	670-2279-00			CKT BOARD ASSY:CRT SCALE ILLUMINATION	80009	670-2279-00
A26DS14086	150-0129-00			LAMP,INCAND:6.3V,200MA	08806	2112D
A26DS14087	150-0129-00			LAMP,INCAND:6.3V,200MA	08806	2112D

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A27	670-7551-00			CKT BOARD ASSY:ANALOG XY OUTPUT	80009	670-7551-00
A27	----- -----			(OPTION 11 ONLY)		
A27C100	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	T0900	SL25T10(T)TP
A27C101	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	T0900	SL25T10(T)TP
A27C103	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	T0900	SL25T10(T)TP
A27C104	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A27C106	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A27C107	285-1075-00			CAP.,FXD,PLSTC:0.1UF,5%,100V	14752	230B1B104J
A27C108	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A27C109	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A27C111	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A27C112	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A27C113	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A27C114	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A27C121	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A27C124	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A27C127	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A27C128	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A27C134	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A27CR100	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A27CR101	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A27CR102	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A27CR103	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A27CR104	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A27CR107	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A27F100	159-0090-00			FUSE,CARTRIDGE:0.25A,125V,FAST-BLOW	71400	GFA 1/4
A27K100	148-0076-00			RELAY,REED:1 FORM A,5V,0.25A,100V	95348	F81-1447
A27R101	307-0488-00			RES,NTWK,FXD,FI:(5)100 OHM,20%,0.75W	01121	106A101 OR 706A1
A27R103	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	CMF55116G20R00F
A27R107	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A27R108	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A27R109	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
A27R111	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
A27R112	307-0542-00			RES,NTWK,FXD,FI:10K OHM,5%,0.125W	01121	106A103
A27R120	321-0816-07			RES.,FXD,FILM:5K OHM,0.1%,0.125W	91637	MFF1816C50000B
A27R121	321-0816-07			RES.,FXD,FILM:5K OHM,0.1%,0.125W	91637	MFF1816C50000B
A27R126	321-0816-07			RES.,FXD,FILM:5K OHM,0.1%,0.125W	91637	MFF1816C50000B
A27R127	321-0816-07			RES.,FXD,FILM:5K OHM,0.1%,0.125W	91637	MFF1816C50000B
A27R128	321-0223-07			RES.,FXD,FILM:2.05K OHM,0.1%,0.125W	91637	MFF1816C20500B
A27R129	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
A27R131	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A27R132	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A27R133	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A27R134	321-0223-07			RES.,FXD,FILM:2.05K OHM,0.1%,0.125W	91637	MFF1816C20500B
A27R135	321-0223-07			RES.,FXD,FILM:2.05K OHM,0.1%,0.125W	91637	MFF1816C20500B
A27S100	260-1589-00			SWITCH,PUSH:(6)SPST,0.1A,5V	00779	435166-4
A27TP100	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	48283-036
A27TP101	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	48283-036
A27TP102	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	48283-036
A27TP103	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	48283-036
A27TP114	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	48283-036
A27TP118	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	48283-036
A27U100	156-0865-02			MICROCIRCUIT,DI:OCTAL D-TYPE FF W/CLEAR	01295	SN74LS273NP3
A27U101	156-1277-00			MICROCIRCUIT,DI:3 STATE OCTAL BFR	27014	DM81LS95

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A27U102	156-0720-02			MICROCIRCUIT,DI:HEX DRVR,4 TO 2 LINE	01295	SN74LS368
A27U103	156-0481-02			MICROCIRCUIT,DI:TRIPLE 3 INP & GATE	27014	DM74LS11NA+
A27U104	156-0392-03			MICROCIRCUIT,DI:QUAD LATCH W/CLEAR	01295	SN74S175NP3
A27U107	156-0402-00			MICROCIRCUIT,LI:TIMER	27014	LM555CN
A27U108	156-0469-02			MICROCIRCUIT,DI:3/8 LINE DCDR	01295	SN74LS138NP3
A27U109	156-1172-01			MICROCIRCUIT,DI:DUAL 4 BIT CNTR	01295	SN74LS393
A27U111	156-0994-02			MICROCIRCUIT,DI:8 INPUT DATA SEL/MUX	01295	SN74LS151NP3
A27U112	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A27U113	156-0953-02			MICROCIRCUIT,DI:4 BIT MAGNITUDE CMPRTR	01295	SN74LS85
A27U114	156-0953-02			MICROCIRCUIT,DI:4 BIT MAGNITUDE CMPRTR	01295	SN74LS85
A27U117	156-0392-03			MICROCIRCUIT,DI:QUAD LATCH W/CLEAR	01295	SN74S175NP3
A27U118	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A27U119	156-0381-02			MICROCIRCUIT,DI:QUAD 2-INP EXCL OR GATE	01295	SN74LS86
A27U121	156-1638-00			MICROCIRCUIT,LI:10 BIT HS,MULT,D/A CONV	80009	156-1638-00
A27U122	156-0957-01			MICROCIRCUIT,DI:SYN 4 BIT UP/DOWN BINARY	27014	DM74LS169
A27U123	156-0957-01			MICROCIRCUIT,DI:SYN 4 BIT UP/DOWN BINARY	27014	DM74LS169
A27U124	156-0957-01			MICROCIRCUIT,DI:SYN 4 BIT UP/DOWN BINARY	27014	DM74LS169
A27U126	156-1638-00			MICROCIRCUIT,LI:10 BIT HS,MULT,D/A CONV	80009	156-1638-00
A27U127	156-1258-01			MICROCIRCUIT,DI:DUAL J-K NEG-EDGE TRIG FF	01295	SN74LS112
A27U128	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
A27U129	156-0515-02			MICROCIRCUIT,DI:TRIPLE 3-CHAN MUX,SEL	80009	156-0515-02
A27U131	156-1173-00			MICROCIRCUIT,LI:VOLTAGE REFERENCE	04713	MC1403UDS
A28	670-6547-00			CKT BOARD ASSY:INTERCONNECT	80009	670-6547-00
A28	----- -----			(NO ELECTRICAL PARTS)		

For Service Manuals Contact
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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A29	670-7045-00			CKT BOARD ASSY:TV SYNC SEPARATOR	80009	670-7045-00
A29	----- -----			(OPTION 05 ONLY)		
A29C201	290-0219-00			CAP.,FXD,ELCTLT:5UF,+75-10%,25V	56289	30D505G025BA9
A29C212	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	04222	SR302E105ZAA
A29C213	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A29C228	283-0698-00			CAP.,FXD,MICA D:390PF,1%,500V	09023	CD15FD391F03
A29C229	290-0283-00			CAP.,FXD,ELCTLT:0.47UF,10%,35V	56289	173D474X9035U
A29C301	290-0219-00			CAP.,FXD,ELCTLT:5UF,+75-10%,25V	56289	30D505G025BA9
A29C305	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	04222	SR302E105ZAA
A29C315	281-0811-00			CAP.,FXD,CER DI:10PF,10%,100V	96733	R2911
A29C316	281-0811-00			CAP.,FXD,CER DI:10PF,10%,100V	96733	R2911
A29C321	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	04222	SR302E105ZAA
A29C323	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	04222	SR302E105ZAA
A29C329	283-0339-00			CAP.,FXD,CER DI:0.22UF.10%,50V	72982	8131N075W5R224K
A29C334	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A29C401	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A29C403	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
A29C404	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A29C405	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A29C425	281-0773-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA201C103KAA
A29CR112	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A29CR310	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A29CR311	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A29CR333	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A29CR404	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A29CR408	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	12969	NDP0263 (1N4152)
A29Q222	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A29Q321	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A29Q325	151-0220-00			TRANSISTOR:PNP,SI,TO-92	07263	S036228
A29Q328	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A29Q331	151-0190-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7969
A29R101	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	57668	NTR25JE01K0
A29R102	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A29R110	315-0106-00			RES.,FXD,CMPSN:10M OHM,5%,0.25W	01121	CB1065
A29R113	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
A29R115	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A29R124	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A29R204	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	57668	NTR25J-E750E
A29R206	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A29R207	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	57668	NTR25J-E 10E0
A29R221	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A29R222	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A29R224	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A29R225	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	57668	NTR25J-E12K0
A29R226	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A29R232	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A29R233	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	57668	NTR25J-E20K0
A29R304	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A29R307	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	57668	NTR25J-E12K0
A29R308	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	57668	NTR25J-E12K0
A29R310	315-0124-00			RES.,FXD,CMPSN:120K OHM,5%,0.25W	01121	CB1245
A29R311	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	57668	NTR25J-E12K0
A29R317	315-0433-00			RES.,FXD,CMPSN:43K OHM,5%,0.25W	57668	NTR25J-E043K
A29R318	315-0684-00			RES.,FXD,CMPSN:680K OHM,5%,0.25W	01121	CB6845

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A29R321	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	57668	NTR25J-E24K0
A29R322	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
A29R324	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A29R325	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	57668	NTR25J-E03K0
A29R326	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	57668	NTR25J-E12K0
A29R327	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A29R328	315-0433-00			RES.,FXD,CMPSN:43K OHM,5%,0.25W	57668	NTR25J-E043K
A29R331	315-0433-00			RES.,FXD,CMPSN:43K OHM,5%,0.25W	57668	NTR25J-E043K
A29R332	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	57668	NTR25J-E24K0
A29R401	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	57668	NTR25J-E100K
A29R402	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A29R403	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	57668	NTR25J-E100K
A29R404	315-0103-00	B010100	B021364	RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A29R404	315-0153-00	B021365		RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A29R405	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	57668	NTR25J-E47K0
A29R406	315-0152-00	B010100	B021364	RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
A29R406	315-0561-00	B021365		RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
A29R407	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	57668	NTR25J-E10K0
A29R408	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	57668	NTR25J-E02K0
A29R409	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	57668	NTR25J-E02K0
A29R425	315-0125-00			RES.,FXD,CMPSN:1.2M OHM,5%,0.25W	01121	CB1255
A29TP333	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A29U126	156-0366-02			MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK	80009	156-0366-02
A29U129	156-0366-02			MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK	80009	156-0366-02
A29U227	156-0704-00			MICROCIRCUIT,LI:PHASE LOCK LOOP	04713	MC14046CP
A29U315	156-0136-00			MICROCIRCUIT,LI:OPNL AMPL	02735	CA 3030
A29U438	156-1152-01			MICROCIRCUIT,DI:PRCN RETRIGGERABLE,BURN-IN	80009	156-1152-01
A29U453	156-0515-02			MICROCIRCUIT,DI:TRIPLE 3-CHAN MUX,SEL	80009	156-0515-02
A29VR211	152-0226-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	14552	TD3810980

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Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				CHASSIS PARTS		
B10001	119-0830-05			FAN,TUBEAXIAL:12VDC,2.4W,5250 RPM,47 CFM	80009	119-0830-05
C3042	283-0156-00			CAP.,FXD,CER DI:1000PF,+100-0%,200V	96733	R2670
C13009	281-0661-00			CAP.,FXD,CER DI:0.8PF,+/-0.1PF,500V	04222	7001-COK-OR8B
C13009	----- -----			(OPTION 05 ONLY)		
C13010	281-0064-00			CAP.,VAR,PLSTC:0.25-1.5PF,600V	74970	273-0001-101
C13012	285-0816-01			CAP.,FXD,PLSTC:0.019UF,10%,600V	80009	285-0816-01
C13012	285-1055-00			CAP.,FXD,PLSTC:0.2UF,10%,400V	80009	285-1055-00
C13012	----- -----			(OPTION 5 ONLY)		
C15101	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C15103	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
CR14498	152-0333-00			SEMICOND DVC DI:SW,SI,55V,200MA,DO-35	03508	DJ2011
DL208	119-0387-00			DELAY LINE,ELEC:120NS,100 OHM	80009	119-0387-00
DS11320	150-1049-00			LT EMITTING DIO:RED/GREEN	000LH	QEC552CRG
DS11320	----- -----			(OPTION 02 ONLY)		
DS15034	150-1001-02			LT EMITTING DIO:RED,660NM,50MA MAX	07263	FLV160/CLIP
DS15036	150-1001-02			LT EMITTING DIO:RED,660NM,50MA MAX	07263	FLV160/CLIP
DS15038	150-1001-02			LT EMITTING DIO:RED,660NM,50MA MAX	07263	FLV160/CLIP
DS16001	150-1001-02			LT EMITTING DIO:RED,660NM,50MA MAX	07263	FLV160/CLIP
DS16002	150-1001-02			LT EMITTING DIO:RED,660NM,50MA MAX	07263	FLV160/CLIP
DS17105	150-1017-00			LT EMITTING DIO:GREEN,550NM,55MA MAX	50437	LSM-16L-100
DS17127	150-1032-00			LT EMITTING DIO:YELLOW,580NM,40MA,MAX	53184	XC-5569-Y2
DS17206	150-1001-02			LT EMITTING DIO:RED,660NM,50MA MAX	07263	FLV160/CLIP
F14500	159-0160-00	B010100	B045049	FUSE,CARTRIDGE:3AG,1.5 A,250 V,18 SEC,UL	71400	MDX 1-1/2
F14500	159-0225-00	B045050		FUSE,CARTRIDGE:3AG,1.5A,250V,18SEC		
FL14500	119-0420-00			FILTER,RFI:6A,250VAC,400HZ	02777	F-11935-6
L14175	108-0714-00			COIL,TUBE DEFLE:Y AXIS ALIGNMENT	80009	108-0714-00
L14176	108-0713-00			COIL,TUBE DEFLE:TRACE ROTATION	80009	108-0713-00
Q390	151-0390-00			TRANSISTOR:SILICON,NPN	04713	SPS3414
Q401	151-0349-00			TRANSISTOR:SILICON,NPN,SEL FROM MJE280	04713	SJE924
Q501	151-0436-00			TRANSISTOR:SILICON,NPN	04713	SJE966
Q701	151-0349-00			TRANSISTOR:SILICON,NPN,SEL FROM MJE280	04713	SJE924
Q718	151-0390-00			TRANSISTOR:SILICON,NPN	04713	SPS3414
Q1108	151-0140-00			TRANSISTOR:SILICON,NPN	02735	36568
R3042	317-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.125W	01121	BB4745
R3045	315-0300-00			RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R13010	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	57668	NTR25J-E75E0
R13012	307-0116-00			RES.,FXD,CMPSN:9.1 OHM,5%,0.25W	01121	CB91G5
R14288	311-2047-00			RES.,VAR NONWIR:PNL,50K/5K OHM,20%,0.5W	12697	CM41749
R14398	311-1482-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	01121	W-8070
R14498	311-1410-00			RES.,VAR,NONWIR:25K OHM,20%,1W	01121	18M912
R14498	----- -----			(REPLACEABLE AS A SET W/S14498)		
R14499	311-0608-00			RES.,VAR,NONWIR:2K OHM,10%,0.75W	01121	W8156
R15102	315-0103-03			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R16002	311-1464-00			RES.,VAR,WW:2K OHM,5%,2W	02111	534-264
R17010	311-1192-00			RES.,VAR,NONWIR:10K OHM,20%,1W,W/SW	71590	BA-232-001
R17010	----- -----			(REPL AS A SET WITH S17010)		
R17305	311-1192-00			RES.,VAR,NONWIR:10K OHM,20%,1W,W/SW	71590	BA-232-001
R17305	----- -----			(REPL AS A SET WITH S17305)		
S270	----- -----			(REPLACEABLE AS A UNIT WITH A11R270)		
S470	----- -----			(REPLACEABLE AS A UNIT WITH A11R470)		
S14520	260-0638-00			SW,THERMOSTATIC:10A,240V,OPEN 75 DEG C	93410	430-364
S14498	----- -----			(REPL AS A SET WITH R14498)		
S17010	----- -----			(REPL AS A SET WITH R17010)		

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
S17305	----- -----			(REPL AS A SET WITH R17305)		
T14500	120-1302-00			TRANSFORMER,RF:HORIZ LINEARITY	80009	120-1302-00
U190	156-0285-01			MICROCIRCUIT,LI:VOLTAGE REGULATOR,CHK	04713	MC7812CTD
U560	156-0872-01			MICROCIRCUIT,LI:VOLTAGE REGULATOR	04713	MC7912CTD
U570	156-0655-01			MICROCIRCUIT,LI:VOLTAGE RGLTR,BURN-IN	04713	MC7905.2CTD
V1400	154-0731-00			ELECTRON TUBE:W/ANODE LEAD	80009	154-0731-00

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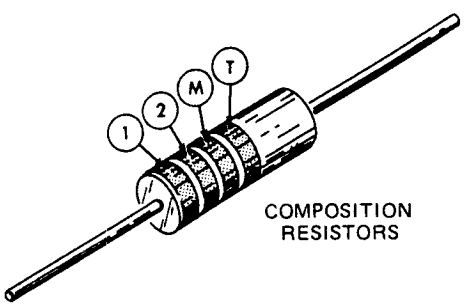
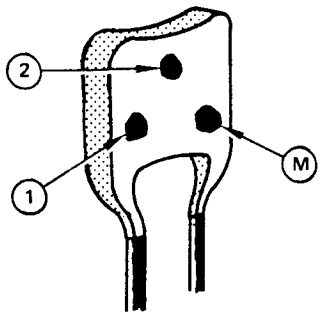
Oxon OX9 4QY
Tel:- 01844-351694 Fax:- 01844-352554
Email:- enquiries@mauritron.co.uk

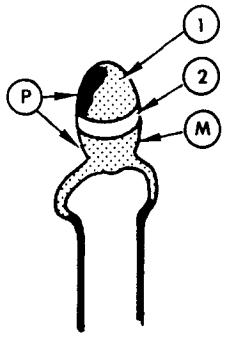
COLOR CODE



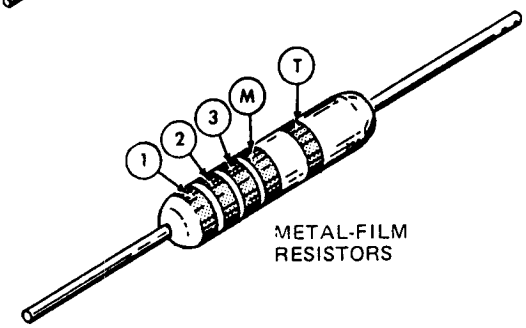
COMPOSITION RESISTORS



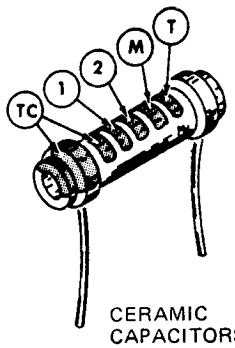
SMALL DISC CAPACITORS



DIPPED TANTALUM ELECTROLYTICS



METAL-FILM RESISTORS



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Email:- enquiries@mauritron.co.uk

(1) (2) and (3) – 1st, 2nd, and 3rd significant figures

(M) –multiplier (T) –tolerance

(TC) –temperature coefficient

(P) –polarity and voltage rating

(T) and/or (TC) color code may not be present on some capacitors

COLOR	SIGNIFICANT FIGURES	RESISTORS		CAPACITORS			DIPPED TANTALUM VOLTAGE RATING
		MULTIPLIER	TOLERANCE	MULTIPLIER	TOLERANCE		
					over 10 pF	under 10 pF	
BLACK	0	1	---	1	±20%	±2 pF	4 VDC
BROWN	1	10	±1%	10	±1%	±0.1 pF	6 VDC
RED	2	10^2 or 100	±2%	10^2 or 100	±2%	---	10 VDC
ORANGE	3	10^3 or 1 K	±3%	10^3 or 1000	±3%	---	15 VDC
YELLOW	4	10^4 or 10 K	±4%	10^4 or 10,000	+100% –9%	---	20 VDC
GREEN	5	10^5 or 100 K	±½%	10^5 or 100,000	±5%	±0.5 pF	25 VDC
BLUE	6	10^6 or 1 M	±¼%	10^6 or 1,000,000	---	---	35 VDC
VIOLET	7	---	±1/10%	---	---	---	50 VDC
GRAY	8	---	---	10^{-2} or 0.01	+80% –20%	±0.25 pF	---
WHITE	9	---	---	10^{-1} or 0.1	±10%	±1 pF	3 VDC
GOLD	–	10^{-1} or 0.1	±5%	---	---	---	---
SILVER	–	10^{-2} or 0.01	±10%	---	---	---	---
NONE	–	---	±20%	---	±10%	±1 pF	---

1861-20 A

Figure 8-1. Color codes for resistors and capacitors.

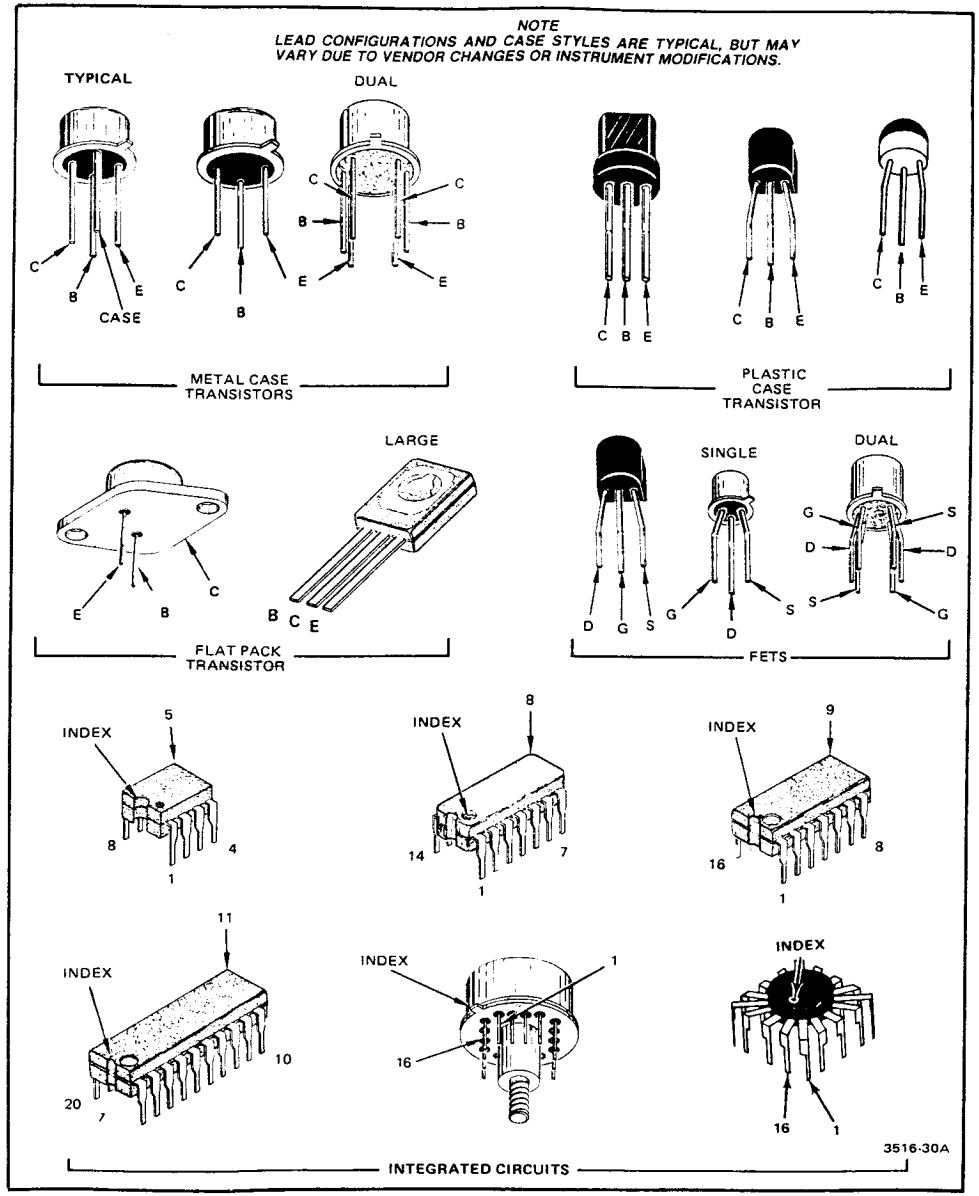

Figure 8-2. Semiconductor lead configurations.

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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:

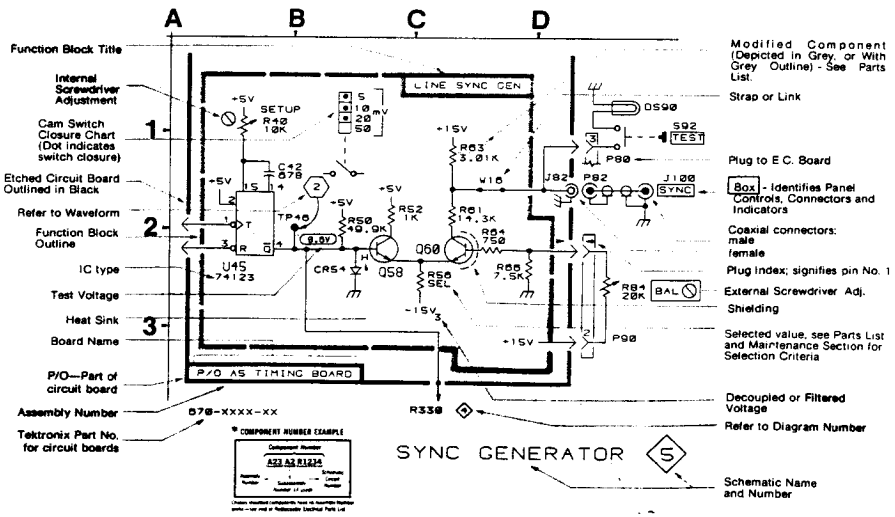
Capacitors = Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).
Resistors = Ohms (Ω).

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.



To identify any component mounted on a circuit board and to locate that component in the appropriate schematic diagram

1. Locate the Circuit Board Illustration

a. In the instrument identify the Assembly Number of the circuit board in question. The Assembly Number is usually printed on the upper left corner of the circuit board on the component side.

b. In the manual locate and pull out tabbed page whose title corresponds with the Assembly Number of the circuit board. Circuit board assembly numbers and board nomenclature are printed on the back side of the tabs (facing the rear of the manual).

2. Determine the Circuit Nu

a. Compare the circuit b the desired componer tion.

b. Scan the table adjacer find the Circuit Numb

c. Determine the Schen component is located

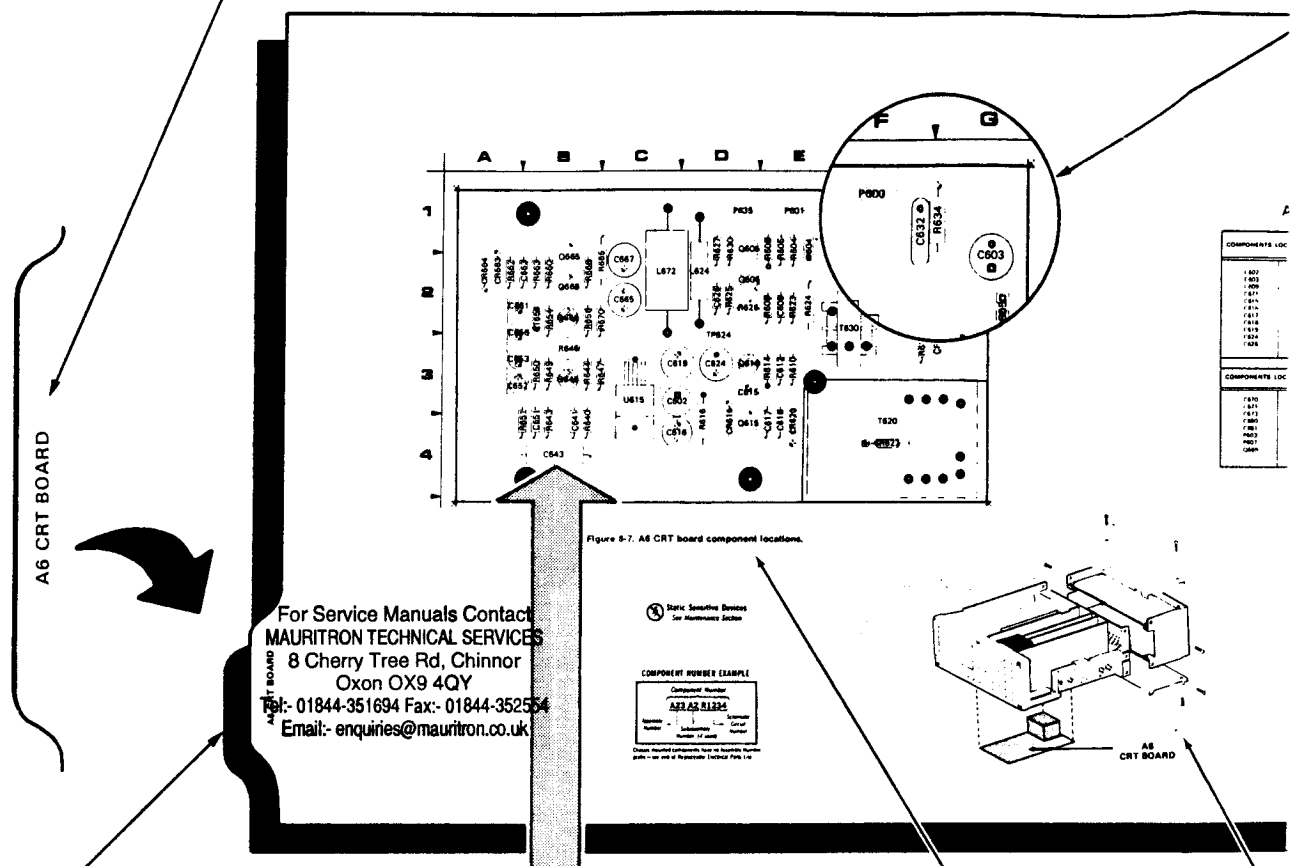


Figure 8-7. A6 CRT board component locations.

PULL OUT PAGE TABS FOR CIRCUIT BOARD ILLUSTRATION

ASSEMBLY NUMBER AND CIRCUIT BOARD NAME

ILLUSTRATI INSTRUMENT BOARD LOC

5. Locate the Component on the Circuit Board

a. In the manual, locate and pull out the tabbed page whose title and Assembly Number correspond with the desired circuit board. This information is on the back side of the tabs.

b. Using the Circuit Number and grid coordinates, locate the component on the Circuit Board Illustration.

c. In the circuit board location illustration, determine the location of the circuit board in the instrument.

d. Find the circuit board in the instrument and compare it with its illustration in the manual to locate the desired component on the board.

4. Determine the Circuit Board Illustration and Comp Location

a. From the schematic diagram, determine the A Number of the circuit board on which the comp mounted. This information is boxed and located ir of the heavy line that distinguishes the board o

b. Scan the Component Location Table for the A Number just determined and find the Circuit Numl desired component.

c. Under the BOARD LOCATION column, read coordinates for the desired component.

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Figure 8-3. Loc circuit board ill

ard Illustration

t identify the Assembly Number of the
estion. The Assembly Number is usually
per left corner of the circuit board on the

ate and pull out tabbed page whose title
the Assembly Number of the circuit
oard assembly numbers and board
e printed on the back side of the tabs
f the manual).

2. Determine the Circuit Number

a. Compare the circuit board with its illustration and locate the desired component by area and shape on the illustration.

b. Scan the table adjacent to the Circuit Board Illustration and find the Circuit Number of the desired component.

c. Determine the Schematic Diagram Number in which the component is located.

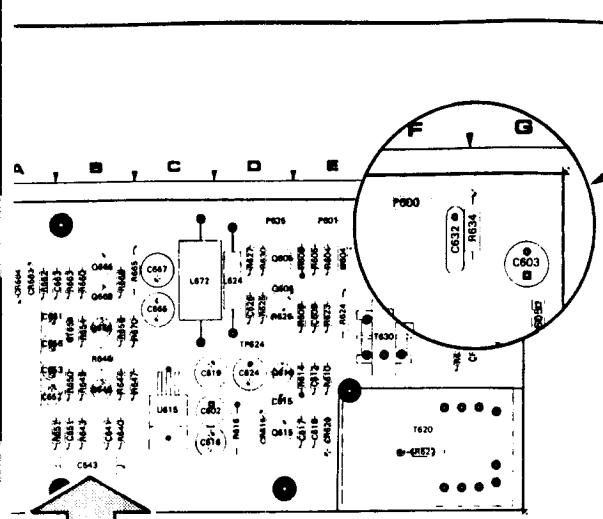
A6 CRT B

COMPONENTS LOCATED ON SCHEM

C602	C632
C603	C641
C609	C643
C671	C651
C615	
C616	Q606
C617	Q610
C618	Q615
C619	Q645
C624	Q656
C626	Q665

COMPONENTS LOCATED ON SCHEM

C670	Q670
C671	Q672
C673	Q673
C680	
C681	R671
P603	R673
P607	R674
Q669	R675



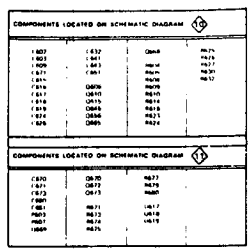
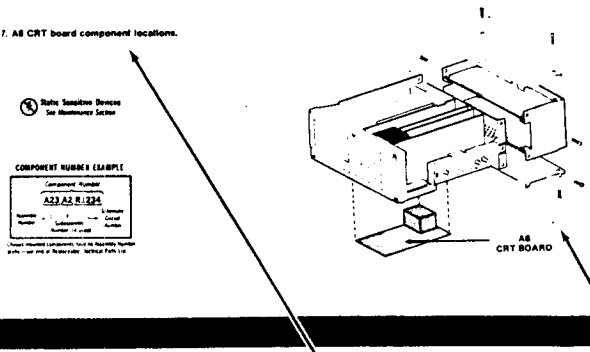


Figure 8-7. A6 CRT board component locations.



MANUAL BINDER

CRT CIR(

A6 ASSEMBLY

CIRCUIT NUMBER	SCHEM LOCATION
C602	2C
C603	1C
C609	4E
C612	7C
C615	7C
C616	2C
C617	7D
C618	7E
C619	6E
C624	4F
C626	7G
C632	8G
C643	3D
C651	3E

Q606	4E
Q610	7C
Q615	7D
Q645	3E

CHASSIS MOUNTED P

CIRCUIT NUMBER	SCHEM LOCATION
L635	51

ASSEMBLY NUMBER AND CIRCUIT BOARD NAME

ILLUSTRATION FOR INSTRUMENT CIRCUIT BOARD LOCATION

4. Determine the Circuit Board Illustration and Component Location

a. From the schematic diagram, determine the Assembly Number of the circuit board on which the component is mounted. This information is boxed and located in a corner of the heavy line that distinguishes the board outline.

b. Scan the Component Location Table for the Assembly Number just determined and find the Circuit Number of the desired component.

c. Under the BOARD LOCATION column, read the grid coordinates for the desired component.

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Figure 8-3. Locating components on schematic diagrams and circuit board illustrations.

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3. Locate the Component on the

a. Locate and pull out tabbed
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determined in the table. Sch
and numbers are printed
(facing the front of the mar

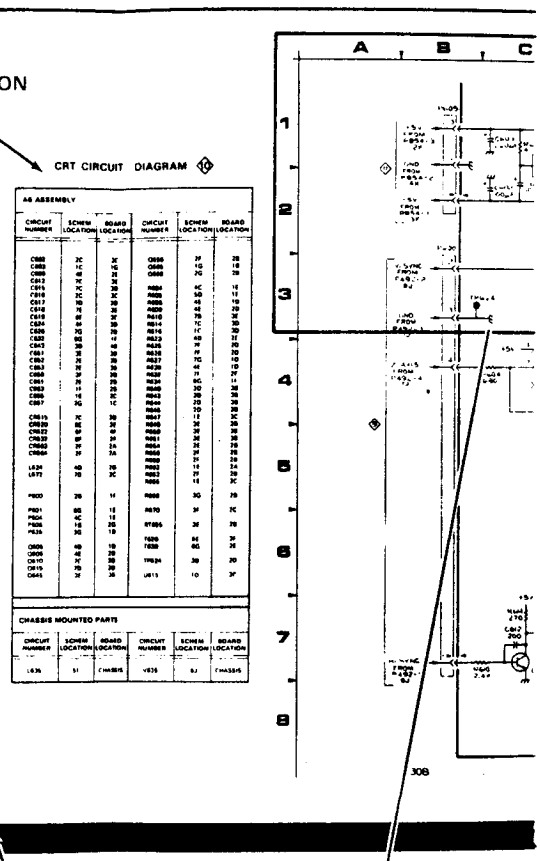
b. Scan the Component Loc
schematic diagram and fir
desired component.

A6 CRT BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 10			
C602	C632	Q668	R625
C603	C641		R626
C609	C643	R604	R627
C671	C651	R605	R630
C615		R608	R632
C616	Q606	R609	
C617	Q610	R610	
C618	Q615	R614	
C619	Q645	R616	
C624	Q656	R623	
C626	Q665	R624	

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 11			
C670	Q670	R677	
C671	Q672	R679	
C673	Q673	R680	
C680			
C681	R671	U617	
P603	R673	U618	
P607	R674	U619	
Q669	R675		

COMPONENT LOCATION TABLE



MANUAL BINDER

CRT CIRCUIT DIAGRAM 10

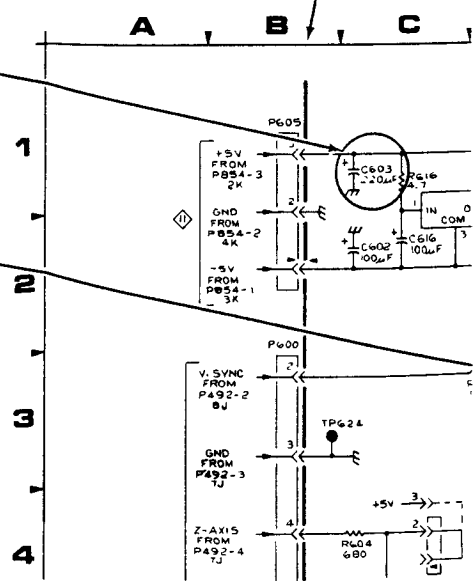
MANUAL BINDER

A6 ASSEMBLY

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C602	2C	3C	Q656	2F	2B
C603	1C	1G	Q665	1G	1B
C609	4E	[illegible]	Q668	2G	2B
C612	7C	3E			
C615	7C	3D	R604	4C	1E
C616	2C	3C	R605	5D	1E
C617	7D	3D	R608	4E	1D
C618	7E	3E	R609	4E	2D
C619	6E	3C	R610	7B	3E
C624	4F	3D	R614	7C	3D
C626	7G	2D	R616	1C	3D
C632	8G	1E	R623	4D	2E
C643	3D	4B	R625	7F	2D
C651	3E	3B	[illegible]	7F	2D
		3B	R627	7G	1D
			R630	4F	1D
Q606	4E	2D			
Q610	7C	3D	TP624	3B	2D
Q615	7D	3D			
Q645	3E	3B	U615	1D	3C

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
L635	51	CHASSIS	V635	6J	CHASSIS



ıematic diagrams and

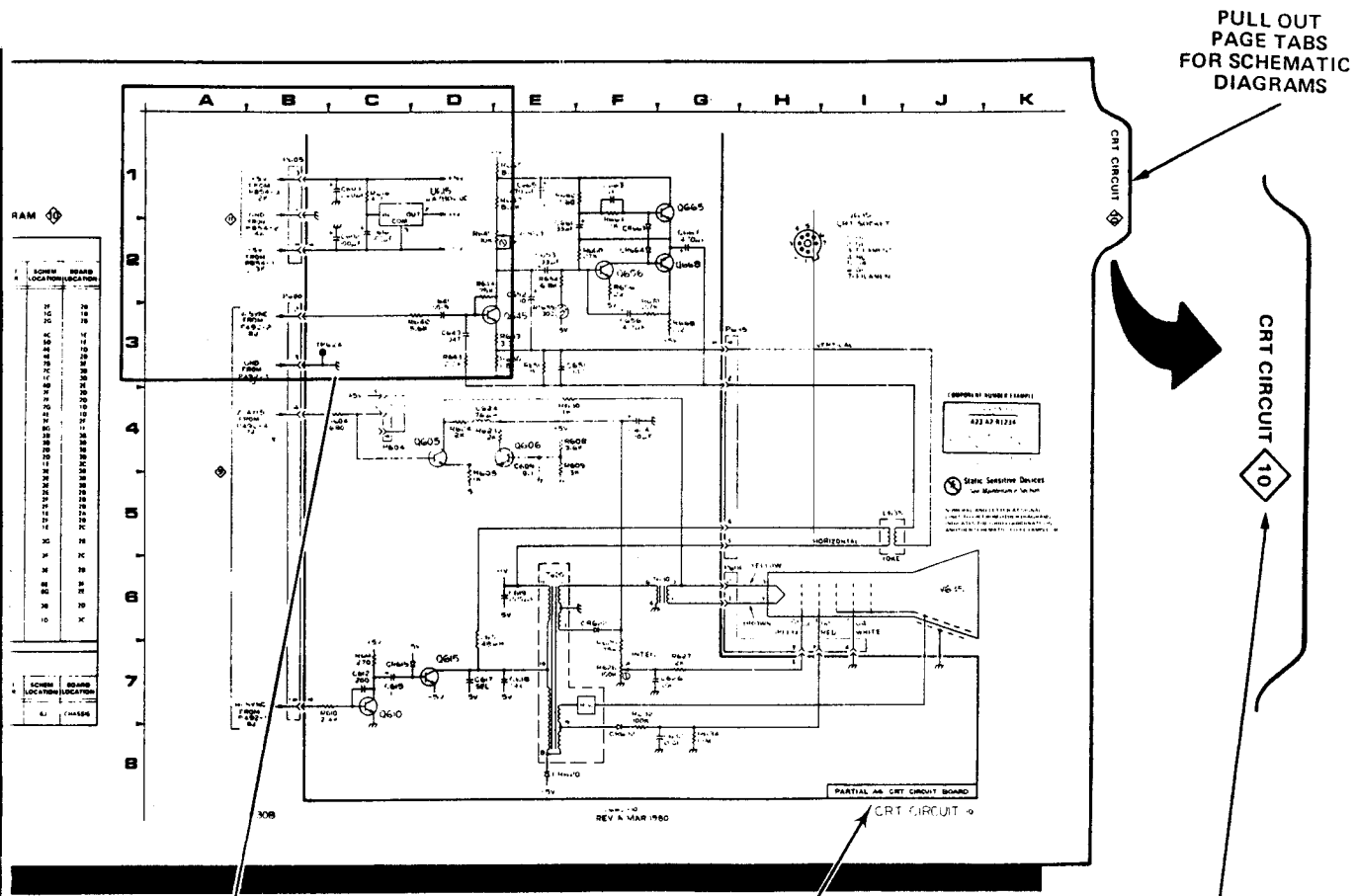
3. Locate the Component on the Schematic Diagram

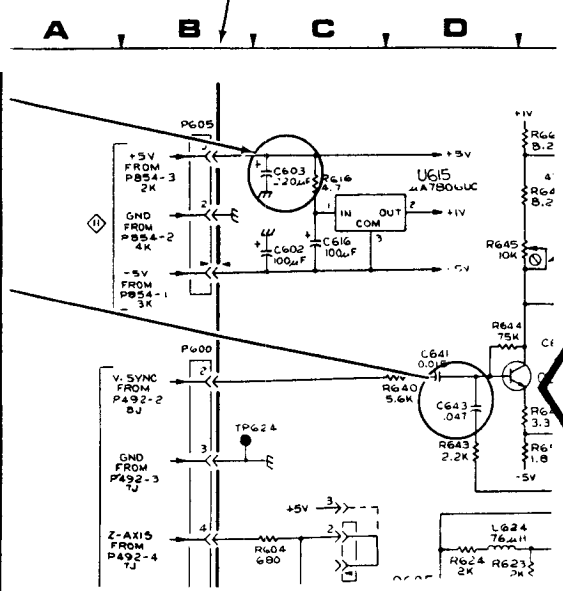
a. Locate and pull out tabbed page whose number and title correspond with the Schematic Diagram Number just determined in the table. Schematic diagram nomenclature and numbers are printed on the front side of the tabs (facing the front of the manual).

b. Scan the Component Location Table adjacent to the schematic diagram and find the Circuit Number of the desired component.

c. Under the SCHEM LOCATION column, read the grid coordinates for the desired component.

d. Using the Circuit Number and grid coordinates, locate the component on the schematic diagram.





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To identify any component in a schematic diagram and to locate that component on its respective circuit board.

3516-81A

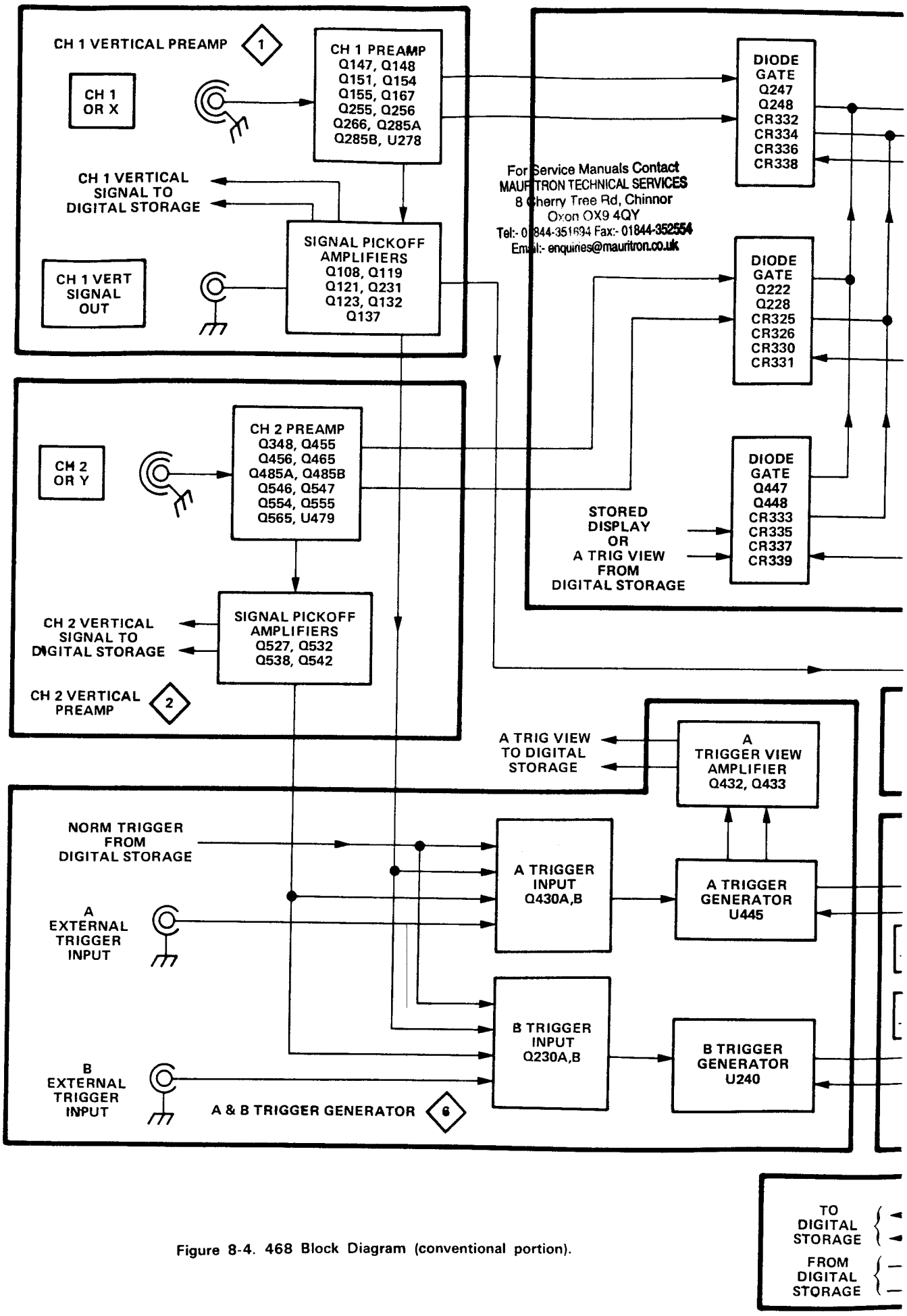
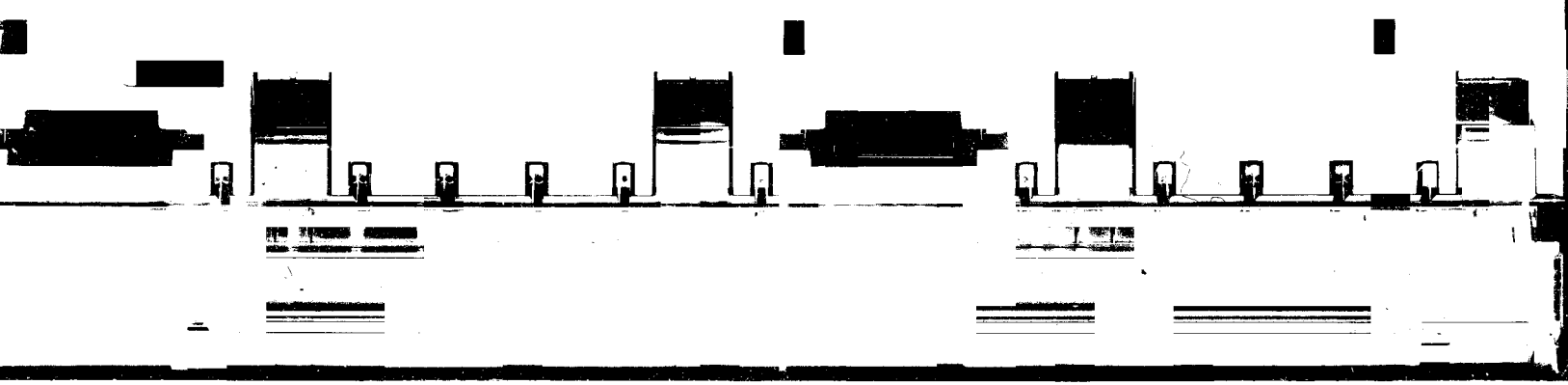


Figure 8-4. 468 Block Diagram (conventional portion).



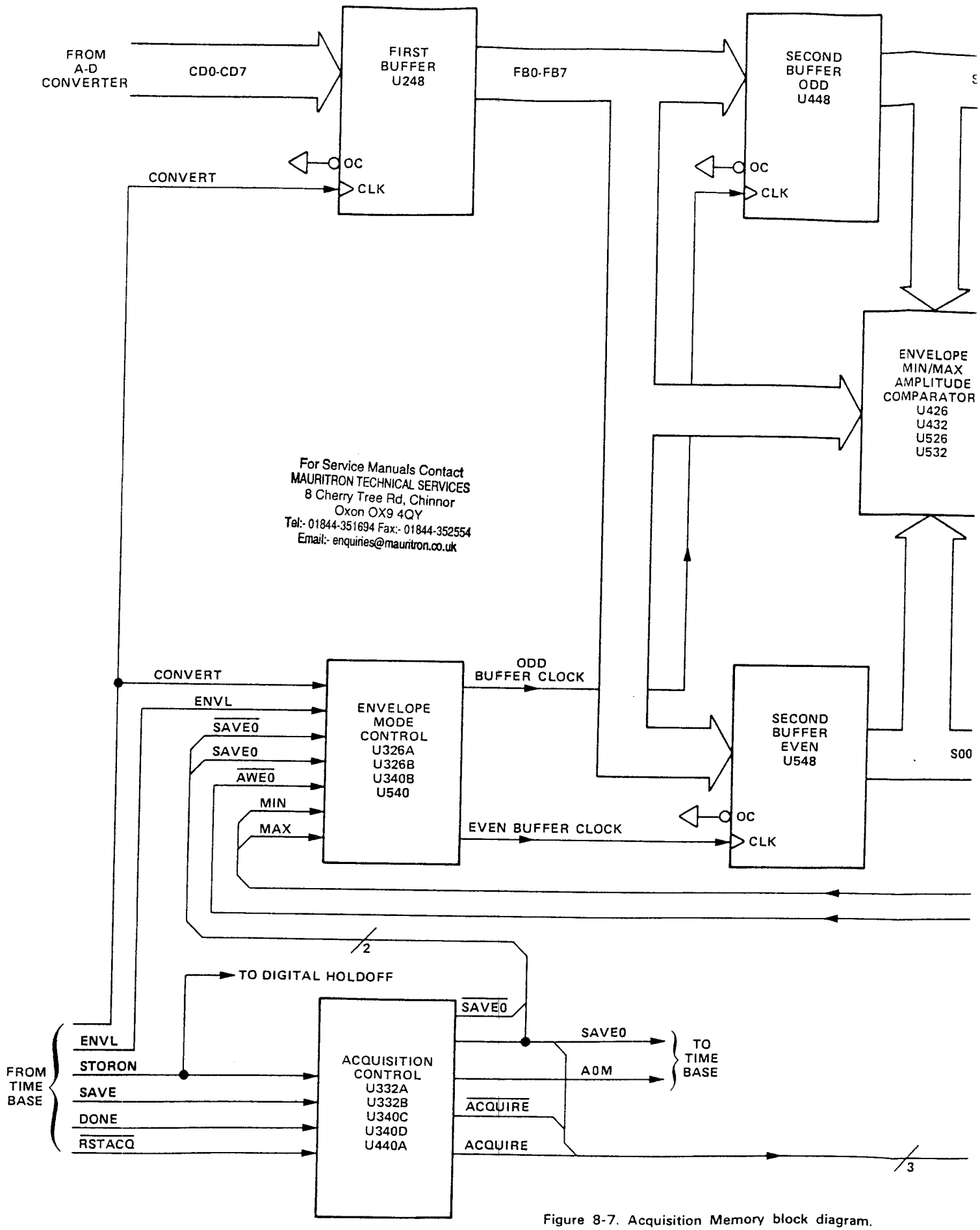


Figure 8-7. Acquisition Memory block diagram.

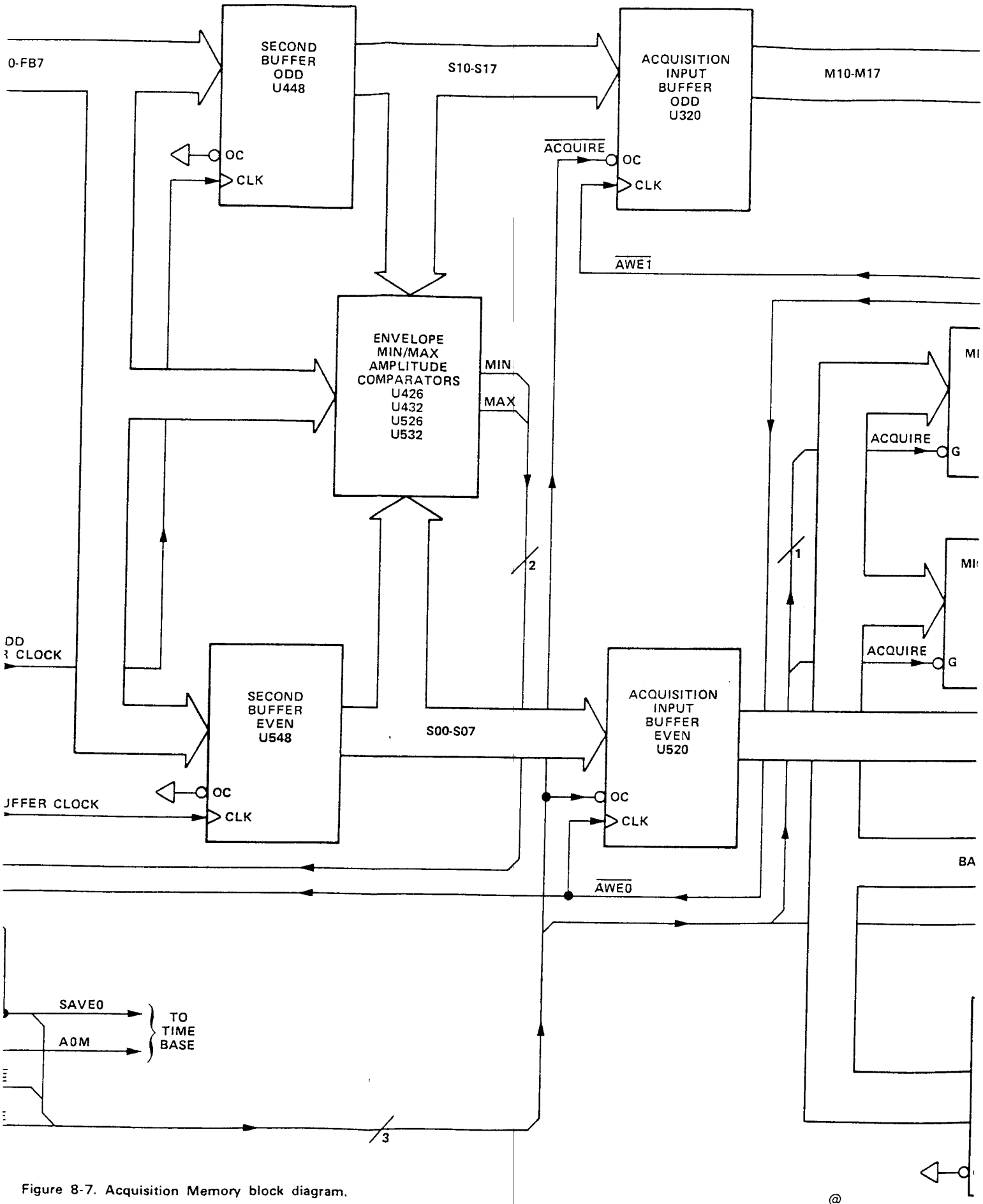
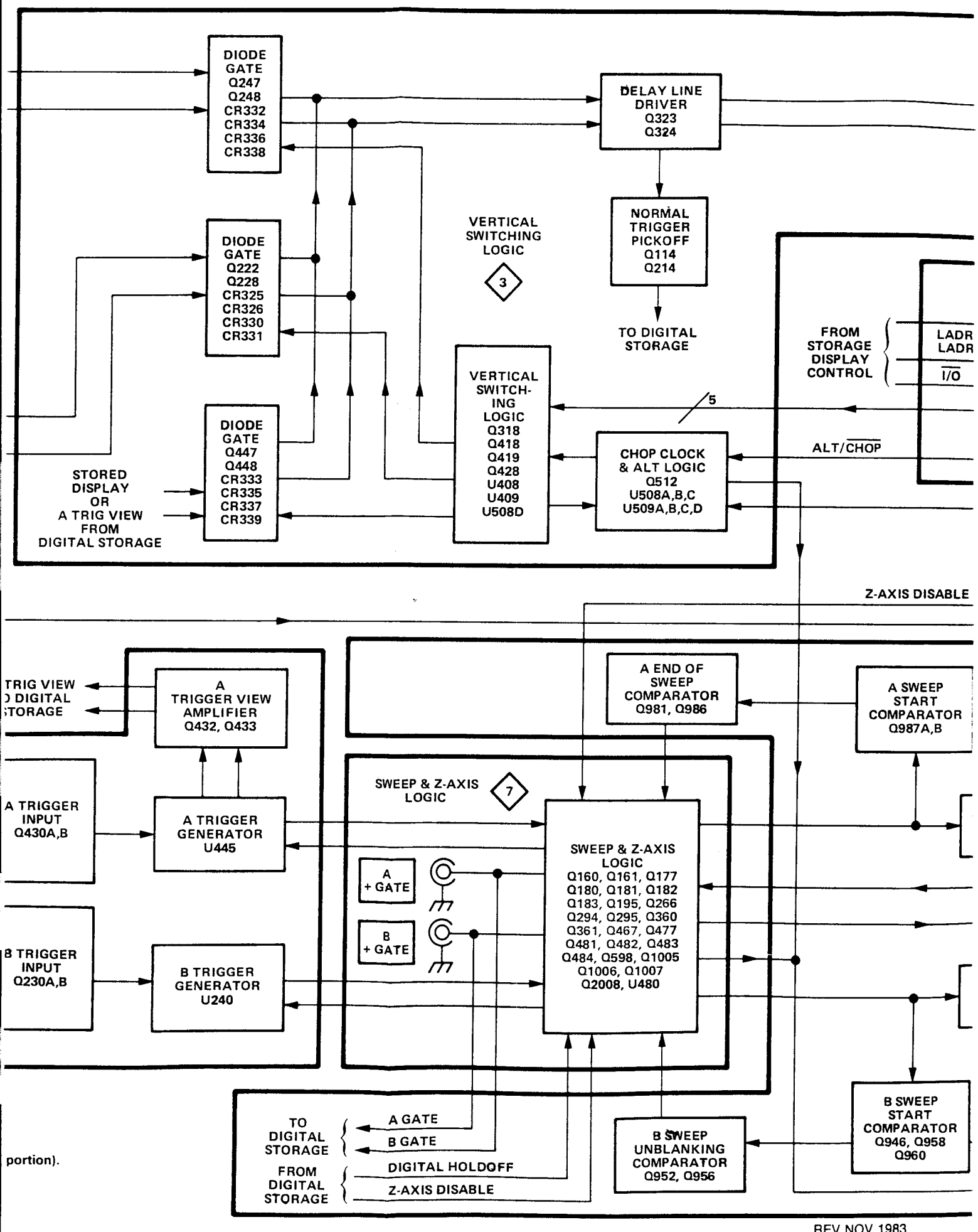


Figure 8-7. Acquisition Memory block diagram.



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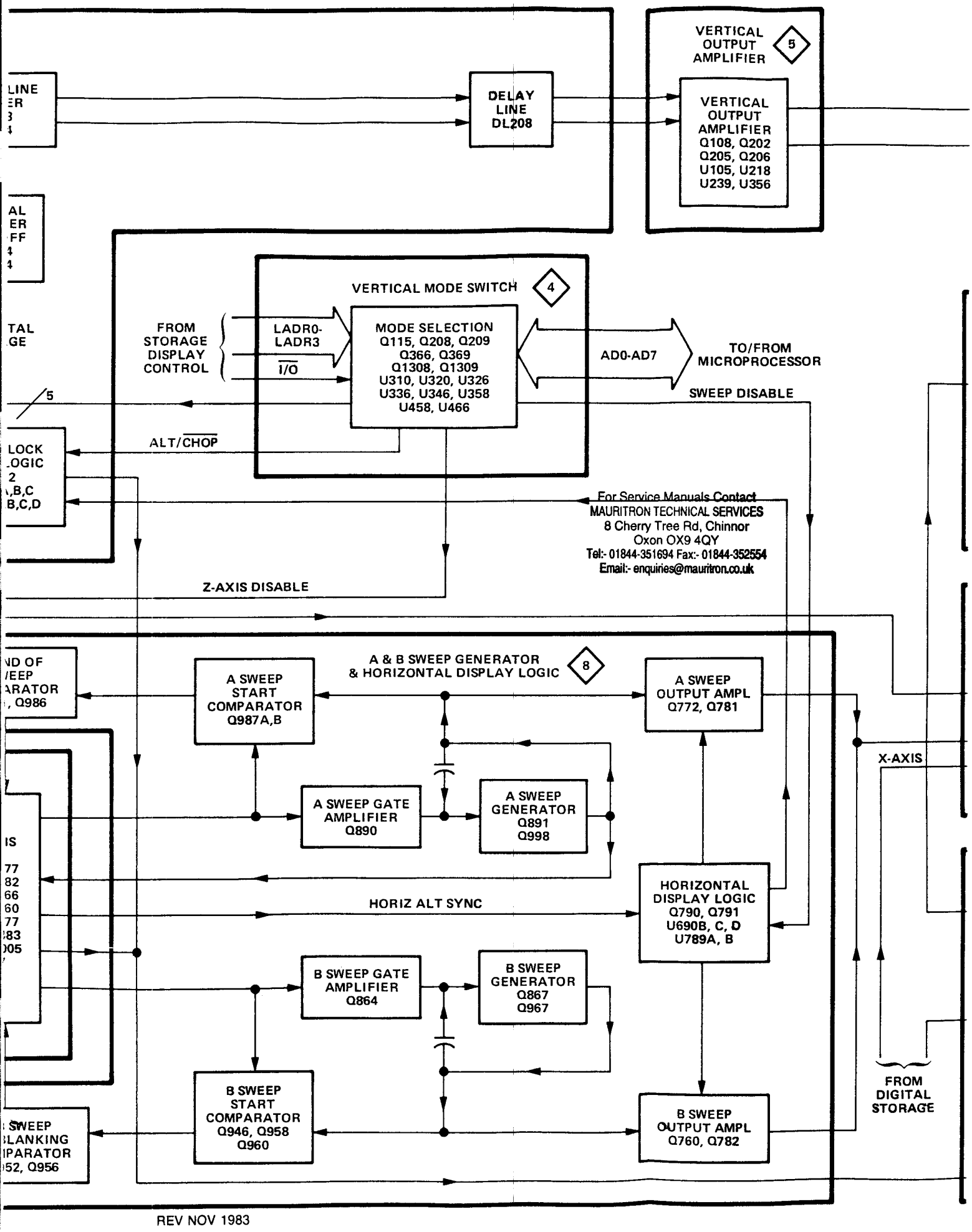
DELAY LINE DL208
VERTICAL OUTPUT AMPLIFIER
5
VERTICAL OUTPUT AMPLIFIER Q108, Q202 Q205, Q206 U105, U218 U239, U356
VERTICAL MODE SWITCH
4
FROM STORAGE DISPLAY CONTROL
LADR0-LADR3
I/O
MODE SELECTION Q115, Q208, Q209 Q366, Q369 Q1308, Q1309 U310, U320, U326 U336, U346, U358 U458, U466
AD0-AD7
TO/FROM MICROPROCESSOR
SWEEP DISABLE
ALT/CHOP
Z-AXIS DISABLE
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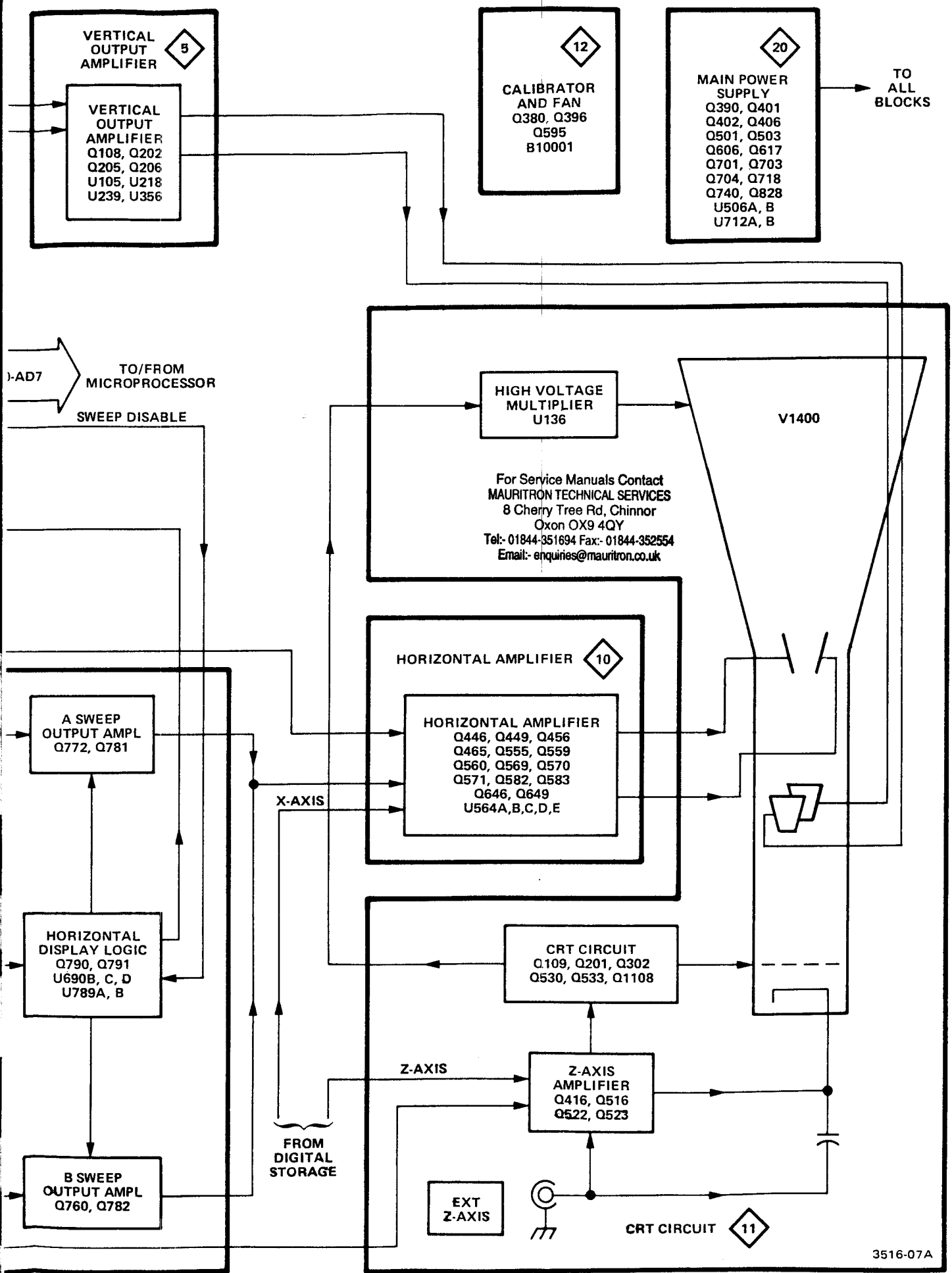
Email:- enquiries@mauritron.co.uk
A & B SWEEP GENERATOR & HORIZONTAL DISPLAY LOGIC
8
A SWEEP START COMPARATOR Q987A,B
A SWEEP OUTPUT AMPL Q772, Q781
A SWEEP GATE AMPLIFIER Q890
A SWEEP GENERATOR Q891 Q998
X-AXIS
HORIZONTAL DISPLAY LOGIC Q790, Q791 U690B, C, D U789A, B
HORIZ ALT SYNC
B SWEEP GATE AMPLIFIER Q864
B SWEEP GENERATOR Q867 Q967
B SWEEP START COMPARATOR Q946, Q958 Q960
B SWEEP OUTPUT AMPL Q760, Q782
FROM DIGITAL STORAGE

REV NOV 1983


VERTICAL OUTPUT AMPLIFIER
5
VERTICAL OUTPUT AMPLIFIER
Q108, Q202
Q205, Q206
U105, U218
U239, U356
12
CALIBRATOR AND FAN
Q380, Q396
Q595
B10001
20
MAIN POWER SUPPLY
Q390, Q401
Q402, Q406
Q501, Q503
Q606, Q617
Q701, Q703
Q704, Q718
Q740, Q828
U506A, B
U712A, B
TO ALL BLOCKS
)-AD7
TO/FROM MICROPROCESSOR
SWEEP DISABLE
HIGH VOLTAGE MULTIPLIER
U136
V1400
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Email:- enquiries@mauritron.co.uk
HORIZONTAL AMPLIFIER
10
HORIZONTAL AMPLIFIER
Q446, Q449, Q456
Q465, Q555, Q559
Q560, Q569, Q570
Q571, Q582, Q583
Q646, Q649
U564A,B,C,D,E
A SWEEP OUTPUT AMPL
Q772, Q781
X-AXIS
HORIZONTAL DISPLAY LOGIC
Q790, Q791
U690B, C, D
U789A, B
CRT CIRCUIT
Q109, Q201, Q302
Q530, Q533, Q1108
Z-AXIS
Z-AXIS AMPLIFIER
Q416, Q516
Q522, Q523
FROM DIGITAL STORAGE
B SWEEP OUTPUT AMPL
Q760, Q782
EXT Z-AXIS
CRT CIRCUIT
11
3516-07A

FIG. 8-4

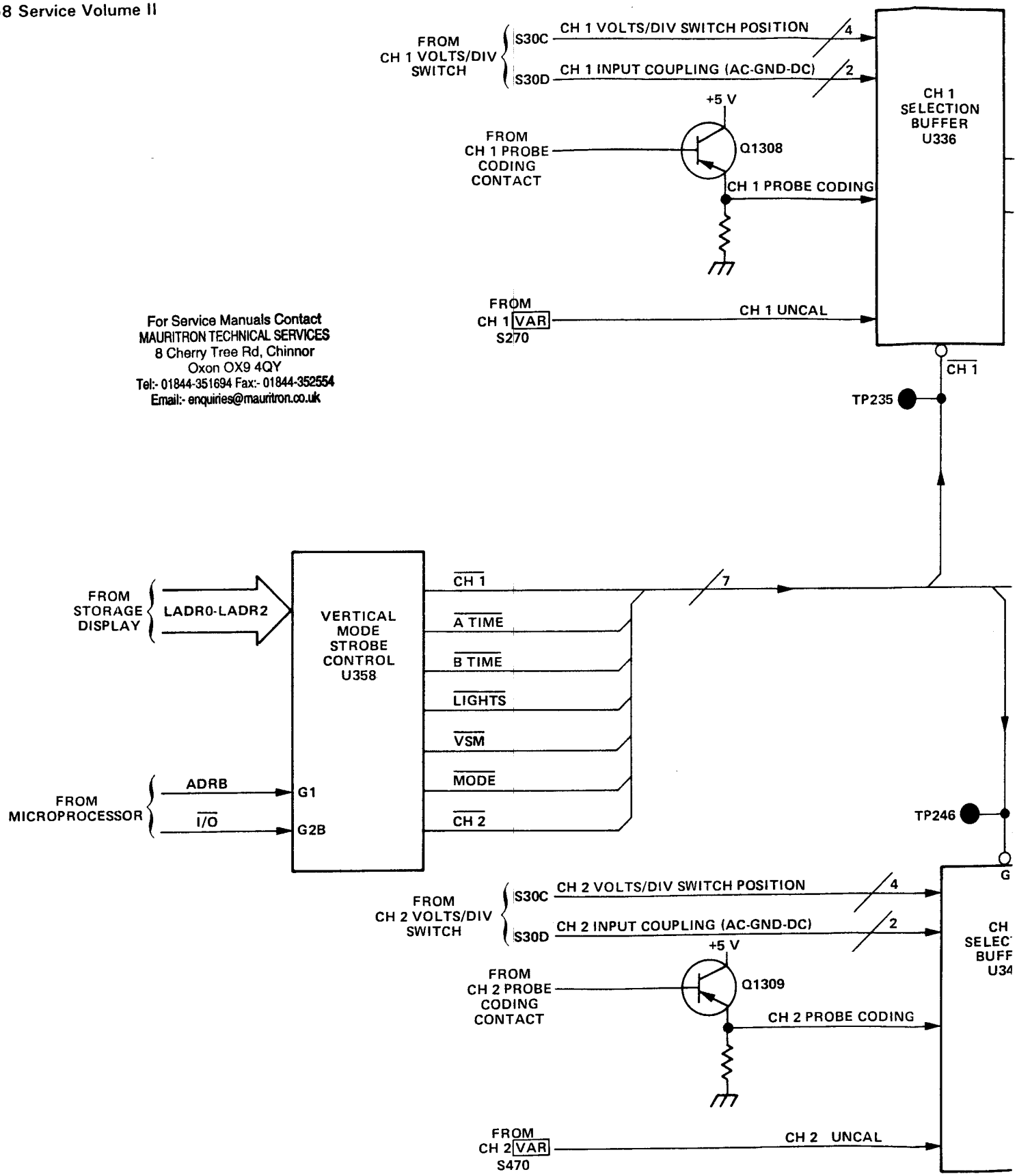
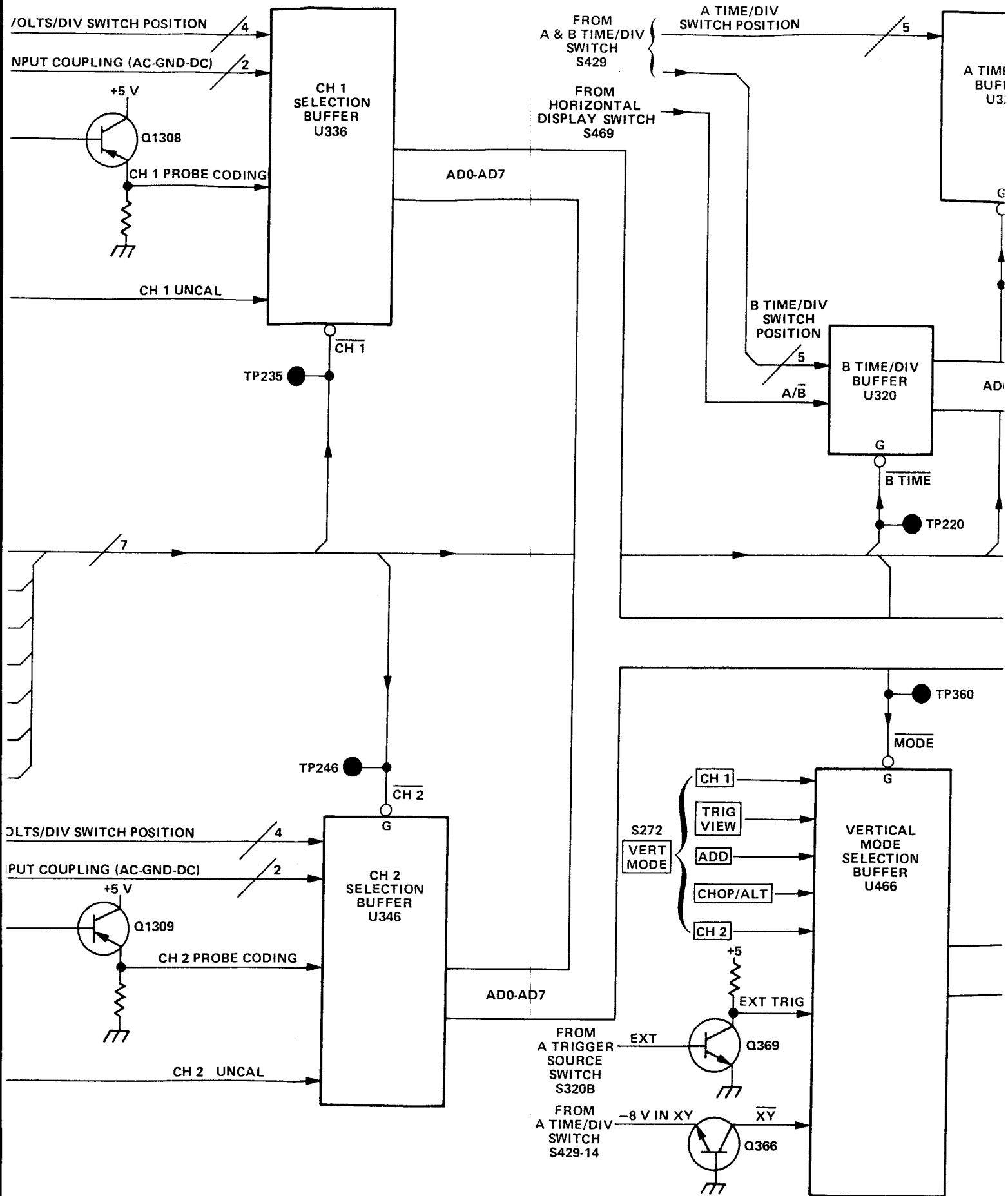
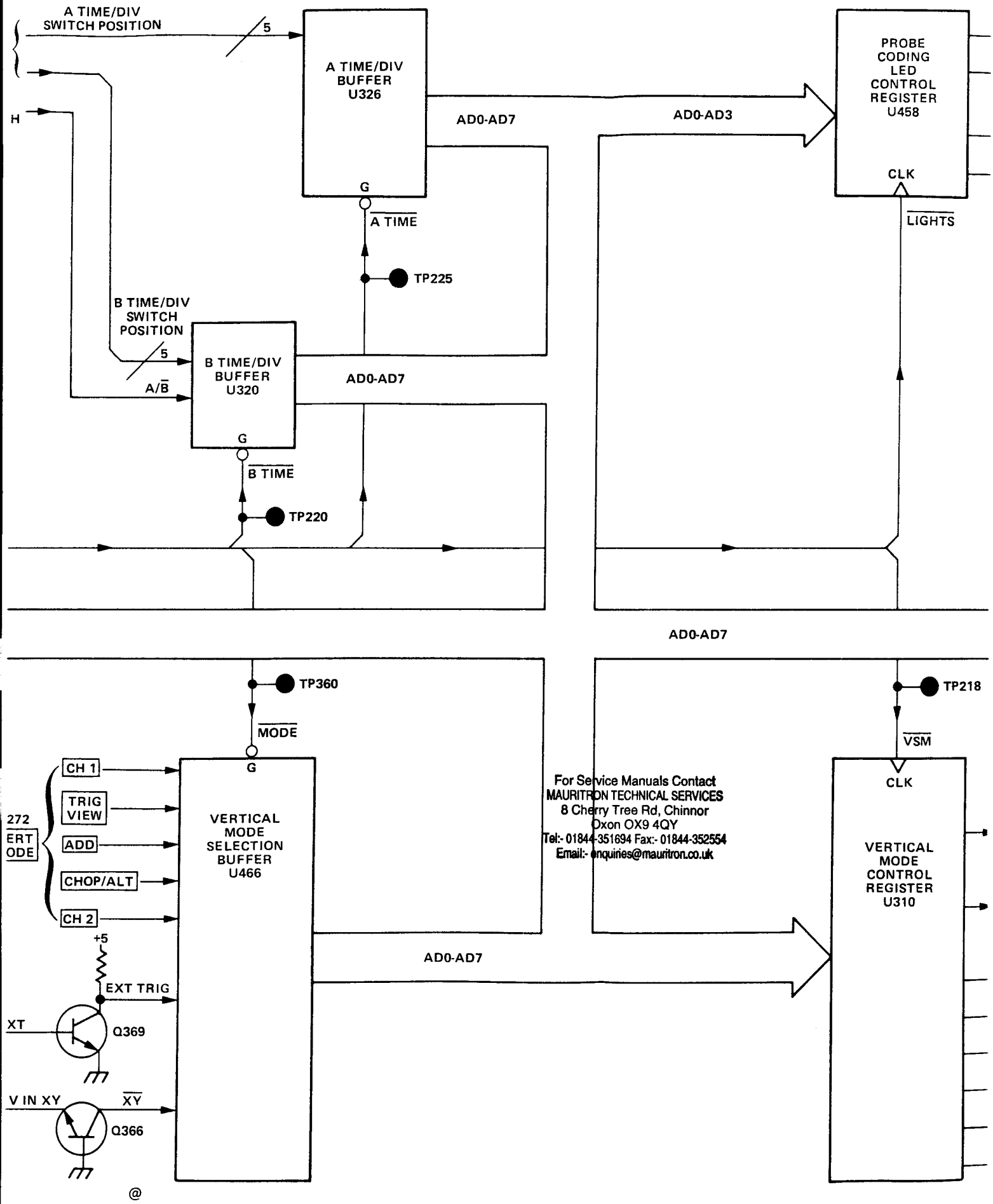


Figure 8-5. Vertical Mode Switch block diagram.



ode Switch block diagram.

@



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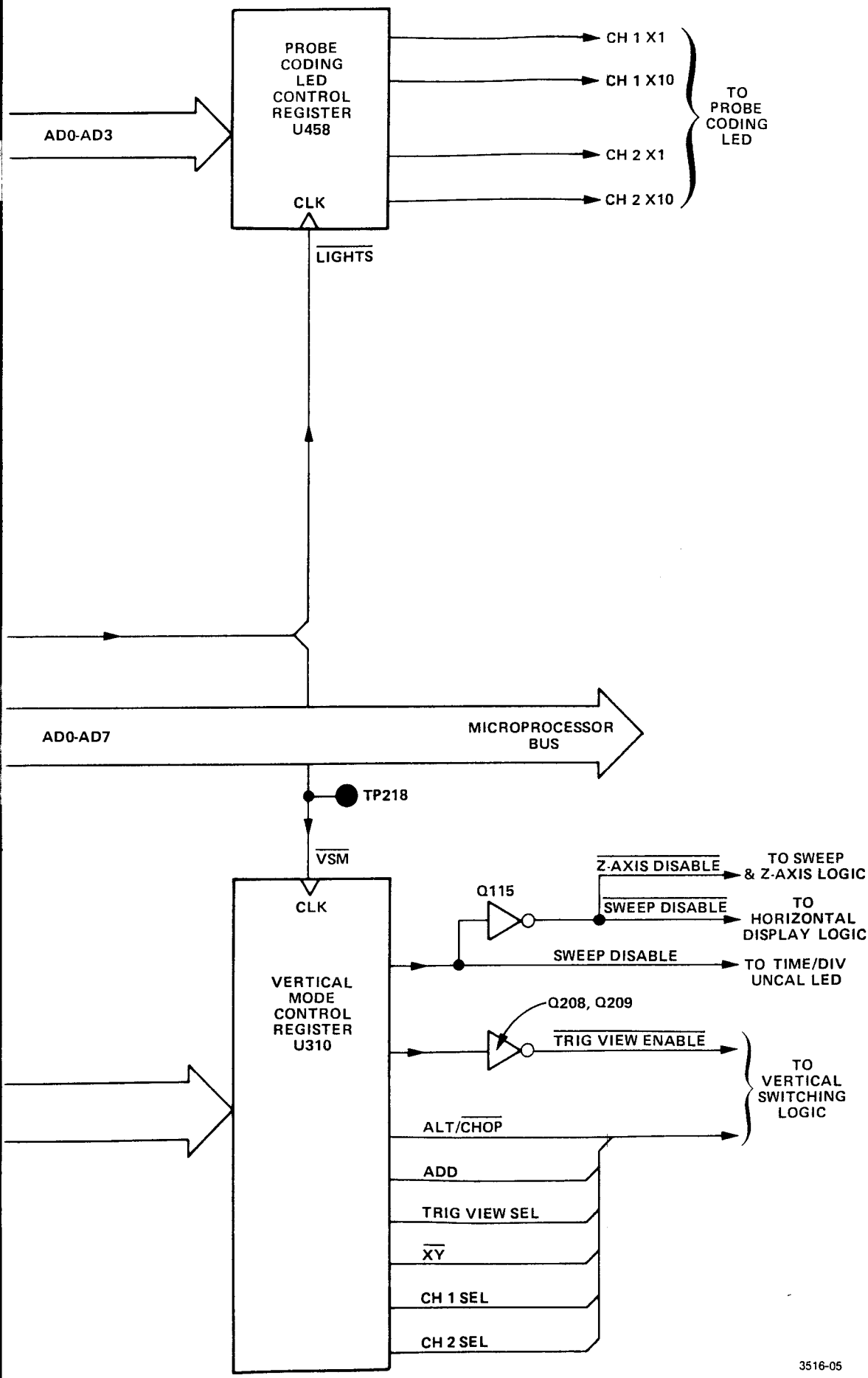
@


PROBE CODING LED CONTROL REGISTER U458
AD0-AD3
CLK
LIGHTS
CH 1 X1
CH 1 X10
CH 2 X1
CH 2 X10
TO PROBE CODING LED
AD0-AD7
MICROPROCESSOR BUS
TP218
VSM
CLK
VERTICAL MODE CONTROL REGISTER U310
Q115
Z-AXIS DISABLE
TO SWEEP & Z-AXIS LOGIC
SWEEP DISABLE
TO HORIZONTAL DISPLAY LOGIC
SWEEP DISABLE
TO TIME/DIV UNCAL LED
Q208, Q209
TRIG VIEW ENABLE
TO VERTICAL SWITCHING LOGIC
ALT/CHOP
ADD
TRIG VIEW SEL
XY
CH 1 SEL
CH 2 SEL
3516-05

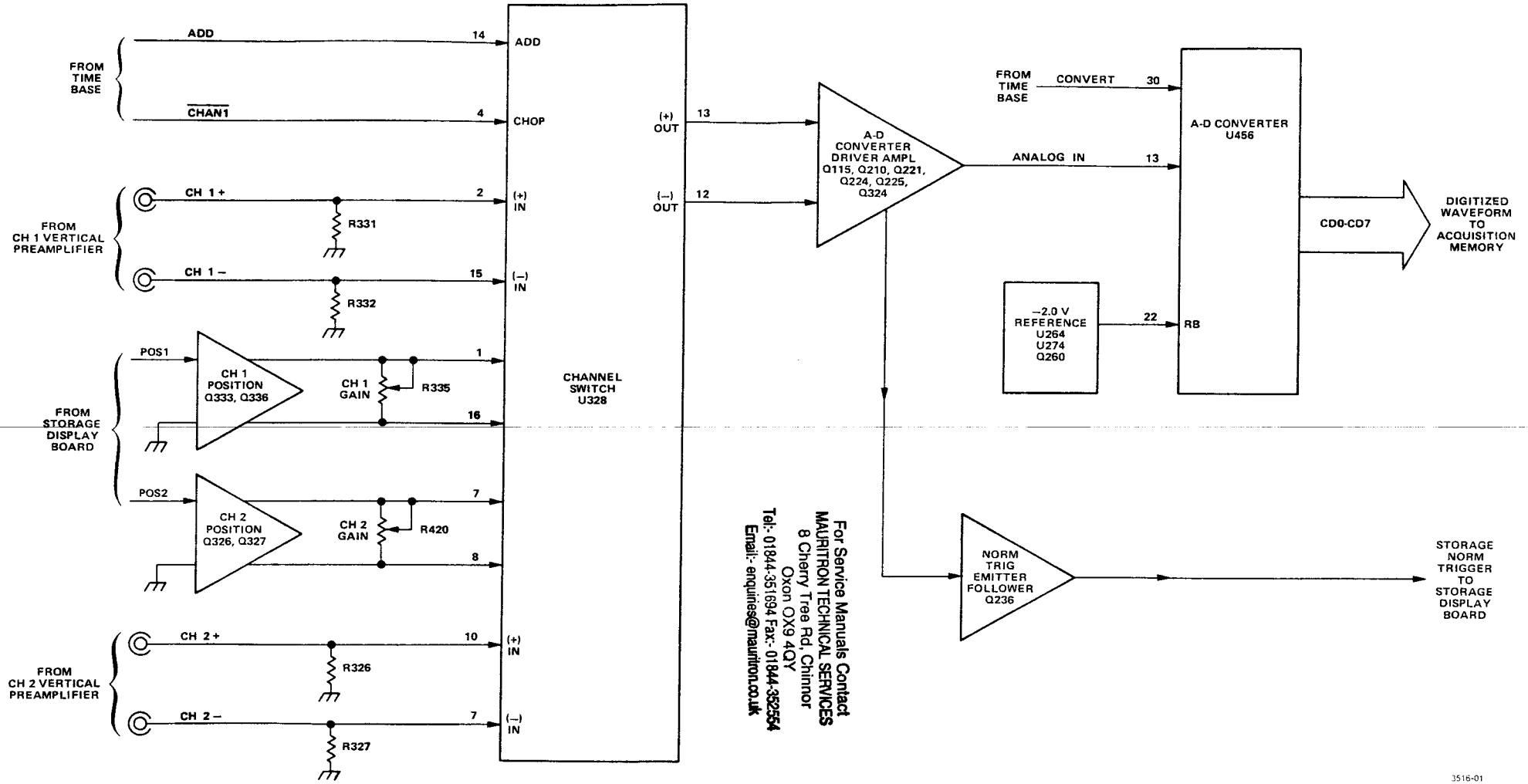


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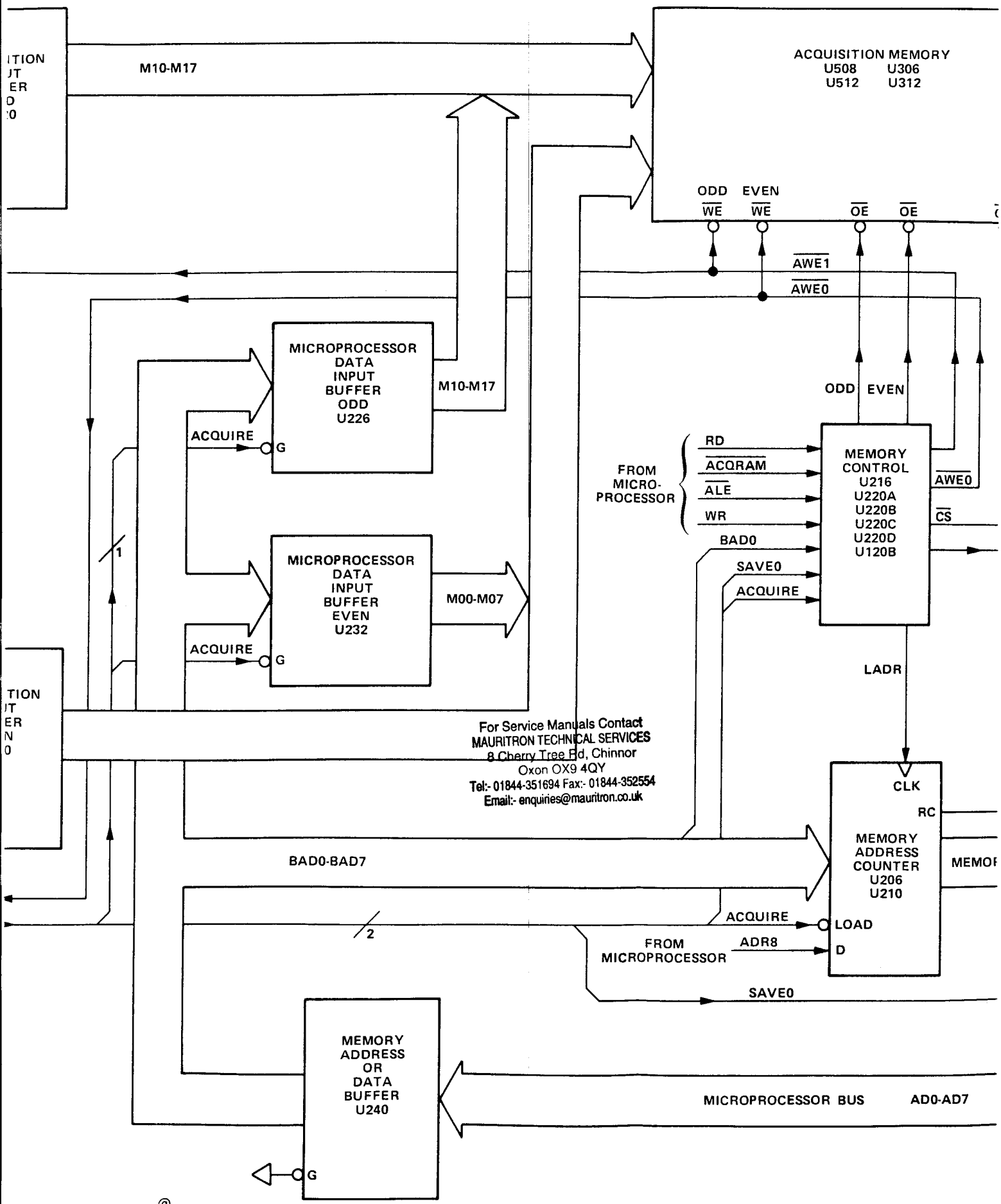
Figure 8-6. A/D Converter and Channel Switch block diagram.


ITION
JT
ER
D
:0
M10-M17
ACQUISITION MEMORY
U508 U306
U512 U312
ODD EVEN
WE WE
OE OE
AWE1
AWE0
MICROPROCESSOR DATA INPUT BUFFER ODD U226
M10-M17
ACQUIRE
G
ODD EVEN
FROM MICRO-PROCESSOR
RD
ACQRAM
ALE
WR
MEMORY CONTROL U216 U220A U220B U220C U220D U120B
AWE0
CS
BAD0
SAVE0
ACQUIRE
1
MICROPROCESSOR DATA INPUT BUFFER EVEN U232
M00-M07
ACQUIRE
G
LADR
TION
IT
ER
N
0
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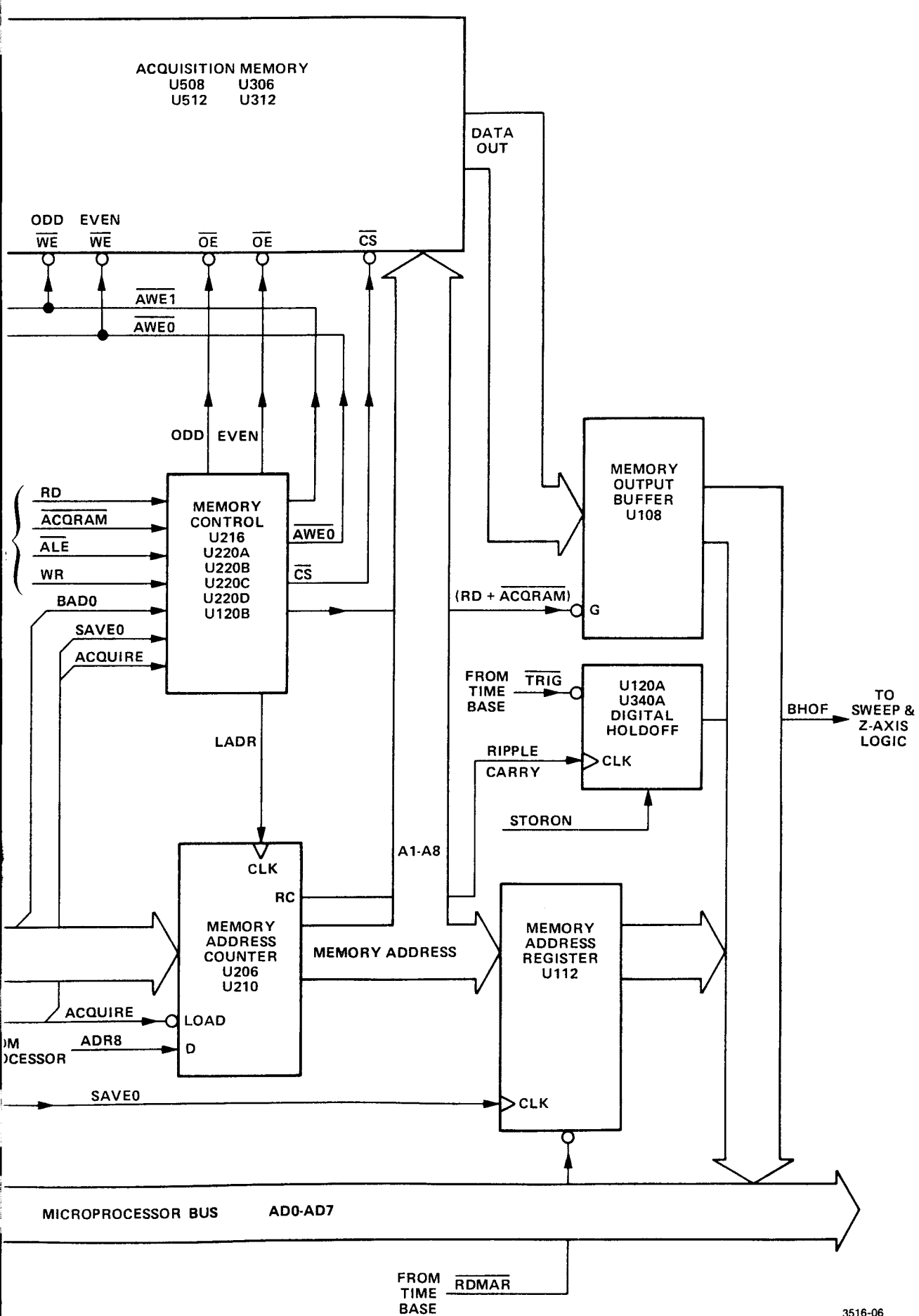
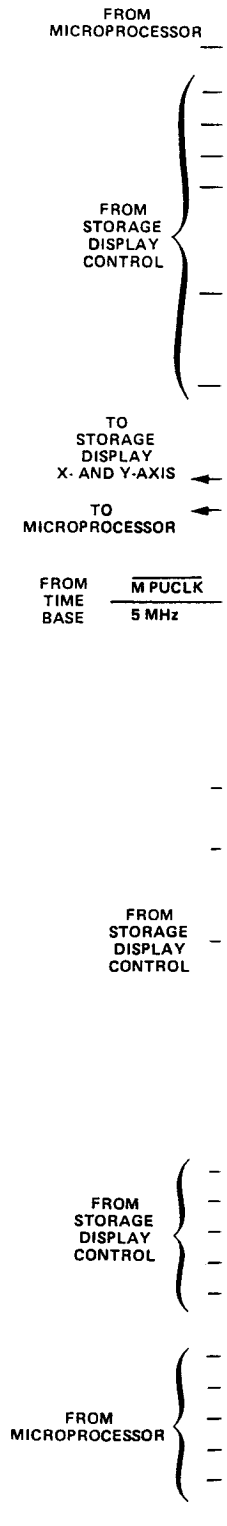
Email:- enquiries@mauritron.co.uk
CLK
RC
MEMORY ADDRESS COUNTER U206 U210
MEMOF
BAD0-BAD7
ACQUIRE
LOAD
2
FROM MICROPROCESSOR
ADR8
D
SAVE0
MEMORY ADDRESS OR DATA BUFFER U240
MICROPROCESSOR BUS
AD0-AD7
G
@


ACQUISITION MEMORY
U508 U306
U512 U312
DATA OUT
ODD WE
EVEN WE
OE
OE
CS
AWE1
AWE0
ODD
EVEN
RD
ACQRAM
ALE
WR
BAD0
SAVE0
ACQUIRE
MEMORY CONTROL
U216
U220A
U220B
U220C
U220D
U120B
AWE0
CS
MEMORY OUTPUT BUFFER U108
(RD + ACQRAM)
G
FROM TIME BASE
TRIG
U120A U340A DIGITAL HOLDOFF
RIPPLE CARRY
CLK
BHOF
TO SWEEP & Z-AXIS LOGIC
STORON
LADR
A1-A8
CLK
RC
MEMORY ADDRESS COUNTER
U206
U210
MEMORY ADDRESS
MEMORY ADDRESS REGISTER
U112
ACQUIRE
LOAD
ADR8
D
SAVE0
CLK
MICROPROCESSOR BUS
AD0-AD7
FROM TIME BASE
RDMAR
3516-06



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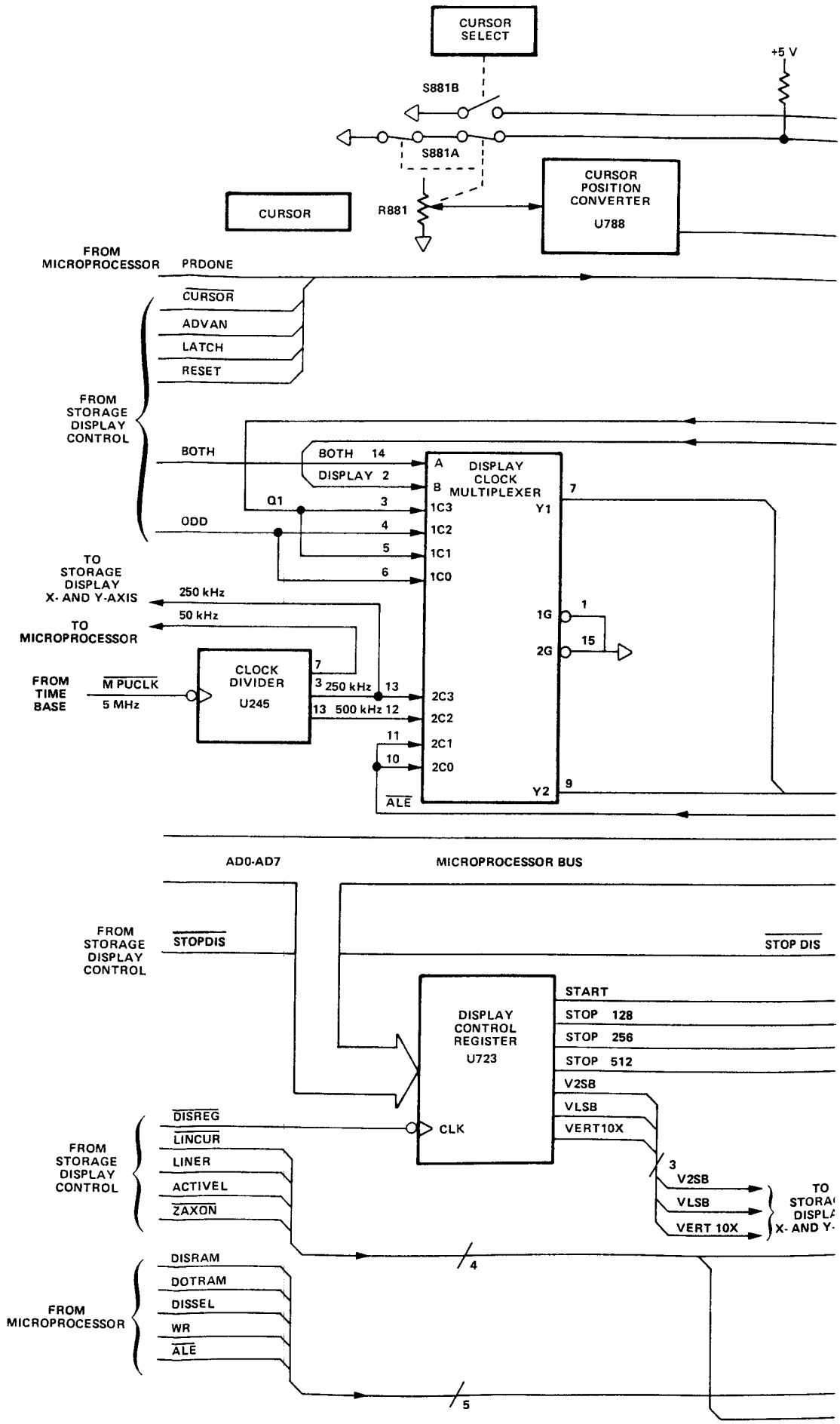


Figure 8-8. Storage Display Ram and Z A.

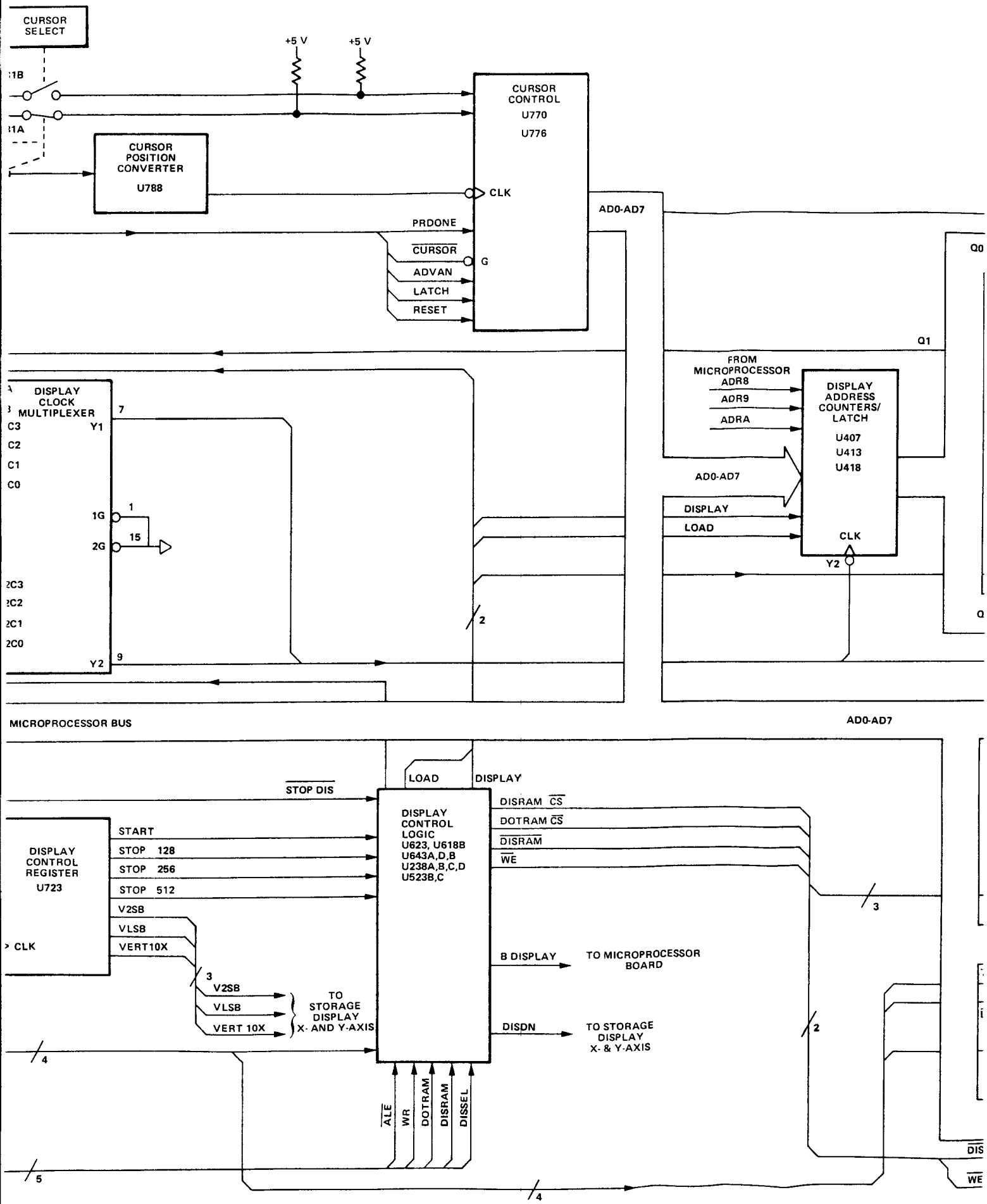
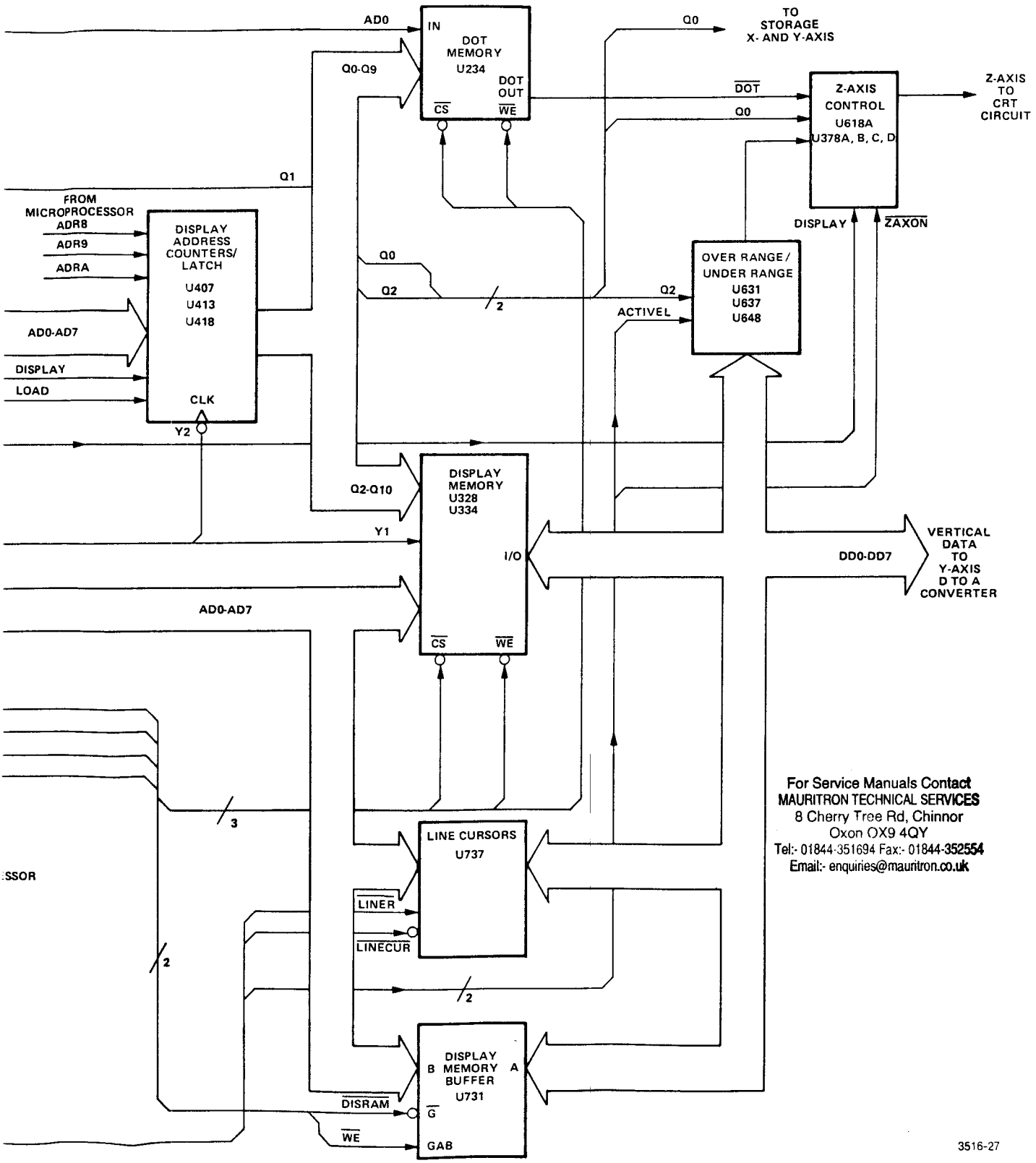


Figure 8-8. Storage Display Ram and Z Axis block diagram.



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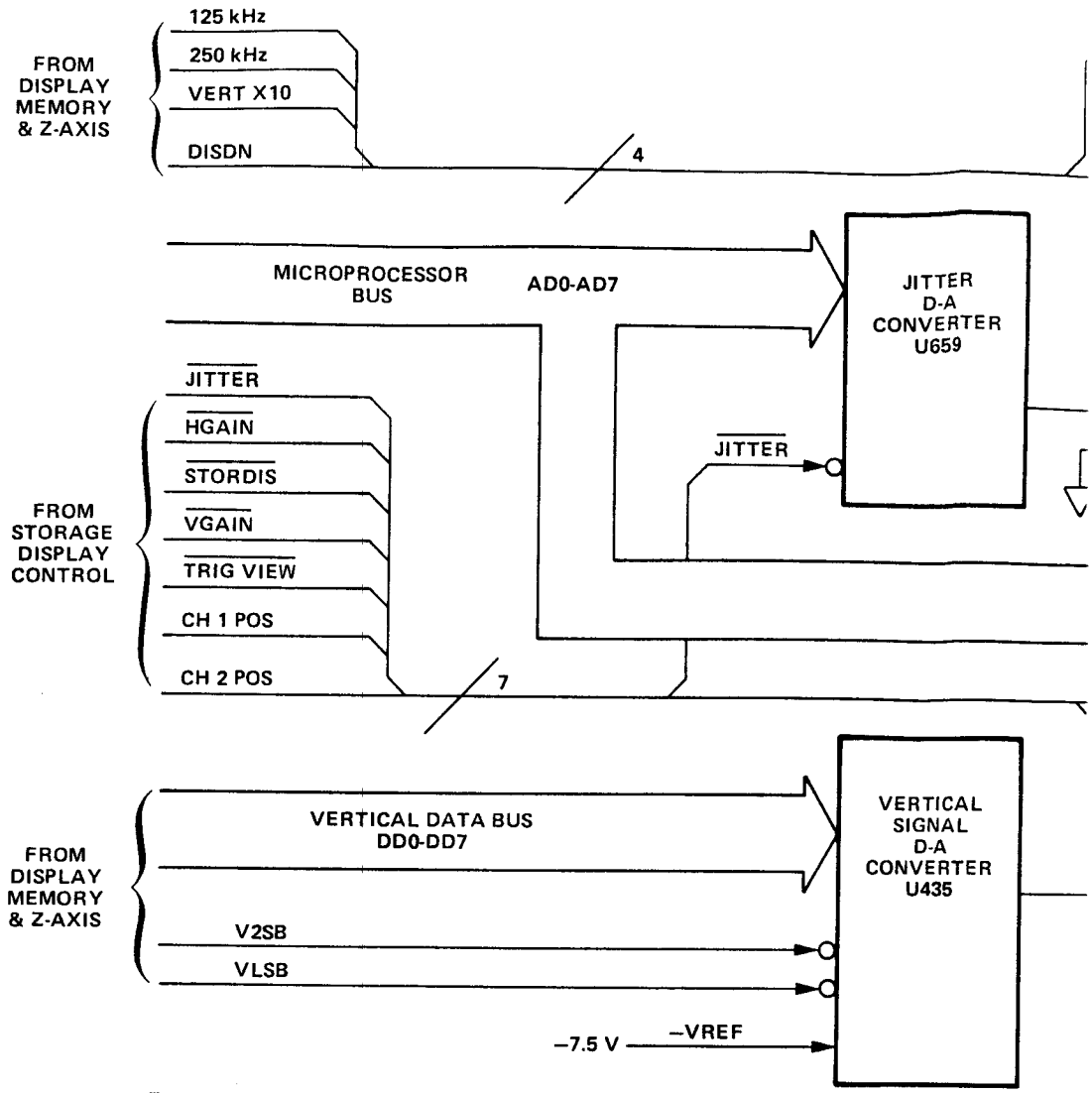

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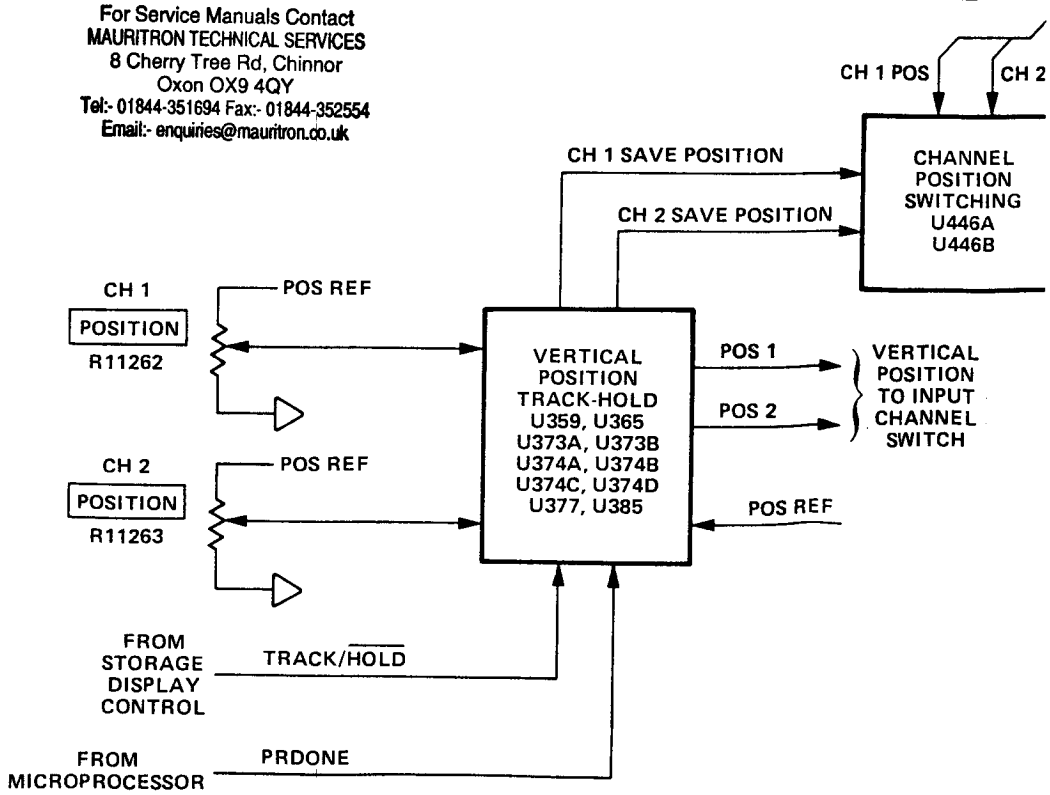


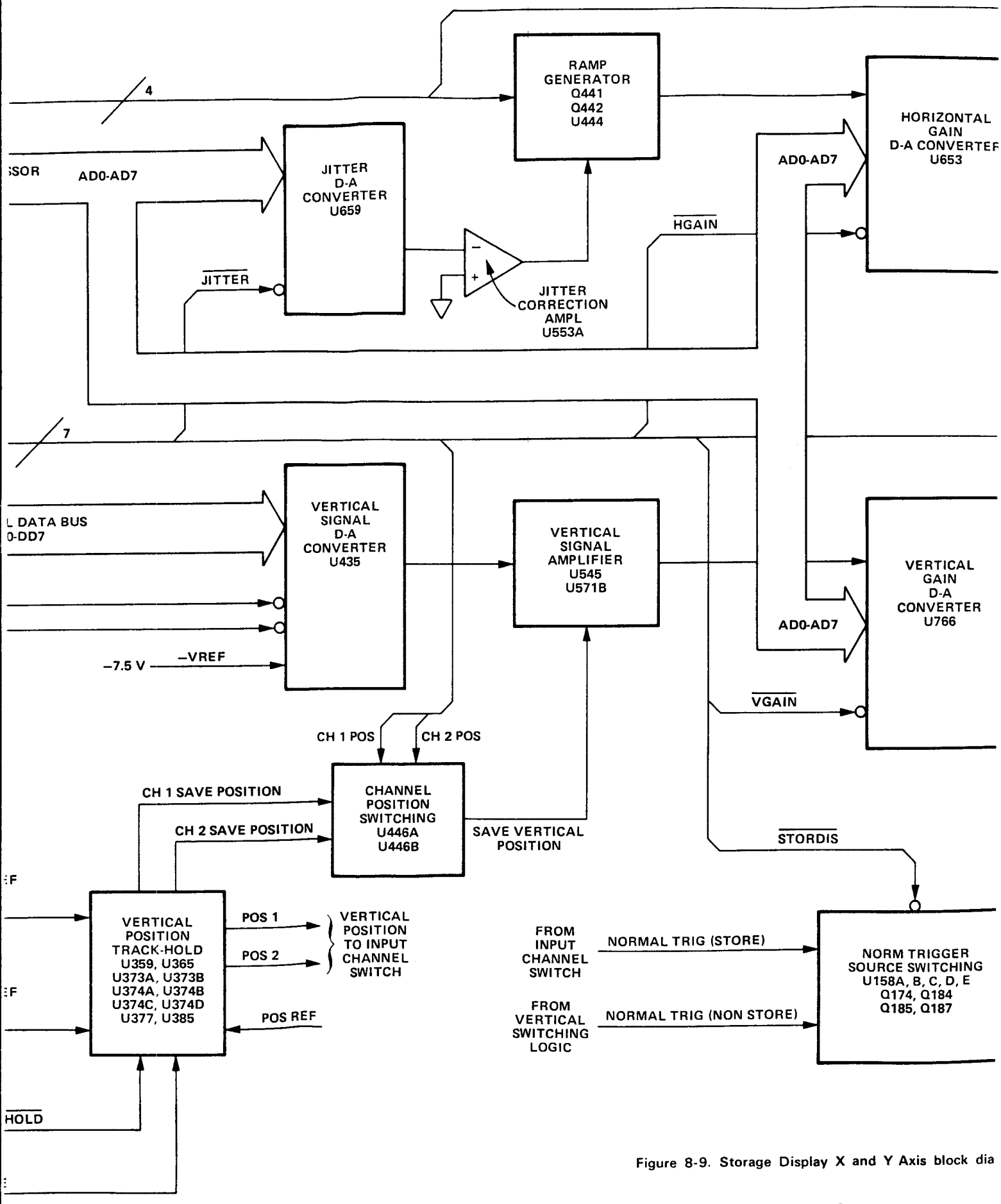
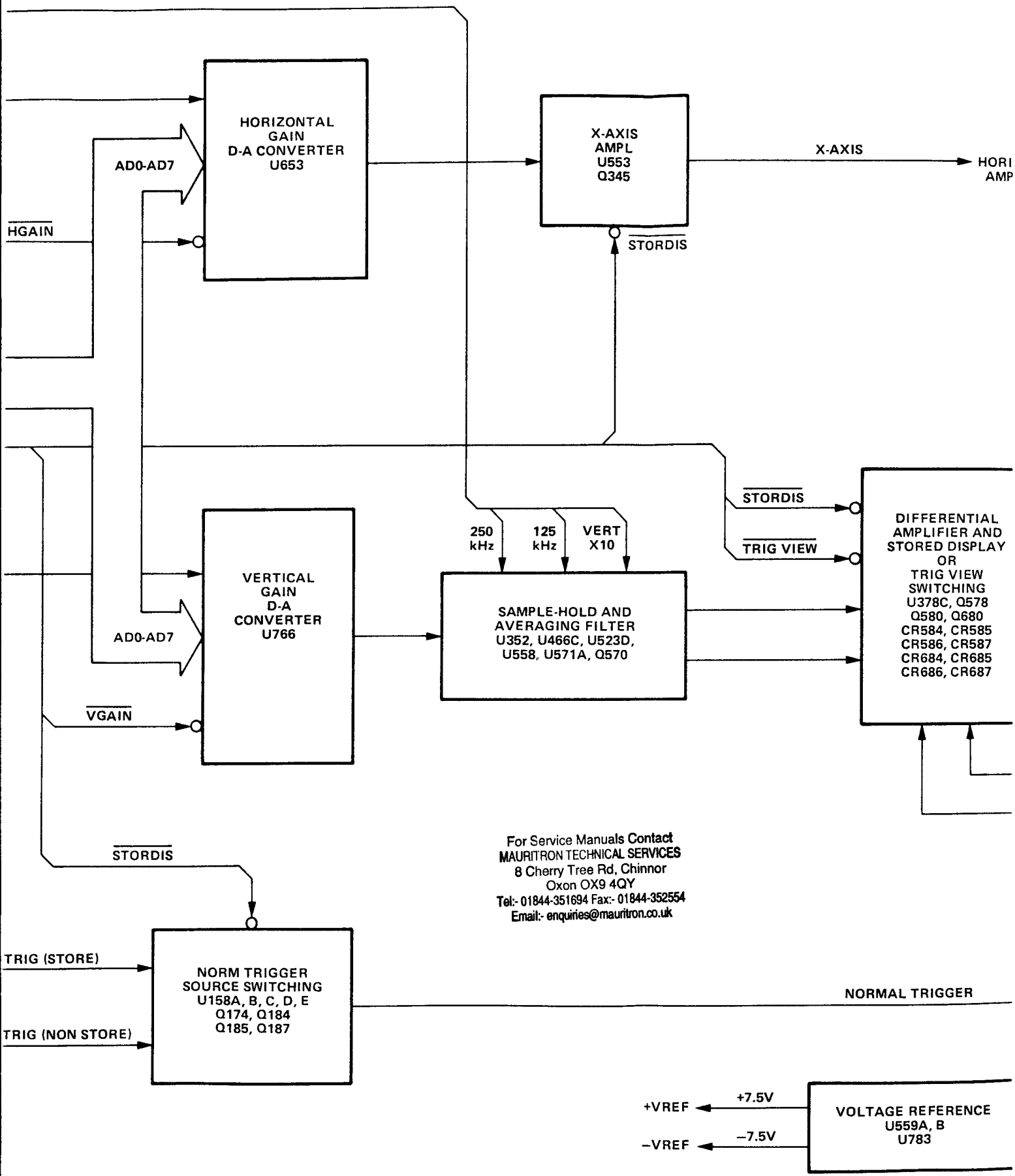


Figure 8-9. Storage Display X and Y Axis block dia

@



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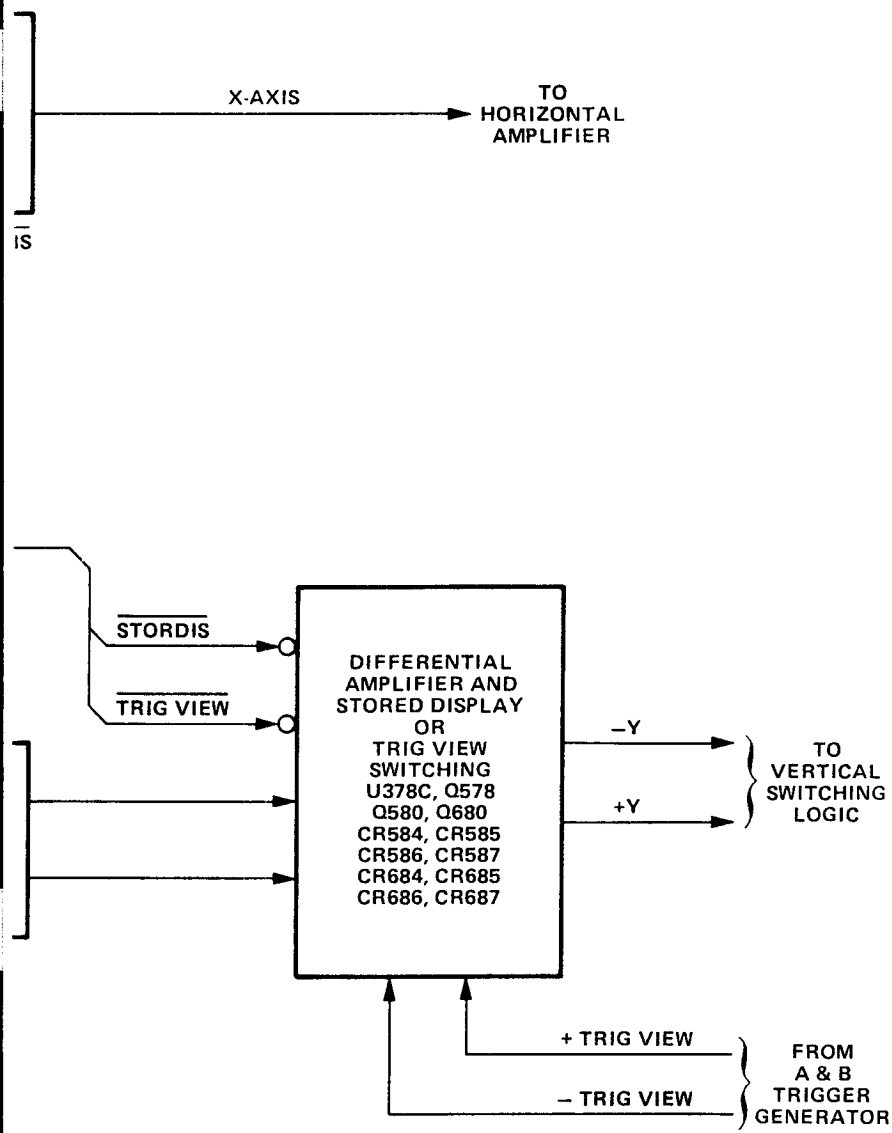
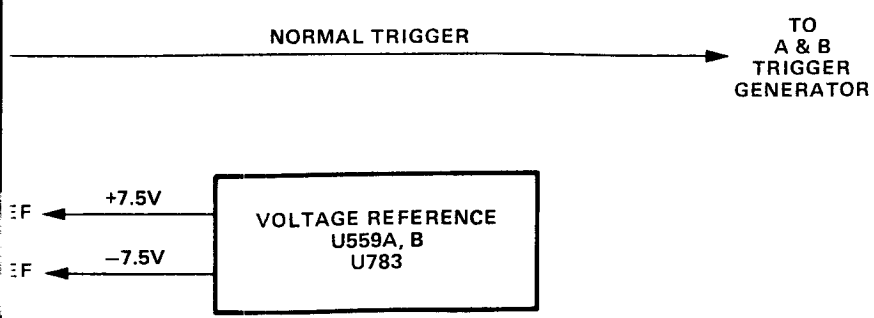
e 8-9. Storage Display X and Y Axis block diagram.

@





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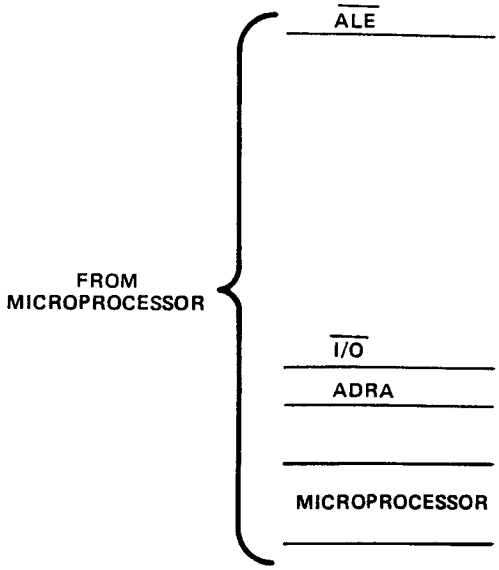

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Figure 8-1

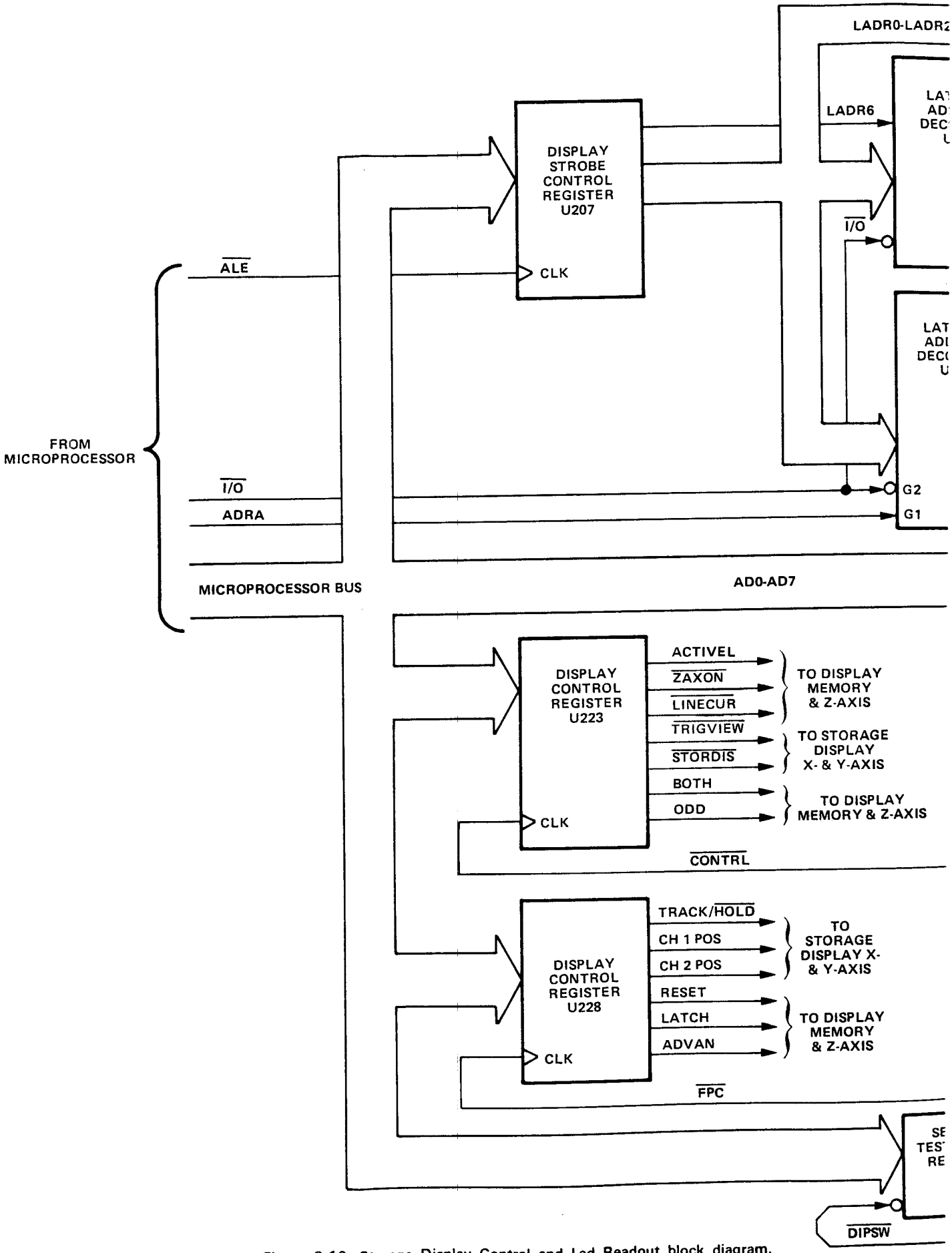
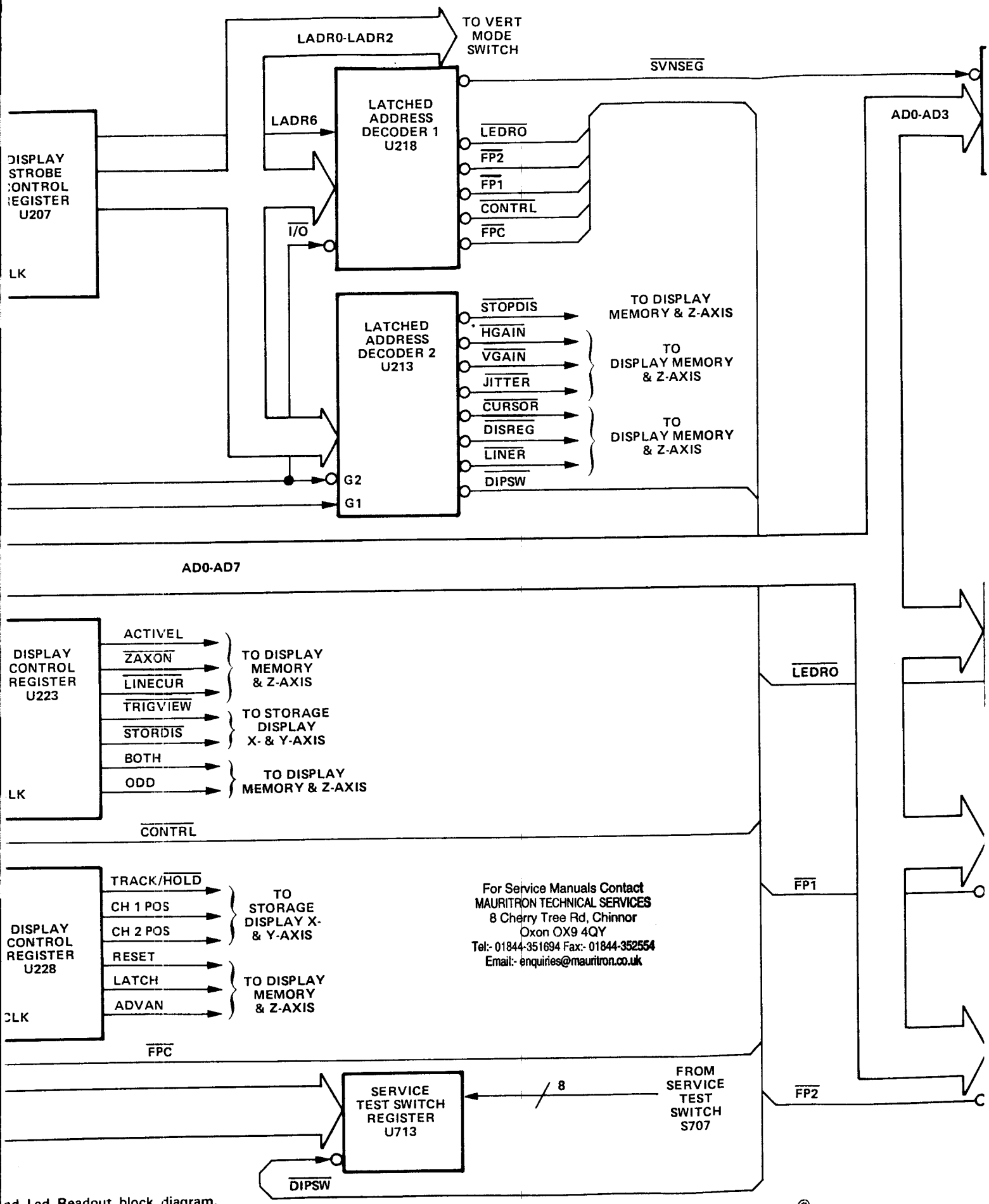


Figure 8-10. Storage Display Control and Led Readout block diagram.



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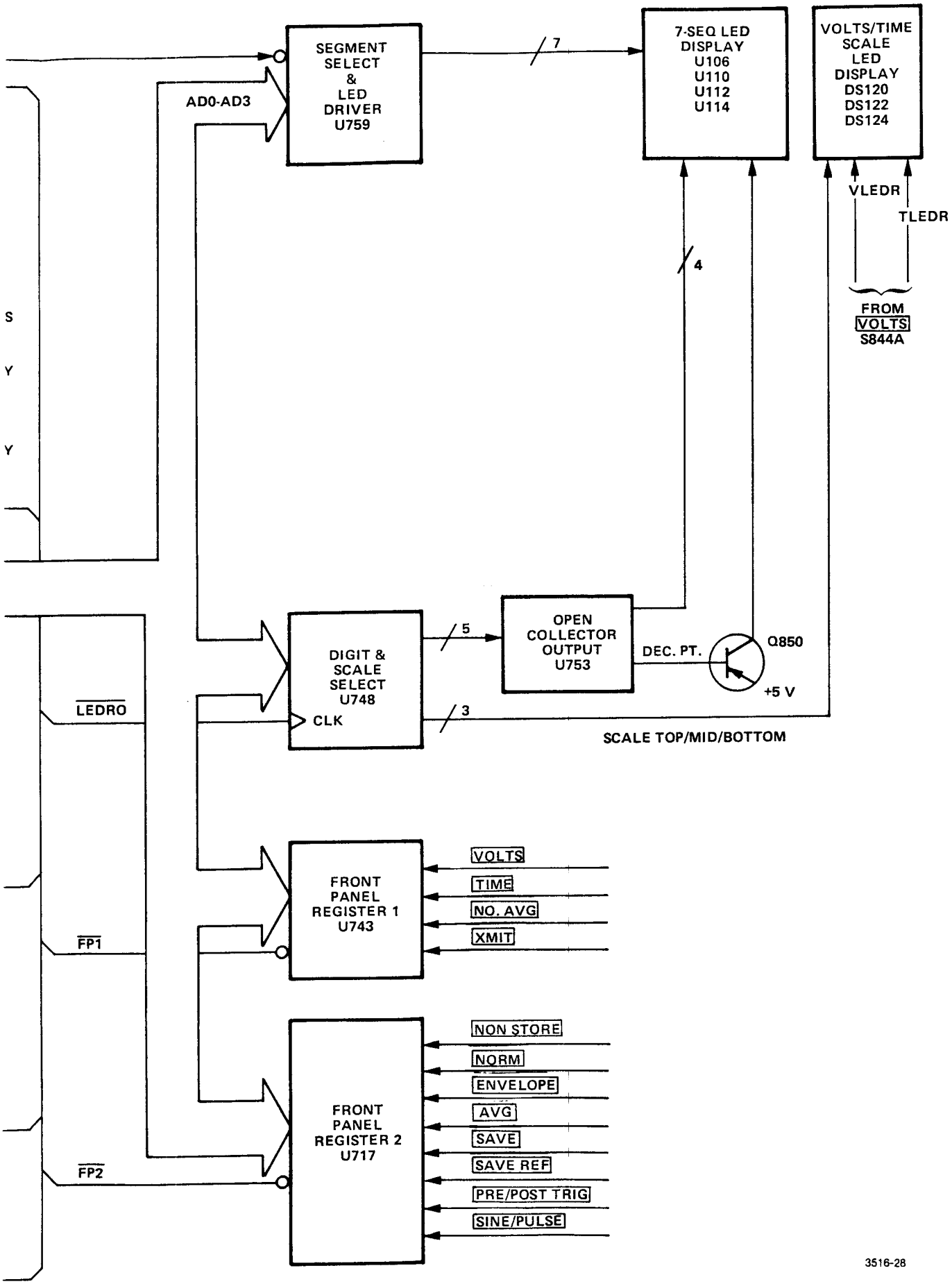
nd Led Readout block diagram.

@


SEGMENT SELECT & LED DRIVER U759
AD0-AD3
7
7-SEQ LED DISPLAY U106 U110 U112 U114
VOLTS/TIME SCALE LED DISPLAY DS120 DS122 DS124
VLEDR
TLEDR
4
FROM VOLTS S844A
S
Y
Y
DIGIT & SCALE SELECT U748
CLK
5
OPEN COLLECTOR OUTPUT U753
DEC. PT.
Q850
+5 V
3
SCALE TOP/MID/BOTTOM
LEDRO
FRONT PANEL REGISTER 1 U743
VOLTS
TIME
NO. AVG
XMIT
FP1
FRONT PANEL REGISTER 2 U717
NON STORE
NORM
ENVELOPE
AVG
SAVE
SAVE REF
PRE/POST TRIG
SINE/PULSE
FP2
3516-28

@

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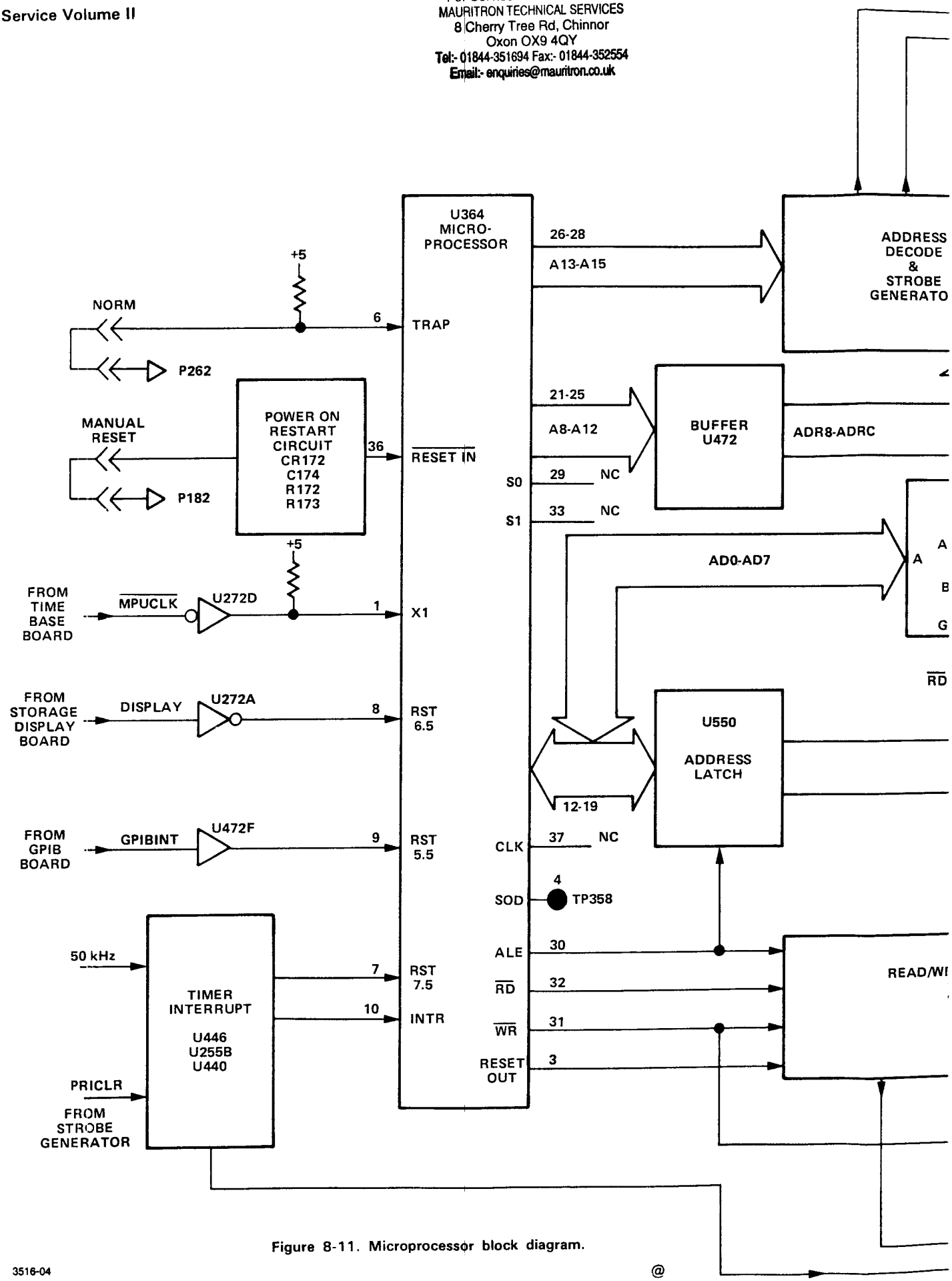
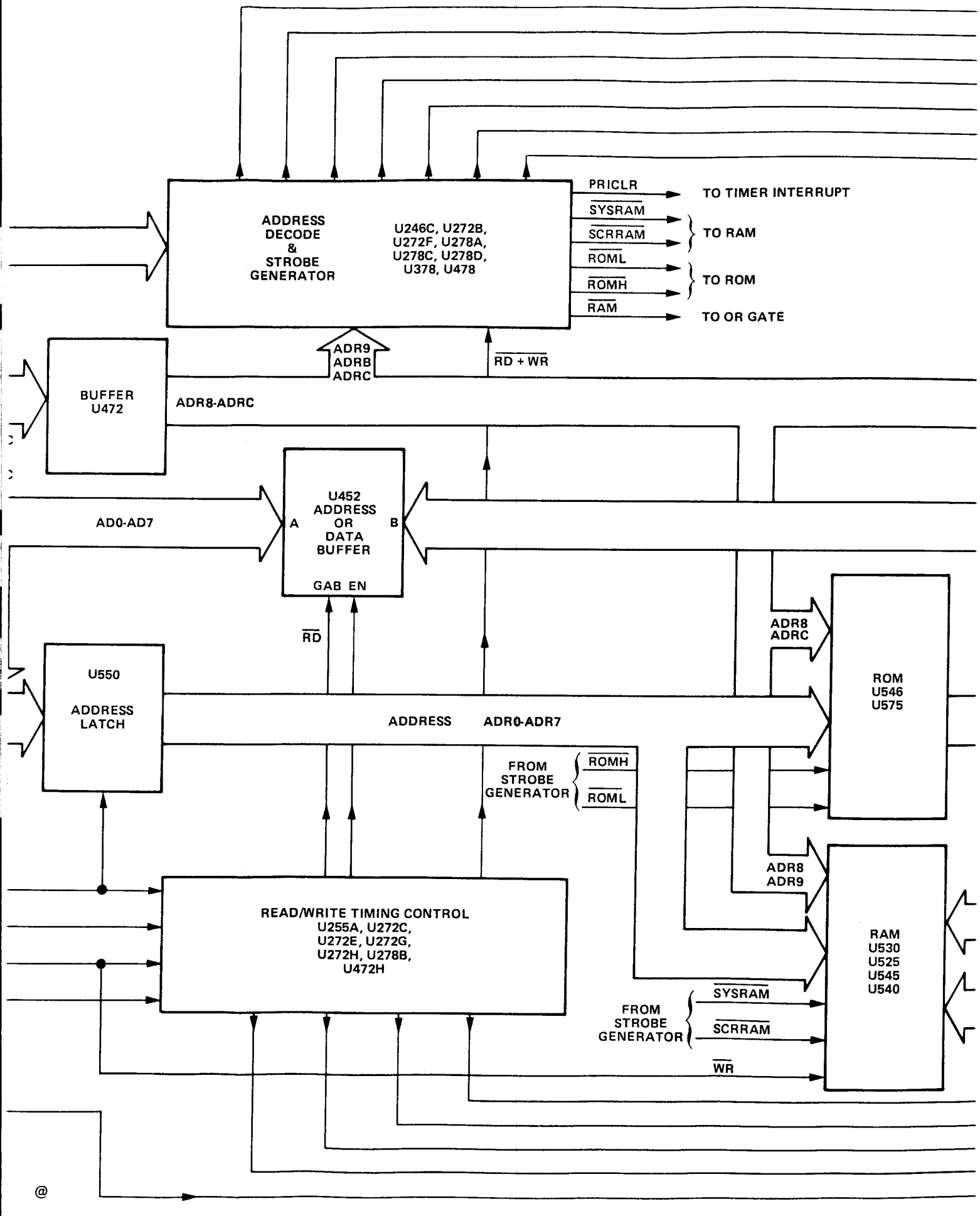
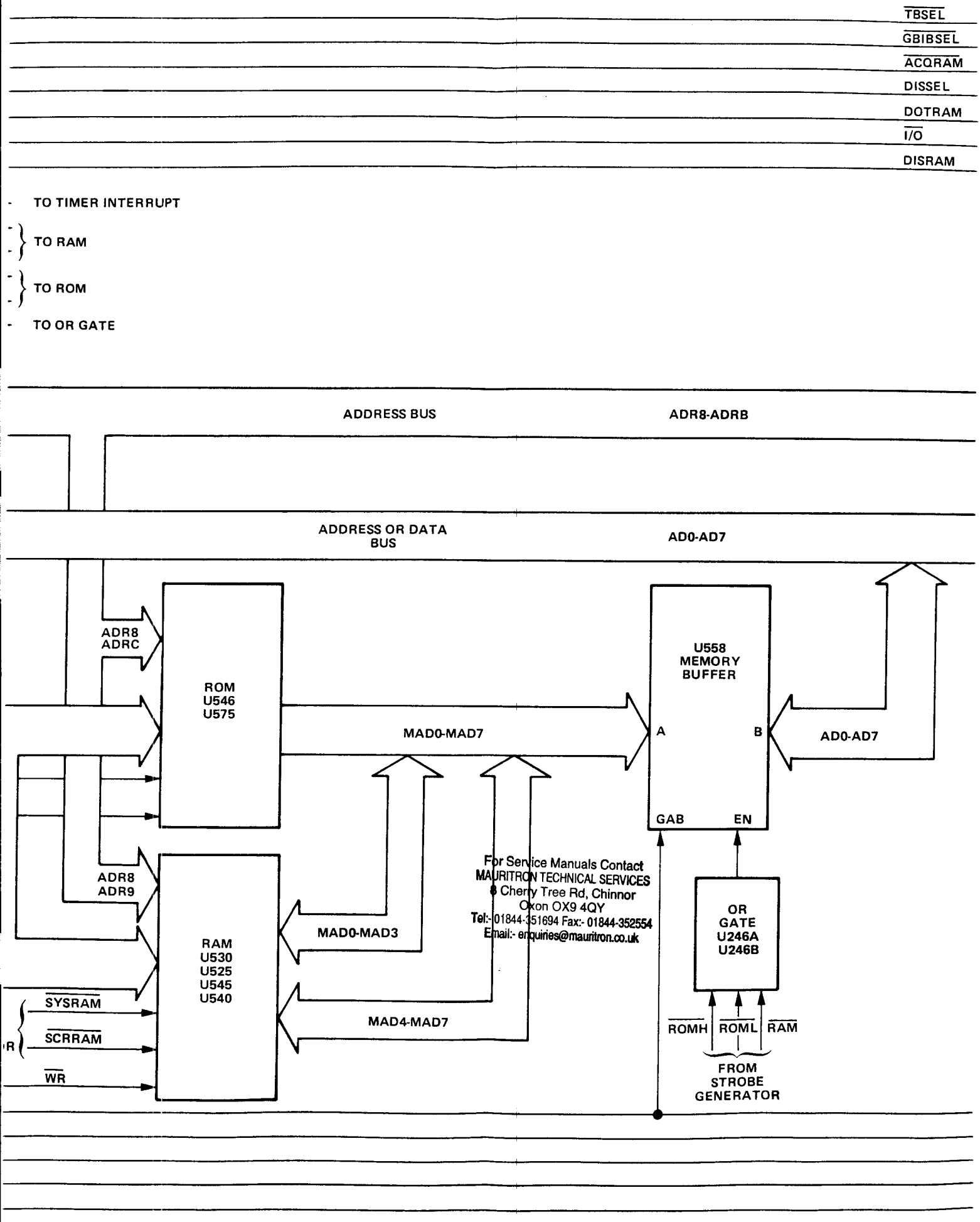


Figure 8-11. Microprocessor block diagram.


ADDRESS DECODE & STROBE GENERATOR
U246C, U272B, U272F, U278A, U278C, U278D, U378, U478
PRICLR
TO TIMER INTERRUPT
SYSRAM
SCRRAM
TO RAM
ROML
ROMH
TO ROM
RAM
TO OR GATE
ADR9 ADRB ADRC
RD + WR
BUFFER U472
ADR8-ADRC
AD0-AD7
U452 ADDRESS OR DATA BUFFER
A
B
GAB EN
RD
U550 ADDRESS LATCH
ADDRESS
ADR0-ADR7
ADR8 ADRC
ROM U546 U575
FROM STROBE GENERATOR
ROMH
ROML
ADR8 ADR9
READ/WRITE TIMING CONTROL U255A, U272C, U272E, U272G, U272H, U278B, U472H
RAM U530 U525 U545 U540
FROM STROBE GENERATOR
SYSRAM
SCRRAM
WR
@


TBSEL
GBIBSEL
ACQRAM
DISSEL
DOTRAM
I/O
DISRAM
- TO TIMER INTERRUPT
- TO RAM
- TO ROM
- TO OR GATE
ADDRESS BUS
ADR8-ADRB
ADDRESS OR DATA BUS
AD0-AD7
ADR8
ADRC
ROM
U546
U575
MAD0-MAD7
U558
MEMORY
BUFFER
A
B
AD0-AD7
GAB
EN
ADR8
ADR9
RAM
U530
U525
U545
U540
MAD0-MAD3
MAD4-MAD7
SYSRAM
SCRRAM
WR
OR
GATE
U246A
U246B
ROMH
ROML
RAM
FROM
STROBE
GENERATOR
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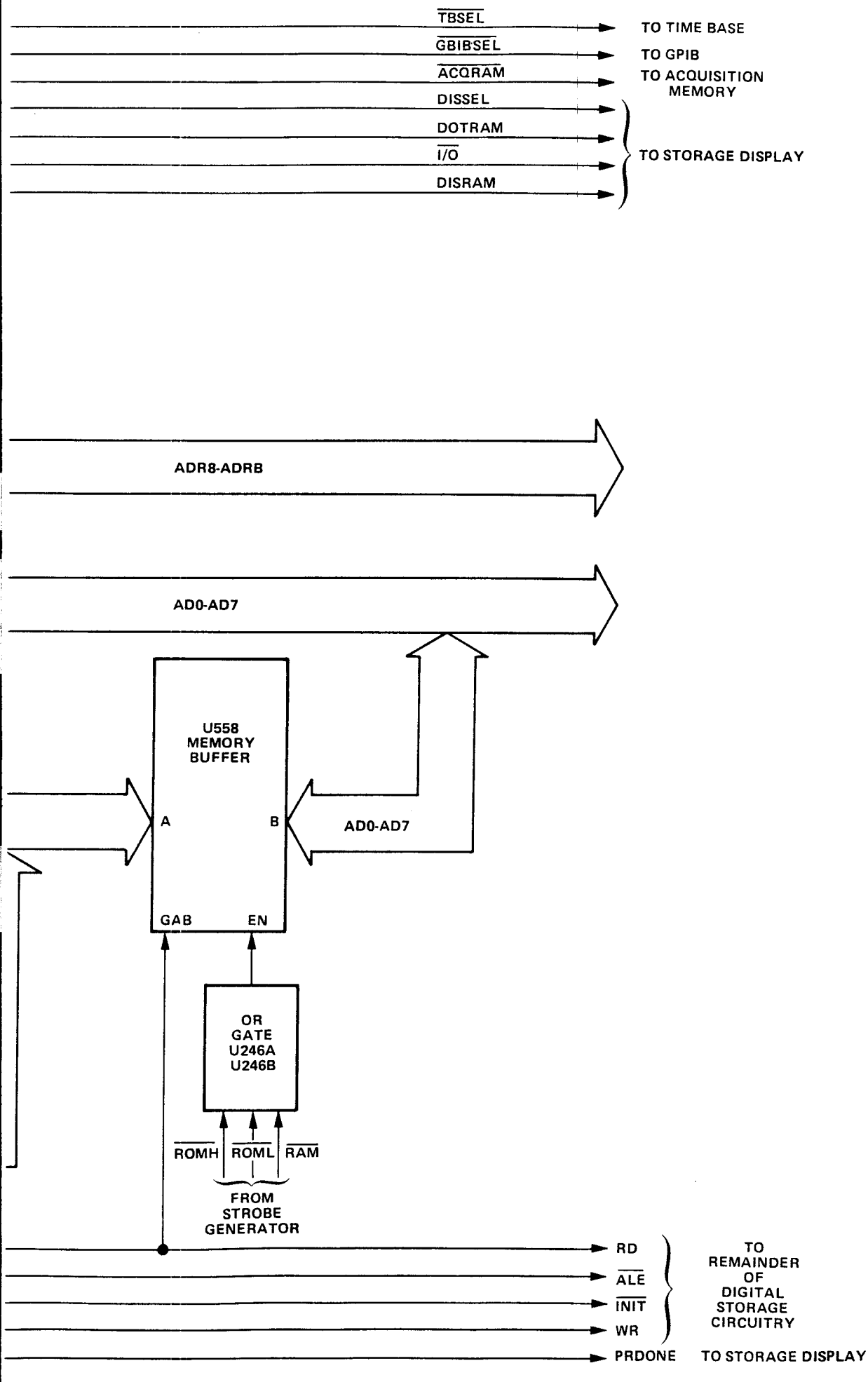
TBSEL
TO TIME BASE
GBIBSEL
TO GPIB
ACQRAM
TO ACQUISITION MEMORY
DISSEL
DOTRAM
I/O
TO STORAGE DISPLAY
DISRAM
ADR8-ADRB
AD0-AD7
U558 MEMORY BUFFER
A
B
AD0-AD7
GAB
EN
OR GATE U246A U246B
ROMH
ROML
RAM
FROM STROBE GENERATOR
RD
ALE
INIT
WR
TO REMAINDER OF DIGITAL STORAGE CIRCUITRY
PRDONE
TO STORAGE DISPLAY

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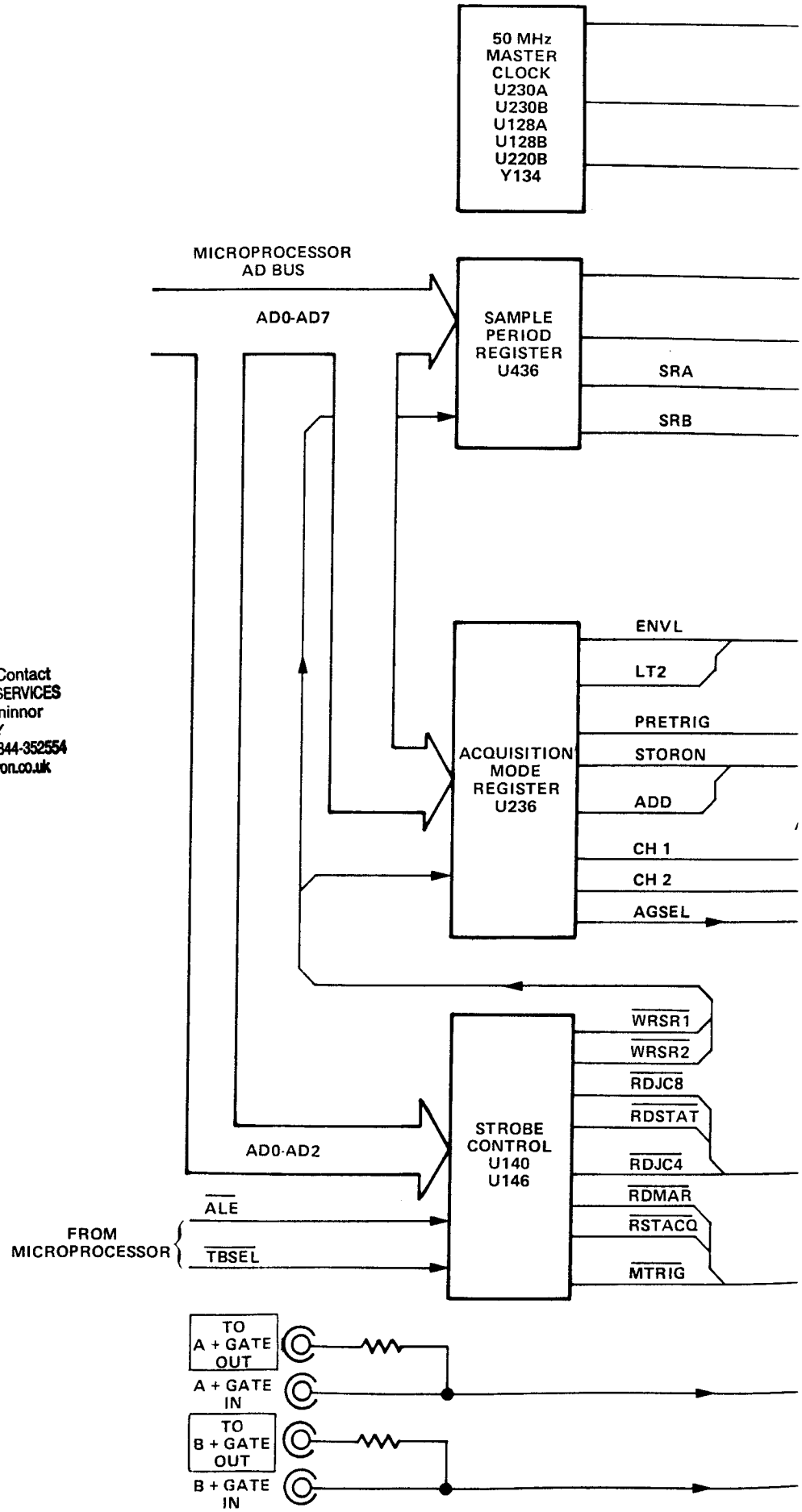
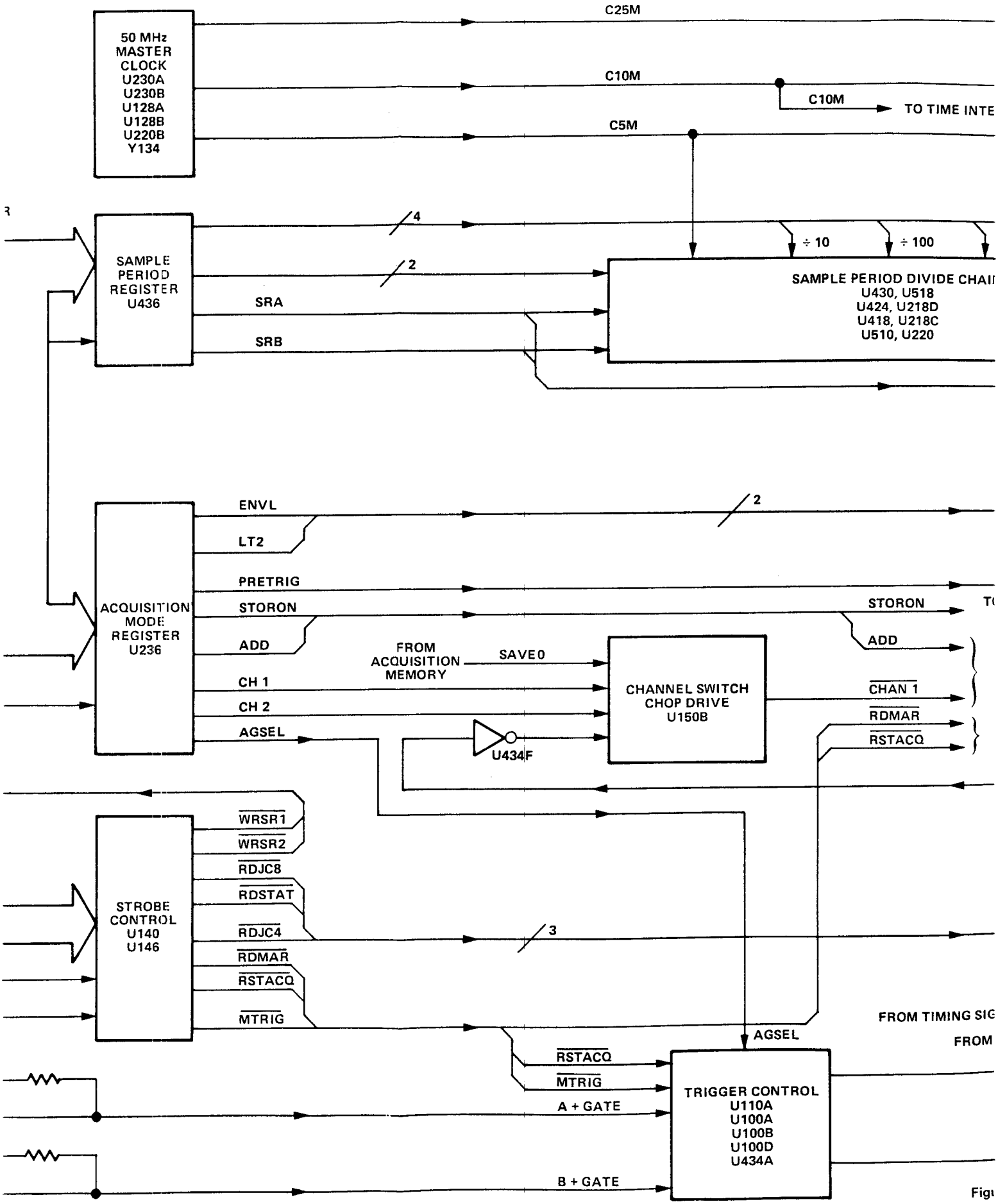



50 MHz MASTER CLOCK U230A U230B U128A U128B U220B Y134
C25M
C10M
C10M
TO TIME INTE
C5M
SAMPLE PERIOD REGISTER U436
4
2
SRA
SRB
÷ 10
÷ 100
SAMPLE PERIOD DIVIDE CHAI
U430, U518
U424, U218D
U418, U218C
U510, U220
ACQUISITION MODE REGISTER U236
ENVL
LT2
2
PRETRIG
STORON
ADD
FROM ACQUISITION MEMORY
SAVE0
CH 1
CH 2
AGSEL
U434F
CHANNEL SWITCH CHOP DRIVE U150B
STORON
ADD
CHAN 1
RDMAR
RSTACQ
STROBE CONTROL U140 U146
WRSR1
WRSR2
RDJC8
RDSTAT
RDJC4
RDMAR
RSTACQ
MTRIG
3
FROM TIMING SIG
FROM
AGSEL
RSTACQ
MTRIG
A + GATE
B + GATE
TRIGGER CONTROL U110A U100A U100B U100D U434A

Figu

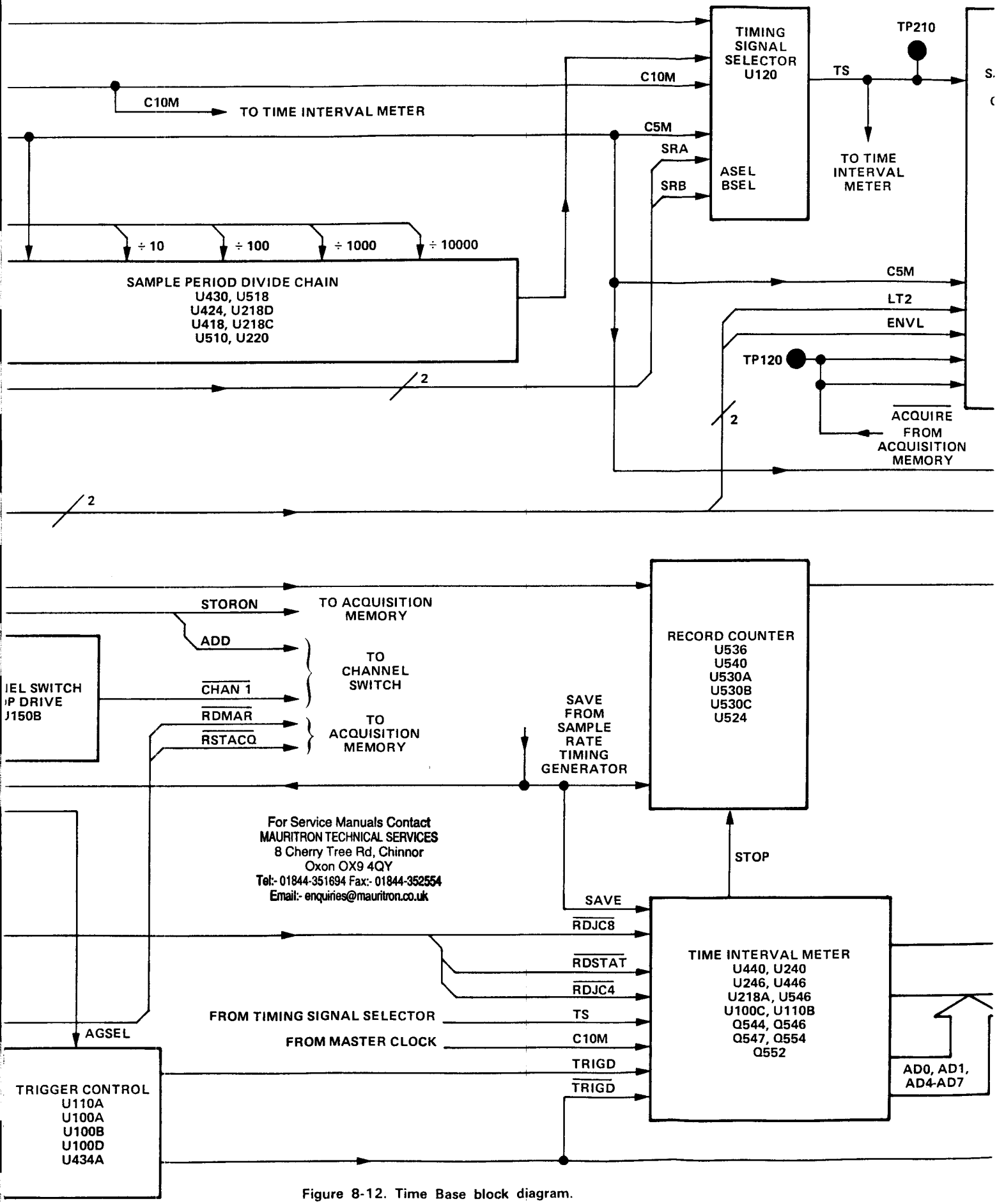
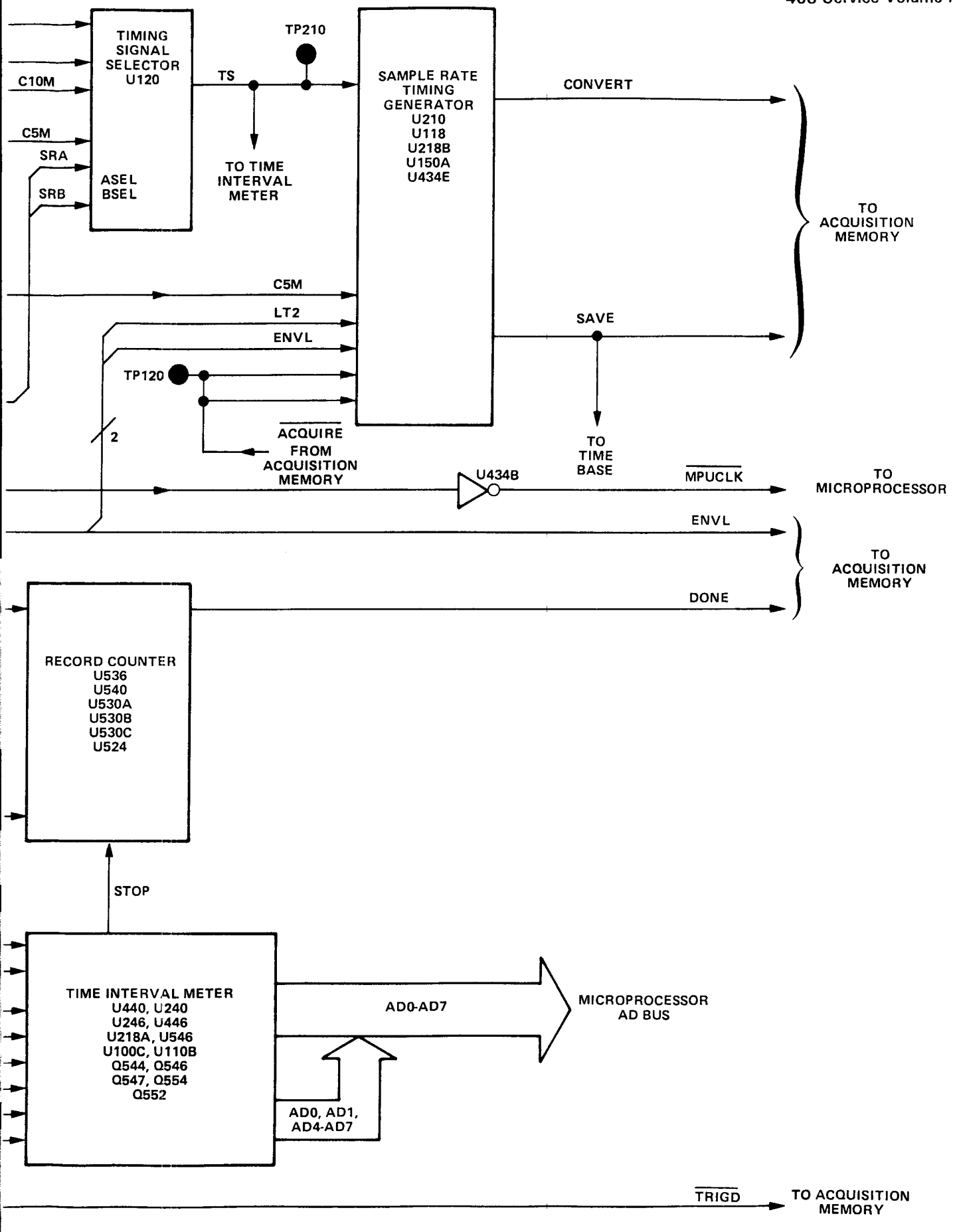


Figure 8-12. Time Base block diagram.

@


TIMING SIGNAL SELECTOR U120
C10M
C5M
SRA
SRB
ASEL
BSEL
TS
TP210
TO TIME INTERVAL METER
SAMPLE RATE TIMING GENERATOR U210 U118 U218B U150A U434E
CONVERT
TO ACQUISITION MEMORY
C5M
LT2
ENVL
TP120
2
ACQUIRE FROM ACQUISITION MEMORY
SAVE
TO TIME BASE
U434B
MPUCLK
TO MICROPROCESSOR
ENVL
TO ACQUISITION MEMORY
DONE
RECORD COUNTER U536 U540 U530A U530B U530C U524
STOP
TIME INTERVAL METER U440, U240 U246, U446 U218A, U546 U100C, U110B Q544, Q546 Q547, Q554 Q552
AD0-AD7
MICROPROCESSOR AD BUS
AD0, AD1, AD4-AD7
TRIGD
TO ACQUISITION MEMORY

3516-03

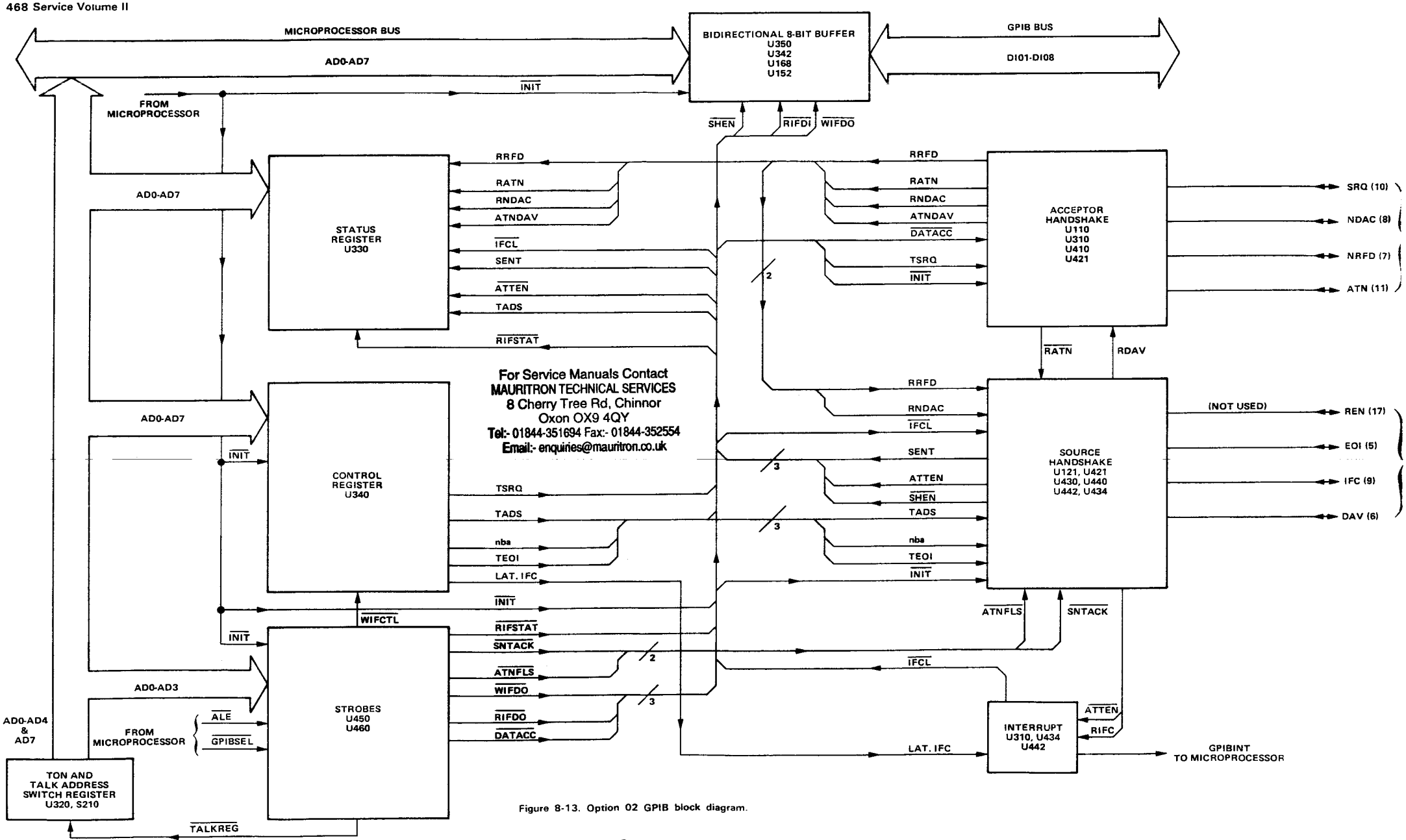


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Figure 8-13. Option 02 GPIB block diagram.

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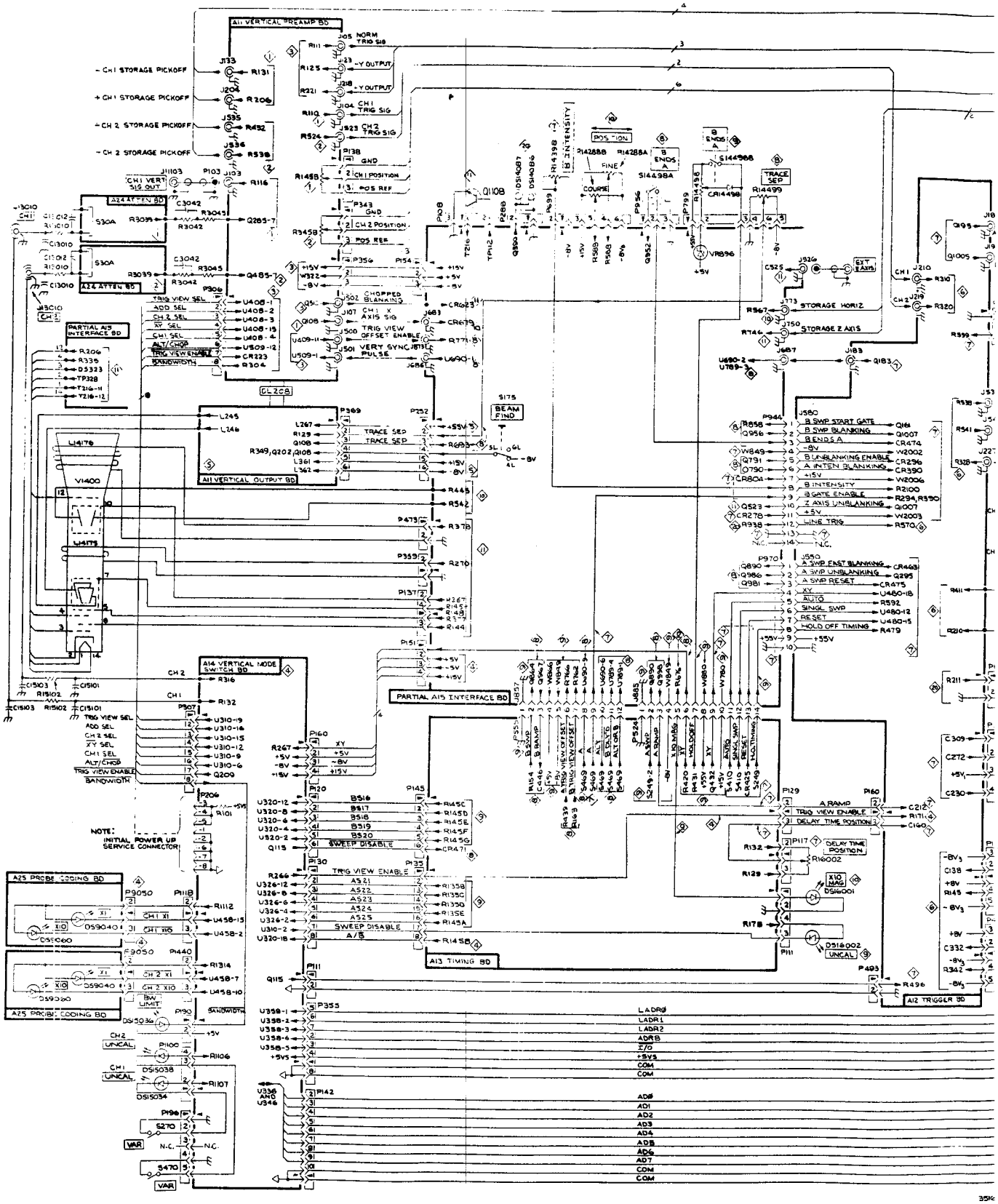

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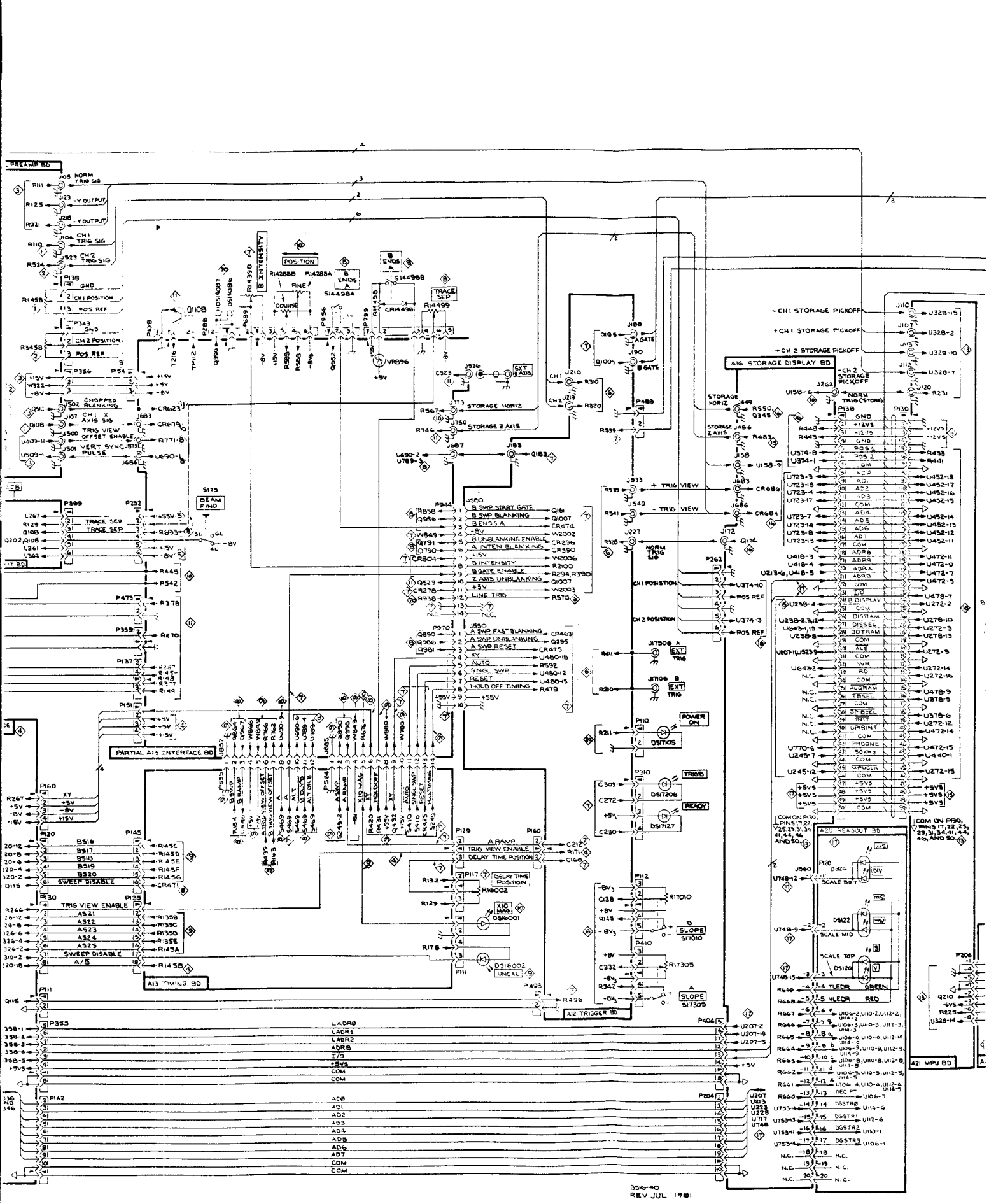
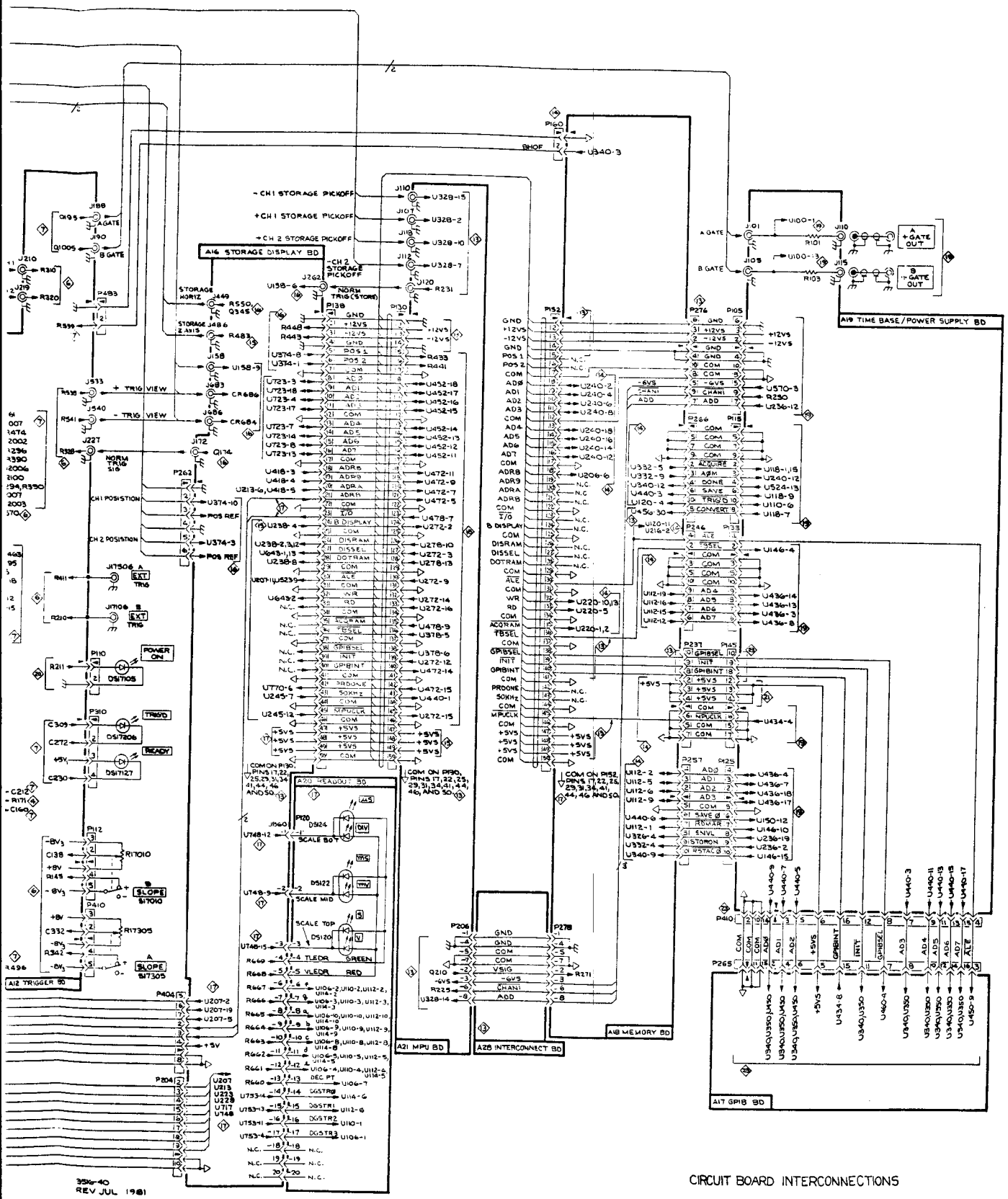

PREAMP BD
A16 STORAGE DISPLAY BD
PARTIAL A15 INTERFACE BD
A13 TIMING BD
A12 TRIGGER BD
A20 READOUT BD
A21 MPU BD
POSITION
FINE
COURSE
B INTENSITY
B ENDS A
TRACE SEP
STORAGE HORIZ
STORAGE Z AXIS
B GATE
A GATE
EXT AXIS
BEAM FIND
CHOPPED BLANKING
TRIG VIEW OFFSET ENABLE
VERT SYNC PULSE
+ TRIG VIEW
- TRIG VIEW
NORM TRIG SIG
POWER ON
TRIG'D
READY
DELAY TIME POSITION
X10 MAG
UNCAL
SWEEP DISABLE
TRIG VIEW ENABLE
A SLOPE
B SLOPE
SCALE BOT
SCALE MID
SCALE TOP
A RAMP
TRIG VIEW ENABLE
DELAY TIME POSITION
B SWP START GATE
B SWP BLANKING
B ENDS A
B UNBLANKING ENABLE
A INTEN BLANKING
B INTENSITY
B GATE ENABLE
Z AXIS UNBLANKING
LINE TRIG
A SWP FAST BLANKING
A SWP UNBLANKING
A SWP RESET
XY
AUTO
SINGL SWP
RESET
HOLD OFF TIMING
LADR0
LADR1
LADR2
ADRB
I/O
+5VS
COM
AD0
AD1
AD2
AD3
AD4
AD5
AD6
AD7
35K-40
REV JUL 1981



CIRCUIT BOARD INTERCONNECTIONS

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CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION
C3042	1	2J
C3042	2	2J
C13010	1	2A
C13010	2	2A
C13012	1	2A
C13012	2	2A
C15101	4	2A
C15101	4	7A
C15103	4	2A
C15103	4	7A
CR14498	9	3H
DL208	3	1M
DS11320	17	5E
DS15034	4	3A
DS15036	4	7M
DS15038	4	8A
DS16001	10	8C
DS16002	9	1E
DS17105	20	3B
DS17127	7	6K
DS17206	7	5K
F14500	20	1A
FL14500	20	2A
J11526	11	5A
J13010	2	2A
J17106	6	2A
J17506	6	6A
L14175	11	4L
L14176	11	2L
P103	1	8K
P104	1	7K
P107	1	7K
P110	13	2A
P112	13	1I
P118	13	6A
P120	13	4I
P133	1	3K
P183	7	3M
P188	7	2M
P190	7	1M
P204	1	7K
P523	2	7K
P535	2	7K
P536	2	3K
P1526	11	5A
P14500	20	2A
Q390	20	8D
Q401	20	6G
Q501	20	1G
Q701	20	4G
Q718	20	5G
Q1108	11	8F
R3042	1	2J
R3042	2	2J
R3045	1	2J
R3045	2	2J
R13010	1	2A
R14288A	10	6A
R14288B	10	6A
R14398	7	4A
R14498	9	2H
R14499	8	4J
R15102	4	2A
R15102	4	7A
R16002	7	8A
R17010	6	3F
R17305	6	6F
S270	4	3A
S470	4	8A
S14498	9	2H
S14498	7	5A
S14498	8	1M
S14520	20	1A
S17010	6	3F
S17305	6	6F
T14500	20	1C
U190	2I	1F
U560	2I	4G
U570	2I	4E
V1400	11	2L

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AC WAVEFORMS

The waveforms adjacent to the circuit diagrams of the conventional portion of the 468 were obtained using the recommended test equipment and setup given below, unless otherwise noted.

Changes to the setup for waveforms adjacent to the digital storage circuit diagrams are noted with each set of waveforms.

RECOMMENDED TEST EQUIPMENT

Item	Specifications	Example
Test Oscilloscope	Frequency Response: DC-100 MHz. Deflection factor: 5 mV/div to 5 V/div (to 50 V/div with 10X probe). Input impedance: 1 MΩ, 20 pF. Sweep rate: 5 ms to 0.5 μs/div.	TEKTRONIX 465B or equivalent.
Probe	Fast-rise 10X probe compatible with the vertical amplifier of the test oscilloscope.	TEKTRONIX P6065 or equivalent.

468 CONTROL SETTINGS

CRT Controls

INTENSITY	As desired
FOCUS	As desired
SCALE ILLUM	As desired

Vertical Controls (both A and B if applicable)

VOLTS/DIV	5 mV
VAR	Calibrated detent
POSITION	Midrange
AG-GND-DC	DC
VERT MODE	CH 1 and CHOP
INVERT	Off (button out)
20 MHz BW LIMIT	Full bandwidth (button out)

Sweep Controls

ITME/DIV (both)	1 ms
VAR	Calibrated detent
HORIZ DISPLAY	A
X10 MAG	Off (button out)
POSITION	Midrange
DELAY TIME POSITION	Fully counterclockwise

Trigger Controls (both A and B unless otherwise noted)

COUPLING	AC
SOURCE	NORM
TRIG MODE	AUTO
SLOPE	+
A TRIGGER LEVEL	As needed for a stable display (locked on positive transition of square-wave input).
A TRIGGER HOLDOFF	NORM

Digital Storage

NON STORE	On (button in)

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TEST OSCILLOSCOPE SETUP

Apply a 20 mV p-p, positive-going square-wave signal to the CH 1 or X input connector. Connect the 468 A + GATE (from the 468 rear panel) to the test oscilloscope external trigger input connector. Use no terminations.

468 Oscilloscope control settings required to obtain valid waveforms are given with each set of waveforms. Changes from the preliminary control settings for the other controls are not required.

Test Oscilloscope Control Settings

All controls as needed for the best display except as noted below:

Vert Mode	Ch 1
AC-Gnd-Dc	As required for the measurement to be made
Volts/Div	As needed for each waveform
Trigger Source	Ext (468 A + GATE)
Trigger Coupling	Ac
Trigger Mode	Auto
Time/Div	As needed for each waveform

Connect a 10X probe to the Channel 1 input of the test oscilloscope. Apply the probe tip to the test point or component lead as indicated on the schematic and the component board layout Figure associated with that schematic.

DC VOLTAGES

Typical voltage measurements were obtained with the instrument operating under the conditions noted in the control settings adjacent to each schematic diagram. Voltage measurements were taken with no signal applied to the vertical or trigger inputs. All voltages are measured with reference to chassis ground and are rounded to the nearest tenth of a volt.

RECOMMENDED TEST EQUIPMENT

Item	Specifications	Example
Digital Multimeter (for voltages up to 1 kV	Range: 0 to 1 kV. Input Impedance: 10 MΩ.	TEKTRONIX DM 501 Digital Multimeter. TEKTRONIX Oscilloscope with DM 44 Option.
DC Voltmeter (for voltages above 1 kV)	Range: 0 to 3 kV. Input Impedance: 20 kΩ/V.	Triplett Model 630NA.

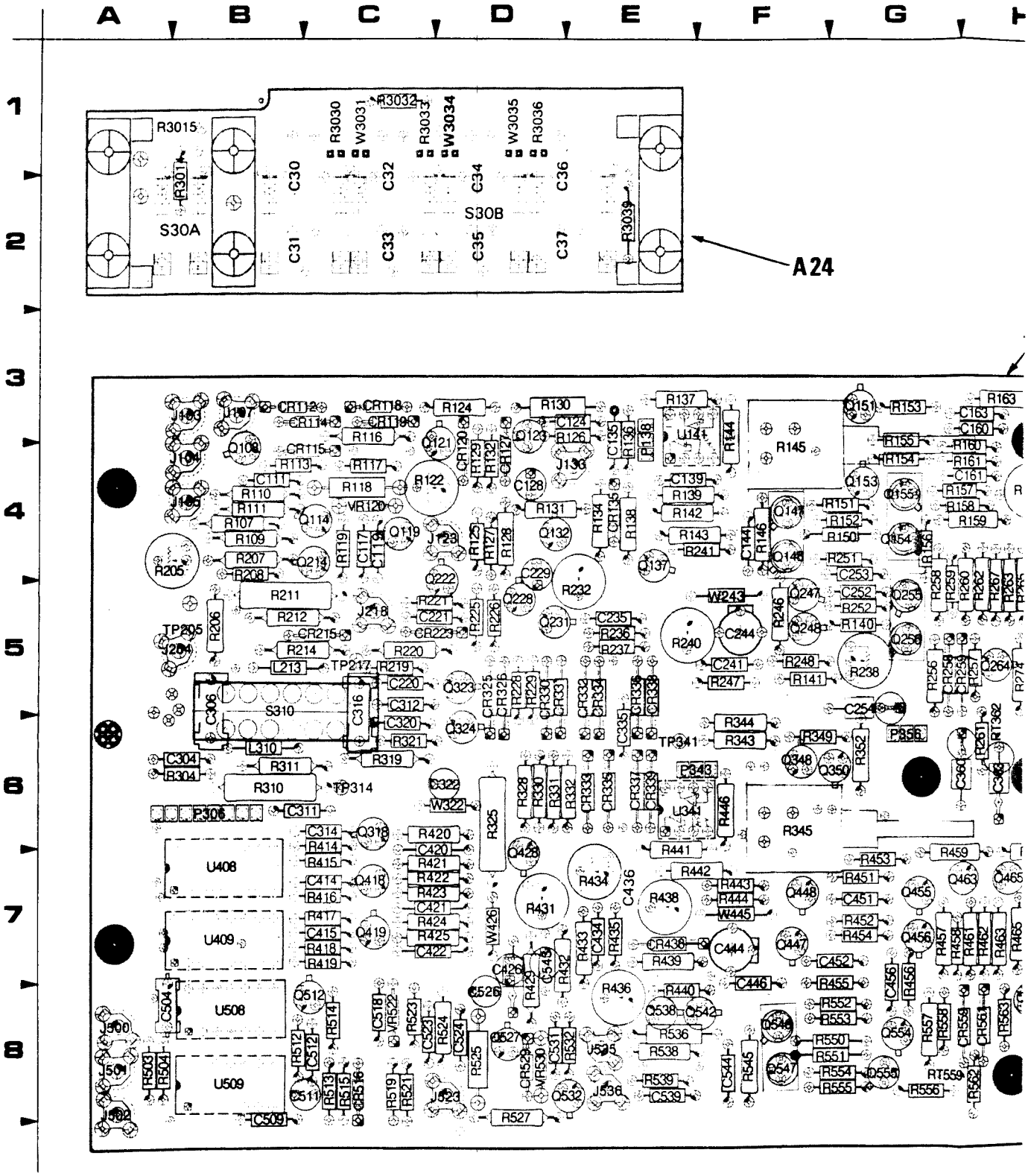

Figure 8-14A. A11 Vertical Preamplifier (SN B040000 & up) and A24 Attenuator

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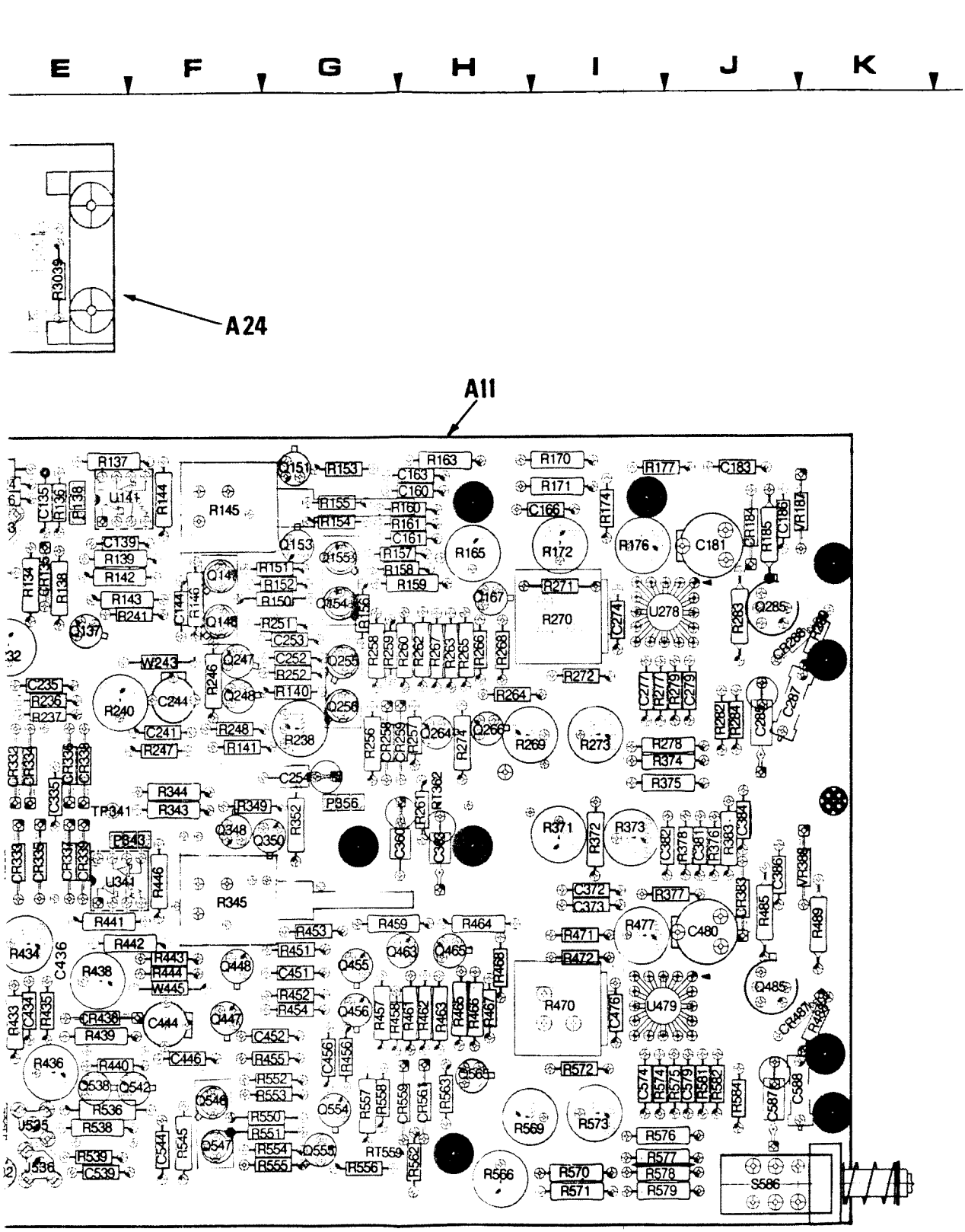


COMPONENTS I	
C30	C3
C31	C3
C32	C3
C33	C3

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 Numl prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

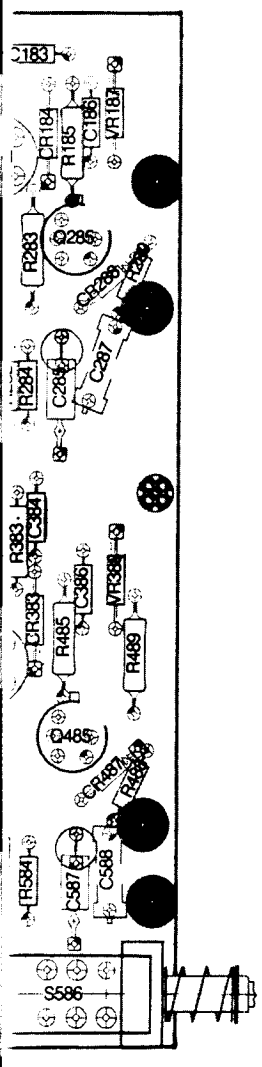
A11 Vertical Preamplifier (SN B040000 & up) and A24 Attenuator boards.

A24 ATTENUATOR BOARD

J K

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM ① ②

C30	C34	R3014	R3033	S30A	W3034
C31	C35	R3015	R3036	S30B	W3035
C32	C36	R3030	R3039		
C33	C37	R3032		W3031	



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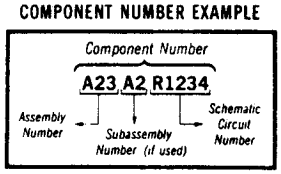
COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

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COMPONENTS

C111	C
C119	C
C124	C
C128	
C135	C
C139	C
C144	C
C160	C
C161	C
C163	C
C166	C
C181	C
C183	C
C186	C
C229	C
C235	C
C252	
C253	J
C274	J
C277	J
C279	J
	J

COMPONENTS

C372	C
C373	C
C381	C
C382	C
C384	C
C386	C
C434	C
C436	C
C451	J
C452	J
C456	J
C476	P
C480	Q
C523	Q
C524	Q
C531	Q
C539	Q
C543	Q
C544	Q
C574	Q
C579	Q

COMPONENTS

C117	C4
C220	C4
C221	C5
C244	C5
C254	C5
C304	C5
C306	C5
C311	C5
C312	
C314	CR
C316	CR
C320	CR
C322	CR
C360	CR
C363	CR
C414	CR
C415	CR
C420	CR
C421	CR
C422	CR

A11 VERTICAL PREAMP BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 1 (SN B040000 & UP)

C111	C285	P138	R110	R144	R177	R268
C119	C287		R113	R145	R185	R269
C124	C335	Q108	R116	R146	R206	R270
C128		Q119	R117	R150	R232	R271
C135	CR112	Q121	R118	R151	R236	R272
C139	CR114	Q123	R122	R152	R237	R273
C144	CR115	Q132	R124	R153	R238	R274
C160	CR118	Q137	R126	R154	R241	R277
C161	CR119	Q147	R128	R155	R246	R278
C163	CR120	Q148	R129	R156	R251	R279
C166	CR127	Q151	R130	R157	R252	R282
C181	CR135	Q153	R131	R158	R256	R283
C183	CR184	Q154	R132	R159	R257	R284
C186	CR258	Q155	R134	R160	R258	R289
C229	CR259	Q167	R136	R161	R259	R374
C235	CR288	Q231	R137	R163	R260	R375
C252		Q255	R138	R165	R261	RT362
C253	J103	Q256	R139	R170	R262	U141A
C274	J104	Q264	R140	R171	R263	U141B
C277	J107	Q266	R141	R172	R264	U278
C279	J133	Q285A	R142	R174	R265	VR120
	J204	Q285B	R143	R176	R266	VR187

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 2 (SN B040000 & UP)

C372	C587	Q532	R432	R463	R550	R578
C373	C588	Q538	R433	R464	R551	R579
C381	CR383	Q542	R434	R465	R552	R581
C382	CR438	Q546	R435	R466	R553	R582
C384	CR487	Q547	R436	R467	R554	R584
C386	CR529	Q554	R439	R468	R555	
C434	CR559	Q555	R440	R470	R556	RT559
C436	CR561	Q565	R441	R471	R557	
C451	J523	R343	R442	R472	R558	S586
C452	J535	R344	R443	R477	R562	
C456	J536	R345	R444	R485	R563	U341A
C476	P343	R349	R446	R488	R566	U341B
C480	Q348	R352	R452	R489	R569	U479
C523	Q350	R371	R454	R524	R570	
C524	Q455	R372	R455	R525	R571	VR388
C531	Q456	R373	R456	R527	R572	VR530
C539	Q463	R376	R457	R532	R573	
C543	Q465	R377	R458	R536	R574	
C544	Q485A	R378	R459	R538	R575	
C574	Q485B	R383	R461	R539	R576	
C579	Q527	R429	R462	R545	R577	
		R431				

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 3

C117	C426	CR337	Q114	R212	R330	R519
C220	C444	CR338	Q214	R214	R331	R521
C221	C504	CR339	Q222	R219	R332	R523
C244	C509	CR516	Q228	R220	R414	
C254	C511		Q247	R221	R415	S310
C304	C512	J105	Q248	R225	R416	
C306	C518	J123	Q318	R226	R417	TP217
C311	C525	J218	Q323	R228	R418	TP314
C312		J500	Q324	R229	R419	
C314	CR215	J501	Q418	R240	R420	U408
C316	CR223	J502	Q419	R247	R421	U409
C320	CR325		Q428	R248	R422	U508A
C322	CR326	L213	Q447	R304	R423	U508B
C360	CR330	L243	Q448	R310	R424	U508C
C363	CR331	L310	Q512	R311	R425	U508D
C414	CR332			R319	R438	U509A
C415	CR333		R107	R321	R451	U509B
C420	CR334	P306	R109	R325	R453	U509C
C421	CR335	P306	R111	R328	R503	U509D
C422	CR336	P306	R119		R504	
		P306	R208		R512	VR522
		P356	R211		R513	
					R514	W322
					R515	W426
						W445

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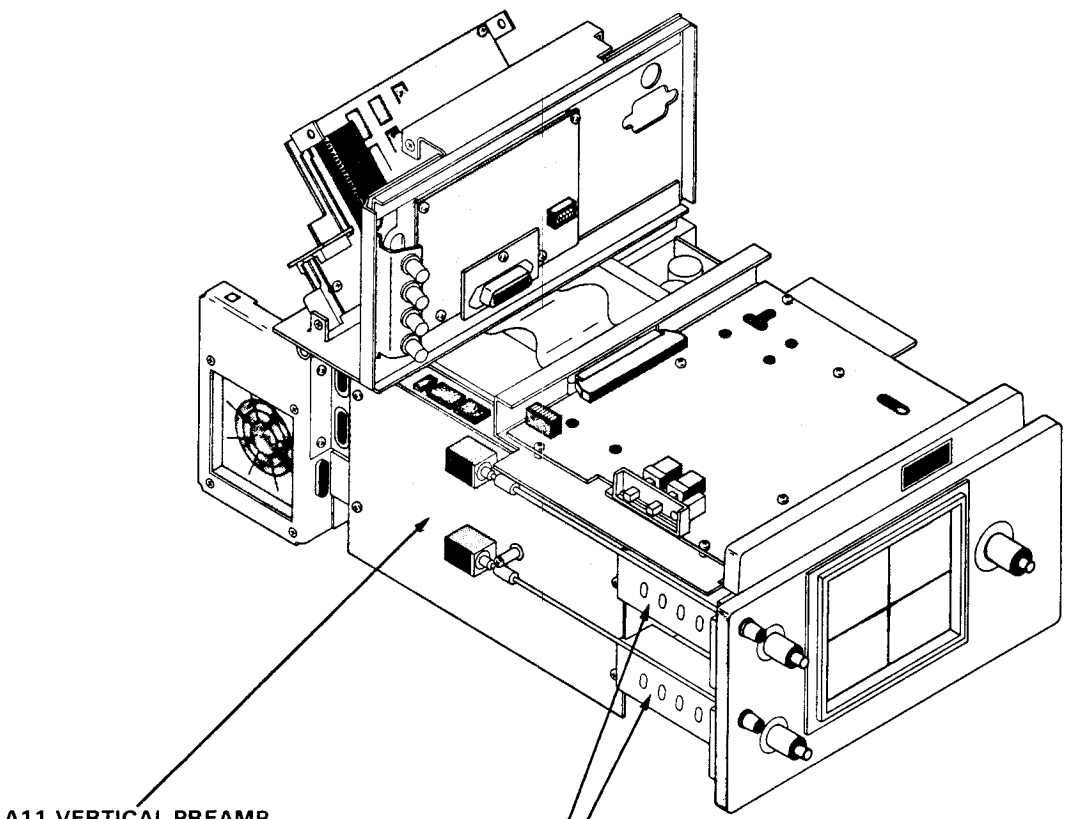


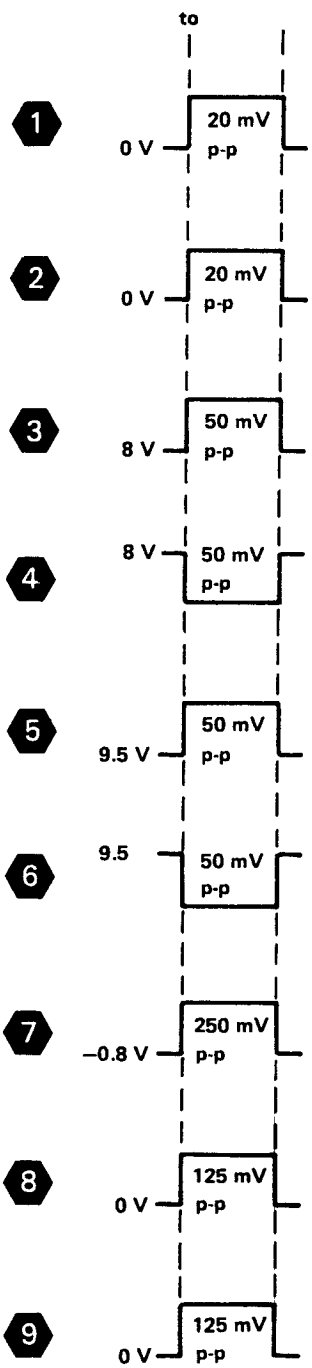
468 CONTROL SETTINGS FOR ①

DC Voltages

VERT MODE	CH 1
AC-GND-DC (both)	GND

AC Waveforms

VERT MODE	CH 1
CH 1 AC-GND-DC	DC
VOLTS/DIV	5 mV
Input	20 mV positive-going square wave



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CH 1 VERTICAL PREAMP DIAGRAM 1 (SN B040000 & UP)

ASSEMBLY A11

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C111	7I	4B	Q151	5J	3G	R170	5A	3I
C119	7H	4C	Q153	5I	4G	R171	5A	3I
C124	8H	3E	Q154	6G	4G	R172	5A	4I
C128	9H	4D	Q155	4G	4G	R174	5B	3I
C135	3G	3E	Q167	4D	4H	R176	5B	4I
C139	5I	4E	Q231	7H	5D	R177	5B	3I
C144	5H	4F	Q255	4F	4G	R185	4A	4J
C160	5A	3H	Q256	6F	5G	R206	7I	5B
C161	5A	4H	Q264	5E	5H	R232	3H	4E
C163	5A	3H	Q266	6D	5H	R236	6H	5E
C166	5A	3I	Q285A	4A	4J	R237	7H	5E
C181	5B	4J	Q285B	4A	4J	R238	5K	5G
C183	5A	3J	R110	7I	4B	R241	4H	4E
C186	3A	4J	R113	7I	4B	R246	5H	5F
C229	5K	4D	R116	8J	3C	R251	4G	4G
C235	6H	5E	R117	8H	4C	R252	6G	5G
C252	6G	5G	R118	7H	4C	R256	5F	5G
C253	4G	4G	R122	9H	4C	R257	6F	5H
C274	3C	4I	R124	8H	3D	R258	5F	5G
C277	7C	5I	R126	8H	3E	R259	4F	5G
C279	7B	5J	R128	7H	4D	R260	6E	5H
C285	4A	5J	R129	8I	4D	R261	6F	5H
C287	4A	5J	R130	3H	3D	R262	4E	5H
C335	7G	6E	R131	3I	4D	R263	5D	5H
CR112	8I	3B	R132	8I	4D	R264	6E	5H
CR114	8I	3C	R134	3H	4E	R265	5D	4H
CR115	7I	4C	R136	4H	3E	R266	4D	4H
CR118	8I	3C	R137	4J	3E	R267	5E	5H
CR119	8I	3C	R138	3H	4E	R268	3C	4H
CR120	8H	4D	R139	5J	4E	R269	5D	5H
CR127	7H	4D	R140	4K	5G	R270	7A	4I
CR135	3H	4E	R141	6K	5F	R271	4D	4I
CR184	4B	4J	R142	5J	4E	R272	6D	5I
CR258	6F	5G	R143	5J	4E	R273	6A	5I
CR259	4F	5G	R144	5J	3F	R274	5E	5H
CR288	3A	4J	R145	6J	4F	R277	7C	5I
J103	8J	3B	R146	5H	4F	R278	7C	5J
J104	7J	4B	R150	5H	4G	R279	7C	5J
J107	7J	3B	R151	4G	4G	R282	6B	5J
J133	3J	4E	R152	6G	4G	R283	4A	4J
J204	7J	5A	R153	4I	3G	R284	6B	5J
P138	6J	3E	R154	4G	4G	R289	4A	4K
Q108	7J	4B	R155	5G	4G	R374	7C	5J
Q119	7H	4C	R156	6G	4G	R375	7B	5J
Q121	8I	3D	R157	4G	4G	RT362	4F	6H
Q123	8H	3D	R158	6G	4G	U141A	5I	3E
Q132	3H	4D	R159	5F	4H	U141B	5J	3E
Q137	4H	4E	R160	5B	4H	U278	3B	4I
Q147	4H	4F	R161	5A	4H	VR120	3H	4C
Q148	6H	4F	R163	5J	3H	VR187	3A	4J
			R165	5A	4H			

Partial A11 also shown on diagrams 2 and 3.

ASSEMBLY A24

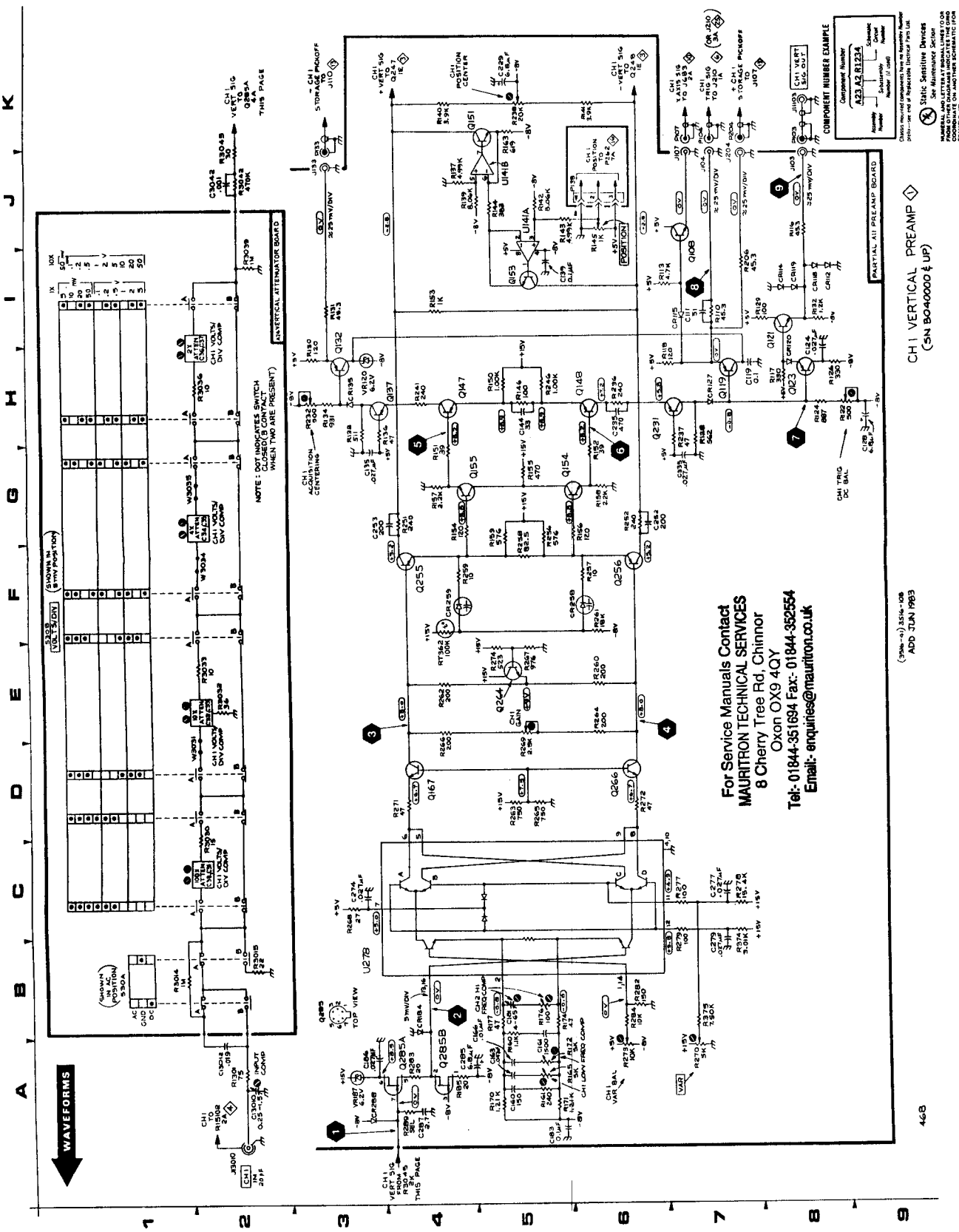
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C30	2C	1B	R3014	1B	1B	S30A	1B	2B
C31	2C	2B	R3015	2B	1B	S30B	1F	2B
C32	2E	1C	R3030	2C	1C			
C33	2E	2C	R3032	2E	1C	W3031	2D	1C
C34	2G	1D	R3033	2E	1C	W3034	2F	1D
C35	2G	2D	R3036	2H	1D	W3035	2G	1D
C36	2H	1D	R3039	2I	2E			
C37	2I	2D						

A24 also shown on diagram 2.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C3042	2J	CHASSIS	P104	7K	CHASSIS	R3042	2J	CHASSIS
C13010	2A	CHASSIS	P107	7K	CHASSIS	R3045	2J	CHASSIS
C13012	2A	CHASSIS	P133	3K	CHASSIS	R13010	2A	CHASSIS
			P204	7K	CHASSIS			
P103	8K	CHASSIS						

(SN B040000 & UP)



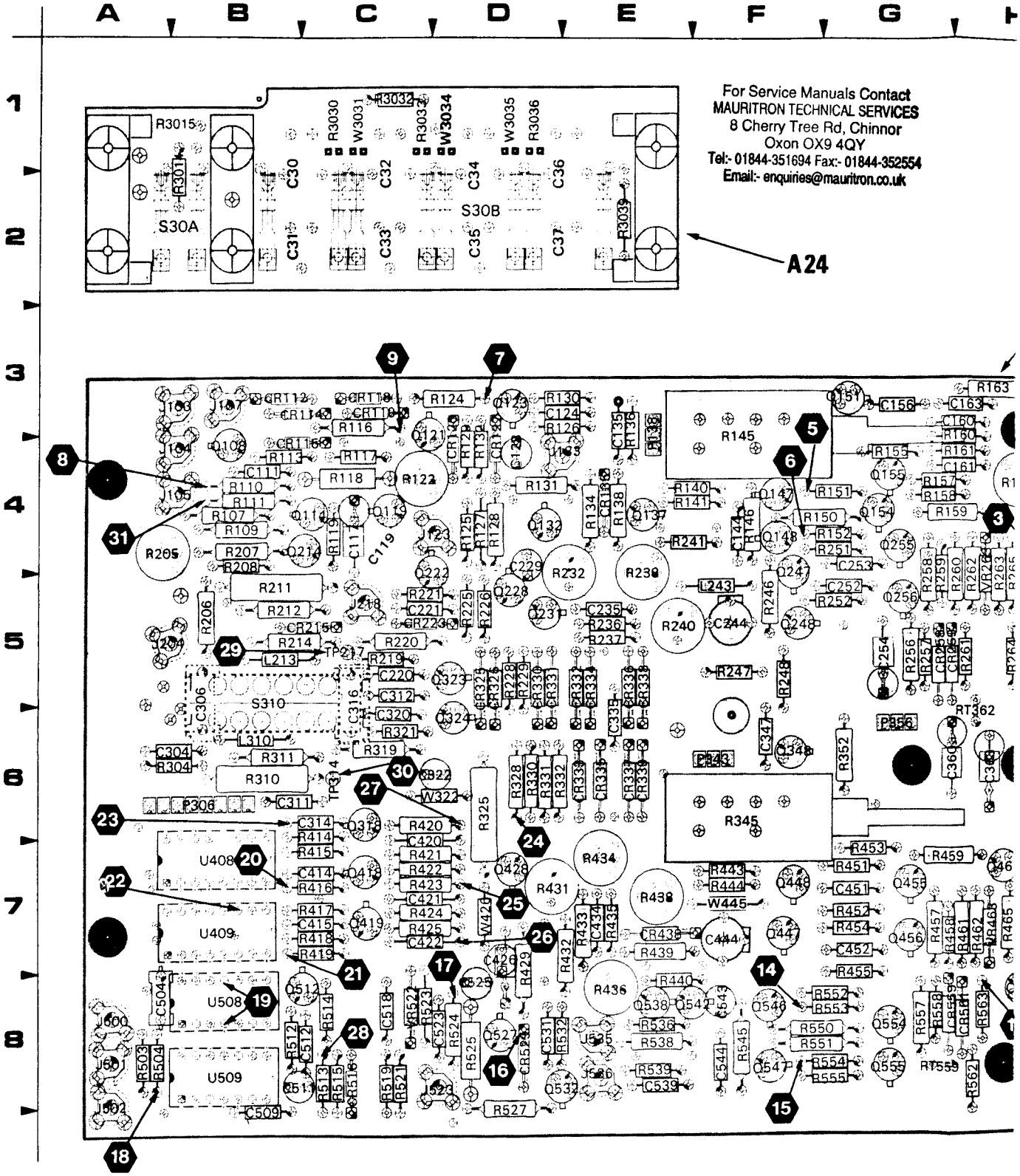


Figure 8-14B. A11 Vertical Preamplifier (SN B039999 & below) and A24 At

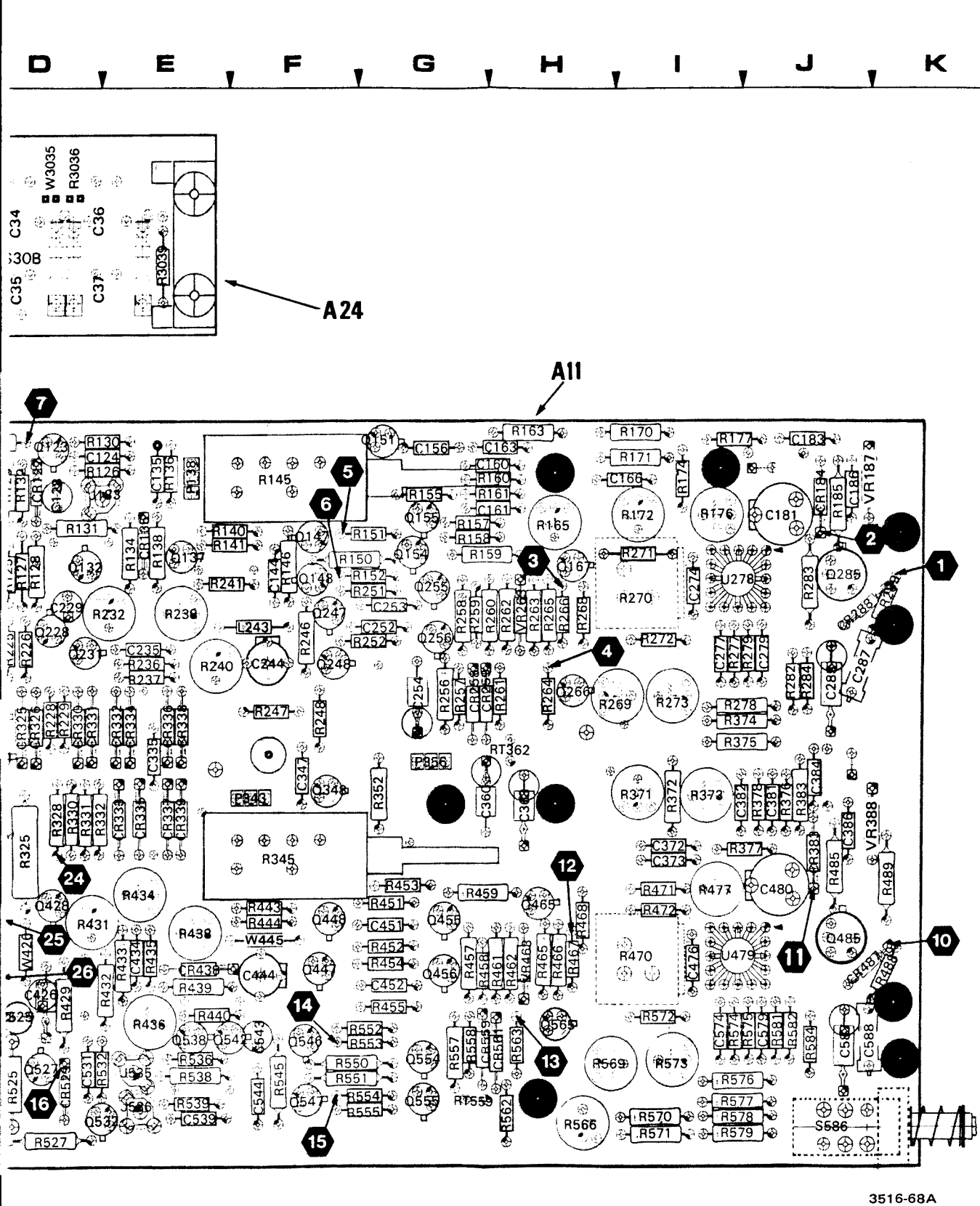
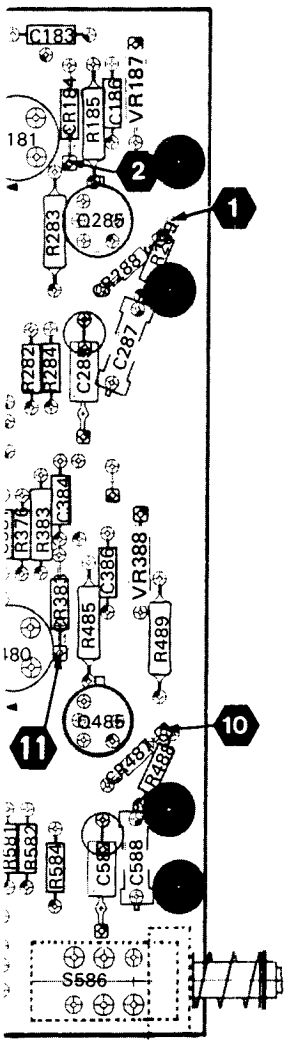


Figure 8-14B. A11 Vertical Preamplifier (SN B039999 & below) and A24 Attenuator boards.

A24 ATTENUATOR BOARD

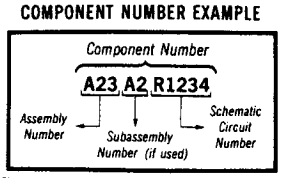
J K

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 1 2					
C30 C31 C32 C33	C34 C35 C36 C37	R3014 R3015 R3030 R3032	R3033 R3036 R3039	S30A S30B W3031	W3034 W3035



3516-68A

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

For Service Manuals Contact
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Email:- enquiries@mauritron.co.uk

COMPONENT
C111
C119
C124
C128
C135
C144
C156
C160
C161
C163
C166
C181
C183
C186
C229
C235
C252
C253
C274
C277
C279

COMPONENT
C347
C372
C373
C381
C382
C384
C386
C434
C451
C452
C476
C480
C523
C531
C539
C543
C544
C574
C579
C587
C588

COMPONENT
C117
C220
C221
C244
C254
C304
C306
C311
C312
C314
C316
C320
C322
C360
C363
C414
C415
C420
C421
C422

A11 VERTICAL PREAMP BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 1 (SN B039999 & BELOW)

C111	C285	P138	R110	R146	R232	R269
C119	C287		R113	R150	R236	R270
C124	C335	Q108	R116	R151	R237	R271
C128		Q119	R117	R152	R238	R272
C135	CR112	Q121	R118	R155	R241	R273
C144	CR114	Q123	R122	R157	R246	R277
C156	CR115	Q132	R124	R158	R251	R278
C160	CR118	Q137	R126	R159	R252	R279
C161	CR119	Q147	R128	R160	R256	R282
C163	CR120	Q148	R129	R161	R257	R283
C166	CR127	Q151	R130	R163	R258	R284
C181	CR135	Q154	R131	R165	R259	R289
C183	CR184	Q155	R132	R170	R260	R374
C186	CR258	Q167	R134	R171	R261	R375
C229	CR259	Q231	R136	R17[illegible]	R262	
C235	CR288	Q255	R138	R174	R263	RT362
C252		Q256	R140	R176	R264	
C253	J103	Q266	R141	R177	R265	U278
C274	J104	Q285A	R145A	R185	R266	
C277	J107	Q285B	R145B		R268	VR187
C279	J133			R206		
	J204					VR263

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 2 (SN B039999 & BELOW)

C347	CR383	Q538	R433	R471	R554	R575
C372	CR438	Q542	R434	R472	R555	R576
C373	CR487	Q546	R435	R477	R557	R577
C381	CR529	Q547	R436	R485	R558	R578
C382	CR559	Q554	R439	R488	R562	R579
C384	CR561	Q555	R440	R489	R563	R581
C386		Q565	R443	R524	R566	R582
C434	J523		R444	R525	R569	R584
C451	J535	R345A	R452	R527	R570	
C452	J536	R345B	R454	R532	R571	RT559
C476		R352	R455	R536	R572	
C480	P343	R371	R457	R538	R573	S586
C523		R372	R458	R539	R574	
C531	Q348	R373	R459	R545		U479
C539	Q455	R376	R461	R550		
C543	Q456	R377	R462	R551		VR388
C544	Q465	R378	R465	R552		
C574	Q485A	R383	R466	R553		VR463
C579	Q485B		R467			
C587	Q527	R429	R468			
C588	Q532	R431	R470			
		R432				

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 3

C117	C426	CR337	Q114	R212	R330	R519
C220	C444	CR338	Q214	R214	R331	R521
C221	C504	CR339	Q222	R219	R332	R523
C244	C509	CR516	Q228	R220	R414	
C254	C511		Q247	R221	R415	S310
C304	C512	J105	Q248	R225	R416	
C306	C518	J123	Q318	R226	R417	TP217
C311	C525	J218	Q323	R228	R418	TP314
C312		J500	Q324	R229	R419	
C314	CR215	J501	Q418	R240	R420	U408
C316	CR223	J502	Q419	R247	R421	U409
C320	CR325		Q428	R248	R422	U508A
C322	CR326	L213	Q447	R304	R423	U508B
C360	CR330	L243	Q448	R310	R424	U508C
C363	CR331	L310	Q512	R311	R425	U508D
C414	CR332			R319	R438	U509A
C415	CR333		R107	R321	R451	U509B
C420	CR334	P306	R109	R325	R453	U509C
C421	CR335	P306	R111	R328	R503	U509D
C422	CR336	P306	R119		R504	
		P306	R208		R512	VR522
		P356	R211		R513	
					R514	W322
					R515	W426
						W445

CH 1 VERTICAL PREAMP DIAGRAM ◇1◇ (SN B039999 & BELOW)

ASSEMBLY A11

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C111	7I	4B	Q132	3H	4D	R172	5A	4I
C119	7H	4C	Q137	4H	4E	R174	5B	3I
C124	8H	3E	Q147	4H	4F	R176	5B	4I
C128	9H	4D	Q148	6H	4F	R177	5B	3I
C135	3G	3E	Q151	5J	3G	R185	4A	4J
C144	5H	4F	Q154	6G	4G			
C156	6J	3G	Q155	4G	4G	R206	7I	5B
C160	5A	3H	Q167	4D	4H	R232	3H	4E
C161	5A	4H	Q231	7H	5D	R236	6H	5E
C163	5A	3H	Q255	4F	4G	R237	7H	5E
C166	5A	3I	Q256	6F	5G	R238	5K	4E
C181	5B	4J	Q266	6D	5H	R241	4H	4F
C183	5A	3J	Q285A	4A	4J	R246	5H	5F
C186	3A	4J	Q285B	4A	4J	R251	4G	4G
C229	5K	4D				R252	6G	5G
C235	6H	5E	R110	7I	4B	R256	5F	5G
C252	6G	5G	R113	7I	4B	R257	6F	5G
C253	4G	4G	R116	8J	3C	R258	5F	5G
C274	3C	4I	R117	8H	4C	R259	4F	5H
C277	7C	5I	R118	7H	4C	R260	6E	5H
C279	7B	5J	R122	9H	4D	R261	6F	5H
C285	4A	5J	R124	8H	3D	R262	4E	5H
C287	4A	5J	R126	8H	3E	R263	5D	4H
C335	7G	6E	R128	7H	4D	R264	6E	5H
CR112	8I	3C	R129	8I	4D	R265	5D	4H
CR114	8I	3C	R130	3H	3E	R266	4D	5H
CR115	7I	4C	R131	3I	4D	R268	3C	5H
CR118	8I	3C	R132	8I	4D	R269	5D	5I
CR119	8I	3C	R134	3H	4E	R270	7A	4I
CR120	8H	4D	R136	4H	3E	R271	4D	4I
CR127	7H	4D	R138	3H	4E	R272	6D	5I
CR135	3H	4E	R140	4K	4F	R273	6A	5I
CR184	4B	4J	R141	6K	4F	R277	7C	5J
CR258	6F	5G	R145A	5I	4F	R278	7C	5J
CR259	4F	5M	R145B	6J	4F	R279	7C	5J
CR288	3A	4K	R146	5H	4F	R282	6B	5J
			R150	5H	4G	R283	4A	4J
J103	8J	3B	R151	4G	4G	R284	6B	5J
J104	7J	4B	R152	6G	4G	R289	4A	5K
J107	7J	3B	R155	5G	4G	R374	7C	5J
J133	3J	4E	R157	4G	4G	R375	7B	5J
J204	7J	5B	R158	6G	4G			
			R159	5F	4H	RT362	4F	6H
P138	6J	3E	R160	5B	4H			
			R161	5A	4H	U278	3B	4J
Q108	7J	4B	R163	5J	3H	VR187	3A	4K
Q119	7H	4C	R165	5A	4H			
Q121	8I	3D	R170	5A	3I	VR263	5E	4H
Q123	8H	3D	R171	5A	3I			

Partial A11 also shown on diagrams 2 and 3.

ASSEMBLY A24

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C30	2C	1B	R3014	1B	1B	S30A	1B	2B
C31	2C	2B	R3015	2B	1B	S30B	1F	2B
C32	2E	1C	R3030	2C	1C			
C33	2E	2C	R3032	2E	1C	W3031	2D	1C
C34	2G	1D	R3033	2E	1C	W3034	2F	1D
C35	2G	2D	R3036	2H	1D	W3035	2G	1D
C36	2H	1D	R3039	2I	2E			
C37	2I	2D						

A24 also shown on diagram 2.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C3042	2J	CHASSIS	P104	7K	CHASSIS	R3042	2J	CHASSIS
C13010	2A	CHASSIS	P107	7K	CHASSIS	R3045	2J	CHASSIS
C13012	2A	CHASSIS	P133	3K	CHASSIS	R13010	2A	CHASSIS
			P204	7K	CHASSIS			
P103	8K	CHASSIS						

For Service Manuals Contact
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8 Cherry Tree Rd, Chinnor
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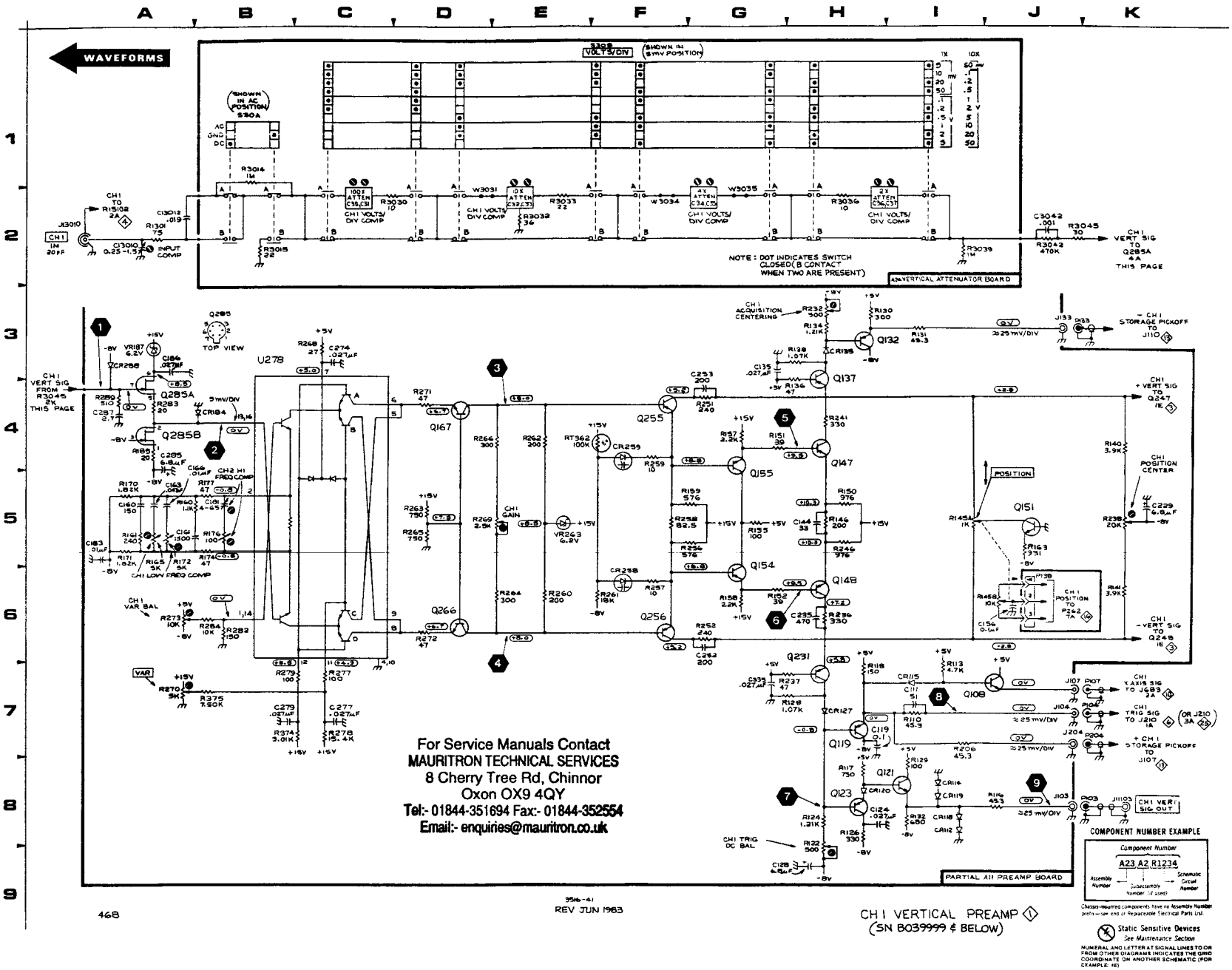

(SN B039999 & BELOW)

468 CONTROL SETTINGS FOR ◇2

DC Voltages

VERT MODE	CH 2
AC-GND-DC (both)	GND

AC Waveforms

VERT MODE	CH 2
CH 2 AC-GND-DC	DC
VOLTS/DIV	5 mV
Input	20 mV positive-going square wave

For Service Manuals Contact
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8 Cherry Tree Rd, Chinnor
Oxon OX9 4QY
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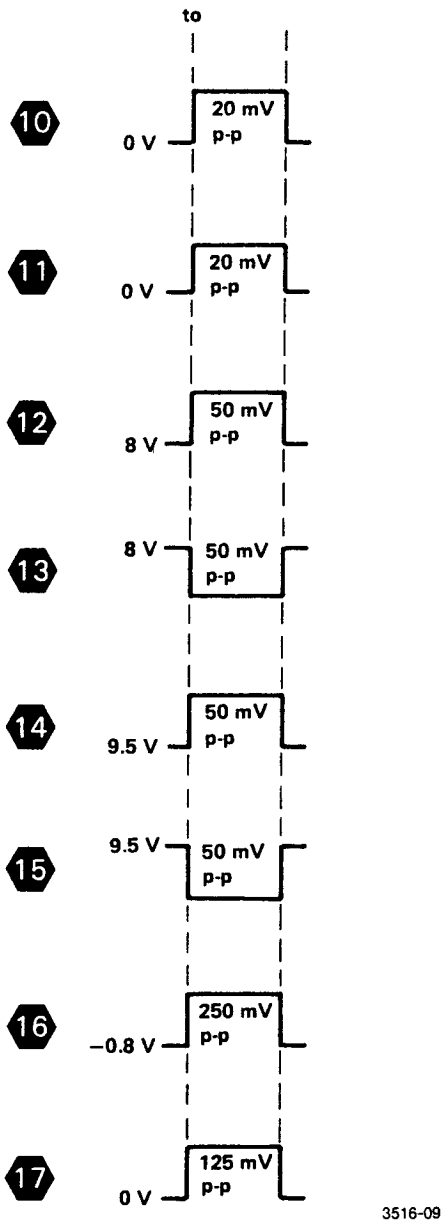

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CH 2 VERTICAL PREAMP DIAGRAM ◇2◇ (SN B040000 & UP)

ASSEMBLY A11

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C372	5A	6I	Q554	4G	8G	R477	5B	7I
C373	5A	6I	Q555	6G	8G	R485	4A	6J
C381	5A	6J	Q565	6D	8H	R488	4A	7K
C382	5A	6J	R343	5J	6F	R489	4A	7K
C384	5A	6J	R344	4J	6F	R524	7I	8D
C386	3A	6J	R345	6J	6F	R525	7H	8D
C434	3G	7E	R349	4I	6F	R527	7H	8D
C436	5I	7E	R352	5J	6G	R532	7H	8E
C451	3G	7G	R371	5A	6I	R536	3H	8E
C452	6G	7G	R372	5A	6I	R538	3I	8D
C456	5G	8G	R373	5A	6I	R539	6H	8E
C476	3C	7I	R376	5A	6J	R545	5H	8F
C480	5B	7J	R377	5B	6J	R550	5H	8D
C523	7I	8C	R378	5A	6J	R551	5H	8G
C524	8H	8D	R383	5A	6J	R552	4G	8G
C531	7G	8D	R429	8H	8D	R553	4G	8G
C539	6H	8E	R431	8H	7D	R554	6H	8G
C543	8H	7D	R432	7I	7D	R555	6G	8G
C544	5H	8F	R433	3H	7D	R556	6G	8G
C574	7C	8I	R434	5K	7E	R557	5G	8G
C579	7B	8J	R435	4H	7E	R558	6F	8G
C587	4A	8J	R436	3H	8E	R562	6F	8H
C588	4A	8K	R439	3H	7E	R563	6E	8H
CR383	4B	6J	R440	4H	8E	R566	7A	8H
CR438	3H	7E	R441	5J	6E	R569	5E	8H
CR487	4A	7J	R442	5J	7E	R570	7B	8I
CR529	7H	8D	R443	6K	7F	R571	7C	8I
CR559	4F	8H	R444	4K	7F	R572	6D	8I
CR561	6F	8H	R446	5J	6F	R573	6A	8I
J523	7J	8D	R452	4G	7G	R574	7C	8I
J535	7J	8E	R454	6G	7G	R575	7B	8J
J536	3J	8E	R455	5G	7G	R576	7B	8I
P343	6J	6E	R456	4G	8G	R577	7B	8I
Q348	5J	6F	R457	5F	7G	R578	7A	8I
Q350	5I	6F	R458	4F	7G	R579	7A	8I
Q455	4F	7G	R459	5G	7G	R581	6A	8J
Q456	6F	7G	R461	4E	7G	R582	6B	8I
Q463	5E	7G	R462	6E	7H	R584	6A	8J
Q465	4D	7H	R463	4F	7H	RT559	4F	8G
Q485A	4A	7J	R464	5F	7H	S586	6A	8J
Q485B	4A	7J	R465	5D	7H			
Q527	8I	8D	R466	5D	7H	U341A	5I	6E
Q532	7H	8E	R467	4E	7H	U341B	5J	6E
Q538	4H	8E	R468	3C	7H	U479	3B	7I
Q542	3H	8F	R470	7A	7I			
Q546	4H	8F	R471	5B	7I	VR388	3A	6K
Q547	6H	8F	R472	4D	7I	VR530	3H	8D

Partial A11 also shown on diagrams 1 and 3.

ASSEMBLY A24

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C30	2C	1B	R3014	1B	1B	S30A	1B	2B
C31	2C	2B	R3015	2B	1B	S30B	1F	2B
C32	2E	1C	R3030	2C	1C			
C33	2E	2C	R3032	2E	1C	W3031	2E	1C
C34	2G	1D	R3033	2E	1C	W3034	2F	1D
C35	2G	2D	R3036	2H	1D	W3035	2G	1D
C36	2H	1D	R3039	2I	2E			
C37	2I	2D						

A24 also shown on diagram 1.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C3042	2J	CHASSIS	P523	7K	CHASSIS	R3045	2J	CHASSIS
C13010	2A	CHASSIS	P535	7K	CHASSIS	R13010	2A	CHASSIS
C13012	2A	CHASSIS	P536	3K	CHASSIS			
J13010	2A	CHASSIS	R3042	2J	CHASSIS			

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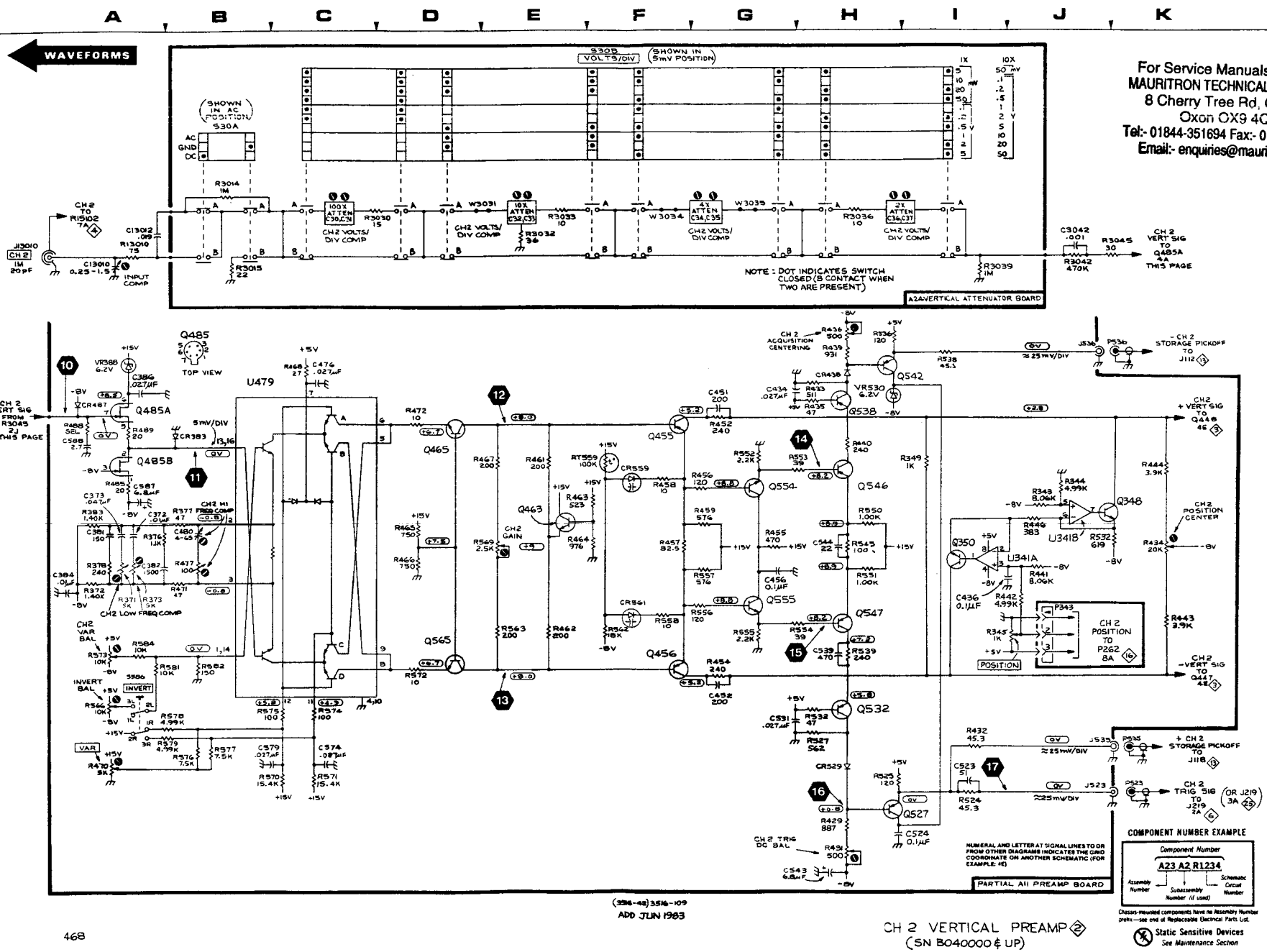


CH 2 VERTICAL PREAMP DIAGRAM ◇2◇ (SN B039999 & BELOW)

ASSEMBLY A11

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C347	6I	6F	Q546	4H	8F	R489	4A	7K
C372	5A	6I	Q547	6H	8F	R524	7I	8D
C373	5A	6I	Q554	4G	8G	R525	7H	8D
C381	5A	6J	Q555	6G	8G	R527	7H	8D
C382	5A	6J	Q565	6D	8H	R532	7H	8E
C384	5A	6J				R536	3H	8E
C386	3A	6J	R345A	5I	6F	R538	3I	8E
C434	3G	7E	R345B	6I	6F	R539	6H	8E
C451	3G	7G	R352	5J	6G	R545	5H	8F
C452	6G	7G	R371	5A	6I	R550	5H	8G
C476	3C	7I	R372	5A	6I	R551	5H	8G
C480	5B	7J	R373	5A	6I	R552	4G	8G
C523	7I	8D	R376	5A	6J	R553	4G	8G
C531	7G	8D	R377	5B	6J	R554	6H	8G
C539	6H	8F	R378	5A	6J	R555	6G	8G
C543	8H	8F	R383	5A	6J	R557	5G	8G
C544	5H	8F				R558	6F	8G
C574	7C	8I	R429	8H	8D	R562	6F	8H
C579	7B	8J	R431	8H	7D	R563	6E	8H
C587	4A	8J	R432	7I	7E	R566	7A	8H
C588	4A	8K	R433	3H	7E	R569	5E	8I
			R434	5K	7E	R570	7B	8I
CR383	4B	6J	R435	4H	7E	R571	7C	8I
CR438	3H	7E	R436	3H	8E	R572	6D	8I
CR487	4A	7K	R439	3H	7E	R573	6A	8I
CR529	7H	8D	R440	4H	8E	R574	7C	8I
CR559	4F	8H	R443	6K	7F	R575	7B	8J
CR561	6F	8H	R444	4K	7F	R576	7B	8I
			R452	4G	7G	R577	7B	8I
J523	7J	8D	R454	6G	7G	R578	7A	8I
J535	7J	8E	R455	5G	7G	R579	7A	8I
J536	3J	8E	R457	5F	7G	R581	6A	8J
			R458	4F	7H	R582	6B	8I
P343	6J	6F	R459	5G	7H	R584	6A	8J
			R461	4E	7H			
Q348	5J	6F	R462	6E	7H	RT559	4F	8G
Q455	4F	7G	R465	5D	7H			
Q456	6F	7G	R466	5D	7H	S586	6A	8J
Q465	4D	7H	R467	4E	7H			
Q485A	4A	7J	R468	3C	7H	U479	3B	7J
Q485B	4A	7J	R470	7A	7I			
Q527	8I	8D	R471	5B	7I	VR388	3A	6K
Q532	7H	8E	R472	4D	7I			
Q538	4H	8E	R477	5B	7I	VR463	5E	7H
Q542	3H	8F	R485	4A	6J			
			R488	4A	7K			

Partial A11 also shown on diagrams 1 and 3.

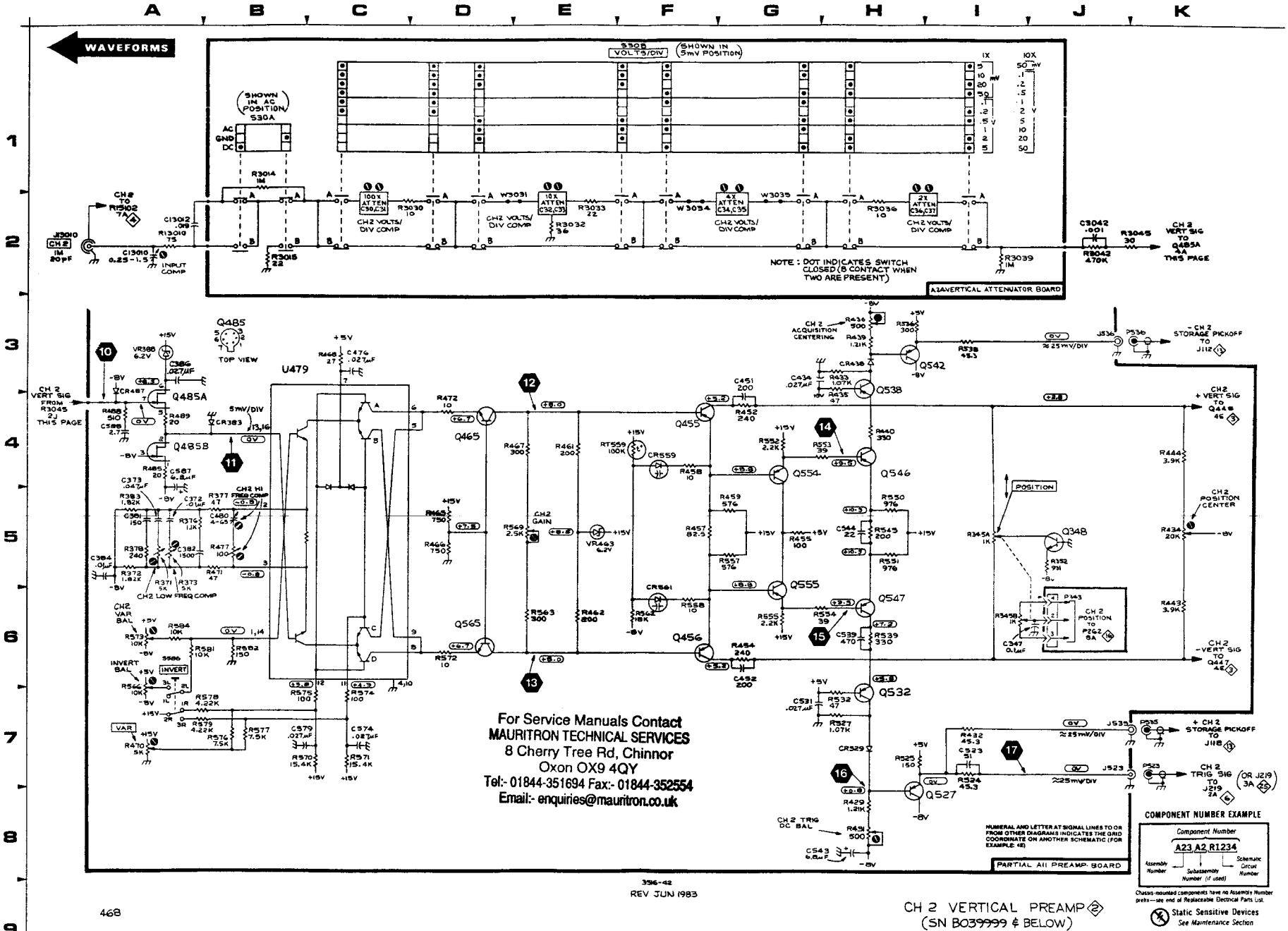
ASSEMBLY A24

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C30	2C	1B	R3014	1B	1B	S30A	1B	2B
C31	2C	2B	R3015	2B	1B	S30B	1F	2B
C32	2E	1C	R3030	2C	1C			
C33	2E	2C	R3032	2E	1C	W3031	2E	1C
C34	2G	1D	R3033	2E	1C	W3034	2F	1D
C35	2G	2D	R3036	2H	1D	W3035	2G	1D
C36	2H	1D	R3039	2I	2E			
C37	2I	2D						

A24 also shown on diagram 1.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C3042	2J	CHASSIS	P523	7K	CHASSIS	R3045	2J	CHASSIS
C13010	2A	CHASSIS	P535	7K	CHASSIS	R13010	2A	CHASSIS
C13012	2A	CHASSIS	P536	3K	CHASSIS			
J13010	2A	CHASSIS	R3042	2J	CHASSIS			


WAVEFORMS
A23 VERTICAL ATTENUATOR BOARD
NOTE : DOT INDICATES SWITCH CLOSED (B CONTACT WHEN TWO ARE PRESENT)
PARTIAL A11 PREAMP BOARD
For Service Manuals Contact
MAURITRON TECHNICAL SERVICES
8 Cherry Tree Rd, Chinnor
Oxon OX9 4QY
Tel:- 01844-351694 Fax:- 01844-352554
Email:- enquiries@mauritron.co.uk
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
396-42
REV JUN 1983
468
CH 2 VERTICAL PREAMP
(SN B039999 & BELOW)

468 CONTROL SETTINGS FOR ③

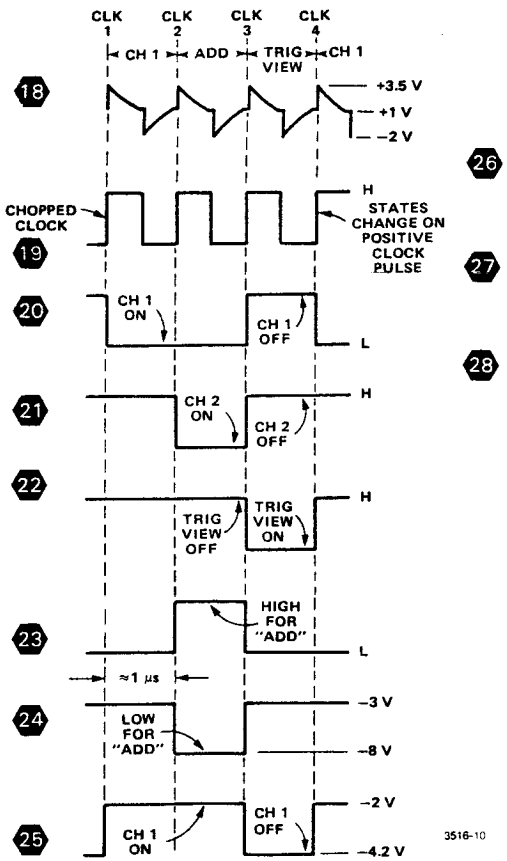
DC Voltages

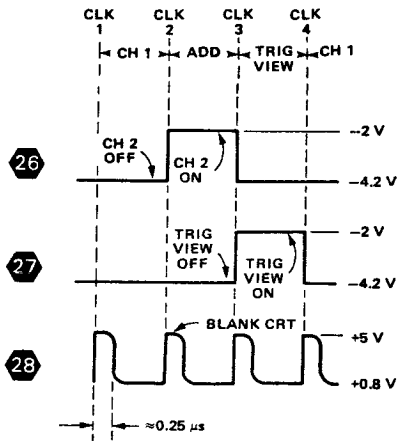
A TRIG MODE	NORM (sweep not running)
VERT MODE	CH 1 and CHOP
AC-GND-DC (both)	GND
CH 1 POSITION	Midrange

AC Waveforms

VERT MODE	CH 1, ADD, A TRIG VIEW, and CHOP
A TRIG MODE	AUTO (no trigger signal)
A AND B TIME/DIV	1 ms
HORIZ DISPLAY	A
AC-GND-DC (both)	GND

H = HI logic level >2 vdc
L = LO logic level <0.8 vdc

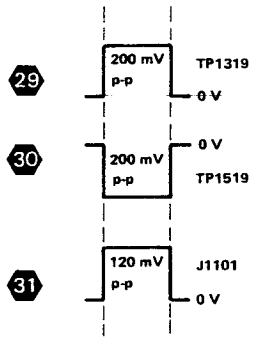




468 CONTROL SETTINGS FOR ③

AC Waveforms

VERT MODE	CH 1
VOLTS/DIV	5 mV
CH 1 AC-GND-DC	DC
Vertical POSITION	Midrange
Input	20 mV positive-going square wave



VERTICAL SWITCHING LOGIC DIAGRAM 3

ASSEMBLY A11

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C117	1L	4C	L213	1M	5B	R319	3J	6C
C220	1K	5C	L243	1D	5F	R321	3K	6C
C221	2D	5D	L310	3L	6B	R325	2K	6D
C244	1D	5F				R328	2J	6D
C254	6A	5G				R330	3J	6D
C304	4L	6A	P306	2B	6B	R331	2J	6D
C306	2L	5B	P306	4A	6B	R332	2J	6E
C311	7A	6C	P306	4M	6B	R414	6H	7C
C312	2D	5C	P306	8A	6B	R415	6I	7C
C314	6H	6C	P356	6A	6G	R416	5H	7C
C316	2L	5C				R417	5H	7C
C320	3K	6C	Q114	1L	4C	R418	5H	7C
C322	7B	6D	Q214	1K	4C	R419	5I	7C
C360	7A	6H	Q222	3E	4D	R420	6I	6D
C363	7A	6H	Q228	2E	5D	R421	6J	7D
C414	5H	7C	Q247	1E	4F	R422	5I	7D
C415	5H	7C	Q248	1E	5F	R423	5J	7D
C420	6J	7D	Q318	6I	6C	R424	5J	7D
C421	5J	7D	Q323	2K	5D	R425	5I	7D
C422	5J	7D	Q324	3K	6D	R438	4D	7E
C426	7B	7D	Q418	5I	7C	R451	4E	7G
C444	4D	7F	Q419	5I	7C	R453	3E	7G
C504	8E	8B	Q428	4I	7D	R503	7E	8A
C509	8C	8B	Q447	4E	7F	R504	7F	8A
C511	7I	8C	Q448	3E	7F	R512	8J	8B
C512	8H	8C	Q512	7I	8C	R513	8J	8C
C518	5H	8C				R514	8H	8C
C525	7B	8D	R107	1K	4B	R515	7H	8C
			R109	1K	4B	R519	4H	8C
CR215	1K	5C	R111	1L	4B	R521	4H	8C
CR223	2D	5D	R119	1L	4C	R523	4I	8D
CR325	2F	5D	R125	2D	4D			
CR326	3F	5D	R127	2E	4D	S310	1L	5B
CR330	3G	5D	R205	1K	4A			
CR331	2G	5D	R207	1K	4B	TP217	1K	5C
CR332	1G	5E	R208	1K	4B	TP314	3K	6C
CR333	4G	6E	R211	1K	5B			
CR334	1F	5E	R212	1K	5B	U408	5C	7B
CR335	4F	6E	R214	1L	5B	U409	5G	7B
CR336	1G	5E	R219	1K	5C	U508A	7F	8B
CR337	3G	6E	R220	1J	5C	U508B	7D	8B
CR338	1F	5E	R221	3D	5D	U508C	7F	8B
CR339	3F	6E	R225	2E	5D	U508D	4H	8B
CR516	8I	8C	R226	2D	5B	U509A	8D	8B
			R228	2F	5D	U509B	7E	8B
J105	1M	4B	R229	3F	5D	U509C	8G	8B
J123	1B	4D	R240	1D	5E	U509D	8D	8B
J218	3B	5C	R247	1E	5F			
J500	6M	8A	R248	1E	5F	VR522	4H	8C
J501	8A	8A	R304	4M	6B	W322	7A	6D
J502	7M	8A	R310	3K	6B	W426	7A	7D
			R311	3L	6B	W445	3D	7F

Partial A11 also shown on diagrams 1 and 2.

ASSEMBLY A15

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P154	6A	2H						

Partial A15 also shown on diagrams 4, 5, 7, 8, 9, 10, 11, 12 and 20.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
DL208	1M	CHASSIS						

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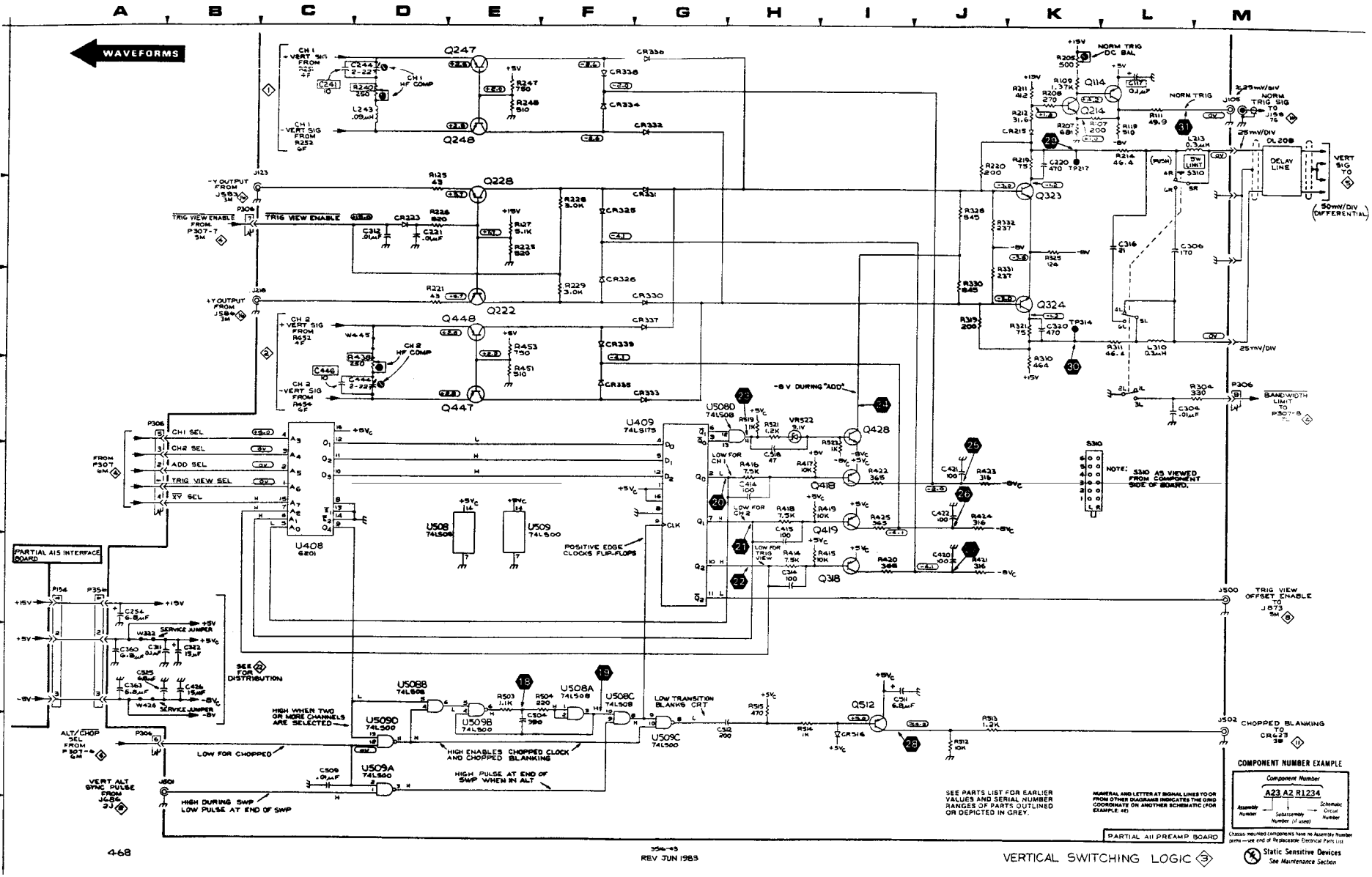
WAVEFORMS
Q247
Q248
Q228
Q222
Q448
Q447
Q114
Q214
Q323
Q324
Q428
Q418
Q419
Q318
Q512
U408
U409
U508
U509
U5080
U5088
U5090
U5098
U508A
U508C
U509A
U509C
TRIG VIEW ENABLE
CH 1 SEL
CH 2 SEL
ADD SEL
TRIG VIEW SEL
XY SEL
NORM TRIG
DELAY LINE
BANDWIDTH LIMIT
TRIG VIEW OFFSET ENABLE
CHOPPED BLANKING
ALT/CHOP SEL
VERT ALT SYNC PULSE
LOW FOR CHOPPED
HIGH ENABLES CHOPPED CLOCK AND CHOPPED BLANKING
HIGH PULSE AT END OF SWP WHEN IN ALT
HIGH DURING SWP
LOW PULSE AT END OF SWP
POSITIVE EDGE CLOCKS FLIP-FLOPS
LOW TRANSITION BLANKS CRT
-8V DURING "ADD"
PARTIAL A15 INTERFACE BOARD
PARTIAL A11 PREAMP BOARD
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.
NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATE ON ANOTHER SCHEMATIC (FOR EXAMPLE: 4E)
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
NOTE: S310 AS VIEWED FROM COMPONENT SIDE OF BOARD.
468
3546-43
REV JUN 1983
VERTICAL SWITCHING LOGIC 3

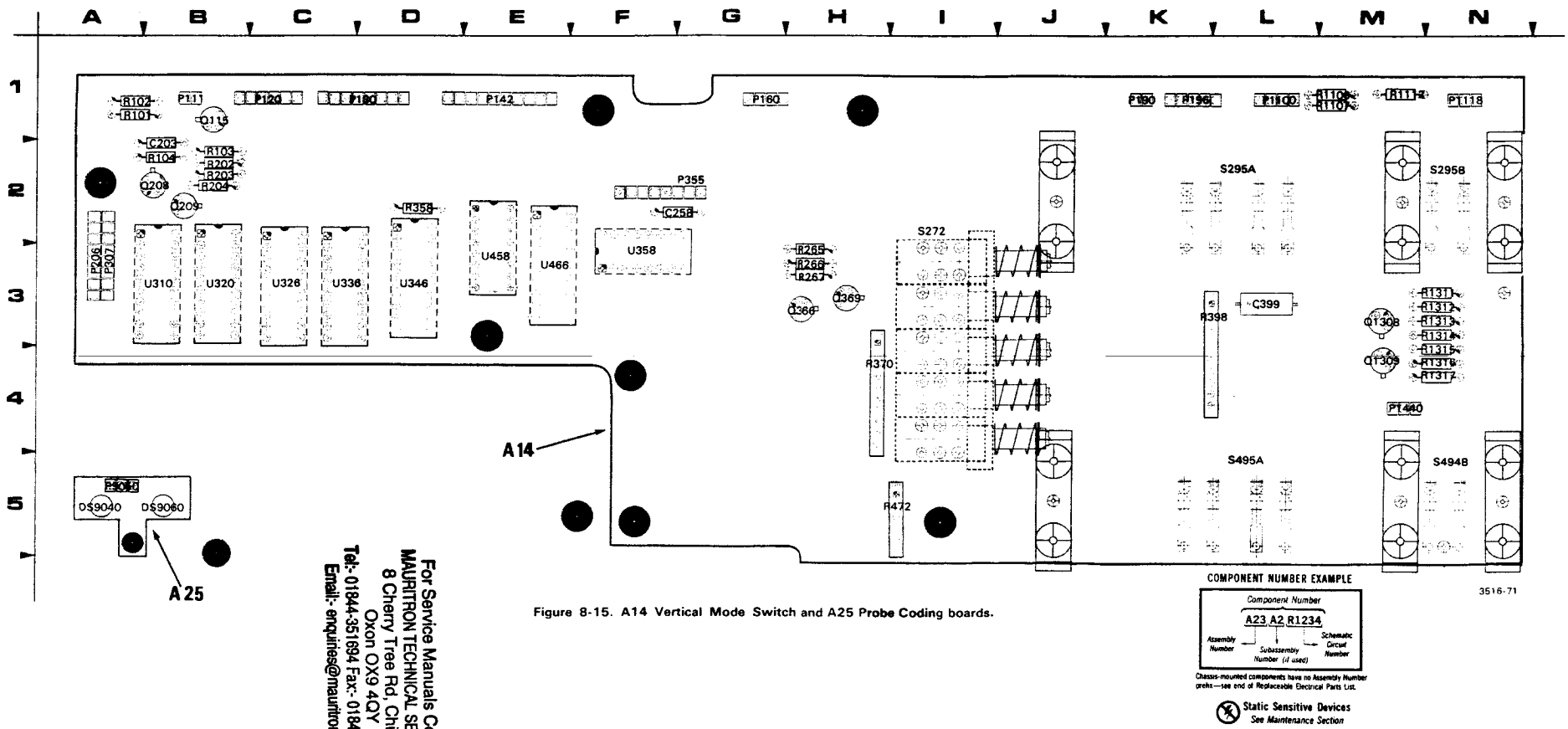

Figure 8-15. A14 Vertical Mode Switch and A25 Probe Coding boards.

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Tel:- 01844-351694 Fax:- 01844-352554
Email:- enquiries@mauritron.co.uk

A14 VERTICAL MODE SWITCH BOARD

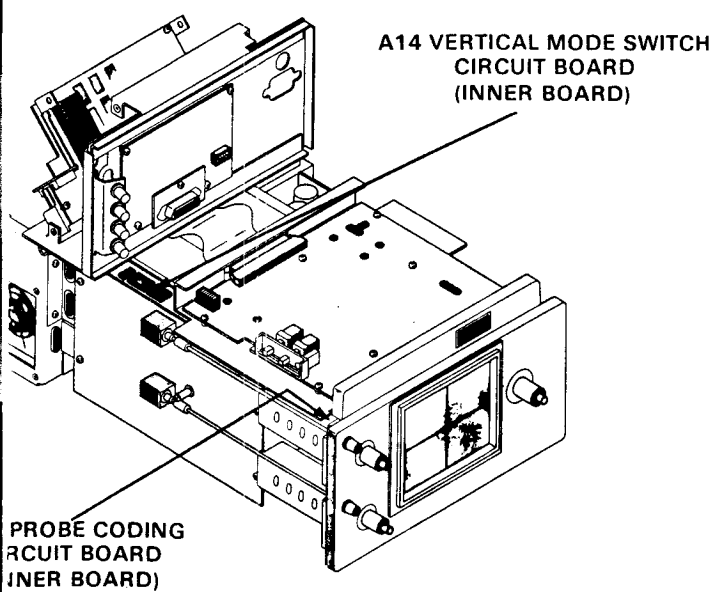
COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 4

C203	P307	R101	R370F	R472E	S495A
C258	P307	R102	R370H	R1106	S495B
C399	P355	R103	R370I	R1107	
	P1100	R104	R398A	R1112	U310
P111	P1100	R202	R398B	R1311	U320
P120	P1118	**R203**	R398C	R1312	U326
P120	P1440	**R204**	R398D	R1313	U336
P130		**R265**	R398E	R1314	U346
P130	Q115	**R266**	R398F	R1315	U358
P142	Q208	**R267**	R398G	R1316	U458
P160	Q209	**R358**	R398H	R1317	
P190	Q366	**R370A**	R466		
P196	Q369	**R370B**	R472B	S272	
P196	Q1308	**R370C**	R472C	S295A	
P206	Q1309	R370D	R472D	S295B	

A25 PROBE CODING BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 4

DS9040	DS9060	P9050



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Oxon OX9 4QY
Tel:- 01844-351694 Fax:- 01844-352554
Email:- enquiries@mauritron.co.uk

VERTICAL MODE SWITCH DIAGRAM 4

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
C212	7E	3B	S320B	7E	4C	P160	7E	1H			

Partial A12 also shown on diagrams 6, 7, 20 and 21.

ASSEMBLY A13

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P129	7F	1D	P146	2F	1F	R145	2F	1F	S469	2E	4I
P135	7F	1E	P146	3M	1F						

Partial A13 also shown on diagrams 7, 8, 9 and 10.

ASSEMBLY A14

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C203	8J	2B	Q115	3L	1B	R370D	5H	4H	R1313	2A	3N
C258	8L	2G	Q208	5K	2B	R370F	5H	4H	R1314	1L	3N
C399	8G	3L	Q209	5L	2B	R370H	5H	4H	R1315	7A	4N
			Q366	8H	3H	R370I	7H	4H	R1316	7A	4N
P111	2M	1B	Q369	7H	3H	R398A	2C	3L	R1317	7A	4N
P120	2F	1C	Q1308	2A	3M	R398B	2C	3L			
P120	3M	1C	Q1309	7A	4M	R398C	2C	3L	S272	6F	2I
P130	1F	1D				R398D	2C	3L	S295A	1B	2L
P130	7G	1D	R101	8L	1A	R398E	2C	3L	S295B	1B	2L
P142	3M	1E	R102	3K	1A	R398F	2C	3L	S495A	5B	5L
P160	8G	1G	R103	3K	2B	R398G	6C	3L	S495B	5B	5L
P190	6M	1K	R104	3K	2B	R398H	6C	3L			
P196	3A	1K	R202	5L	2B	R466	6I	3E	U310	6J	3B
P196	8A	1K	R203	5K	2B	R472B	6C	5I	U320	3G	3B
P206	8M	3A	R204	5K	2B	R472C	6C	5I	U326	1H	3C
P307	5M	3A	R265	7G	3H	R472D	6C	5I	U336	2D	3C
P307	7L	3A	R266	7G	3H	R472E	6C	5I	U346	7D	3D
P355	4A	2G	R267	8H	3H	R1106	8A	1M	U358	4B	3F
P1100	3A	1L	R358	2I	2D	R1107	3A	1M	U458	1I	3E
P1100	7A	1L	R370A	8I	4H	R1112	1L	1M			
P1118	1L	1N	R370B	5H	4H	R1311	2A	3N			
P1440	1L	4M	R370C	5H	4H	R1312	2A	3N			

ASSEMBLY A15

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P151	8F	2H									

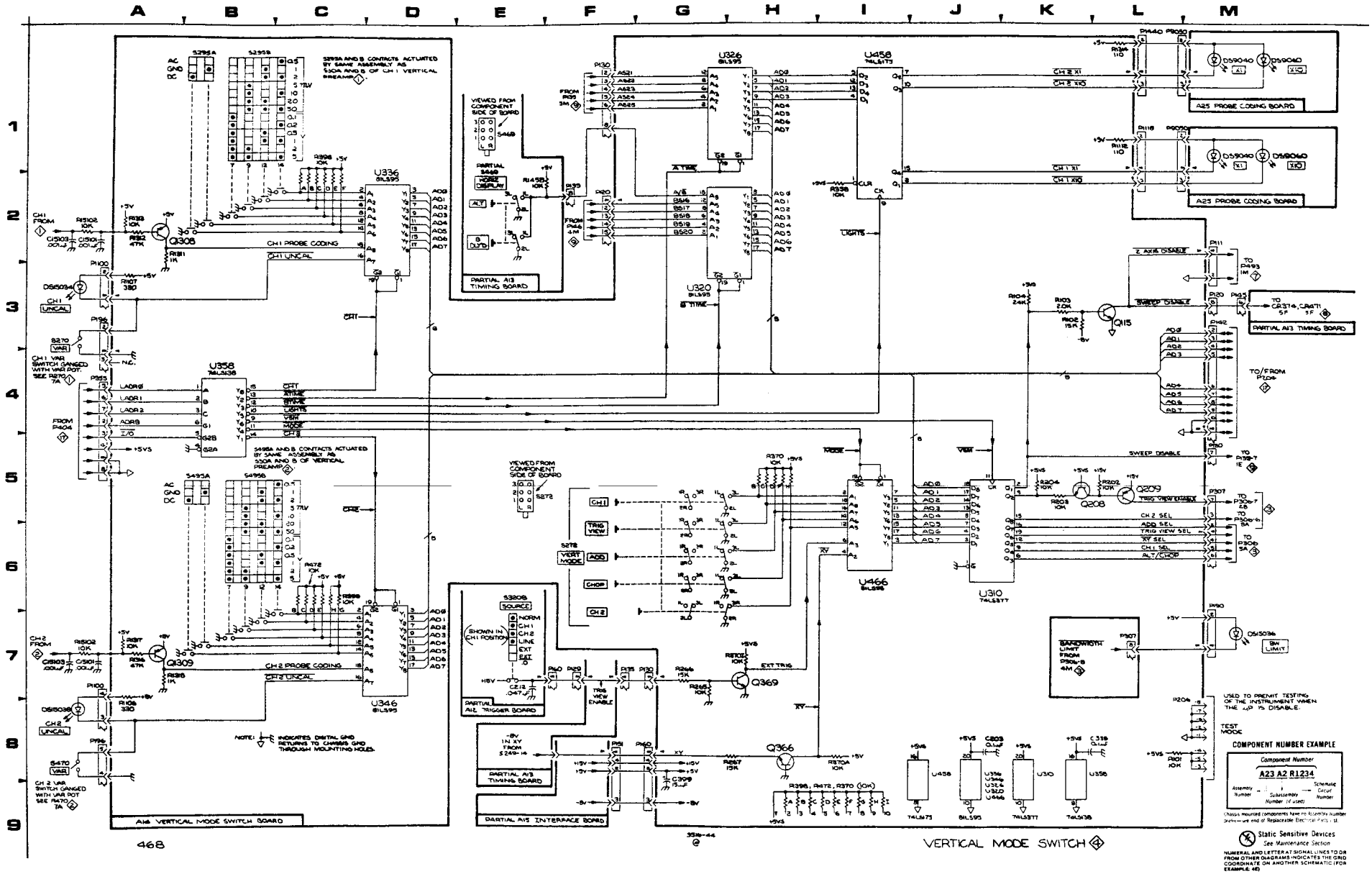
Partial A15 also shown on diagrams 3, 5, 7, 8, 9, 10, 11, 12 and 20

ASSEMBLY A25

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
DS9040	1M	5A	P9050	1M	5A	DS9060	1M	5B	DS9060	1M	5B
DS9040	1M	5A	P9050	1M	5A						

CHASSIS MOUNTED 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
C15101	2A	CHASSIS	DS15034	3A	CHASSIS	R15102	2A	CHASSIS	S270	3A	CHASSIS
C15101	7A	CHASSIS	DS15036	7M	CHASSIS	R15102	7A	CHASSIS	S470	8A	CHASSIS
C15103	2A	CHASSIS	DS15038	8A	CHASSIS						
C15103	7A	CHASSIS									


A1 VERTICAL MODE SWITCH BOARD
PARTIAL A13 TIMING BOARD
PARTIAL A12 TRIGGER BOARD
PARTIAL A15 INTERFACE BOARD
A25 PROBE CODING BOARD
U358
U336
U346
U326
U320
U458
U466
U310
Q308
Q309
Q369
Q366
Q208
Q15
CH 1 PROBE CODING
CH 2 PROBE CODING
CH 1 UNCAL
CH 2 UNCAL
CH 1 VAR SWITCH GANGED WITH VAR POT. SEE R270 7A
CH 2 VAR SWITCH GANGED WITH VAR POT SEE R470 7A
NOTE: INDICATES DIGITAL GND RETURNS TO CHASSIS GND THROUGH MOUNTING HOLES.
VERTICAL MODE SWITCH
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Static Sensitive Devices
See Maintenance Section
468

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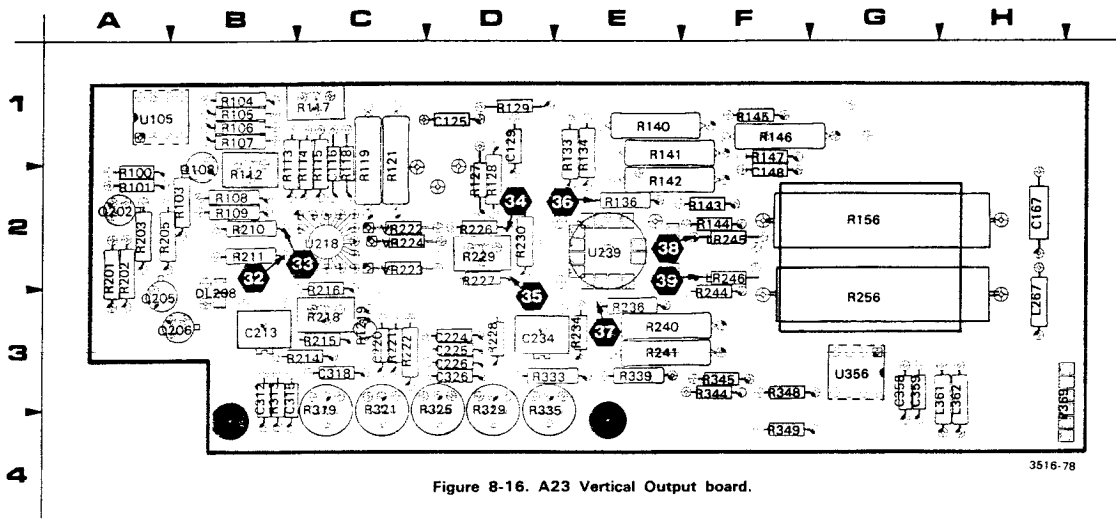


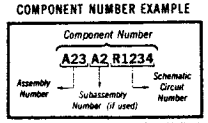
Figure 8-16. A23 Vertical Output board.

A23 VERTICAL OUTPUT BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM ◇5

C116	L362	R108	R144	**R229**	**RT219**
C125		R109	R145	**R230**	
C129	LR245	R112	R146	R234	U105
C148	LR246	R113	R147	R236	U218
C167		R114	R156	R240	U239
C213	P369	R115	R201	R241	U356
C220	P369	R117	R202	R244	
C224		R118	R203	R256	VR222
C225	Q108	R119	R205	R313	VR223
C226	Q202	R121	R210	R319	VR224
C234	Q205	R127	R211	R321	
C312	Q206	R128	R214	R325	
C315		R129	R215	R329	
C318	R100	R133	R216	R333	
C326	R101	R134	R218	R335	
C358	R103	R136	R221	R339	
C359	R104	R140	R222	R344	
	R105	R141	R226	R345	
L267	R106	R142	R227	R348	
L361	R107	R143	R228	R349	

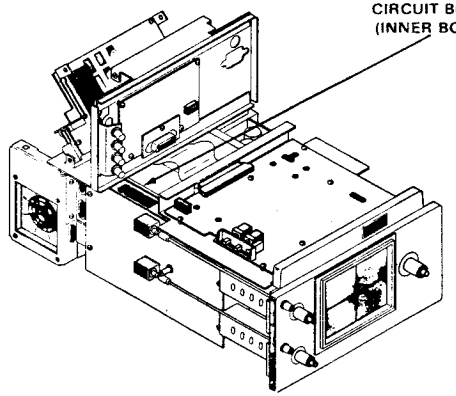
COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

A23 VERTICAL OUTPUT CIRCUIT BOARD (INNER BOARD)



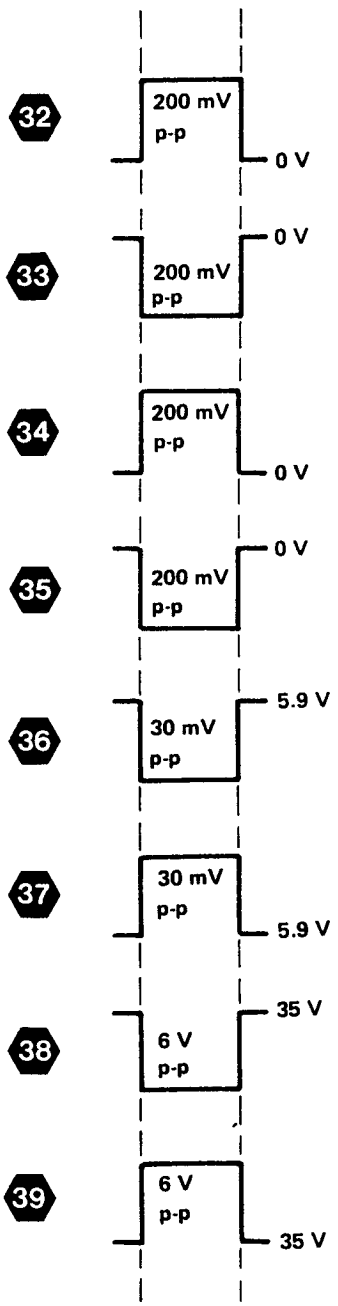
468 CONTROL SETTINGS FOR ◇5

DC Voltages

VERT MODE	CH 1
Vertical POSITION	Midrange
AC-GND-DC (both)	GND

AC Waveforms

VERT MODE	CH 1
VOLTS/DIV	5 mV
CH 1 AC-GND-DC	DC
Input	20 mV positive-going square wave



3516-13

VERTICAL OUTPUT AMPLIFIER DIAGRAM 5

ASSEMBLY A15

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P252	1B	2H	S175	2A	2K			
P252	3A	2H						

Partial A15 also shown on diagrams 3, 4, 7, 8, 9, 10, 11, 12 and 20.

ASSEMBLY A23

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C116	2C	1C	R105	5B	1B	R218	5E	3C
C125	6D	1D	R106	5B	1B	R221	6H	3C
C129	2G	1D	R107	6B	1B	R222	6G	3C
C148	2C	2F	R108	6D	2B	R226	4H	2D
C167	2C	2H	R109	5D	2B	R227	6H	2D
C213	4E	3B	R112	6B	2B	R228	4H	3D
C220	6H	3C	R113	2F	1B	R229	4H	2D
C224	4H	3D	R114	2F	1C	R230	5H	2D
C225	4G	3D	R115	3F	1C	R234	5H	3E
C226	4G	3D	R117	3F	1C	R236	5I	3E
C234	5H	3D	R118	3C	1C	R240	6K	3E
C312	7C	3B	R119	3G	1C	R241	5K	3E
C315	5D	3B	R121	6G	1C	R244	6M	3F
C318	5D	3C	R127	4H	2D	R256	6M	3G
C326	4G	3D	R128	3G	2D	R313	4D	3B
C358	3C	3G	R129	6D	1D	R319	4D	3C
C359	2C	3G	R133	5I	1E	R321	5H	4C
			R134	5I	1E	R325	5H	4D
L267	1C	3H	R136	4I	2E	R329	5G	4D
L361	2C	3H	R140	4I	1E	R333	4G	3D
L362	3C	3H	R141	4K	1E	R335	5G	4D
			R142	4K	2E	R339	5G	3E
LR245	4M	2F	R143	5M	2F	R344	5K	3F
LR246	6M	2F	R144	3M	2F	R345	5K	3F
			R145	4K	1F	R348	5K	3F
P369	1B	3H	R146	2C	1F	R349	7D	4F
P369	6B	3H	R147	4K	1F			
			R156	3M	2G	RT219	5E	3C
Q108	6C	2B	R201	5C	2A			
Q202	6C	2A	R202	5C	2A	U105	6B	1A
Q205	6C	3A	R203	6C	2A	U218	6G	2C
Q206	6C	3B	R205	6C	2A	U239	3K	2E
			R210	6E	2B	U356	5K	3G
R100	6C	2A	R211	4E	2B			
R101	6C	2A	R214	4D	3C	VR222	4G	2C
R103	6C	2B	R215	5D	3C	VR223	6G	2C
R104	5B	1B	R216	4E	2C	VR224	6F	2C

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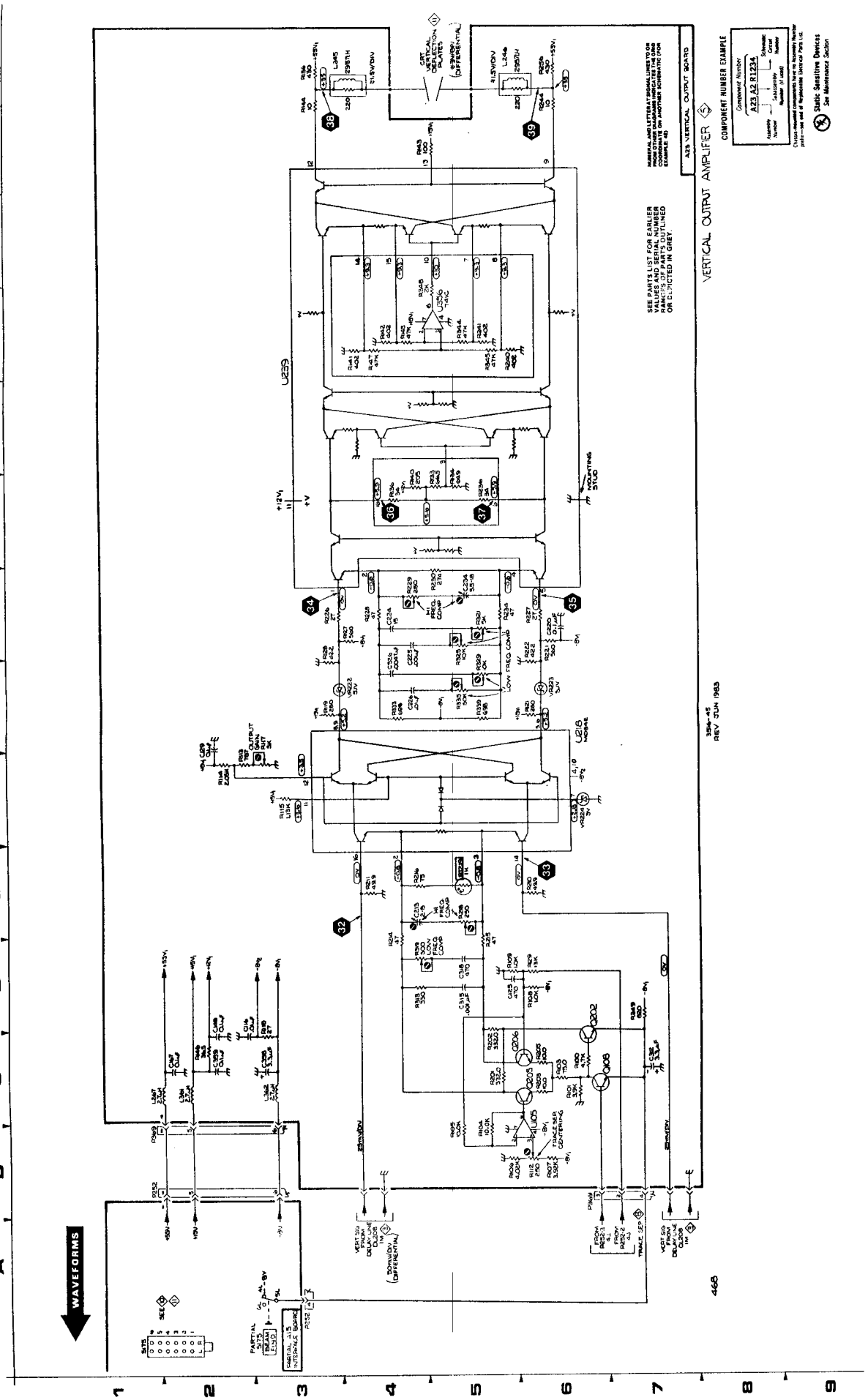
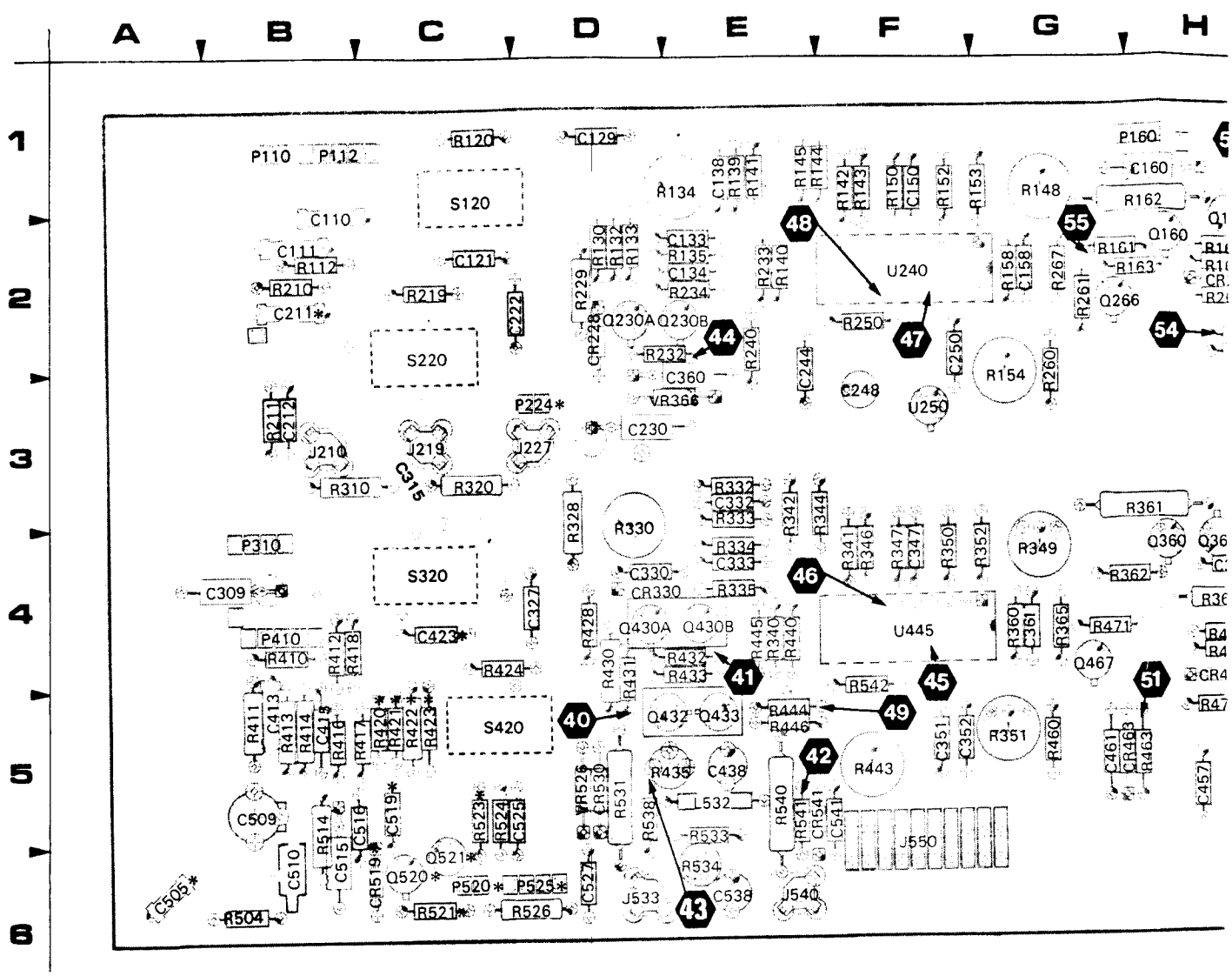

A23 VERTICAL OUTPUT BOARD
VERTICAL OUTPUT AMPLIFIER
COMPONENT NUMBER EXAMPLE
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.
Static Sensitive Devices
See Maintenance Section
WAVEFORMS
35W-45
REV JUN 1983
468



*See Option 05

Figure 8-17. A12 Trigger board.

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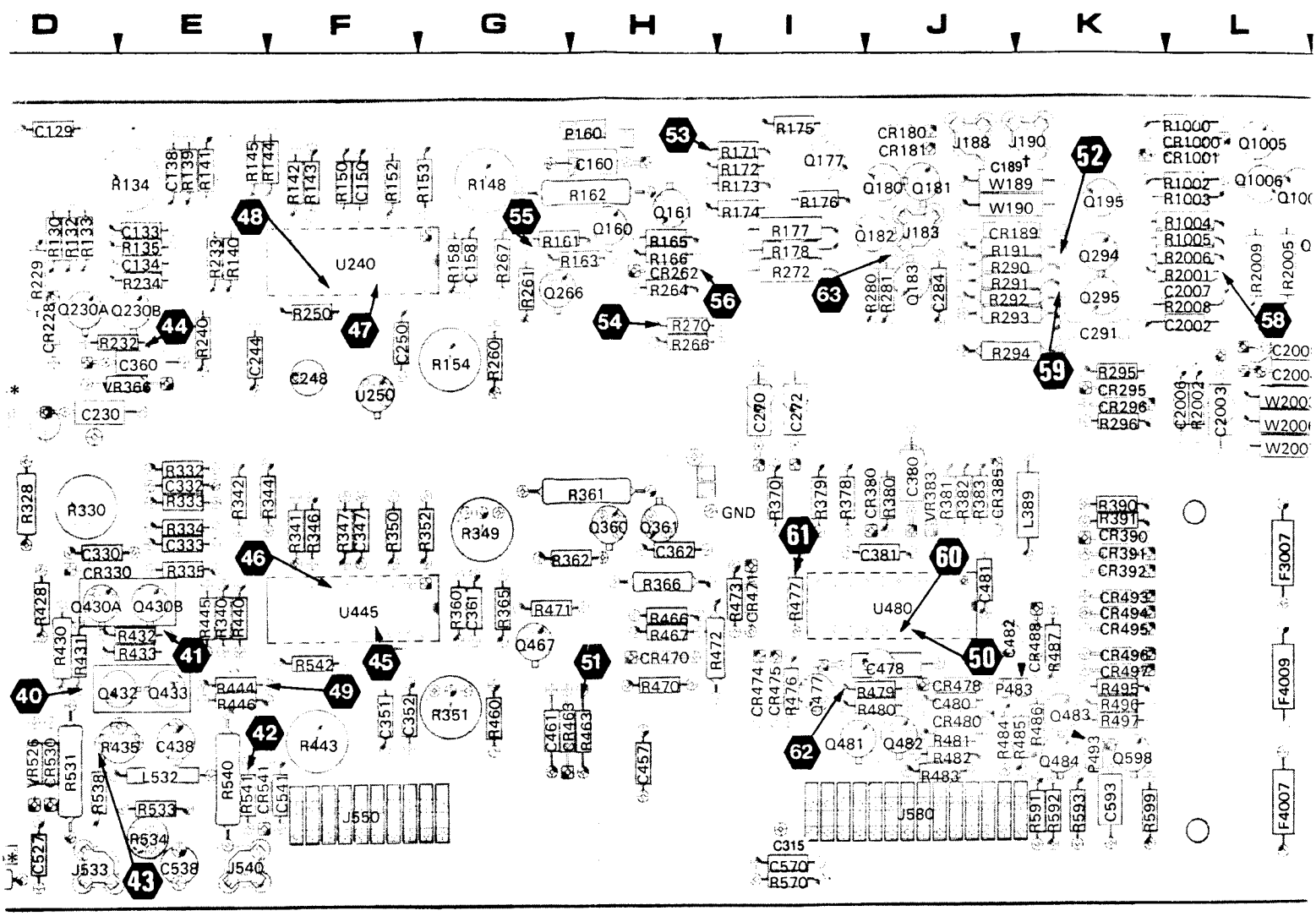


Figure 8-17. A12 Trigger board.

COMPONENT NUMBER EXAMI

Component Number

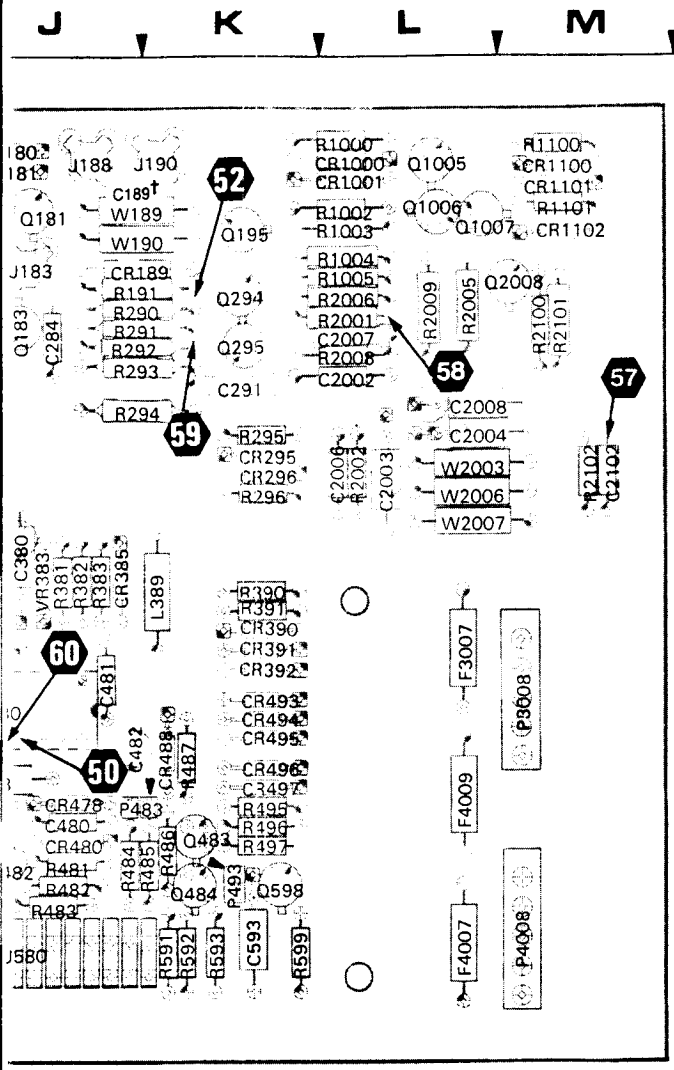
A23 A2 R1234

Assembly Number

Subassembly Number (if used)

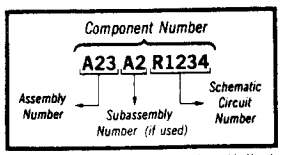
Chassis-mounted components have no Assembl prefix—see end of Replaceable Electrical Par

Static Sensitive Devi See Maintenance Sectic



3516-69A

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

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COMPONENTS LOCATED ON SCHEMATIC DIAGRAM

C212	P160	S3208	

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM

C110	C332	C538	L532
C111	C333	C541	
C121	C347	C570	P112
C129	C351		P112
C133	C352	CR228	P410
C134	C361	CR330	P410
C138	C413	CR530	
C150	C415	CR541	Q230A
C158	C423		Q230B
C222	C438	J210	Q430A
C244	C509	J219	Q430B
C248	C510	J227	Q432
C250	C516	J533	Q433
C315	C525	J540	
C327	C527	J580	R112
C330			

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM

C160	C2004	CR471	J550
C189†	C2006	CR474	J550
C230	C2007	CR475	J550
C270	C2003	CR478	J550
C272	C2008	CR480	J550
C284	C2102	CR488	J580
C291		CR493	J580
C309	CR180	CR494	J580
C360	CR181	CR495	J580
C362	CR189	CR496	J580
C380	CR262	CR497	
C381	CR295	CR1000	L389
C457	CR296	CR1001	
C461	CR380	CR1100	P160
C478	CR385	CR1101	P310
C480	CR390	CR1102	P483
C481	CR391		P493
C482	CR392	J183	
C515	CR463	J188	Q160
C593	CR470	J190	Q161
C2002			

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM

P110	R211		

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM

F3007	F4007	F4009	P3008

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM

C110	C413	CR330	Q230A
C111	C415	CR519	Q230B
C121	C423		Q430A
C129	C505	J210	Q430B
C133	C509	J219	Q520
C134	C510	J227	Q521
C211	C516	J580	
C222	C519		R112
C315	C525	P224	R120
C327	C570	P410	R130
C330		P520	R132
C333	CR228	P525	R133

A12 TRIGGER BOARD

LOCATED ON SCHEMATIC DIAGRAM 4

P160	S320B							

LOCATED ON SCHEMATIC DIAGRAM 6

C332	C538	L532	R120	R152	R328	R351	R432	R540
C333	C541		R130	R153	R330	R352	R433	R541
C347	C570	P112	R132	R154	R332	R360	R435	R542
C351		P112	R133	R158	R333	R410	R440	R570
C352	CR228	P410	R134	R210	R334	R411	R443	
C361	CR330	P410	R135	R219	R335	R412	R444	S120
C413	CR530		R139	R229	R340	R413	R445	S220A
C415	CR541	Q230A	R140	R232	R341	R414	R446	S220B
C423		Q230B	R141	R233	R342	R416	R460	S320A
C438	J210	Q430A	R142	R234	R344	R417	R514	S420
C509	J219	Q430B	R143	R240	R346	R418	R524	
C510	J227	Q432	R144	R250	R347	R424	R526	U240
C516	J533	Q433	R145	R260	R349	R428	R531	U250
C525	J540		R148	R310	R350	R430	R533	U445
C527	J580	R112	R150	R320	R351	R431	R534	
							R538	VR526

LOCATED ON SCHEMATIC DIAGRAM 7

C2004	CR471	J550	Q177	Q1007	R267	R381	R485	R2005
C2006	CR474	J550	Q180	Q2008	R270	R382	R486	R2006
C2007	CR475	J550	Q181		R272	R383	R487	R2008
C2003	CR478	J550	Q182	R161	R280	R390	R495	R2009
C2008	CR480	J550	Q183	R162	R281	R391	R496	R2100
C2102	CR488	J580	Q195	R163	R290	R463	R497	R2101
	CR493	J580	Q266	R165	R291	R466	R504	R2102
CR180	CR494	J580	Q294	R166	R292	R467	R591	
CR181	CR495	J580	Q295	R171	R293	R470	R592	U480
CR189	CR496	J580	Q360	R172	R294	R471	R593	
CR262	CR497		Q361	R173	R295	R472	R599	VR366
CR295	CR1000	L389	Q467	R174	R296	R473	R1000	VR383
CR296	CR1001		Q477	R175	R361	R476	R1002	
CR380	CR1100	P160	Q481	R176	R362	R477	R1003	W189
CR385	CR1101	P310	Q482	R177	R365	R479	R1004	W190
CR390	CR1102	P483	Q483	R178	R366	R480	R1005	W2003
CR391		P493	Q484	R191	R370	R481	R1100	W2006
CR392	J183		Q598	R261	R378	R482	R1101	W2007
CR463	J188	Q160	Q1005	R264	R379	R483	R2001	
CR470	J190	Q161	Q1006	R266	R380	R484	R2002	

†Option 04 SN B010220-up

LOCATED ON SCHEMATIC DIAGRAM 20

R211								

LOCATED ON SCHEMATIC DIAGRAM 21

F4007	F4009	P3008	P4008					

LOCATED ON SCHEMATIC DIAGRAM 25

C413	CR330	Q230A	R134	R410	R424	S120		
C415	CR519	Q230B	R210	R411	R428	S220A		
C423		Q430A	R219	R412	R430	S320A		
C505	J210	Q430B	R229	R413	R431	S420		
C509	J219	Q520	R232	R414	R432			
C510	J227	Q521	R234	R416	R433			
C516	J580		R310	R417	R514			
C519		R112	R320	R418	R521			
C525	P224	R120	R328	R420	R523			
C570	P410	R130	R334	R421	R524			
	P520	R132	R335	R422	R570			
CR228	P525	R133		R423				

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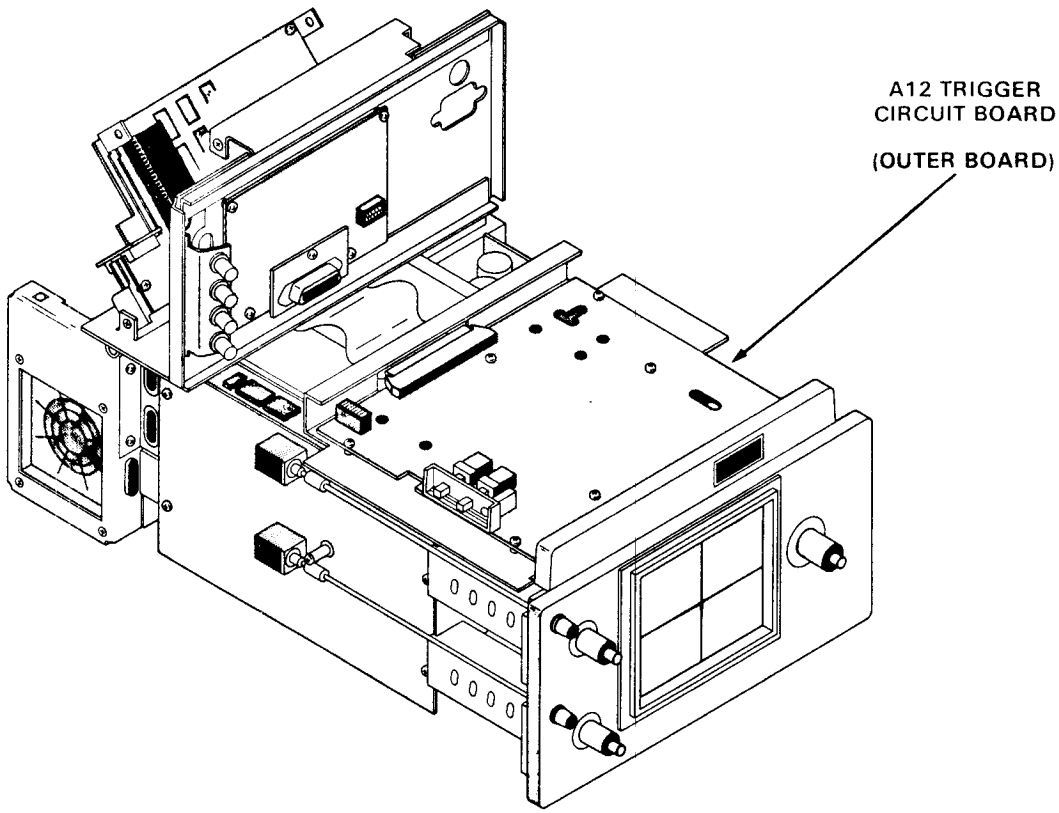


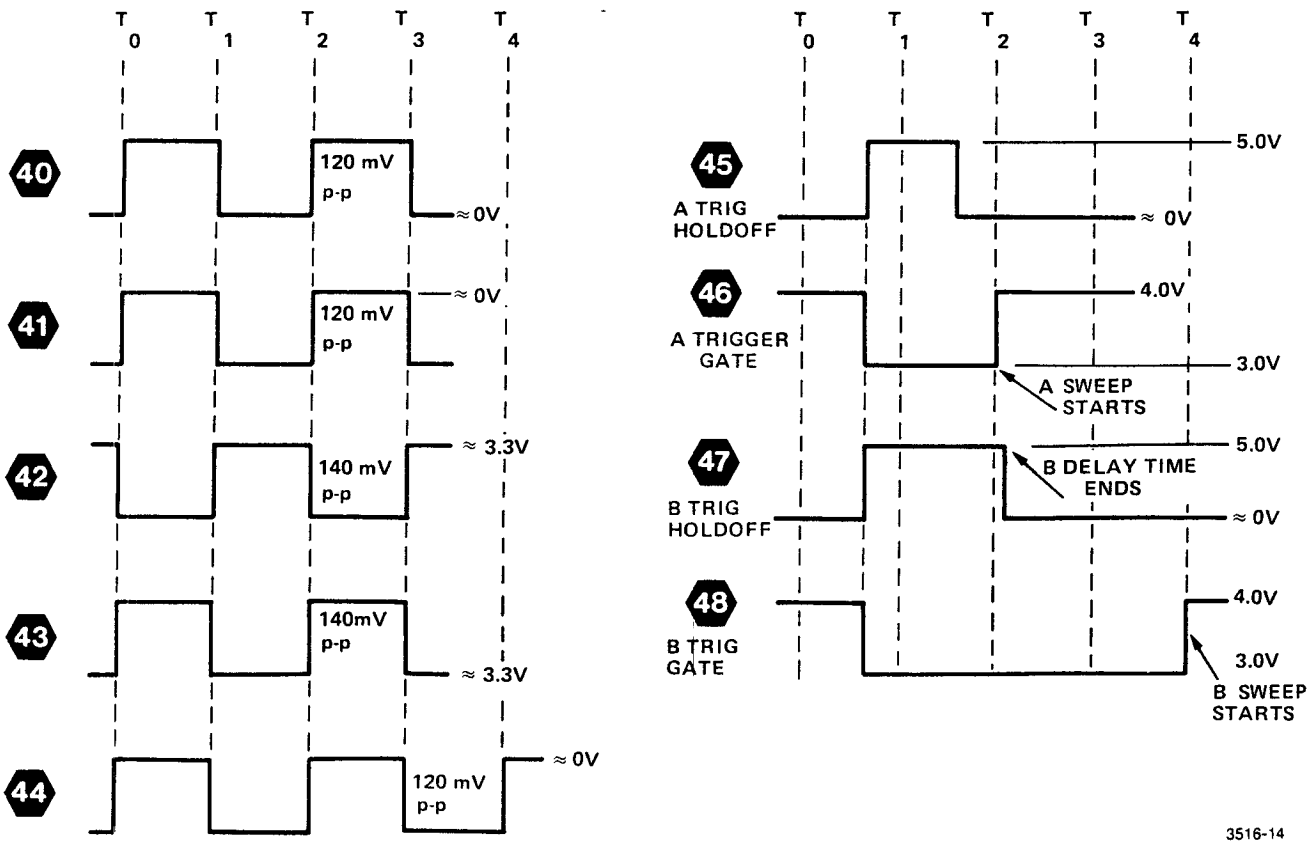
468 CONTROL SETTINGS FOR ◇6

DC Voltages

A TRIG MODE	NORM (sweep not running)
TRIGGER SOURCE (both)	EXT
TRIGGER LEVEL (both)	Midrange
TRIGGER SLOPE (both)	+
TRIGGER COUPLING (both)	AC
VERT MODE	A TRIG VIEW and CHOP
AC-GND-DC (both)	GND

AC Waveforms

TIME/DIV	0.2 ms
TRIGGER SOURCE (both)	EXT
TRIGGER LEVEL (both)	Midrange
TRIGGER SLOPE (both)	+
TRIGGER COUPLING (both)	AC
VERT MODE	A TRIG VIEW and CHOP
HORIZ DISPLAY	A INTEN
DELAY TIME POSITION	Fully counterclockwise
Trigger Input (both)	0.5 V, 1 kHz square wave



A & B TRIGGER GENERATOR DIAGRAM 6

ASSEMBLY A12

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C110	2B	2B	P410	5G	4B	R347	6K	4F
C111	2A	2B				R349	4K	4G
C121	1C	2C	Q230A	1E	2D	R350	6J	4F
C129	1D	1D	Q230B	2E	2D	R351	5M	5G
C133	1E	2E	Q430A	4E	4D	R352	6I	4F
C134	3E	2E	Q430B	6E	4D	R360	4J	4G
C138	3G	1E	Q432	8J	5D	R410	6A	4B
C150	3K	1F	Q433	7J	5E	R411	6A	5B
C158	1J	2G				R412	6A	4B
C222	2C	2C	R112	2A	2B	R413	6A	5B
C244	8E	3E	R120	2C	1C	R414	6A	5B
C248	8E	3F	R130	2D	2D	R416	6A	5B
C250	2L	2F	R132	1D	2D	R417	6B	5B
C315	5B	3C	R133	1E	2D	R418	6B	4B
C327	5C	4D	R134	2G	1E	R424	4C	4C
C330	4E	4D	R135	3E	2D	R428	6D	4D
C332	6G	3E	R139	3G	1E	R430	5D	4D
C333	7E	4E	R140	2H	2E	R431	4D	5D
C347	6K	4F	R141	2G	1E	R432	4E	4E
C351	5L	5F	R142	3G	1F	R433	4E	4E
C352	5M	5F	R143	3H	1F	R435	8K	5D
C361	4J	3E	R144	3H	1E	R440	8I	4E
C413	6A	5B	R145	3H	1E	R443	8K	5F
C415	6A	5B	R148	1K	1G	R444	7I	5E
C423	4C	4C	R150	4K	1F	R445	5H	4E
C438	7K	5E	R152	3J	1F	R446	8K	5E
C509	5A	5B	R153	4I	1F	R460	5M	5G
C510	6A	6B	R154	2M	3G	R514	6A	5B
C516	6B	5B	R158	1J	2G	R524	5C	5C
C525	4D	5C	R210	2A	2B	R526	8J	6D
C527	8J	6D	R219	1C	2C	R531	9J	5D
C538	8L	6E	R229	2D	2D	R533	7J	6E
C541	7J	5F	R232	1E	2D	R534	8J	6E
C570	5A	6I	R233	2H	2E	R538	8L	5D
CR228	2E	2D	R234	2E	2E	R540	7J	5E
CR330	6E	4D	R240	1H	2E	R541	7L	5E
CR530	9J	5D	R250	3K	2F	R542	6K	5F
CR541	7J	5E	R260	2M	3G	R570	5A	6I
			R310	5A	3B			
J210	2A	3B	R320	5A	3C	S120	1D	1C
J219	2A	3C	R328	4A	3D	S220A	1A	2C
J227	1A	3D	R330	5G	4D	S220B	1G	2C
J533	8M	6D	R332	5G	3E	S320A	3B	4C
J540	7M	6E	R333	6G	4E	S420	3D	5C
J580	5A	6J	R334	7E	4E			
			R335	6E	4E	U240	1I	2F
L532	8K	5E	R340	5H	4E	U250	8E	3F
			R341	6G	4F	U445	4I	4F
P112	2F	1B	R342	6H	3E			
P112	2G	1B	R344	6H	3E	VR526	9I	5D
P410	5F	4B	R346	6H	4F			

Partial A12 also shown on diagrams 4, 7, 20 and 21.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
J17106	2A	CHASSIS	R17010	3F	CHASSIS	S17010	3F	CHASSIS
J17506	6A	CHASSIS	R17305	6F	CHASSIS	S17305	6F	CHASSIS

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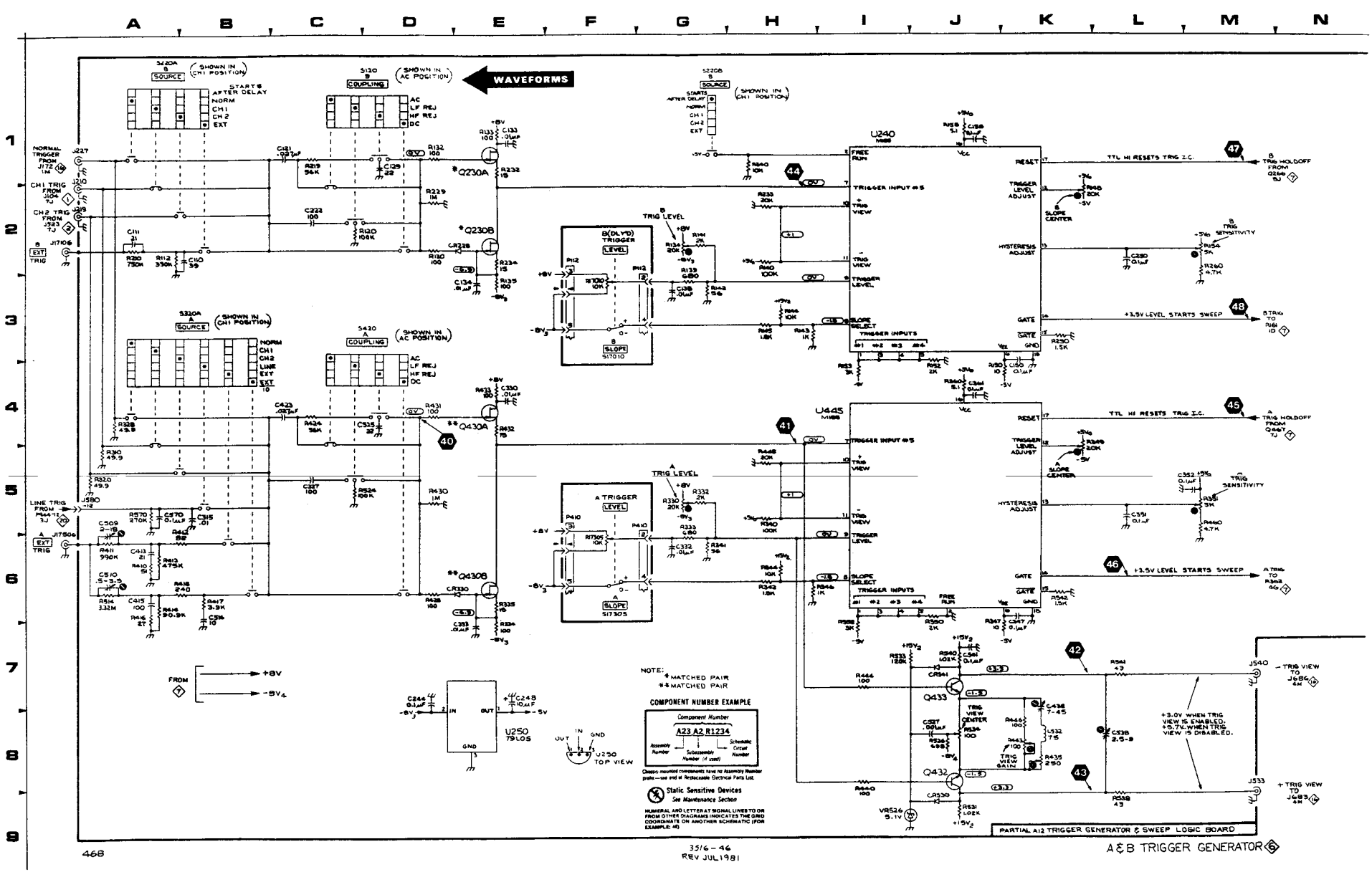
WAVEFORMS
NORMAL TRIGGER FROM J172 1N
CH1 TRIG FROM J104 1J
CH2 TRIG FROM J123 2J
B EXT TRIG J1706
LINE TRIG FROM R44 1J
A EXT TRIG J1706
B TRIG LEVEL
A TRIG LEVEL
B(DLYD) TRIGGER LEVEL
A TRIGGER LEVEL
B SLOPE SI7010
A SLOPE SI7305
U240 M88
U445 M88
TRIGGER INPUTS
TRIGGER LEVEL ADJUST
HYSTERESIS ADJUST
TRIG SENSITIVITY
SLOPE CENTER
TTL HI RESETS TRIG I.C.
+3.5V LEVEL STARTS SWEEP
B TRIG HOLDOFF FROM Q248
A TRIG HOLDOFF FROM Q448
B TRIG TO R64
A TRIG TO R364
+TRIG VIEW TO J683
-TRIG VIEW TO J684
+3.0V WHEN TRIG VIEW IS ENABLED; +5.7V WHEN TRIG VIEW IS DISABLED.
TRIG VIEW GAIN
TRIG VIEW CENTER
U250 75L05
TOP VIEW
NOTE: *MATCHED PAIR **MATCHED PAIR
COMPONENT NUMBER EXAMPLE
Component Number A23 A2 R1234
Static Sensitive Devices
See Maintenance Section
PARTIAL A12 TRIGGER GENERATOR & SWEEP LOGIC BOARD
A & B TRIGGER GENERATOR 6

468 CONTROL SETTINGS FOR ⑦

DC Voltages

A TRIG MODE	NORM (sweep not running)
AC-GND-DC (both)	GND

For Service Manuals Contact
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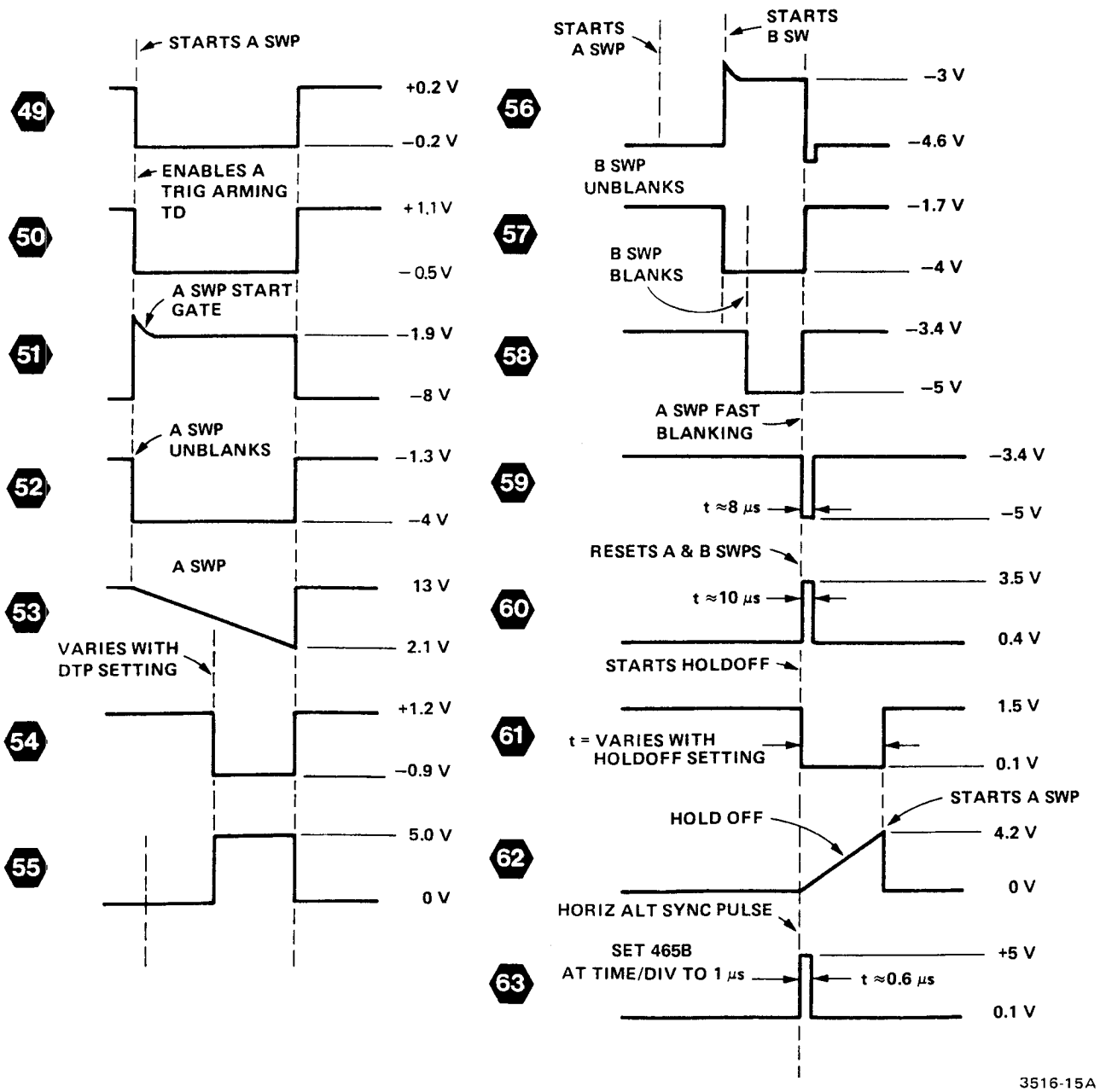
AC Waveforms

A TRIG MODE	AUTO (no trigger signal)
B TRIGGER SOURCE	STARTS AFTER DELAY
DELAY TIME POSITION	5.00
HORIZ DISPLAY	A INTEN
A TIME/DIV	1 ms
B TIME/DIV	0.1 ms
AC-GND-DC (both)	GND



3516-15A

NON STORAGE SWEEP & Z-AXIS DIAGRAM 7

ASSEMBLY A13

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
CR423	7B	5D	P524	6B	4D	R428	6B	5D
CR425	7B	5D	P555	1A	5H			
						S410	6A	4B
P117	8A	1C	R129	9A	1D	S469	1A	4I
P129	8B	1D	R132	8A	2E			

Partial A13 also shown on diagrams 4, 8, 9 and 10

ASSEMBLY A15

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C698	4B	7N	P944	1B	10G	P970	7N	10J
			P944	7N	10G	P970	9N	10J
J857	1A	9I	P956	5A	10I			
J885	6B	9L	P970	4B	10J	W849	9N	9G
			P970	4M	10J			
P699	3A	7N	P970	6B	10J			

Partial A15 also shown on diagrams 3, 4, 5, 8, 9, 10, 11, 12 and 20.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
DS17127	6K	CHASSIS	P188	2M	CHASSIS	R16002	8A	CHASSIS
DS17206	5K	CHASSIS	P190	1M	CHASSIS			
						S14498	5A	CHASSIS
P183	3M	CHASSIS	R14398	4A	CHASSIS			

TABLE (CONT)

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MAURITRON TECHNICAL SERVICES
8 Cherry Tree Rd, Chinnor
Oxon OX9 4QY
Tel:- 01844-351694 Fax:- 01844-352554
Email:- enquiries@mauritron.co.uk

NON STORAGE SWEEP & Z-AXIS DIAGRAM 7

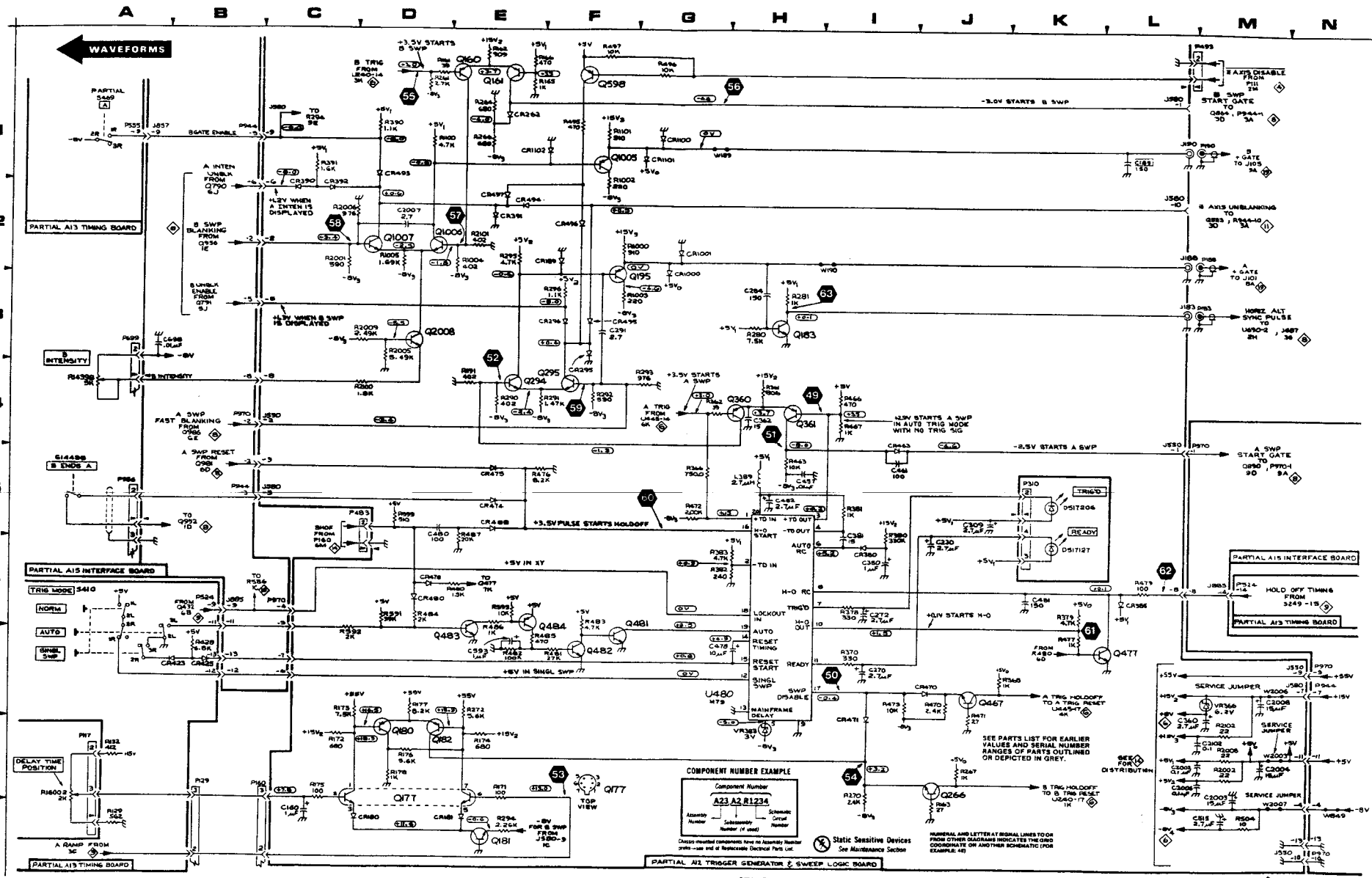
ASSEMBLY A12

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C160	9C	1H	J580	1L	6J	R361	4H	3H
C189*	2L	1J	J580	2L	6J	R362	4G	4G
C230	6J	3D	J580	5C	6J	R365	7J	4G
C270	7I	3I	J580	7N	6J	R366	5G	4H
C272	6I	3I				R370	7I	4I
C284	3H	2J	L389	5H	4K	R378	6I	4I
C291	3F	2K				R379	6K	4I
C309	5J	4B	P160	8B	1H	R380	5I	4J
C360	7M	3E	P310	5K	4B	R381	5I	4J
C362	4H	4H	P483	5D	5J	R382	6H	4J
C380	6I	3J	P493	1L	5K	R383	6H	4J
C381	5I	4J				R390	1D	4K
C457	5H	5H	Q160	1E	2H	R391	1C	4K
C461	5I	5G	Q161	1E	2H	R463	5H	5H
C478	7G	5J	Q177	8D	1I	R466	4I	4H
C480	5D	5J	Q180	8D	1J	R467	4I	4H
C481	6K	4J	Q181	9E	1J	R470	7J	5H
C482	5H	4J	Q182	8D	2J	R471	7J	4G
C515	9M	6B	Q183	3H	2J	R472	5G	5H
C593	7E	6K	Q195	3F	2K	R473	7I	4I
C2002	8M	2L	Q266	8J	2G	R476	5E	5I
C2003	8M	3L	Q294	4E	2K	R477	7K	4I
C2004	8M	3L	Q295	4F	2K	R479	6L	5I
C2006	8M	3L	Q360	4H	4H	R480	6E	5I
C2007	2D	2L	Q361	4H	4H	R481	7F	5J
C2008	7M	3L	Q467	7J	4G	R482	7E	5J
C2102	8M	3N	Q477	7L	5I	R483	6F	5J
			Q481	7F	5I	R484	6D	5J
CR180	9D	1J	Q482	7F	5J	R485	7E	5J
CR181	9E	1J	Q483	7E	5K	R486	6E	5K
CR189	2F	2J	Q484	6E	5K	R487	5E	5K
CR262	1E	2H	Q598	1F	5K	R495	1F	5K
CR295	3F	3K	Q1005	1F	1L	R496	1G	5K
CR296	3F	3K	Q1006	2D	1L	R497	1F	5K
CR380	6I	4I	Q1007	2D	1L	R504	9M	6B
CR385	6L	4J	Q2008	3D	2N	R591	6D	6K
CR390	2C	4K				R592	7C	6K
CR391	2E	4K	R161	1D	2G	R593	6E	6K
CR392	2C	4K	R162	1E	2G	R599	5D	6K
CR463	4I	5G	R163	9J	2G	R1000	2F	1L
CR470	7J	5H	R165	1E	2H	R1002	1F	1L
CR471	7I	4I	R166	1E	2H	R1003	3F	2L
CR474	5E	5I	R171	8E	1I	R1004	2E	2L
CR475	5E	5I	R172	8C	1I	R1005	2D	2L
CR478	6D	5J	R173	7C	1I	R1100	1D	1N
CR480	6D	5J	R174	8E	2I	R1101	1F	1M
CR488	5E	5K	R175	8C	1I	R2001	2C	2L
CR493	1D	4K	R176	8D	2I	R2002	8M	3L
CR494	2E	4K	R177	7D	2I	R2005	3D	2L
CR495	3F	4K	R178	8D	2I	R2006	2C	2L
CR496	2F	5K	R191	4E	2J	R2008	8M	2L
CR497	2E	5K	R261	1D	2G	R2009	3D	2L
CR1000	2G	1L	R264	1E	2H	R2100	4D	2M
CR1001	2G	1L	R266	1E	3H	R2101	2E	2M
CR1100	1G	1N	R267	8J	2G	R2102	8M	3N
CR1101	1G	1N	R270	8I	2H			
CR1102	1E	2N	R272	7E	2I	U480	7H	4J
			R280	3H	2I			
J183	3L	2J	R281	3H	2J	VR366	7M	3E
J188	2L	1J	R290	4E	2J	VR383	8H	4J
J190	1L	1K	R291	4E	2J			
J550	4C	6F	R292	4F	2J	W189	1G	1J
J550	4L	6F	R293	4G	2J	W190	2I	2J
J550	6C	6F	R294	9E	3J	W2003	8M	3L
J550	7N	6F	R295	2E	3K	W2006	7M	3L
J550	9N	6F	R296	3F	3K	W2007	8M	3L
J580	1C	6J						

Partial A12 also shown on diagrams 4, 6, 20 and 21.

***Option 04 SN B010220-up**

TABLE (CONT)


WAVEFORMS
PARTIAL A13 TIMING BOARD
PARTIAL A15 INTERFACE BOARD
PARTIAL A12 TRIGGER GENERATOR & SWEEP LOGIC BOARD
PARTIAL A13 TIMING BOARD
COMPONENT NUMBER EXAMPLE
Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number
Static Sensitive Devices
See Maintenance Section
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.
NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATE OR ANOTHER SCHEMATIC (FOR EXAMPLE 4B)
SEE FOR DISTRIBUTION
TRIG MODE
NORM
AUTO
SNGL SWP
DELAY TIME POSITION
A RAMP FROM 3C
B INTENSITY
A SWP FAST BLANKING FROM Q960 C6
A SWP RESET FROM Q960 D6
B UNBLK ENABLE FROM Q791 9J
A INTEN UNBLK FROM Q790 6J
B SWP BLANKING FROM Q956 12
B GATE ENABLE
B TRIG FROM U660-14 3K
A TRIG FROM U445-14 6K
+3.5V STARTS B SWP
-3.0V STARTS B SWP
B SWP START GATE TO Q864, P944-1 3D 3A
B AXIS DISABLE FROM P111 2M
B AXIS UNBLANKING TO Q853, P944-10 3D 3A
B + GATE TO J105 3A
A + GATE TO J101 8A
WIDEZ ALT SYNC PULSE TO U690-2, J687 3H
+2.5V STARTS A SWP IN AUTO TRIG MODE WITH NO TRIG SIG
-2.5V STARTS A SWP
A SWP START GATE TO Q850, P970-H 9D 9A
+3.5V PULSE STARTS HOLDOFF
+5V IN XY
+5V IN SINGL SWP
+12V WHEN A INTEN IS DISPLAYED
+12V WHEN B SWP IS DISPLAYED
+12V STARTS H-O
A TRIG HOLDOFF TO A TRIG RESET U445-17 4K
B TRIG HOLDOFF TO B TRIG RESET U540-17 1K
HOLD OFF TIMING FROM Q249-15
SERVICE JUMPER
SERVICE JUMPER
SERVICE JUMPER
TOP VIEW
Q177
Q181
Q1007
Q1006
Q1005
Q1001
Q1000
Q195
Q2008
Q294
Q295
Q183
Q360
Q361
Q480
Q482
Q483
Q484
Q481
Q477
Q467
Q266
U480
DS17206
DS17127
468
3614-47
REV MAR 1981
NON STORAGE SWEEP & Z AXIS LOGIC 7

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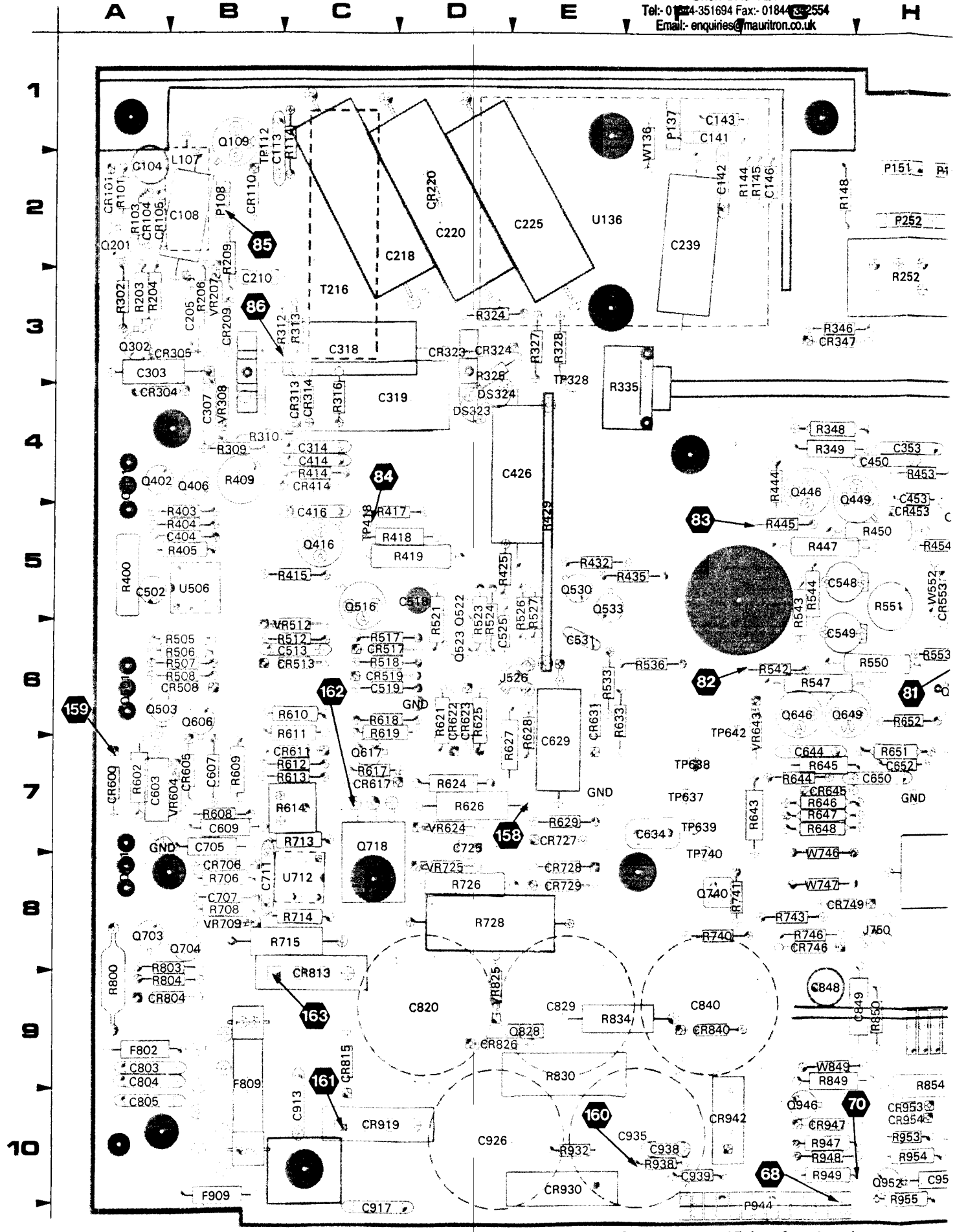


Figure 8-18. A15 Interface board.

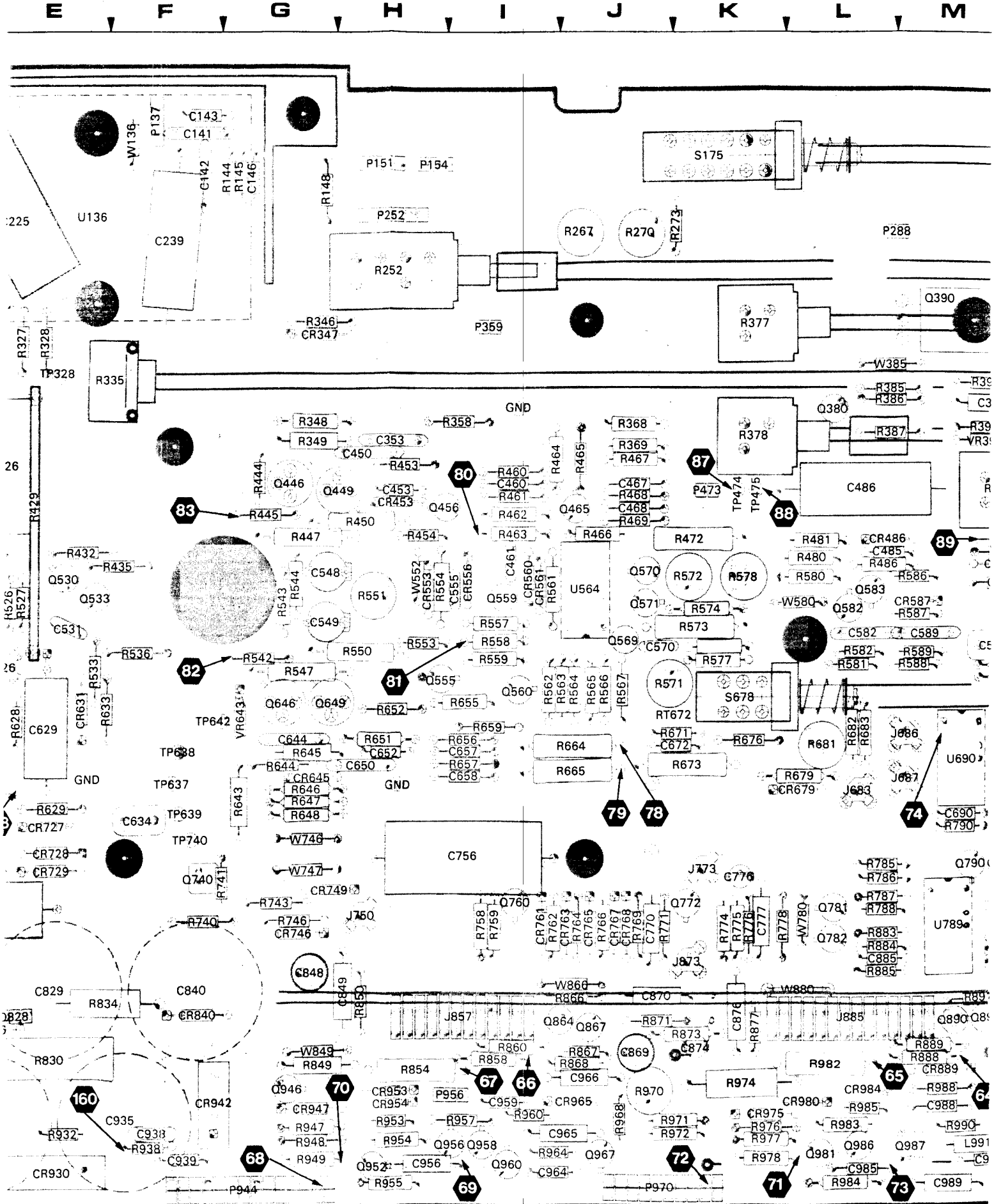
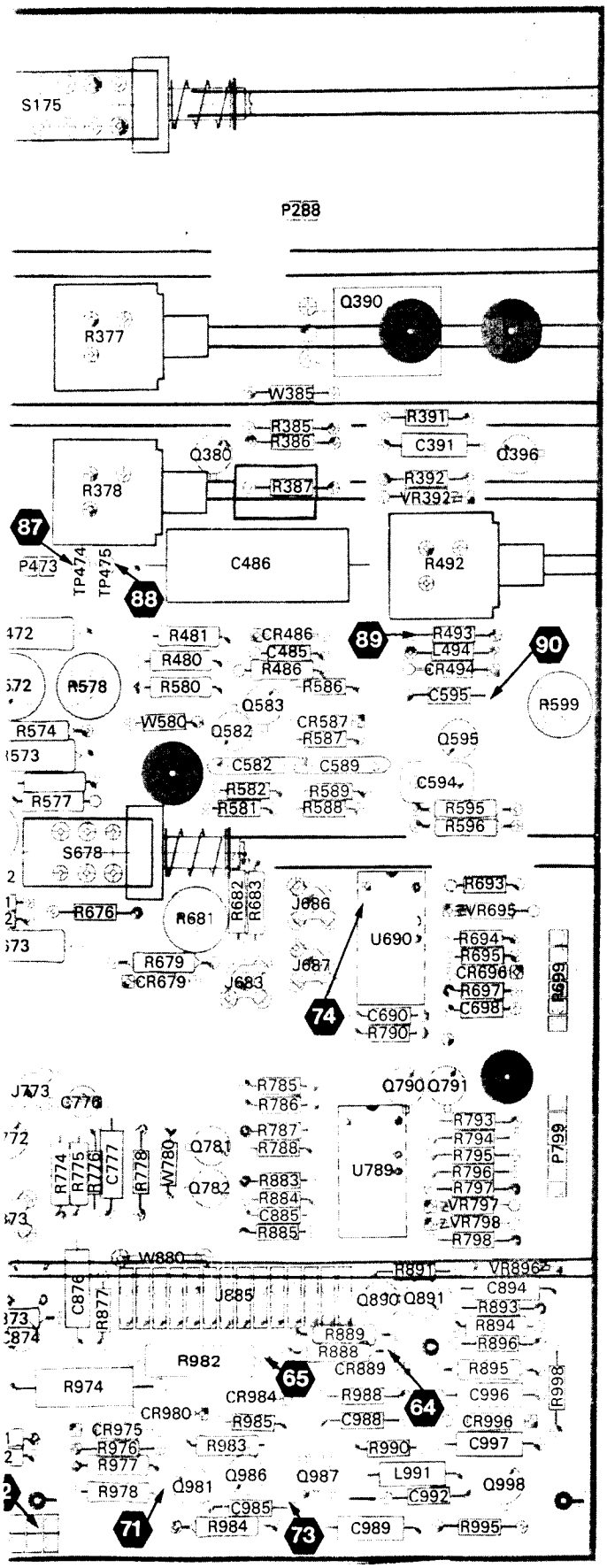


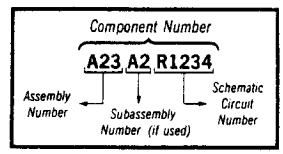
Figure 8-18. A15 Interface board.

K L M N



3516-72A

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

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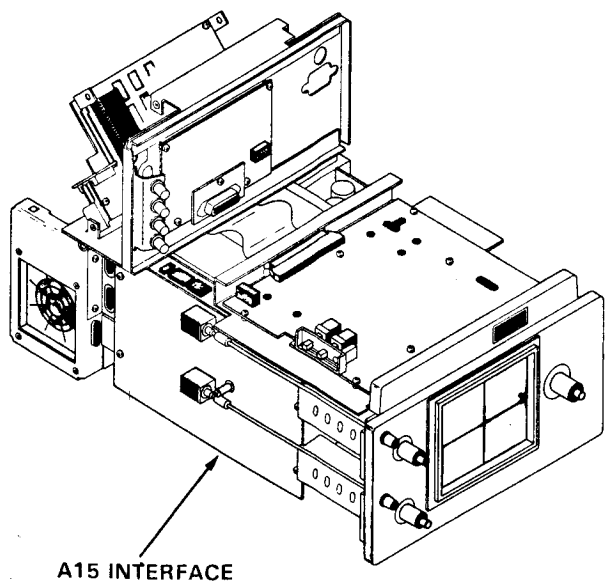


A15 INTERFACE CIRCUIT BOARD
(UNDERNEATH BOARD)

REV A DEC 1980

COMPONENTS

P154

COMPONENTS

P151

COMPONENTS

P252

COMPONENTS

C698

J857
J885

P699

COMPONENTS

C690
C770
C776
C777
C848
C849
C869
C870
C874
C876
C885
C894
C956
C959
C964
C965
C966
C985
C988
C989
C992
C996
C997

CR696
CR761
CR763
CR765
CR767
CR768

COMPONENTS

P799

VR896

A15 INTERFACE BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 3

P154					

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 4

P151					

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 5

P252	P252	S175			

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 7

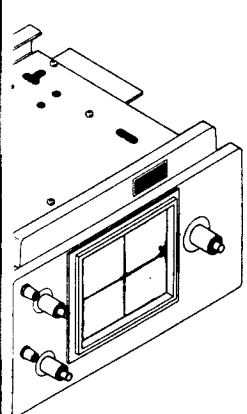
C698	P944	P970			
	P944	P970			
J857	P956				
J885	P970	W849			
	P970				
P699	P970				

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 8

C690	CR889	P970	R759	R873	R983
C770	CR947	P970	R762	R877	R984
C776	CR953		R764	R883	R985
C777	CR954	Q760	R766	**R884**	R988
C848	CR965	Q772	R769	**R885**	R990
C849	CR975	Q781	R771	**R888**	R995
C869	CR980	Q782	R774	**R889**	R998
C870	CR984	Q790	R775	**R891**	
C874	CR996	Q791	R776	**R893**	U6908
C876		Q864	R778	R894	U690C
C885	J686	Q867	R785	R895	U690D
C894	J687	Q890	R786	R896	U789A
C956	J857	Q891	R787	R947	U789B
C959	J857	Q946	R788	R948	
C964	J857	Q952	R790	R949	VR695
C965	J857	Q956	R793	R953	VR797
C966	J857	Q958	R794	R954	VR798
C985	J873	Q960	R795	R955	
C988	J885	Q967	R796	R957	W746
C989	J885	Q981	R797	R960	W747
C992	J885	Q986	R798	R964	W849
C996		Q987A	R849	R968	
C997	L991	Q987B	R850	R970	
		Q998	R854	R971	
CR696	P252		R858	R972	
CR761	P799	R693	R860	R974	
CR763	P944	R694	R866	R976	
CR765	P944	R695	R867	R977	
CR767	P944	R697	R868	R978	
CR768	P956	R758	R871	R982	

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 9

P799	W780	W880			
	W849				
VR896	W866				



468 CONTROL SETTINGS FOR ⑧

DC Voltages

A TRIG MODE	NORM (sweep not running)
AC-GND-DC (both)	GND

AC Waveforms

A TRIG MODE	AUTO (no trigger signal)
B TRIGGER SOURCE	STARTS AFTER DELAY
HORIZ DISPLAY	A INTEN
DELAY TIME POSITION	5.00
A TIME/DIV	1 ms
B TIME/DIV	0.1 ms
AC-GND-DC (both)	GND

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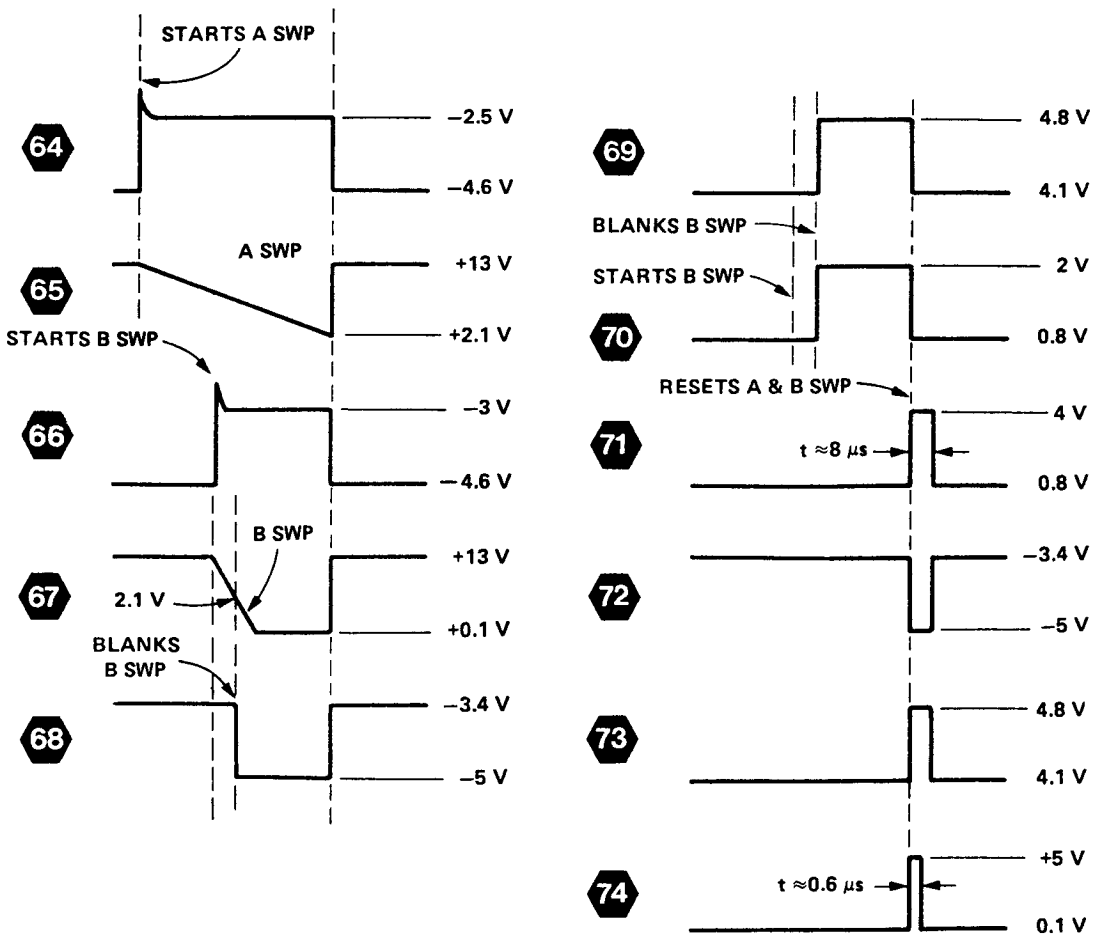

3516-16A

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HORIZ DISPLAY LOGIC & A & B SWEEP GENERATOR DIAGRAM 8

ASSEMBLY A13

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
CR00374	5F	4I	P555	4F	5H	S469	4F	4I
CR471	5F	5I						

Partial A13 also shown on diagrams 4, 7, 9 and 10.

ASSEMBLY A15

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C690	4D	7N	P944	3A	10G	R858	3C	9I
C770	5L	8J	P944	5L	10G	R860	3E	9I
C776	7K	8K	P956	1M	10I	R866	2E	9J
C777	8J	8K	P970	6M	10J	R867	2E	9J
C848	4B	9G	P970	9A	10J	R868	3E	10J
C849	1C	9H				R871	2F	9J
C869	1A	9J	Q760	2L	8I	R873	3E	9K
C870	2F	9J	Q772	7L	8K	R877	6B	9K
C874	9C	9K	Q781	5K	8L	R883	4H	10L
C876	6B	9K	Q782	5K	8L	R884	5I	9L
C885	5J	9L	Q790	6J	8M	R885	5H	9L
C894	8F	9N	Q791	5J	8N	R888	9C	9N
C956	1E	10H	Q864	3D	9J	R889	9E	9M
C959	1B	10I	Q867	2E	9J	R891	8E	9M
C964	1E	10I	Q890	9D	10M	R893	8F	9N
C965	2G	10J	Q891	8E	9M	R894	9E	9N
C966	3E	10J	Q946	1B	10G	R895	8E	9N
C985	6D	10L	Q952	1D	10H	R896	8F	9N
C988	7B	10N	Q956	1E	10I	R947	1D	10G
C989	1A	10N	Q958	1B	10I	R948	1C	10G
C992	9A	10N	Q960	1C	10I	R949	1D	10G
C996	8D	10N	Q967	2G	10J	R953	1B	10H
C997	8G	10N	Q981	6D	10L	R954	1D	10H
			Q986	6E	10L	R955	1D	10H
CR696	3G	7N	Q987A	7B	10M	R957	1C	10I
CR761	4L	8I	Q987B	7C	10M	R960	1B	10I
CR763	4L	8J	Q998	8G	10N	R964	1G	10I
CR765	5L	8J				R968	3F	10J
CR767	5L	8J	R693	3I	7N	R970	1A	10J
CR768	5L	8J	R694	3H	7N	R971	1A	10K
CR889	9D	10M	R695	3G	7N	R972	1A	10K
CR947	1C	10G	R697	4H	7N	R974	6B	10K
CR953	1B	10H	R758	1K	8I	R976	6C	10K
CR954	1B	10H	R759	1I	8I	R977	6D	10K
CR965	2G	10J	R762	4M	8I	R978	6D	10K
CR975	6C	10K	R764	5L	8J	R982	7G	10L
CR980	6B	10L	R766	5M	8J	R983	6D	10L
CR984	6B	10L	R769	4L	8J	R984	6D	10L
CR996	8G	10N	R771	5M	8K	R985	6B	10L
			R774	7K	8K	R988	6C	10M
J686	2J	7M	R775	7J	8K	R990	7B	10M
J687	3G	7M	R776	7I	8K	R995	9A	10N
J857	2D	9I	R778	7K	8L	R998	8F	10N
J857	2E	9I	R785	4G	8L			
J857	4G	9I	R786	5G	8L	U690B	4G	7M
J857	4M	9I	R787	5G	8L	U690C	6H	7M
J857	5M	9I	R788	4I	8L	U690D	2H	7M
J873	4M	9K	R790	5G	8M	U789A	5H	8M
J885	3G	9L	R793	6J	8N	U789B	6I	8M
J885	7E	9L	R794	6J	8N			
J885	8D	9L	R795	5J	8N	VR695	3I	7N
			R796	5J	8N	VR797	5I	9N
L991	7F	9M	R797	5I	8N	VR798	6I	9N
			R798	6I	9N			
P252	3J	2H	R849	1B	10G	W746	4B	8G
P799	3J	8N	R850	1B	9H	W747	4B	8G
P944	1M	10G	R854	1G	10H	W849	5B	9G

Partial A15 also shown on diagrams 3, 4, 5, 7, 9, 10, 11, 12 and 20.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
R14499	4J	CHASSIS	S14498	1M	CHASSIS			

A15 INTERFACE BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 10

C353	C658	J885	Q649	R464	R557	R582	R665	U564E
C450	C672			R465	R558	R586	R671	
C453	C756	P699	R273	R466	R559	R587	R673	VR643
C460		P970	R348	R467	R561	R588	R676	
C461	CR453		R349	R468	R562	R589	R679	W552
C467	CR486	Q446	R358	R469	R563	R643	R681	W580
C468	CR553	Q449	R368	R472	R564	R644	R682	W746
C485	CR556	Q456	R369	R480	R565	R645	R683	W747
C548	CR560	Q465	R444	R481	R566	R646		W849
C549	CR561	Q555	R445	R486	R567	R647	RT672	
C555	CR587	Q559	R447	R542	R571	R648		
C570	CR645	Q560	R450	R543	R572	R651	S175	
C582	CR679	Q569	R453	R544	R573	R652	S678	
C589		Q570	R454	R547	R574	R655		
C644	J683	Q571	R460	R550	R577	R656	U564A	
C650	J773	Q582	R461	R551	R578	R657	U564B	
C652	J885	Q583	R462	R553	R580	R659	U564C	
C657	J885	Q646	R463	R554	R581	R664	U564D	

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 11

C104	C426	CR414	P137	R145	R335	R518	T216	
C108	C513	CR517	P137	R148	R346	R521		
C113	C518	CR519	P359	R203	R377	R523	TP112	
C141	C519	CR622	P473	R204	R378	R524	TP328	
C142	C525	CR623	P944	R206	R409	R526	TP418	
C143	C531	CR631		R209	R414	R527		
C146	C629	CR727	Q109	R252A	R415	R533	U136	
C205		CR746	Q201	R252B	R417	R536		
C210	CR101	CR749	Q302	R267	R418	R618	VR207	
C218	CR104		Q416	R270	R419	R619	VR308	
C220	CR105	DS323	Q516	R302	R425	R621	VR512	
C225	CR110	DS324	Q522	R309	R429A	R625		
C239	CR209		Q523	R310	R429B	R627	W136	
C303	CR220	F809	Q530	R312	R429C	R628		
C307	CR305		Q533	R313	R429D	R629		
C314	CR313	J526		R316	R432	R633		
C318	CR314	J750	R101	R324	R435	R743		
C319	CR323		R103	R325	R512	R746		
C414	CR324	L107	R114	R327	R513			
C416	CR347	P108	R144	R328	R517	S175		

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 12

C391	CR494	Q380	R385	R493	TP474			
C486		Q396	R386	R595	TP475			
C594	L494	Q595	R387	R596				
C595			R391	R599	W385			

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 20

C404	C926	CR729	P288	Q704	R507	R706	R834	U712B
C502	C935	CR804	P944	Q718 [a]	R508	R708	R932	
C603	C938	CR813		Q740	R602	R713	R938	VR392
C607	C939	CR815	Q390 [a]	Q828	R608	R714		VR604
C609		CR826	Q401 [a]		R609	R715	TP637	VR624
C634	CR304	CR840	Q402	R392	R610	R726	TP638	VR709
C705	CR508	CR919	Q406	R400	R611	R728	TP639	VR725
C707	CR600	CR930	Q501 [a]	R403	R612	R740	TP642	VR825
C711	CR605	CR942	Q503	R404	R613	R741	TP740	
C725	CR611		Q606	R405	R614	R800		
C820	CR617	F802	Q617	R492	R617	R803	U506A	
C829	CR706	F809	Q701 [a]	R505	R624	R804	U506B	
C840	CR728	F909	Q703	R506	R626	R830	U712A	

OPTION 04 COMPONENTS (SEE OPTION SECTION IN VOLUME 1)

[a] Chassis mounted

C803	C804	C805	C913	C917				

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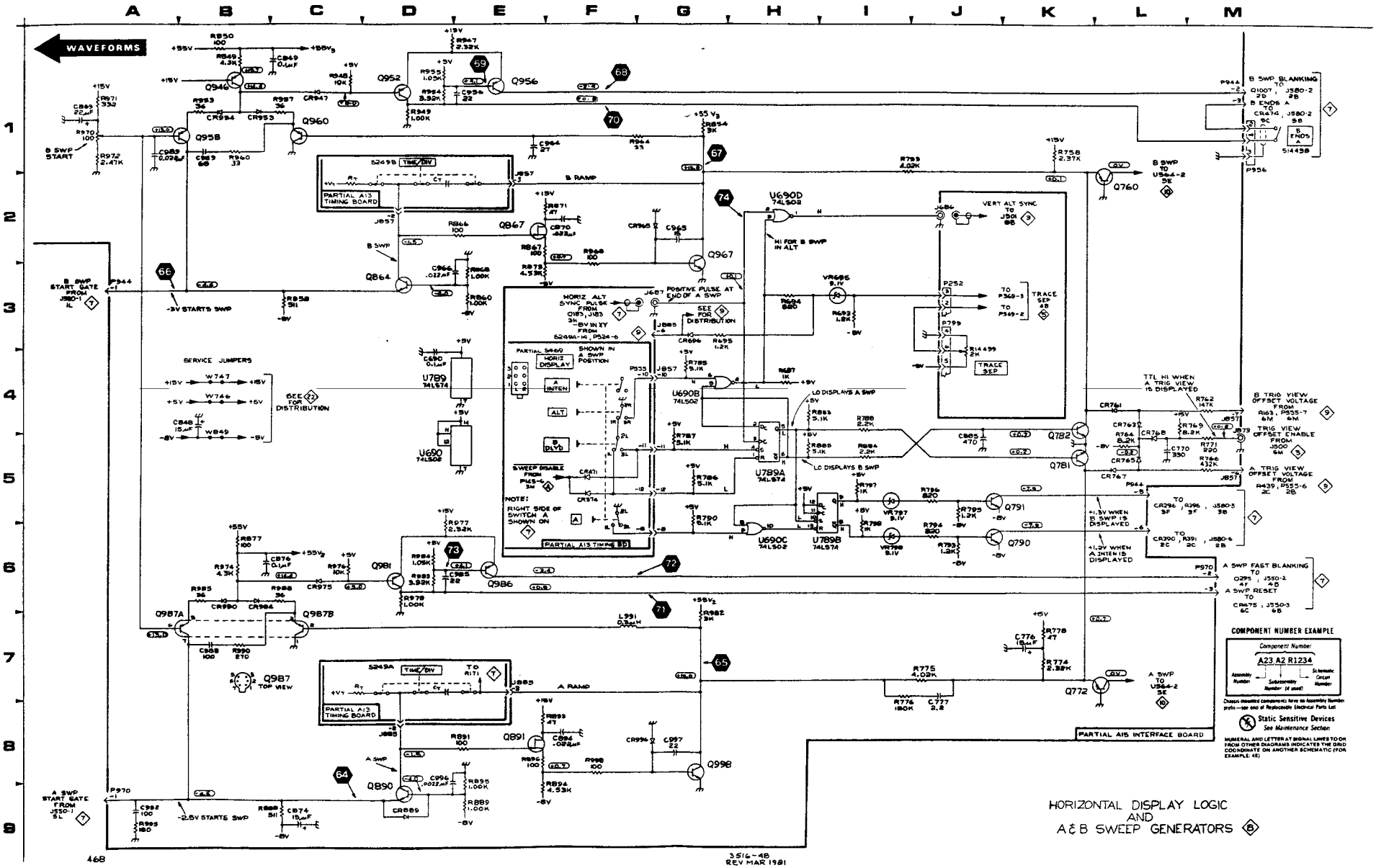

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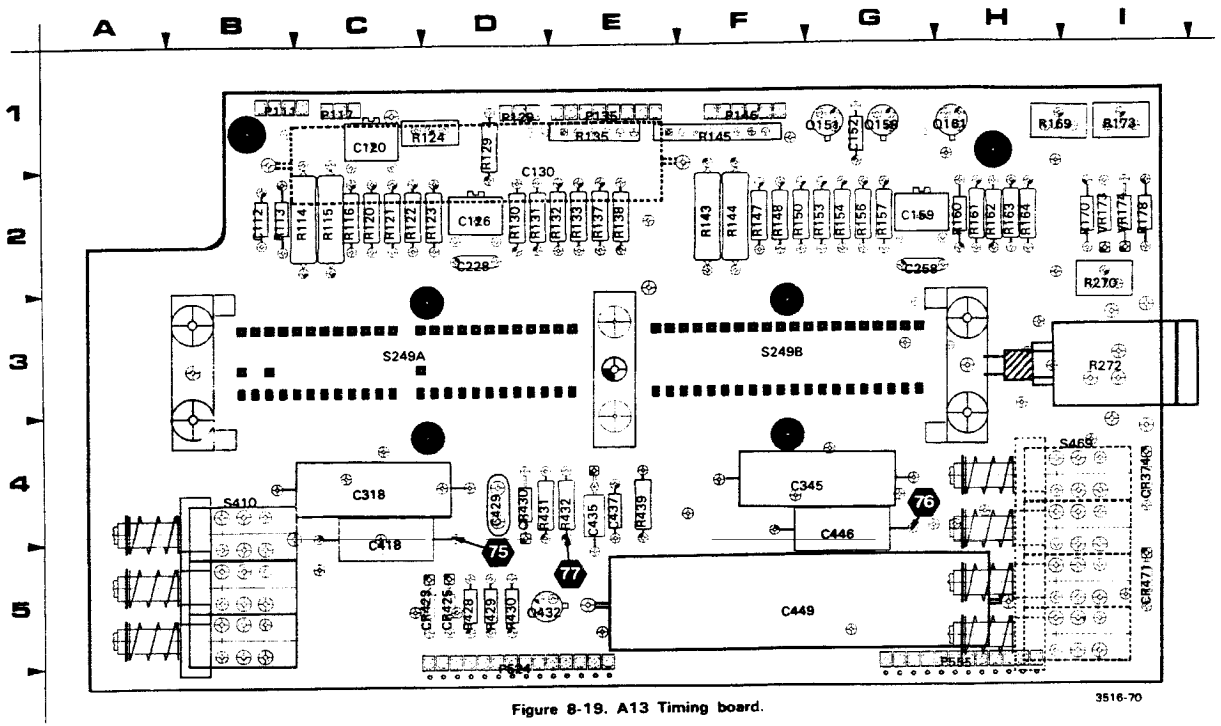
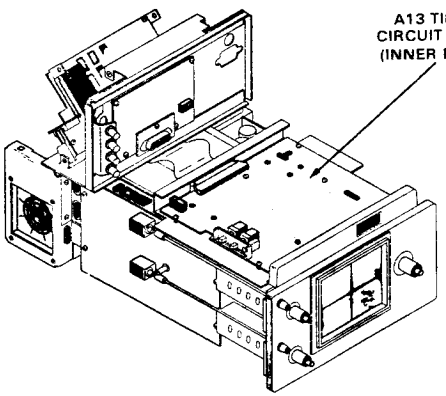
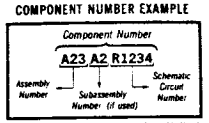


Figure 8-19. A13 Timing board.



COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

A13 TIMING BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 4

P129	P135	P146	R145	S469	

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 7

CR423 CR425	P117 P129	P524 P555	R129 R132	R428	S410 S469

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 8

CR374	CR471	P555	S469		

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 9

C112	C449	P555	R124	R154	R430
C120			R130	R156	R431
C126	CR430	Q151	R131	R157	R432
C130		Q158	R133	R160	R439
C152	P111	Q161	R135	R161	
C159	P135	Q432	R137	R162	S249A
C228	P135		R138	R163	S249B
C258	P146	R113	R143	R164	S272
C318	P524	R114	R144	R169	
C345	P524	R115	R145	R170	VR173
C418	P524	R116	R145A	R173	VR174
C429	P524	R120	R147	R178	
C435	P524	R121	R148	R270	
C437	P524	R122	R150	R272	
C446	P524	R123	R153	R429	

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 10

P111	P524				

468 CONTROL SETTINGS FOR ◇9

DC Voltages

A TIME/DIV	X-Y
AC-GND-DC (both)	GND

AC Waveforms

A TRIG MODE	AUTO (no trigger signal)
B TRIGGER SOURCE	STARTS AFTER DELAY
HORIZ DISPLAY	A INTEN
DELAY TIME POSITION	5.00
A TIME/DIV	1 ms
B TIME/DIV	0.1 ms
AC-GND-DC (both)	GND

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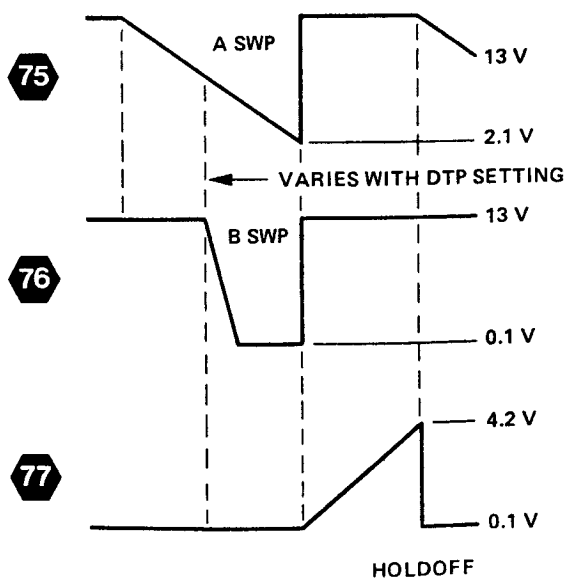

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A & B TIMING SWITCH DIAGRAM 9

ASSEMBLY A13

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C112	5B	2B	P555	1B	5H	R147	2J	2F
C120	3C	1C	P555	1B	5H	R148	2J	2F
C126	5B	2D	P555	2B	5H	R150	2J	2F
C130	4B	1D	P555	2M	5H	R153	2J	2G
C152	2E	1G	P555	6M	5H	R154	3I	2G
C159	2L	2G				R156	3I	2G
C228	5B	2D	Q151	2E	1G	R157	3I	2G
C258	2L	2G	Q158	1F	1G	R160	1I	2H
C318	4B	4C	Q161	1I	1H	R161	6L	2H
C345	2L	4G	Q432	6B	5E	R162	6M	2H
C418	4C	4C				R163	6M	2H
C429	4F	4D	R113	5B	2B	R164	7M	2H
C435	5F	4E	R114	4D	2C	R169	1H	1H
C437	5F	4E	R115	4D	2C	R170	2H	2I
C446	2K	4G	R116	4D	2C	R173	1G	1I
C449	2L	5F	R120	5D	2C	R178	1F	2I
			R121	5D	2C	R270	5M	2I
CR430	3F	4D	R122	5D	2C	R272	2F	3I
			R123	6E	2D	R429	6B	5B
P111	1E	1B	R124	2D	1D	R430	6B	5B
P135	1E	1E	R130	6E	2D	R431	3F	4D
P135	4M	1E	R131	6E	4D	R432	3F	4E
P146	3M	1F	R133	3C	2E	R439	2C	4E
P524	1B	5D	R135	4H	1E			
P524	1B	5D	R137	2D	2E	S249A	8I	3C
P524	1B	5D	R138	2D	2E	S249B	8I	3C
P524	3A	5D	R143	2J	2F	S272	1F	3I
P524	3F	5D	R144	2I	2F			
P524	4G	5D	R145	3I	1F	VR173	1H	2I
P524	5A	5D	R145A	4H	1F	VR174	1H	2I

Partial A13 also shown on diagrams 4, 7, 8 and 10.

ASSEMBLY A15

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P799	2G	8N	W780	1A	8L	W880	1A	9L
			W849	1A	9G			
VR896	2G	9N	W866	1A	9J			

Partial A15 also shown on diagrams 3, 4, 5, 7, 8, 10, 11, 12 and 20.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
CR14498	3H	CHASSIS	R14498	2H	CHASSIS			
DS16002	1E	CHASSIS	S14498	2H	CHASSIS			

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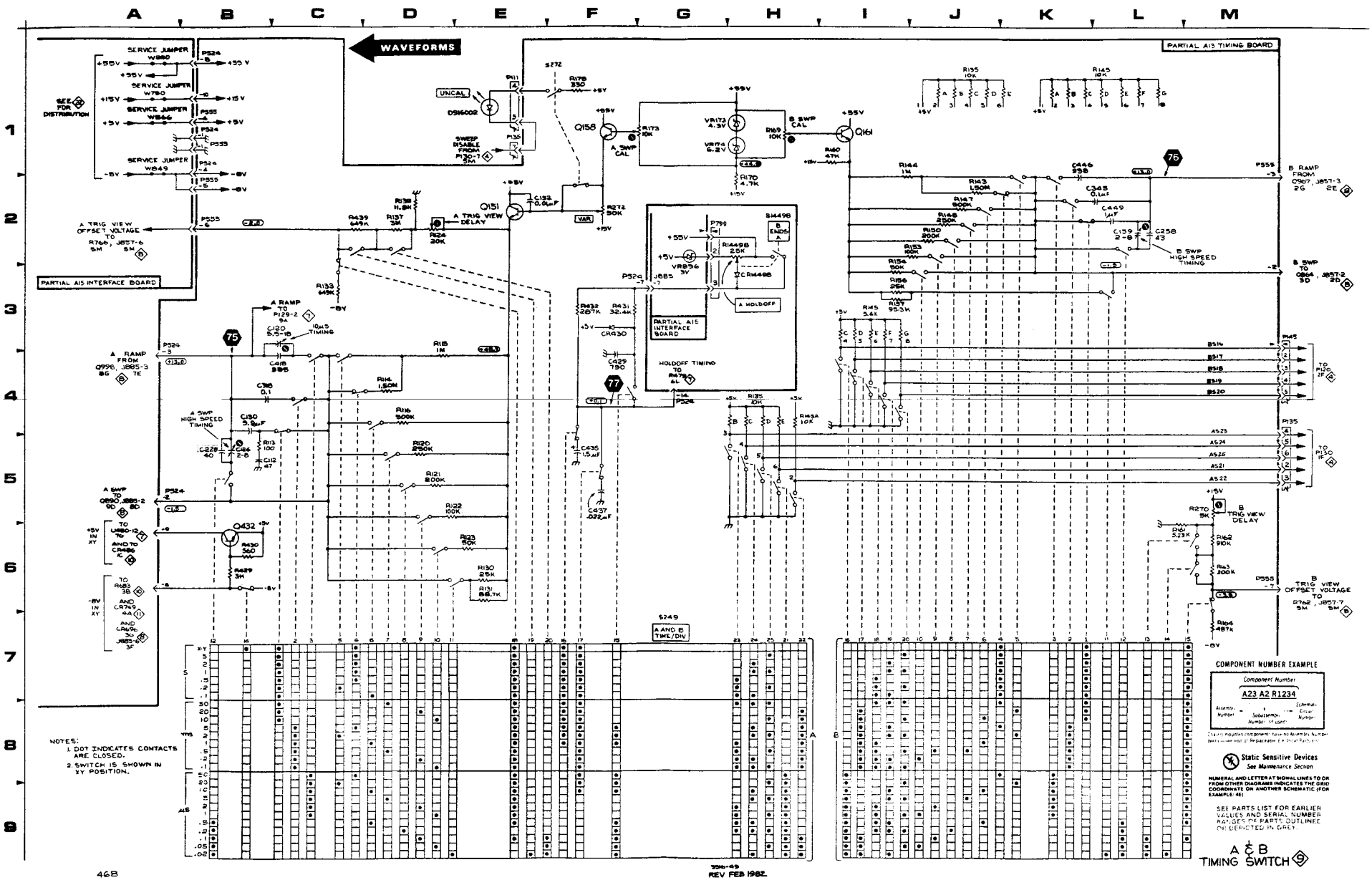


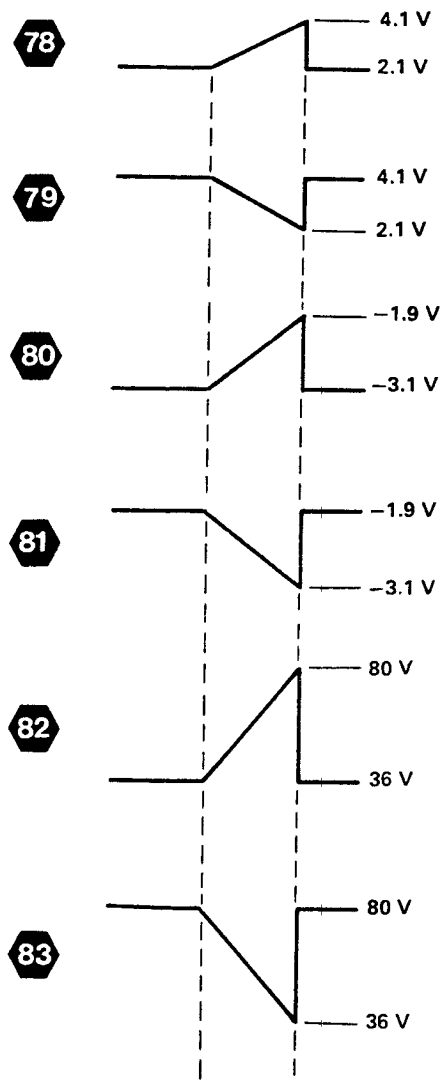
468 CONTROL SETTINGS FOR ⑩

DC Voltages

A TIME/DIV	X-Y
CH 2 POSITION	Beam centered
Horizontal POSITION	Beam centered
AC-GND-DC (both)	GND

AC Waveforms

A TRIG MODE	AUTO (no trigger signal)
HORIZ DISPLAY	A
A TIME/DIV	1 ms
Horizontal POSITION	Trace centered
AC-GND-DC (both)	GND



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HORIZONTAL AMPLIFIER DIAGRAM 10

ASSEMBLY A13

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P111	7C	1B	P524	7D	5D			

Partial A13 also shown on diagrams 4, 7, 8 and 9.

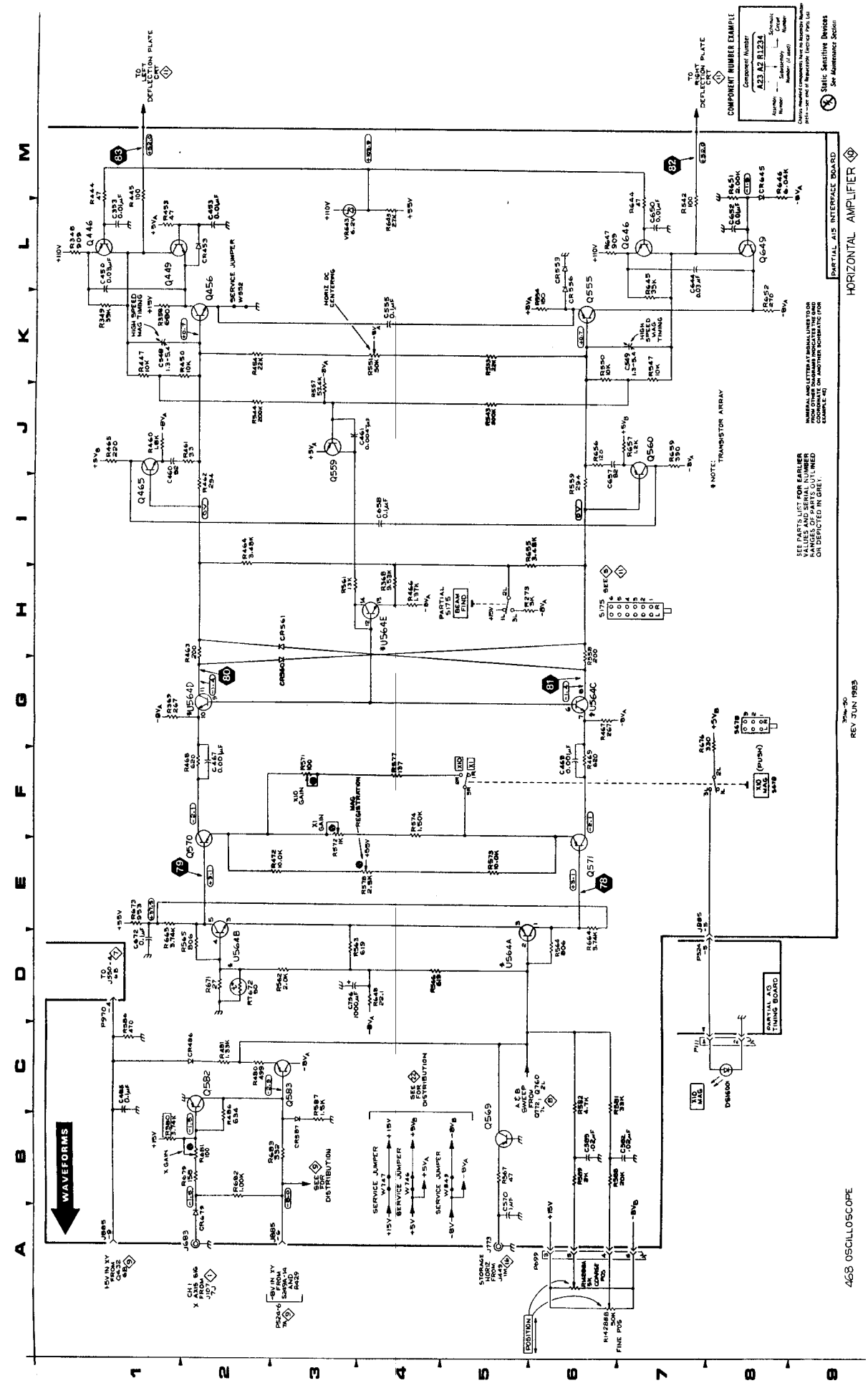
ASSEMBLY A15

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C353	1L	4H	Q582	2C	6L	R573	5E	6K
C450	1L	4H	Q583	3C	5L	R574	4F	6K
C453	2L	5H	Q646	7L	6G	R577	4F	6K
C460	1J	5I	Q649	8L	6G	R578	4E	5K
C461	4J	5I				R580	1B	5L
C467	2F	5J	R273	6H	2K	R581	7C	6L
C468	6F	5J	R348	1L	4G	R582	6C	6L
C485	1C	5L	R349	1K	4G	R586	1C	5M
C548	1K	5H	R358	1K	4I	R587	3B	6M
C549	7K	6H	R368	4H	4J	R588	7B	6M
C555	4K	5I	R369	1G	4J	R589	6B	6M
C570	5A	6J	R444	1M	4G	R643	4L	7G
C582	7B	6L	R445	1M	5G	R644	7L	7G
C589	6B	6M	R447	1K	5G	R645	7L	7G
C644	7L	7G	R450	2K	5H	R646	8M	7G
C650	7L	7H	R453	1L	4H	R647	7L	7G
C652	8L	7H	R454	2K	5H	R648	4D	7G
C657	7J	7I	R460	1J	4I	R651	8M	7H
C658	4I	7I	R461	2J	5I	R652	8K	6H
C672	1D	7K	R462	2I	5I	R655	6H	6I
C756	3D	8I	R463	2H	5I	R656	6J	7I
			R464	2I	4J	R657	7J	7I
CR453	2L	5H	R465	1J	4J	R659	7J	7I
CR486	2C	5L	R466	4H	5J	R664	6E	7J
CR553	6L	5H	R467	6G	4J	R665	1E	7J
CR556	6K	5I	R468	2F	5J	R671	2D	7K
CR560	3G	5I	R469	6F	5J	R673	1E	7K
CR561	3H	5I	R472	3E	5K	R676	8G	7K
CR587	3B	6M	R480	2C	5L	R679	2B	7L
CR645	8M	7G	R481	2C	5L	R681	2B	7L
CR679	2A	7L	R486	2B	5L	R682	2B	7L
			R542	8L	6G	R683	3B	7L
J683	2A	7L	R543	5J	6G			
J773	5A	8K	R544	2J	5G	RT672	2D	7K
J885	1A	9L	R547	7K	6G			
J885	3A	9L	R550	6K	6H	S175	5H	2K
J885	8E	9L	R551	4K	5H	S678	8F	6K
			R553	5K	6H			
P699	6A	7N	R554	6K	5I	U564A	5D	5J
P970	1D	10J	R557	3J	6I	U564B	2D	5J
			R558	6H	6I	U564C	6G	5J
Q446	1L	5G	R559	6I	6I	U564D	2G	5J
Q449	2L	5H	R561	4H	5I	U564E	4H	5J
Q456	2K	5H	R562	3D	6I			
Q465	1J	5J	R563	3D	6J	VR643	3L	6G
Q555	6K	6I	R564	6D	6J			
Q559	3J	6I	R565	2D	6J	W552	2K	5H
Q560	7J	6I	R566	4D	6J	W580	2C	6L
Q569	5B	6J	R567	5B	6J	W746	4B	8G
Q570	2E	5J	R571	3F	6K	W747	4B	8G
Q571	6E	6J	R572	3E	5K	W849	5B	9G

Partial A15 also shown on diagrams 3, 4, 5, 7, 8, 9, 11, 12 and 20.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
DS16001	8C	CHASSIS	R14288A	6A	CHASSIS			
			R14288B	6A	CHASSIS			


HORIZONTAL AMPLIFIER
WAVEFORMS
TO LEFT DEFLECTION PLATE
TO RIGHT DEFLECTION PLATE
PARTIAL A15 INTERFACE BOARD
PARTIAL X10 TIMING BOARD
TRANSISTOR ARRAY
SERVICE JUMPER W932
SERVICE JUMPER W747
SERVICE JUMPER W644
SEE DISTRIBUTION
HORIZ DC CENTERING
HIGH SPEED MAG TIMING
X GAIN
X10 GAIN
MAG REGISTRATION
X1 GAIN
X10 MAG
FINE POS
POSITION
STORAGE SWEEP FROM J473
A.C.B. SWEEP FROM J460
CH 1 X AMP FROM J67
+5V IN XY FROM Q432
-8V IN XY FROM SAMPLER AND Q425
TO J550
TO J970
TO J885
TO J683
TO P999
TO P2340
COMPONENT NUMBER EXAMPLE
Static Sensitive Devices
See Maintenance Section
REV JUN 1983
468 OSCILLOSCOPE

468 CONTROL SETTINGS FOR ⟨11⟩

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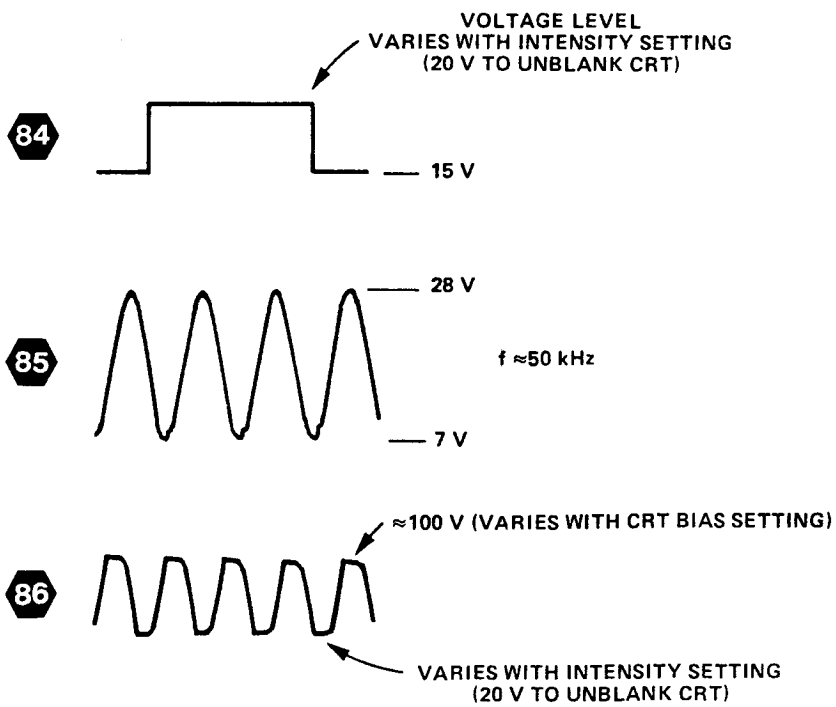
DC Voltages

A TRIG MODE	NORM (sweep not running)
AC-GND-DC (both)	GND

AC Waveforms

A TRIG MODE	AUTO (no trigger signal)
HORIZ DISPLAY	A
A TIME/DIV	1 ms
AC-GND-DC (both)	GND



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CRT CIRCUIT DIAGRAM 11

ASSEMBLY A15

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C104	7D	2A	F809	5F	10B	R409	3G	4B
C108	6F	2B				R414	1F	4C
C113	6F	2C	J526	5A	6E	R415	2E	5C
C141	3M	1F	J750	3A	8H	R417	2I	5D
C142	5M	2F				R418	2G	5D
C143	5M	1F	L107	5F	2B	R419	4F	5D
C146	4M	2G				R425	8C	5E
C205	4H	3B	P108	7F	2B	R429A	5J	5E
C210	4I	3B	P137	3M	1F	R429B	5J	5E
C218	6H	2D	P137	5M	1F	R429C	5C	5E
C220	6H	2D	P359	4M	3I	R429D	6C	5E
C225	6J	2E	P473	2M	5K	R432	3C	5E
C239	5J	2F	P944	3A	10G	R435	4E	5F
C303	3H	3A				R512	2E	6C
C307	3H	4B	Q109	5E	1B	R513	1G	6C
C314	2E	4C	Q201	6D	2A	R517	3F	6C
C318	3I	3C	Q302	6E	3A	R518	3E	6C
C319	2I	4D	Q416	2F	5C	R521	4E	6D
C414	1F	4C	Q516	3F	5C	R523	3D	6D
C416	1G	5C	Q522	3E	6D	R524	3E	6D
C426	7J	4E	Q523	3D	6D	R526	8B	6E
C513	2F	6C	Q530	5C	5E	R527	5C	6E
C518	4F	5D	Q533	5E	5E	R533	5C	6E
C519	3G	6C				R536	5C	6F
C525	6B	6E	R101	5D	2A	R618	3F	6C
C531	5C	6E	R103	5E	2A	R619	4D	7C
C629	4C	7E	R114	6E	2C	R621	3D	6D
			R144	5M	2G	R625	2D	6D
CR101	6D	2A	R145	4N	2G	R627	5B	7E
CR104	5F	2A	R148	4N	2G	R628	5E	7E
CR105	7E	2A	R203	6D	3A	R629	3D	7E
CR110	5E	2B	R204	6D	3A	R633	4C	6F
CR209	5H	3B	R206	4H	3B	R743	4B	8G
CR220	7G	2D	R209	5H	2B	R746	3B	8G
CR305	6E	3B	R252A	2B	3H			
CR313	3I	4C	R252B	4J	3H	S175	1C	2K
CR314	3I	4C	R267	3M	2J			
CR323	3J	3D	R270	4M	2J	T216	6F	3C
CR324	3J	3D	R302	6D	3A			
CR347	2C	3G	R309	3H	4B	TP112	6F	2B
CR414	1F	4E	R310	3H	4B	TP328	7K	4E
CR517	3F	6D	R312	3I	3C	TP418	2I	5C
CR519	2H	6C	R313	3I	3C			
CR622	3E	6D	R316	2I	4C	U136	1I	2E
CR623	3B	6D	R324	7H	3D			
CR631	5C	6E	R325	3J	3D	VR207	4H	3B
CR727	1E	7E	R327	4J	3E	VR308	3H	4B
CR746	3B	8G	R328	7J	3E	VR512	1E	6C
CR749	4B	8G	R335	5J	4F			
			R346	2B	3G	W136	1I	1F
DS323	6J	4D	R377	4M	3K			
DS324	6J	4D	R378	2M	4K			

Partial A15 also shown on diagrams 3, 4, 5, 7, 8, 9, 10, 12 and 20

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
J11526	5A	CHASSIS	P1526	5A	CHASSIS	V1400	2L	CHASSIS
L14175	4L	CHASSIS	Q1108	8F	CHASSIS			
L14176	2L	CHASSIS						

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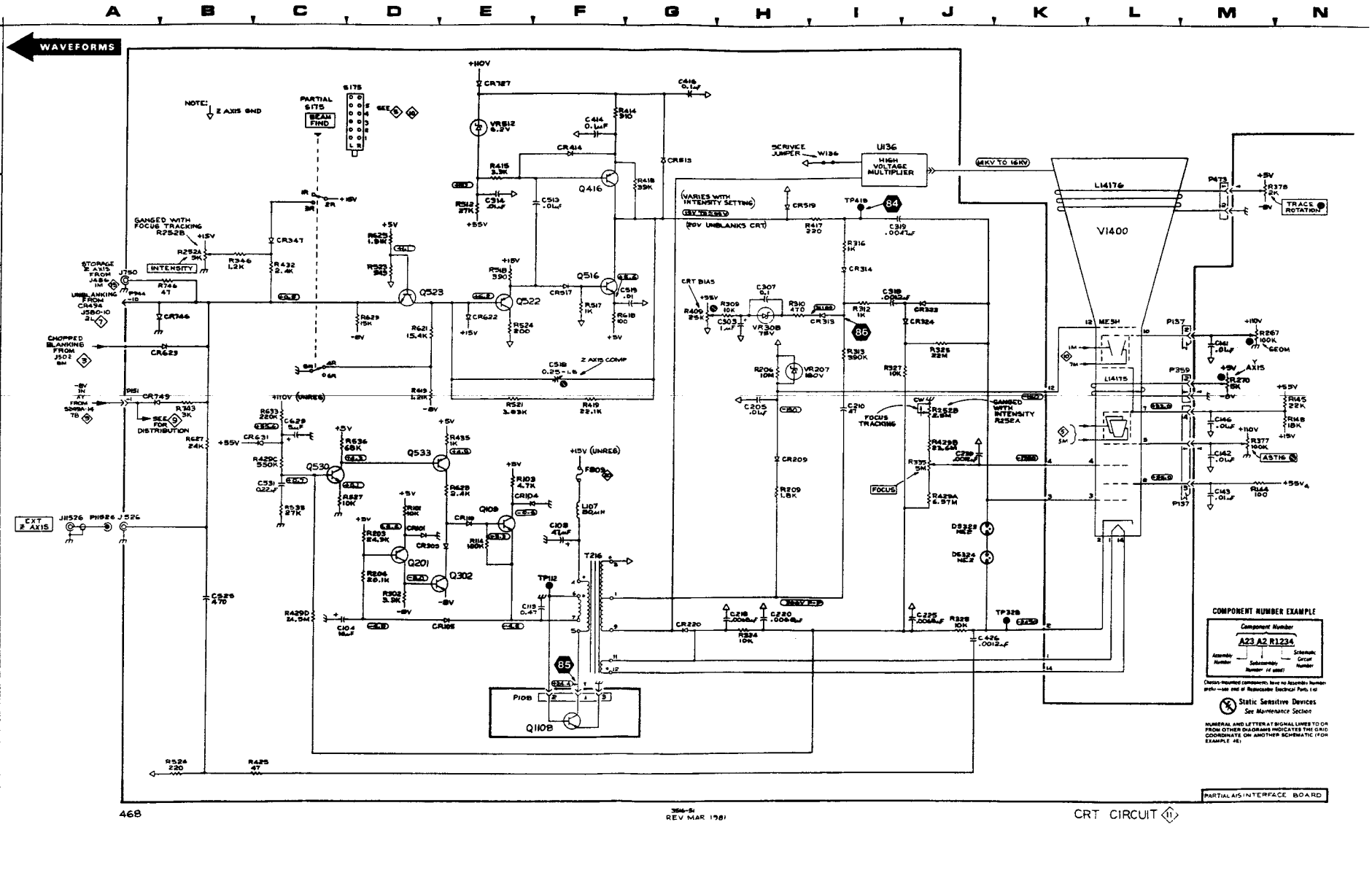


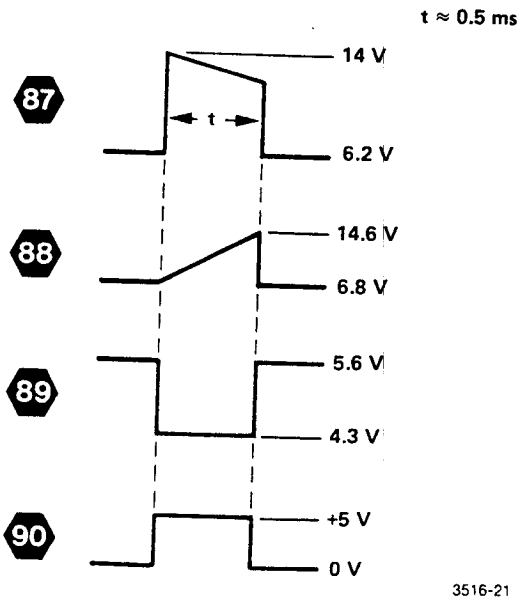
468 CONTROL SETTINGS FOR ◇12◇

DC Voltages

Remove Q1496 to make dc measurements in the Calibrator circuit.

AC Waveforms

Fan circuit waveform taken at 25°C ambient temperature.



CALIBRATOR & FAN DIAGRAM 12

ASSEMBLY A15

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C391	4B	4M
C486	3B	5L
C594	4D	6M
C595	5C	5M
CR494	4C	5M
L494	4D	5M
Q380	3B	4L
Q396	4C	4N
Q595	4D	6N
R385	4B	4L
R386	3B	4L
R387	3B	4L
R391	3C	4M
R493	5C	5M
R595	5D	6N
R596	6D	6N
R599	5D	5N
TP474	4A	5K
TP475	3C	5K
W385	4B	3L

Partial A15 also shown on diagrams 3, 4, 5, 7, 8, 9, 10, 11 and 20.

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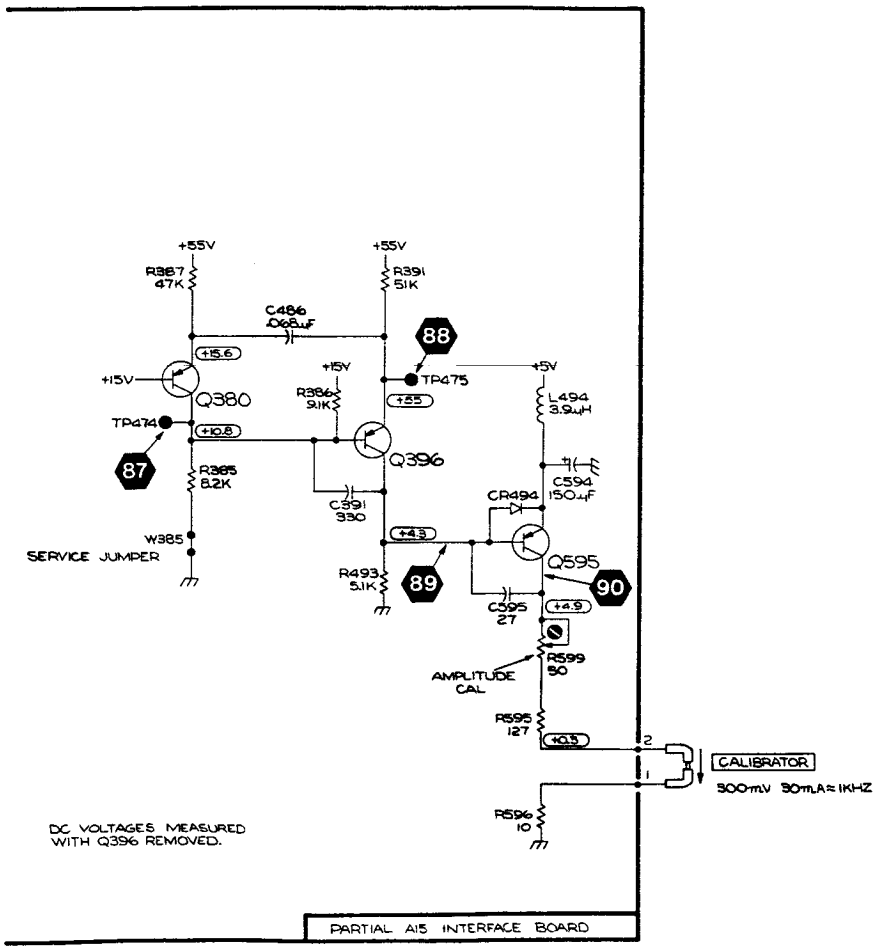
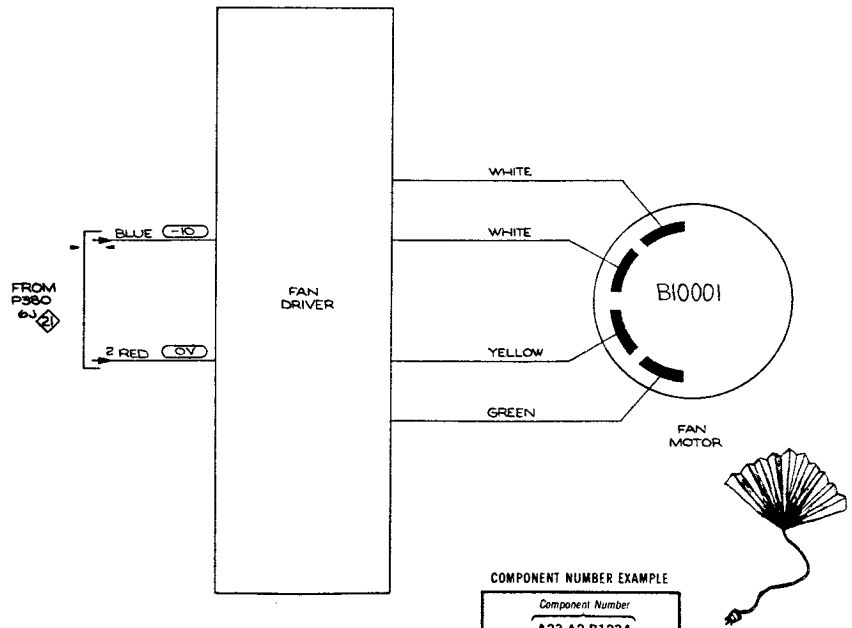
A B C D E F G H I J K

1 2 3 4 5 6 7

WAVEFORMS





COMPONENT NUMBER EXAMPLE

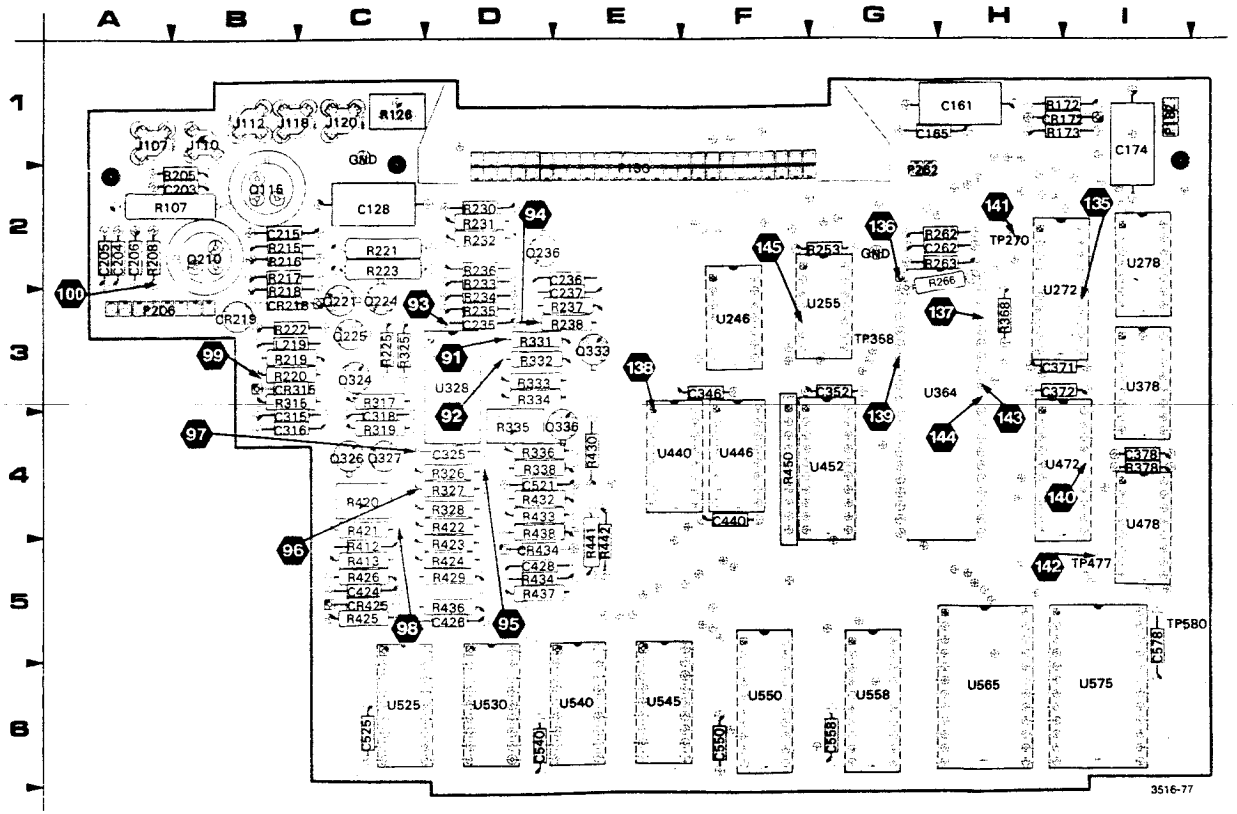
Component Number: A23 A2 R1234
- A23 — Assembly Number
- A2 — Subassembly Number (if used)
- R1234 — Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix—see end of Repaceable Electrical Parts List.

NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATE ON ANOTHER SCHEMATIC (FOR EXAMPLE: 4E)

Static Sensitive Devices
See Maintenance Section

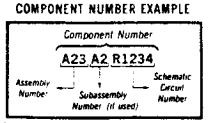
CALIBRATOR & FAN 12



3516-77

Figure 8-20. A21 Microprocessor board.

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

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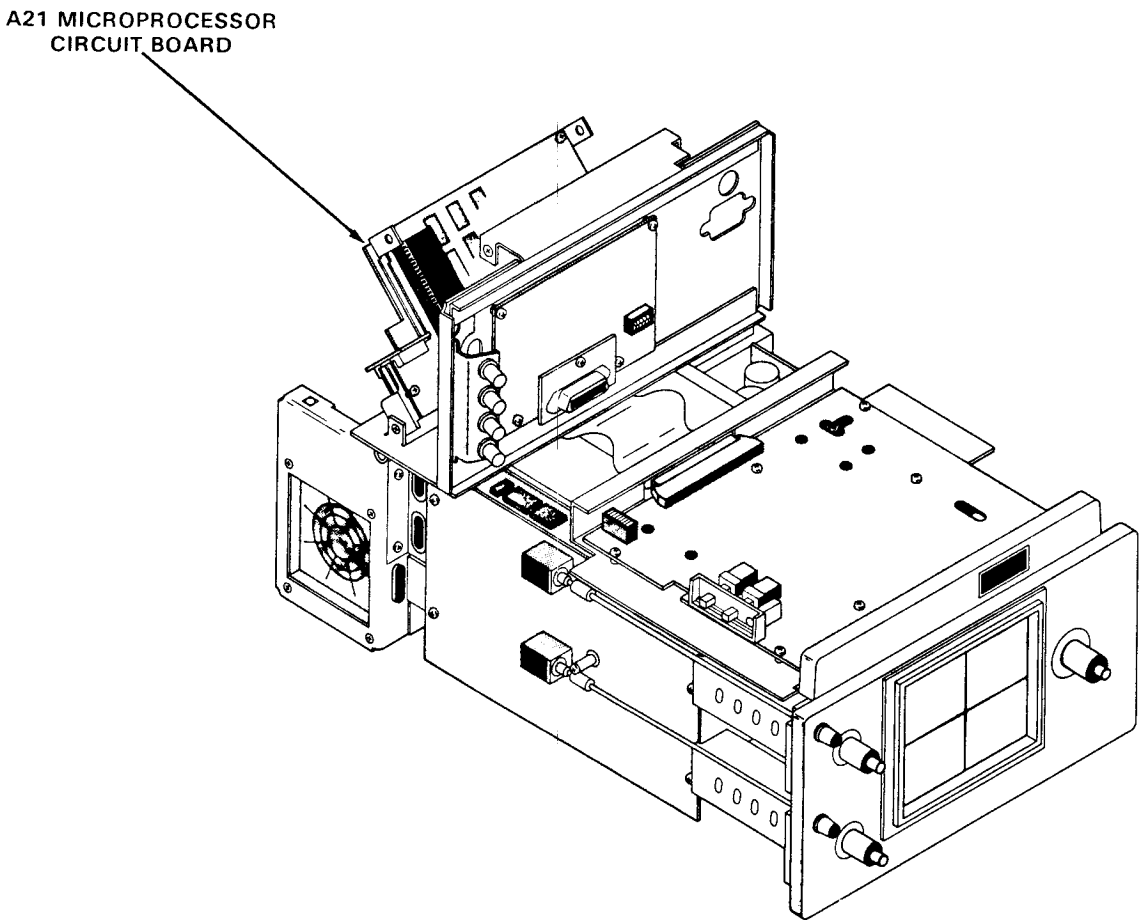
A21 MICROPROCESSOR BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 13

C128	CR425	Q326	R232	R412
C203	CR434	Q327	R233	R413
C204		Q333	R234	R420
C205	J107	Q336	R235	R421
C206	J110		R236	R422
C215	J112	R107	R237	R423
C235	J118	R126	R238	R424
C236	J120	R205	R315	R425
C237		R208	R317	R426
C315	L219	R215	R319	R429
C316		R216	R325	R430
C318	P130	R217	R326	R432
C325	P130	R218	R327	R433
C424		R219	R328	R434
C426	Q115	R220	R331	R436
C428	Q210	R221	R332	R437
C521	Q221	R222	R333	R438
	Q224	R223	R334	R441
CR218	Q225	R225	R335	R442
CR219	Q236	R230	R336	
CR315	Q324	R231	R338	U328

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 18

C161	P130	R450C	U272A	U452
C165	P130	R450D	U272A	U472B
C174	P130	R450E	U272B	U472C
C262	P130	R450F	U272C	U472D
C346	P130	R450G	U272D	U472E
C352	P182	R450H	U272E	U472F
C371	P262		U272F	U472G
C372		TP270	U272G	U472H
C378	R172	TP358	U272H	U478
C440	R173	TP477	U278A	U525
C525	R253	TP580	U278B	U530
C540	R262		U278C	U540
C550	R263	U246A	U278D	U545
C558	R266	U246B	U364	U550
C578	R368	U246C	U378	U558
	R378	U255A	U440	U565
CR172	R450A	U255B	U446	U575
	R450B			


A21 MICROPROCESSOR
CIRCUIT BOARD

468 CONTROL SETTINGS FOR ◇13

DC Voltages

STORAGE MODE	NORM
TRIG MODE	AUTO

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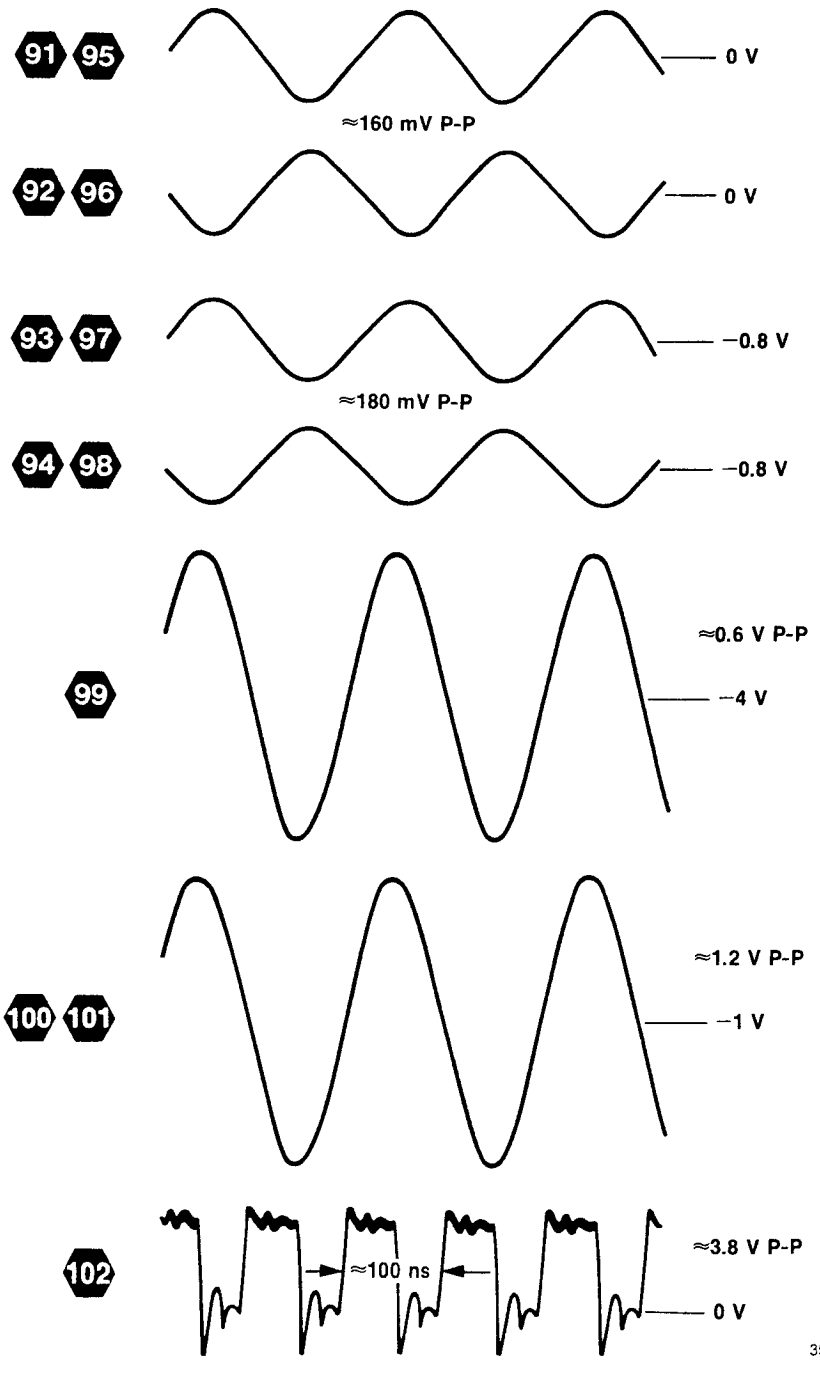
AC Waveforms

STORAGE MODE	NORM
A TRIG MODE	AUTO
A TRIGGER LEVEL	Fully clockwise
VERT MODE	CH 1
TIME/DIV	5 μs
VOLTS/DIV	5 mV
AC-GND-DC (both)	DC
CH 1 & CH 2 input signal	6-division, 50-kHz reference sine wave



3516-32

A/D CONVERTER & CHANNEL SWITCH DIAGRAM 13

ASSEMBLY A18

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C172	7K	2H	P276	6L	2I	R252G	1M	3F
C255	3M	2G	P278	1J	3I	R255	1M	2G
C266	2L	3H				R265	3K	2H
C556	7K	5H	Q260	3L	2G	R266	2K	2H
						R267	2K	2H
CR174	1K	2H	R252A	1M	3F	R271	1K	4H
			R252B	1M	3F			
P152	6M	1E	R252C	1M	3F	U264	3K	2H
P152	7J	1E	R252D	1M	3F	U274	2K	2I
P246	6M	2E	R252E	1M	3F	U356	5M	3G
P266	1J	2H	R252F	1M	3F	U456	1L	5G

Partial A18 also shown on diagram 14.

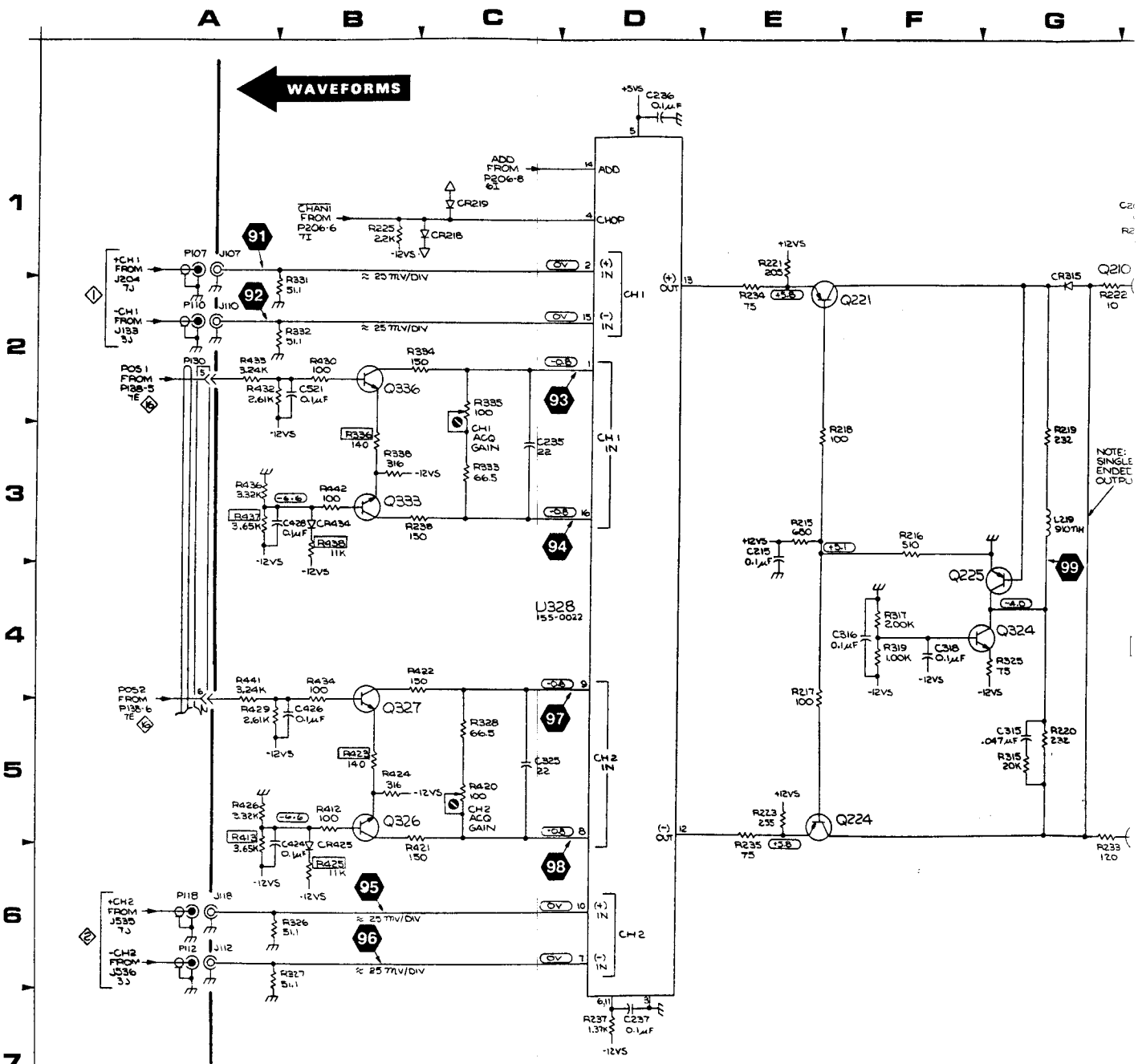
ASSEMBLY A21

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C128	2H	2C	Q115	1I	2B	R315	5G	3B
C203	1H	2B	Q210	2H	2B	R317	4F	3C
C204	2H	2A	Q221	2E	3C	R319	4F	4C
C205	1I	2A	Q224	5E	3C	R325	4G	3G
C206	1H	2A	Q225	4G	3C	R326	6B	4D
C215	3E	2B	Q236	5H	2D	R327	6B	4D
C235	3C	3D	Q324	4G	3C	R328	5C	4D
C236	1D	2E	Q326	5B	4C	R331	2B	3D
C237	7D	3E	Q327	5B	4C	R332	2B	3D
C315	5G	4B	Q333	3B	3E	R333	3C	3D
C316	4F	4B	Q336	2B	4E	R334	2B	3D
C318	4F	4C				R335	2C	4D
C325	5C	4D	R107	1I	2A	R336	3B	4D
C424	6B	5C	R126	4H	1C	R338	3B	4D
C426	5B	5D	R205	1H	2B	R412	5B	5C
C428	3B	5D	R208	1H	2A	R413	5A	5C
C521	2B	4D	R215	3E	2B	R420	5C	4C
			R216	3F	2B	R421	6B	4C
CR218	1C	3B	R217	5E	2B	R422	4B	4D
CR219	1C	3B	R218	3E	3B	R423	5B	5D
CR315	2G	3B	R219	3G	3B	R424	5B	5D
CR425	6B	5C	R220	5G	3B	R425	6B	5C
CR434	3B	5D	R221	1E	2C	R426	5A	5C
			R222	2G	3B	R429	5A	5D
J107	1A	1A	R223	5E	2C	R430	2B	4E
J110	2A	1B	R225	1B	3C	R432	2A	4D
J112	6A	1B	R230	4H	2D	R433	2A	4D
J118	6A	1B	R231	5H	2D	R434	5B	5D
J120	5H	1C	R232	5H	2D	R436	3A	5D
			R233	5G	2D	R437	3A	5D
L219	3G	3B	R234	1E	3D	R438	3B	4D
			R235	6E	3D	R441	5A	5E
P130	2A	1E	R236	5H	2D	R442	3B	5E
P130	7I	1E	R237	7D	3E			
			R238	3B	3E	U328	4D	3D

Partial A21 also shown on diagram 18.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P107	1A	CHASSIS	P118	6A	CHASSIS	P206	1I	CHASSIS
P110	2A	CHASSIS	P120	4I	CHASSIS			
P112	1I	CHASSIS						


WAVEFORMS
A
B
C
D
E
F
G
1
2
3
4
5
6
7
8
9
+5VS
C236 0.1µF
ADD FROM P206-8 6I
ADD
CHAN1 FROM P206-6 7I
CHOP
CR219
CR218
R225 2.2K
-12VS
+CH1 FROM J204 7J
-CH1 FROM J183 3J
P107
J107
P110
J110
91
92
R331 51.1
R332 51.1
≈ 25 mV/DIV
0V
CH1 IN
POS1 FROM P138-5 7E
P130
R435 3.24K
R432 2.61K
C521 0.1µF
R430 100
R334 150
Q336
R335 100
CH1 ACQ GAIN
R336 316
R333 66.5
C235 22
R436 3.32K
R437 3.65K
C428 0.1µF
R442 100
Q333
CR434
R438 11K
R238 150
93
94
U328
155-0022
POS2 FROM P138-6 7E
R441 3.24K
R429 2.61K
C426 0.1µF
R434 100
R422 150
Q327
R328 66.5
C325 22
R423 140
R424 316
R420 100
CH2 ACQ GAIN
R426 3.32K
R413 3.65K
C429 0.1µF
R412 100
Q326
CR425
R425 11K
R421 150
97
98
95
96
CH2 IN
+CH2 FROM J535 7J
-CH2 FROM J536 3J
P118
J118
P112
J112
R326 51.1
R327 51.1
R237 1.37K
C237 0.1µF
+12VS
R221 205
R234 75
Q221
CR815
Q210
R222 10
R218 100
R219 232
R215 680
C215 0.1µF
R216 510
Q225
99
R317 2.00K
C316 0.1µF
R319 1.00K
C318 0.1µF
Q324
R325 75
R217 100
C315 .047µF
R315 20K
R220 232
R223 235
R235 75
Q224
R233 120
(+) OUT
(-) OUT
NOTE: SINGLE ENDED OUTPUT
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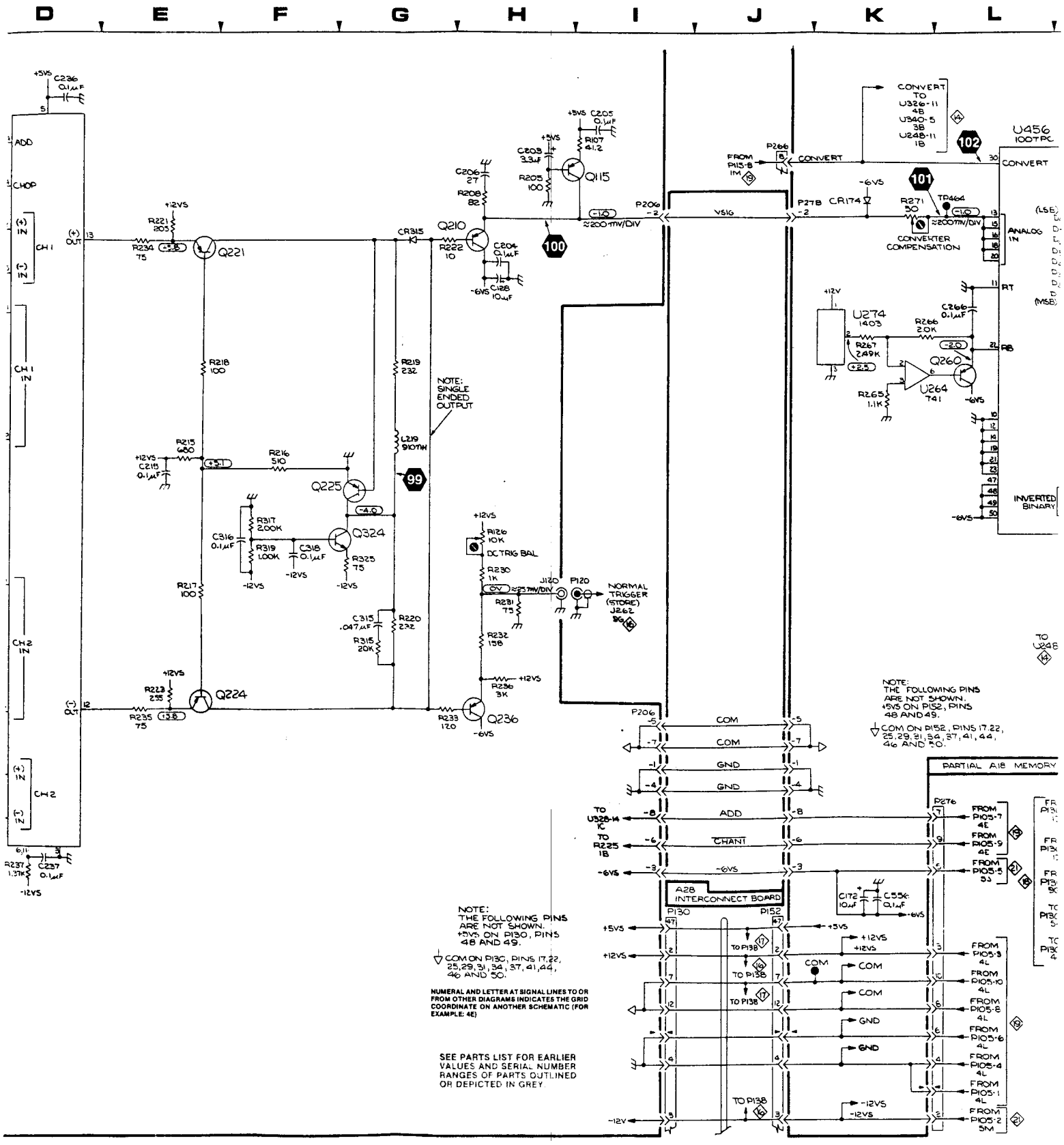
PARTIAL A21 MPU BOARD



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A-D CONVERTER & CHANNEL SWITCH

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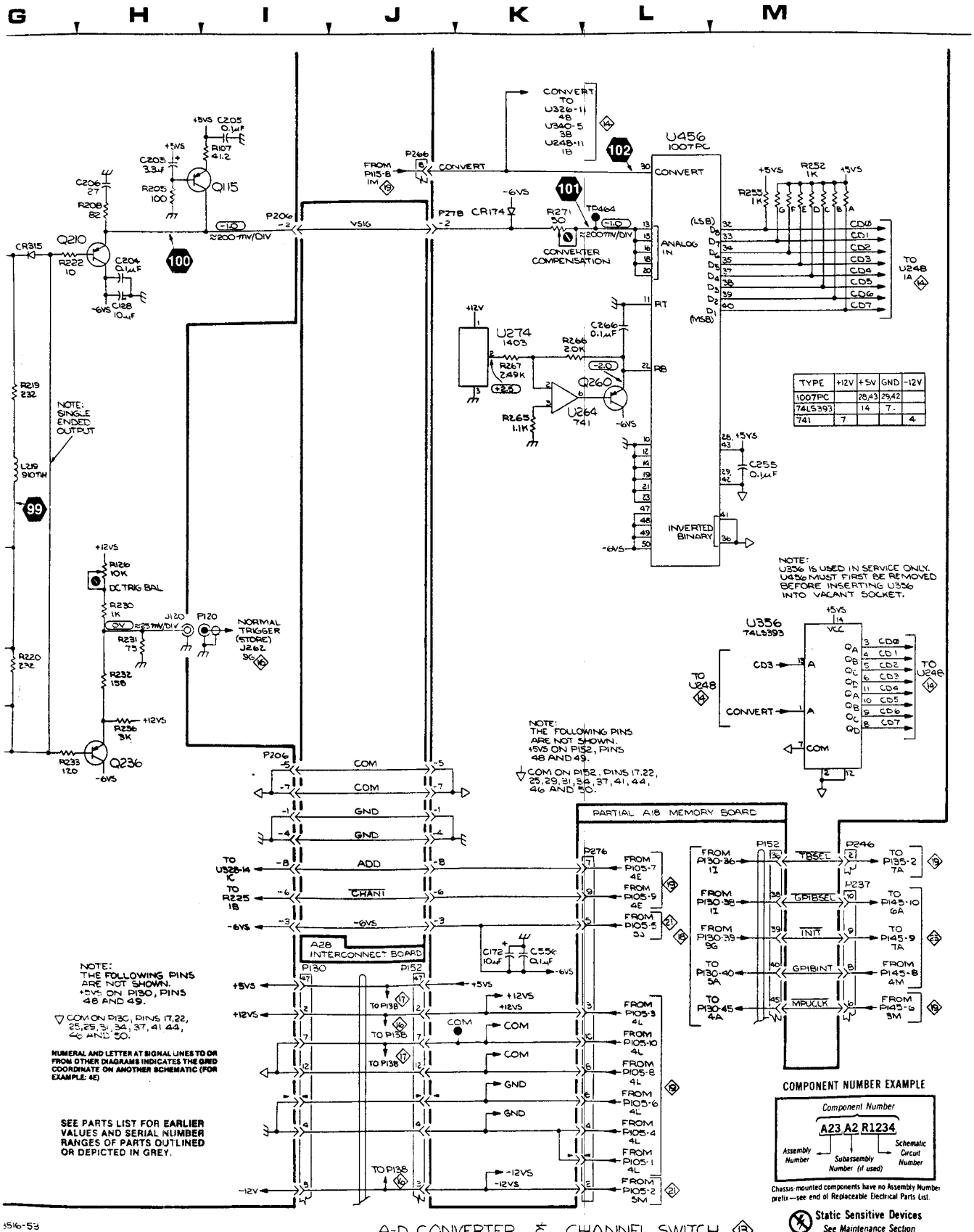

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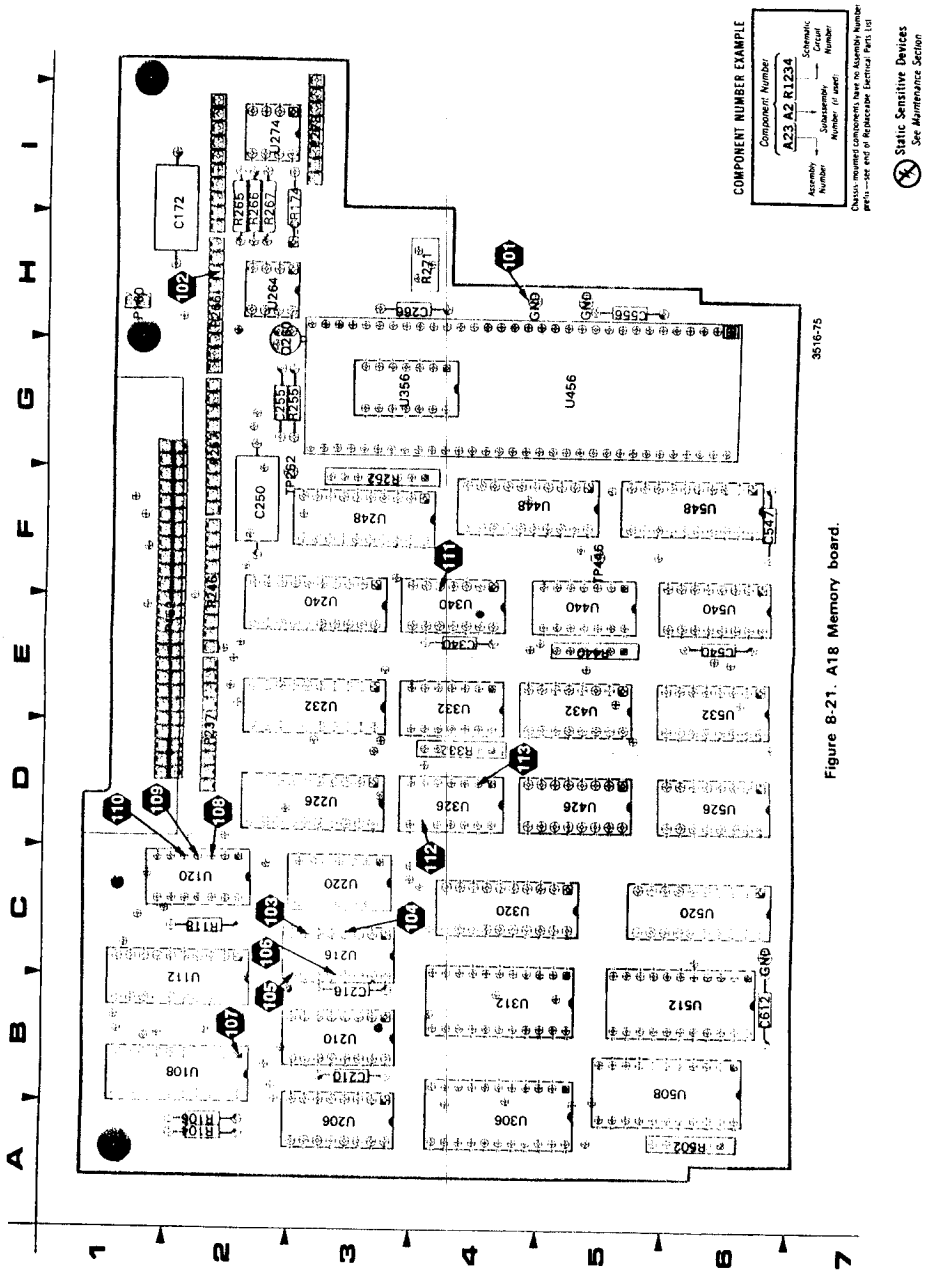


Figure 8-21. A18 Memory board.

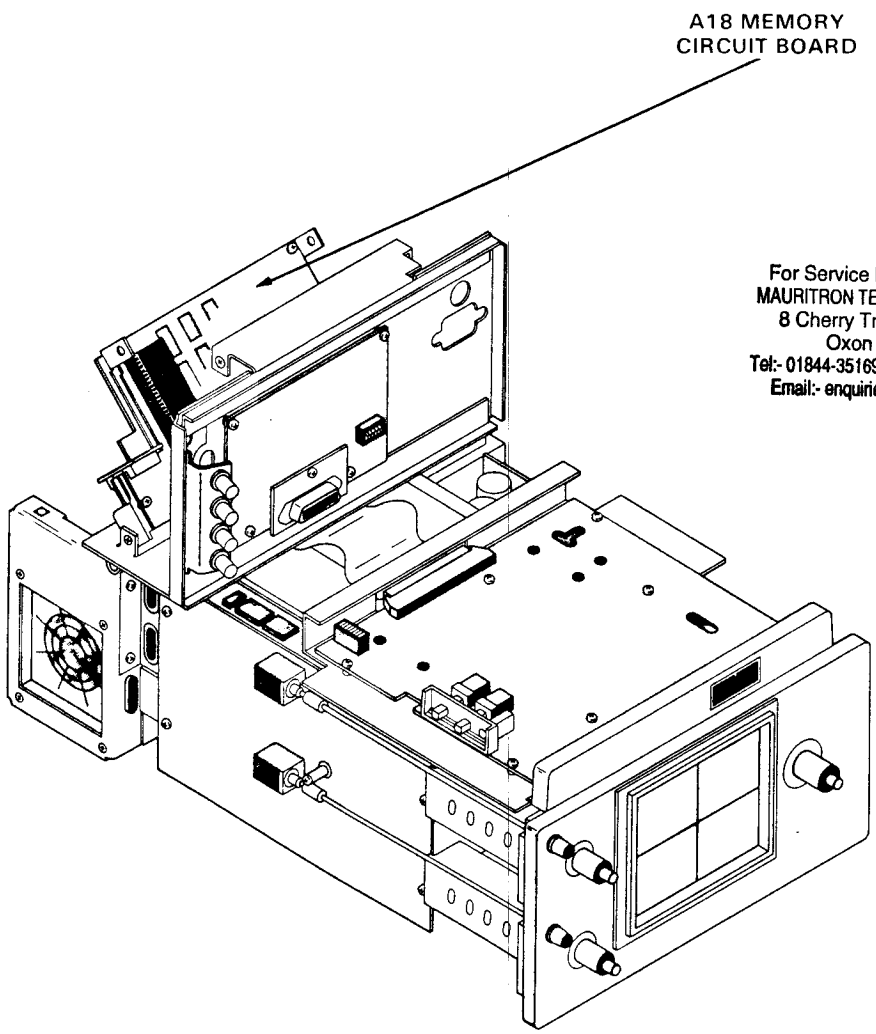
A18 MEMORY BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 13

C172 C255 C266 C556 CR174	P152 P152 P246 P266 P276	P278 Q260 R252A	R252B R252C R252D R252E R252F	R252G R255 R265 R266 R267	R271 U264 U274 U356 U456

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 14

C210 C216 C250 C255 C340 C540 C547 C612 P152 P152 P160 P237 P246	P246 P257 P257 P257 P257 P257 P266 P266 P266 R104 R106 R118 R332A	R332B R332C R332D R332E R440A R440B R440C R440D R440E R502B R502C R502E R502F	TP252 TP446 U108 U112 U120A U120B U206 U210 U216 U220A U220B U220C	U220D U226 U232 U240 U248 U306 U312 U320 U326A U326B U332A U332B U340A U340B	U340C U340D U426 U432 U440A U448 U508 U512 U520 U526 U532 U540 U548



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468 CONTROL SETTINGS FOR ◇14

DC Voltages

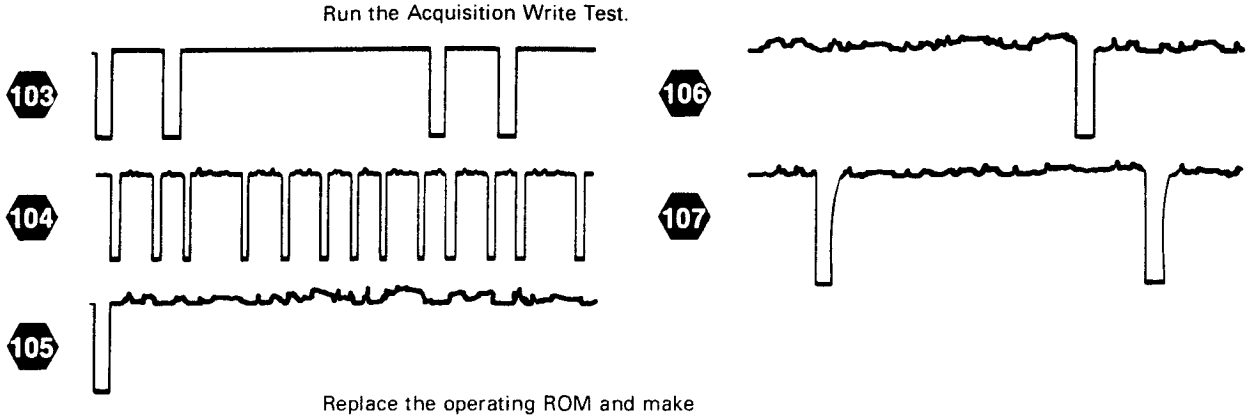
STORAGE MODE	NORM

AC Waveforms

Setup in service mode. (See "Service Test" information in the Maintenance section of Volume I of this manual.)

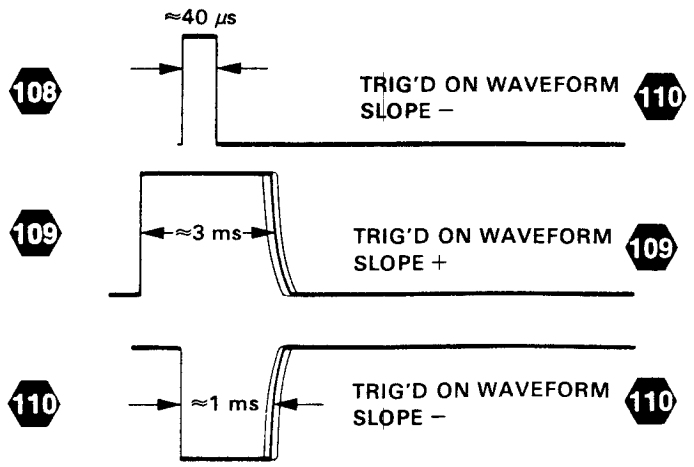
Waveform p-p amplitude is from 0 V to ≈3.8 V (TTL levels).

Run the Acquisition Write Test.

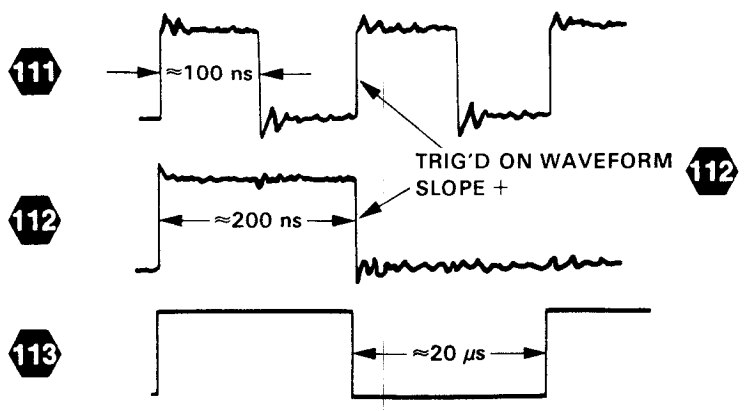


Replace the operating ROM and make the following 468 CONTROL SETTINGS:

STORAGE MODE	NORM
CH 1 INPUT SIGNAL	CALIBRATOR
TIME/DIV	1 ms
VERT MODE	CH 1
TRIG MODE	AUTO
Test Oscilloscope	
Trigger Source	Ext



SET: STORAGE MODE TO ENVELOPE



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ACQUISITION & MEMORY DIAGRAM 14

ASSEMBLY A18

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C210	7B	3B	TP252	1B	2F
C216	7B	3B	TP446	4A	5F
C250	7B	2F			
C255	3M	2G			
C340	7C	4E	U108	4M	2B
C540	7C	6E	U112	7L	2B
C547	7C	6F	U120A	6L	2C
C612	7B	6B	U120B	4J	2C
			U206	8K	3A
P152	3J	1E	U210	7J	3B
P152	7A	1E	U216	5L	3C
P160	5M	1H	U220A	3K	3C
P237	2A	2D	U220B	3L	3C
P246	5M	2E	U220C	4K	3C
P246	8M	2E	U220D	5K	3C
P257	3A	2G	U226	3H	3D
P257	4B	2G	U232	4H	3E
P257	6A	2G	U240	7F	3E
P257	7M	2G	U248	1C	3F
P257	9A	2G	U306	1M	4A
P266	4A	2H	U312	1L	4B
P266	5B	2H	U320	1H	4C
P266	5J	2H	U326A	4A	4D
			U326B	3C	4D
R104	8K	2A	U332A	6B	4E
R106	7I	2A	U332B	6B	4E
R118	4J	2C	U340A	5M	4E
R332A	3B	4D	U340B	3C	4E
R332B	5A	4D	U340C	6A	4E
R332C	3B	4D	U340D	5A	4E
R332D	5A	4D	U426	2G	5D
R332E	6A	4D	U432	2F	5E
R440A	4C	5E	U440A	4A	5E
R440B	2F	5E	U448	1E	4F
R440C	4A	5E	U508	1K	6B
R440D	5C	5E	U512	1J	6B
R440E	3F	5E	U520	6I	4E
R502B	1I	6A	U526	4G	6D
R502C	1J	6A	U532	4F	6E
R502E	1L	6A	U540	3D	6E
R502F	1M	6A	U548	5E	6E

Partial A18 also shown on diagram 13.

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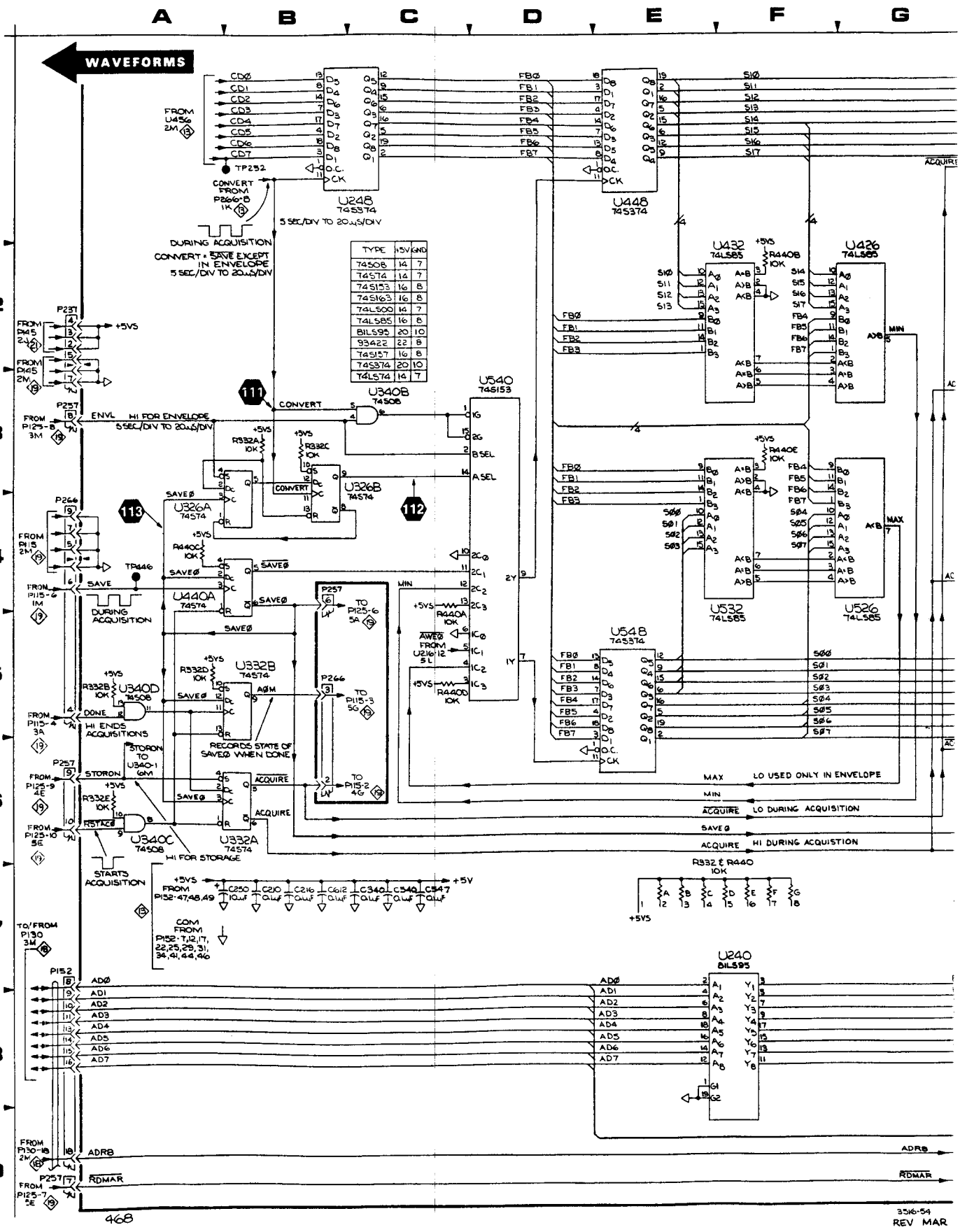

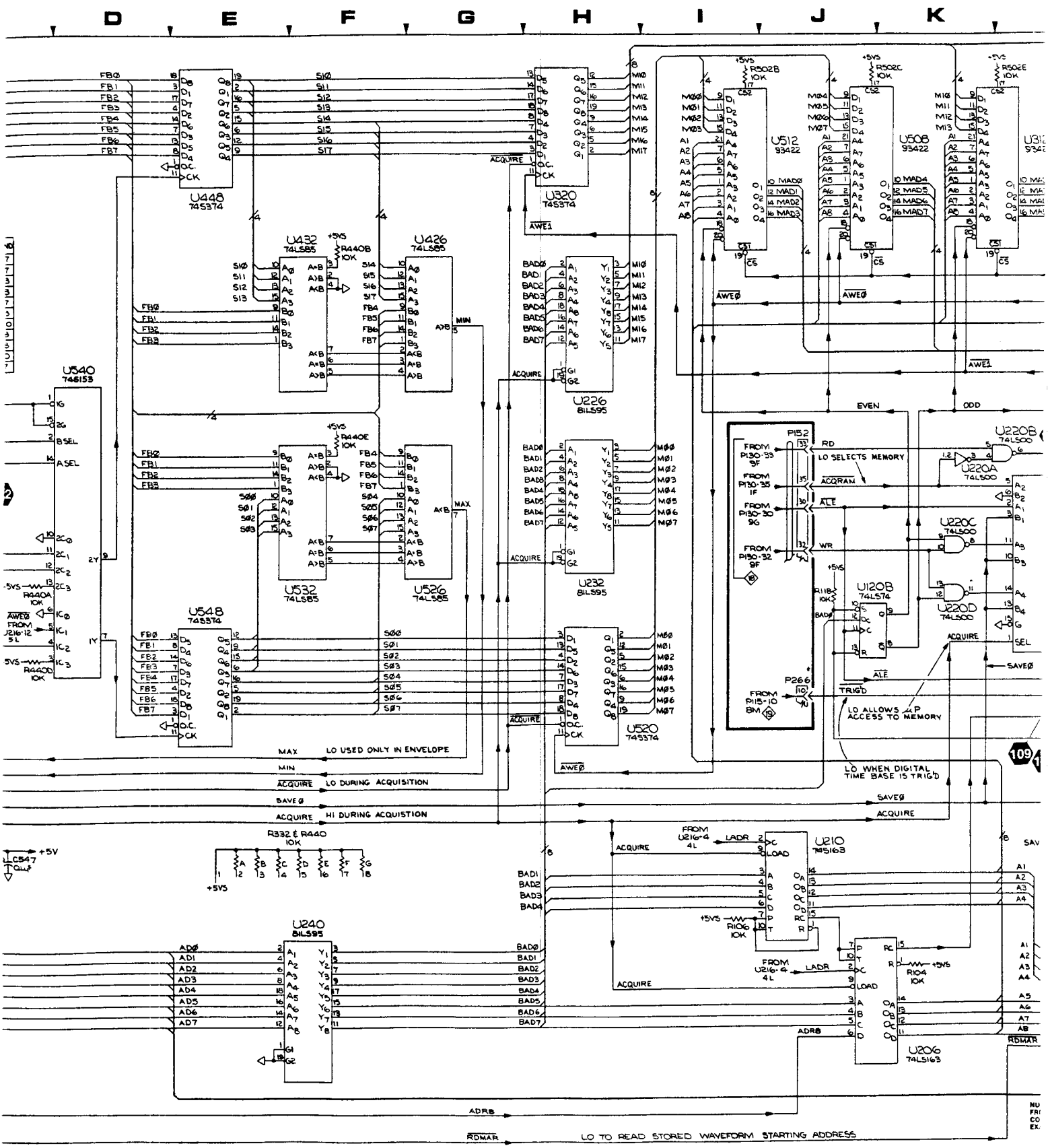
D E F G H I J K
U448 74S374
U320 74S374
U512 93422
U508 93422
U432 74LS85
U426 74LS85
U540 74S153
U532 74LS85
U526 74LS85
U548 74S374
U226 81LS95
U232 81LS95
U520 74S374
U240 81LS95
U210 74S163
U206 74LS163
U220B 74LS00
U220A 74LS00
U220C 74LS00
U220D 74LS00
U120B 74LS74
P152
P266
R502B 10K
R502C 10K
R502E 10K
R440B 10K
R440E 10K
R440A 10K
R440D 10K
R332 & R440 10K
R118 10K
R106 10K
R104 10K
C547 .01uF
FROM P130-33 9F
FROM P130-35 1F
FROM P130-30 9G
FROM P130-32 9F
FROM P115-10 8M
FROM U216-12 5L
FROM U216-4 4L
RD
LO SELECTS MEMORY
ACQRAM
ALE
WR
TRIG'D
LO ALLOWS µP ACCESS TO MEMORY
LO WHEN DIGITAL TIME BASE IS TRIG'D
EVEN
ODD
MAX
LO USED ONLY IN ENVELOPE
MIN
ACQUIRE
LO DURING ACQUISITION
SAVEØ
ACQUIRE
HI DURING ACQUISTION
ADRB
RDMAR
LO TO READ STORED WAVEFORM STARTING ADDRESS
109

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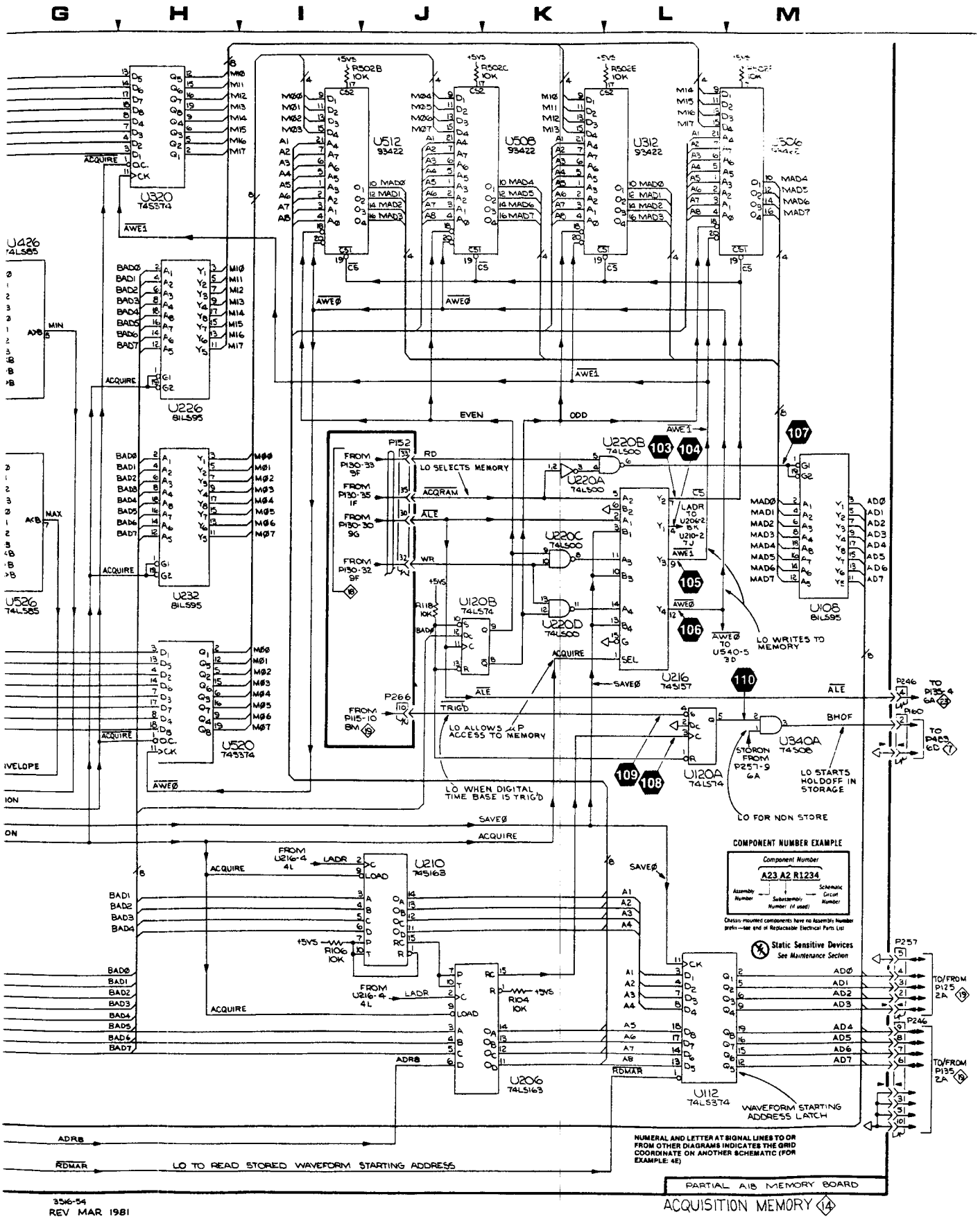

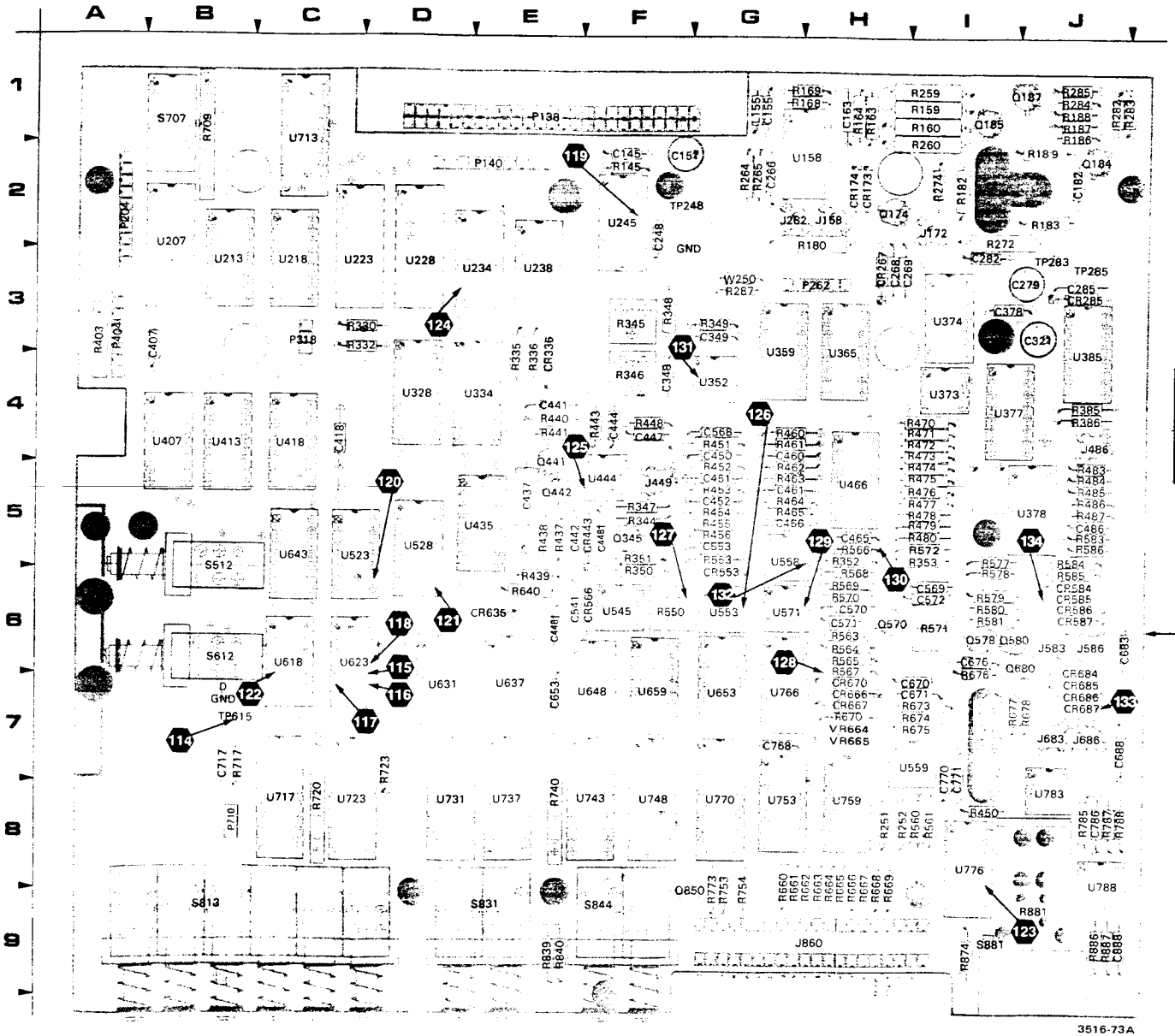

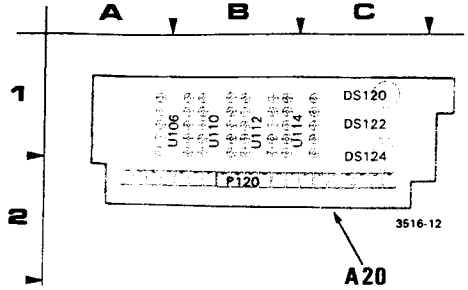

A20 READOUT BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM ◇17				
DS120 DS122	DS124	P120	U106 U110	U112 U114

COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234

Assembly Number: A23 — Subassembly Number (if used): A2 — Schematic Circuit Number: R1234

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

†C448 Alternate location

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Figure 8-22. A16 Storage Display and A20 Readout boards.

A16 STORAGE DISPLAY BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 15

C145	R145	R487	R874	U238A	U378E	U631B	U770
C486	R403A	R577	R881	U238B	U407	U637A	U776
C688	R403B	R578	R886	U238C	U413	U637B	U788
C786	R403C	R583	R887	U238D	U418	U643A	
C888	R478	R586		U245	U523	U643B	
	R479	R720A	S881A	U328	U523B	U643D	
J486	R483	R773	S881B	U334	U528	U648	
	R484	R785		U378A	U618B	U723	
P138	R485	R787	TP615	U378B	U623	U731	
P138	R486	R788		U378D	U631A	U737	
			U234				

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 16

C155	C553	CR670	Q578	R335	R462	R584	U377
C163	C568	CR684	Q580	R336	R463	R585	U378C
C182	C569	CR685	Q680	R344	R464	R640	U385
C266	C570	CR686		R345	R465	R670	U435
C268	C571	CR687	R159	R346	R470	R673	U444
C269	C572		R160	R347	R471	R674	U466A
C279	C670	J158	R163	R348	R472	R675	U466B
C282	C671	J172	R164	R349	R473	R676	U466C
C285	C676	J262	R168	R350	R474	R677	U523D
C321	C683	J449	R169	R351	R475	R678	U545
C348	C770	J583	R180	R352	R476	R717	U553A
C349	C771	J586	R182	R353	R477	R723	U553B
C378		J683	R183	R385	R480		U558
C437	CR173	J686	R186	R386	R550	TP283	U559A
C441	CR174		R187	R437	R553	TP285	U559B
C442	CR267	L155	R188	R438	R560		U571A
C444	CR285		R189	R439	R561	U158A	U571B
C447	CR336	P138	R251	R440	R563	U158B	U653
C448	CR443	P138	R252	R441	R564	U158C	U659
C450	CR553	P262	R259	R443	R565	U158D	U766
C451	CR566	P262	R260	R448	R566	U158E	U783
C452	CR584		R264	R450	R567	U352	
C460	CR585	Q174	R265	R451	R568	U359	VR664
C461	CR586	Q184	R272	R452	R569	U365	VR665
C465	CR587	Q185	R274	R453	R570	U373A	
C466	CR635	Q187	R282	R454	R571	U373B	W250
C541	CR666	Q345	R283	R455	R572	U374A	
	CR667	Q441	R284	R456	R579	U374B	
		Q442	R285	R460	R580	U374C	
		Q570	R287	R461	R581	U374D	

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 17

C151	P138	R660	R709B	R720F	R840	S831A	U228
C248	P140	R661	R709C	R720G		S831B	U713
C407	P204	R662	R709D	R720H	S512	S844A	U717
C418	P318	R663	R709E	R720I	S612	S844B	U743
C653	P404	R664	R709F	R740A	S707		U748
C717	P404	R665	R709G	R740B	S813A	TP248	U753
C768	P710	R666	R709H	R740C	S813B		U759
	Q850	R667	R720B	R740E	S813C	U207	
J860		R668	R720C	R753	S813D	U213	
J860	R330	R669	R720D	R754	S813E	U218	
	R332	R709A	R720E	R839	S813F	U223	

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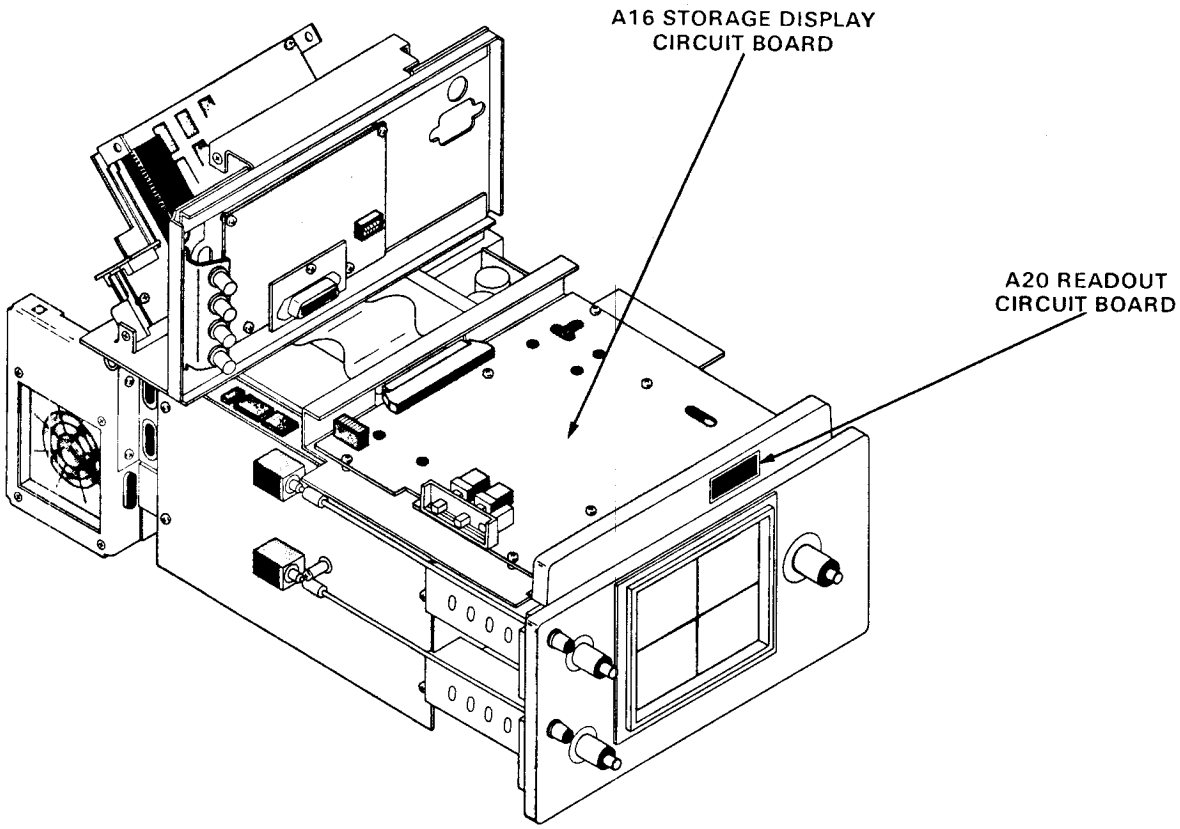


468 CONTROL SETTINGS FOR ◇15◇

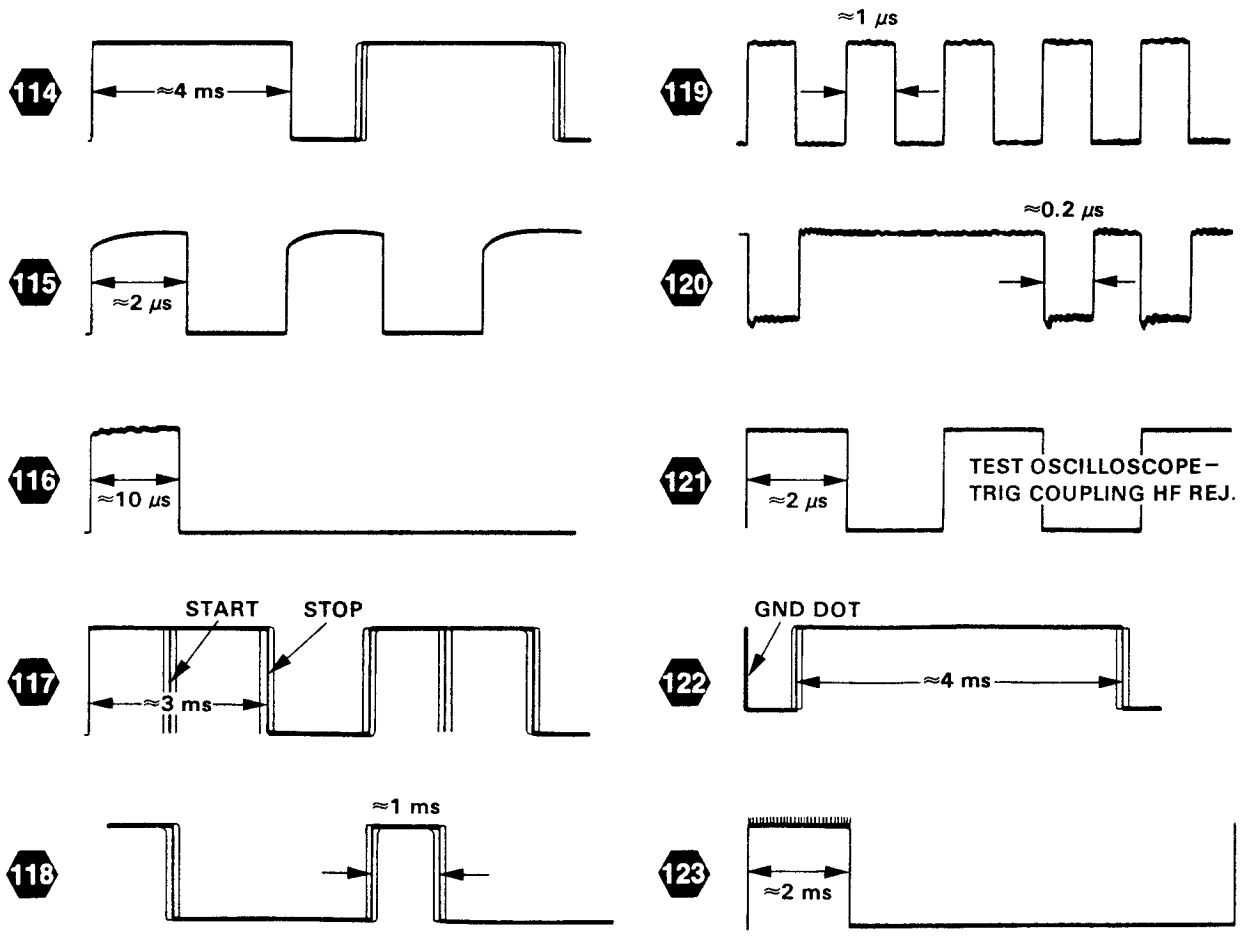
DC Voltages

STORAGE MODE	NORM

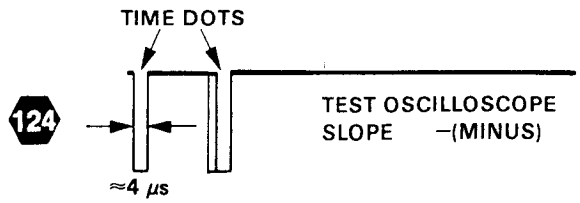
AC Waveforms

STORAGE MODE	NORM
VERT MODE	CH 1
HORIZ DISPLAY	A
TIME/DIV	5μs
VOLTS/DIV	5 mV
CH 1 INPUT	6-division, 50-kHz reference sine wave
A TRIG MODE	AUTO
A TRIGGER SOURCE	NORM
A TRIGGER LEVEL	Stable, triggered display
CURSOR FUNCTION	Both off (push buttons out)

Obtain a NORM Storage Display of the CH 1 input signal, then press in the SAVE Storage Mode push button.



SET:
CURSOR FUNCTION TIME
POSITION TIME DOTS 0.2 DIVISION APART ON CRT



STORAGE DISPLAY RAM & Z AXIS DIAGRAM 15

ASSEMBLY A16

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C145	3A	2F	TP615	6D	7B
C486	1L	5J			
C688	1B	7J	U234	2H	3E
C786	1A	8J	U238A	7G	3E
C888	1A	9J	U238B	8G	3E
			U238C	4G	3E
J486	1M	4J	U238D	5G	3E
			U245	3A	2F
P138	2A	1E	U328	5H	3D
P138	8G	1E	U334	6H	4E
			U378A	1M	5J
R145	3A	2F	U378B	1L	5J
R403A	1F	3A	U378D	1J	5J
R403B	2F	3A	U378E	1K	5J
R403C	4F	3A	U407	1G	4B
R478	1J	5I	U413	2G	4B
R479	1I	5I	U418	3G	4C
R483	1M	4J	U523	4B	5D
R484	1M	5J	U523B	5F	5D
R485	1M	5J	U528	3C	5D
R486	1M	5J	U618B	6D	6C
R487	1L	5J	U623	5C	8C
R577	1I	5I	U631A	2J	7D
R578	1J	5I	U631B	2J	7D
R583	1K	5J	U637A	3J	7E
R586	1K	5J	U637B	3J	7E
R720A	6D	8C	U643A	8F	5C
R773	2A	8G	U643B	5B	5C
R785	1A	8J	U643D	5F	5C
R787	1A	8J	U648	2L	7F
R788	1B	8J	U723	8B	8C
R874	2B	9I	U731	6J	8D
R881	1A	9J	U737	5J	8E
R886	1B	9J	U770	1D	8G
R887	1A	9J	U776	1C	8I
			U788	1A	8J
S881A	2A	9I			
S881B	2A	9I			

Partial A16 also shown on diagrams 16 and 17.

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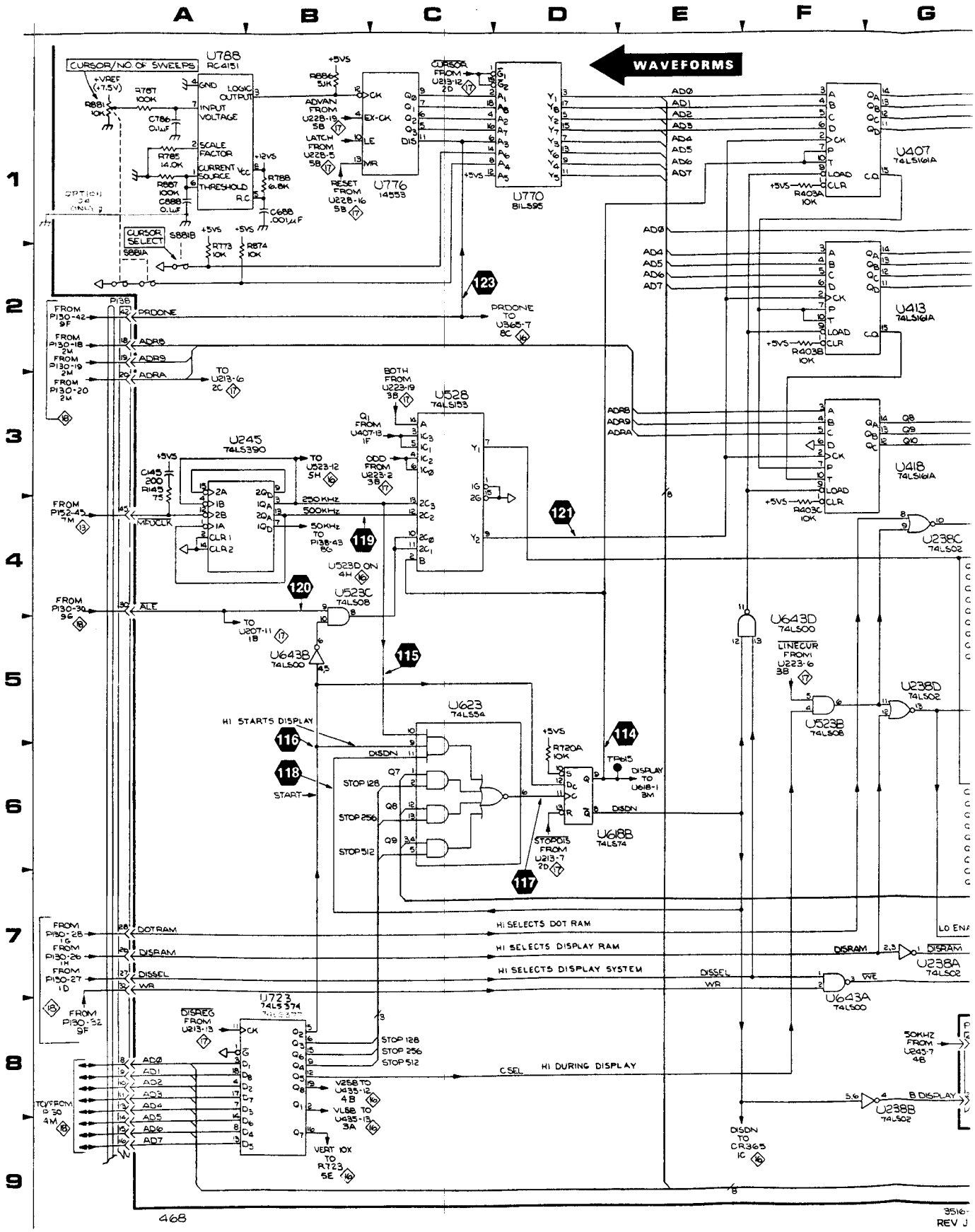
WAVEFORMS
CURSOR/NO OF SWEEPS
U788
RC4151
CURSOR SELECT
S881A
S881B
U776
14553
U770
81LS95
U407
74LS161A
U413
74LS161A
U418
74LS161A
U528
74LS153
U245
74LS390
U523C
74LS08
U643B
74LS00
U643D
74LS00
U623
74LS54
U618B
74LS74
U723
74LS574
U238A
74LS02
U238B
74LS02
U238C
74LS02
U238D
74LS02
U523B
74LS08
U643A
74LS00
HI STARTS DISPLAY
START
STOP 128
STOP 256
STOP 512
HI SELECTS DOT RAM
HI SELECTS DISPLAY RAM
HI SELECTS DISPLAY SYSTEM
HI DURING DISPLAY
50KHz
500KHz
250KHz
468
3516-
REV J

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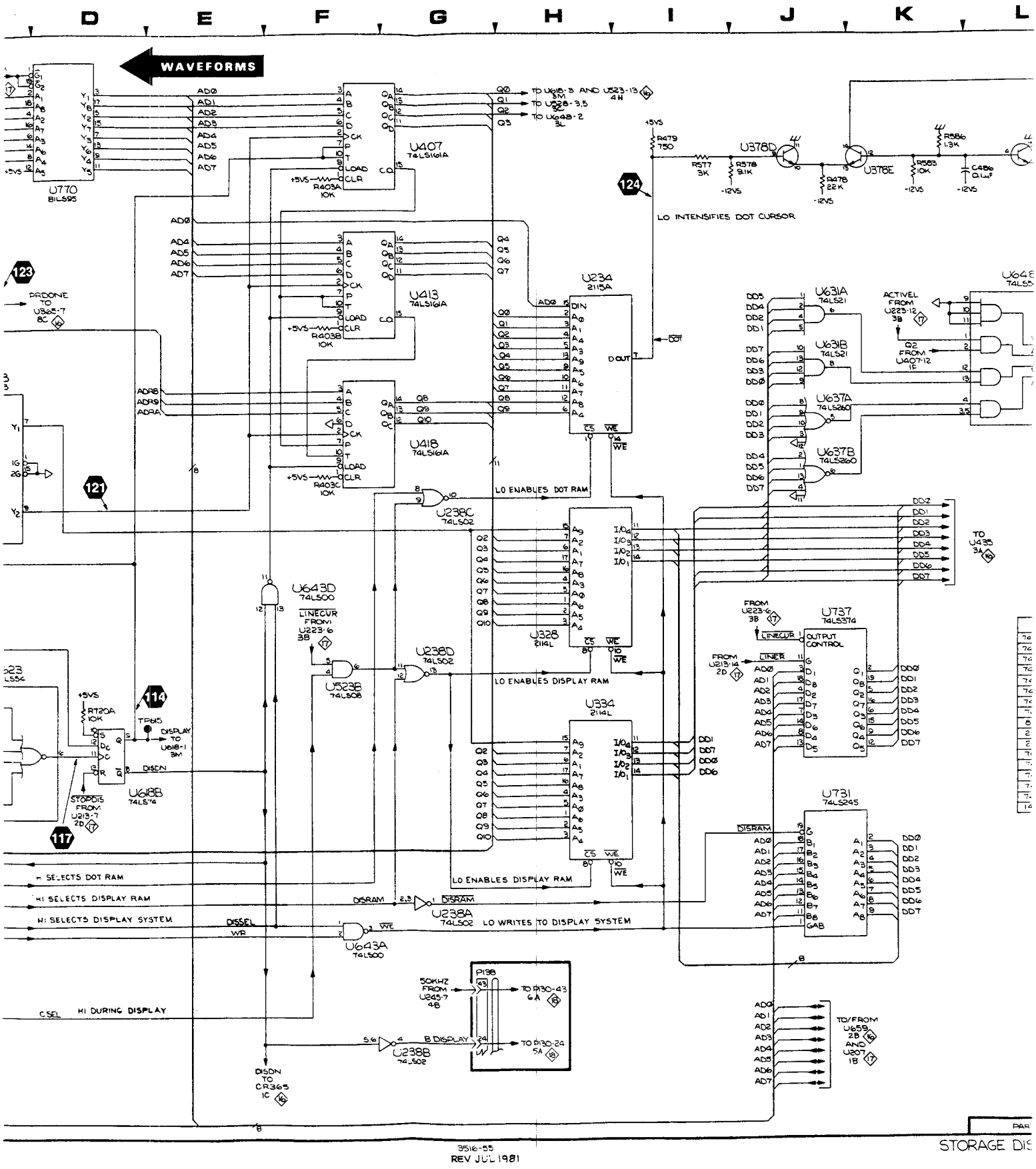

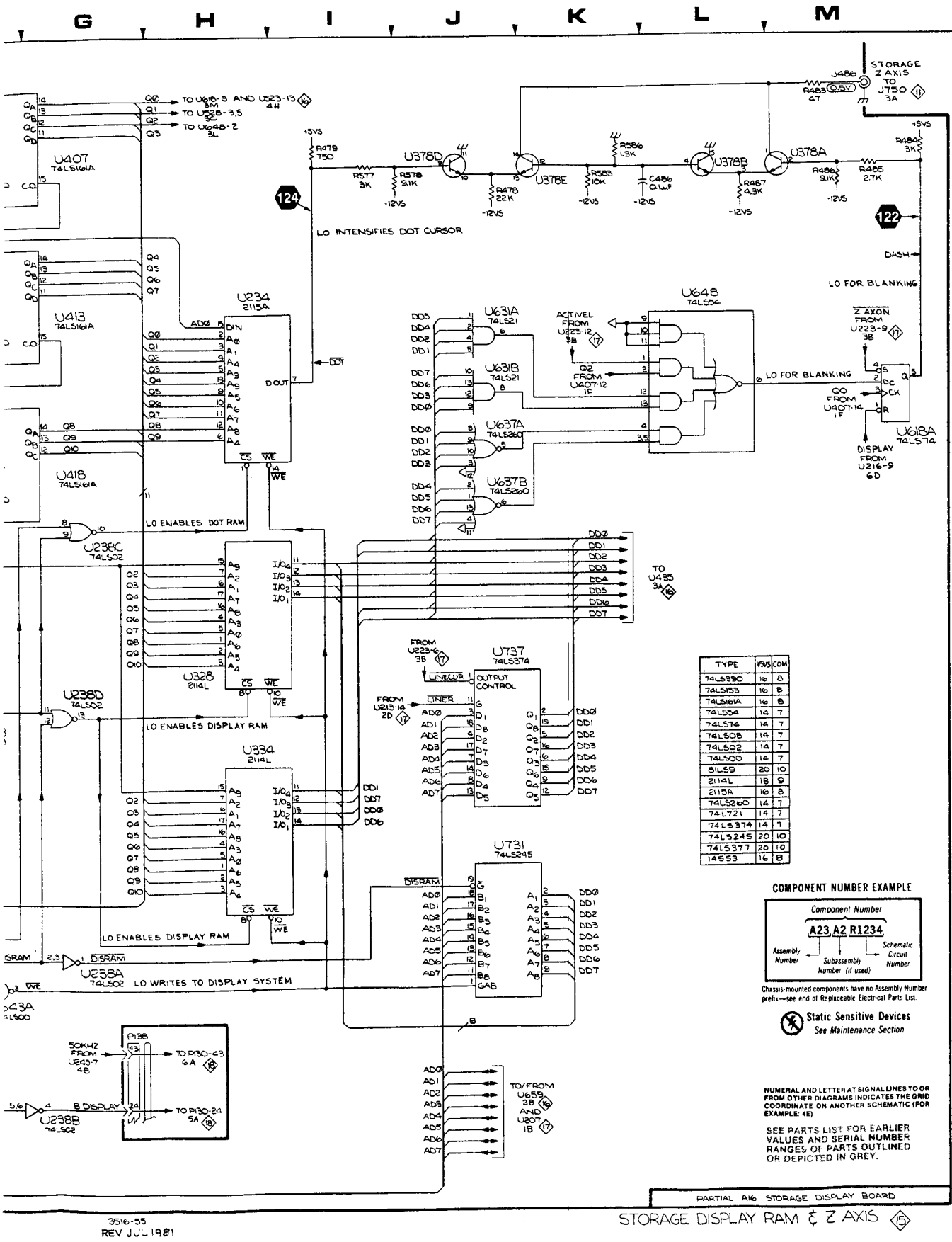

TYPE	+5V	COM
74LS390	16	8
74LS153	16	8
74LS161A	16	8
74LS55A	14	7
74LS74	14	7
74LS08	14	7
74LS02	14	7
74LS00	14	7
81LS9	20	10
2114L	18	9
2115A	16	8
74LS260	14	7
74L721	14	7
74LS374	14	7
74LS245	20	10
74LS377	20	10
14553	16	8

468 CONTROL SETTINGS FOR 16

DC Voltages

STORAGE MODE	NORM

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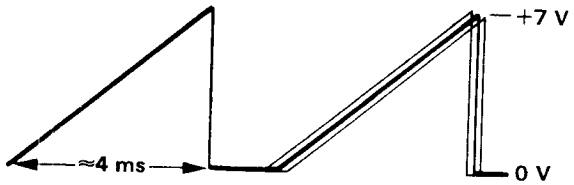
AC Waveforms

STORAGE MODE	NORM
VERT MODE	CH 1
HORIZ DISPLAY	A
TIME/DIV	5μs
VOLTS/DIV	5 mV
CH 1 INPUT	6-division, 50-kHz reference sine wave
A TRIG MODE	AUTO
A TRIGGER SOURCE	NORM
A TRIGGER LEVEL	Stable, triggered display
CURSOR FUNCTION	Both off (push buttons out)

Trigger the test oscilloscope on the waveform at TP615.

125



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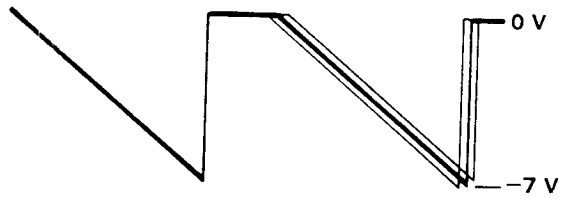
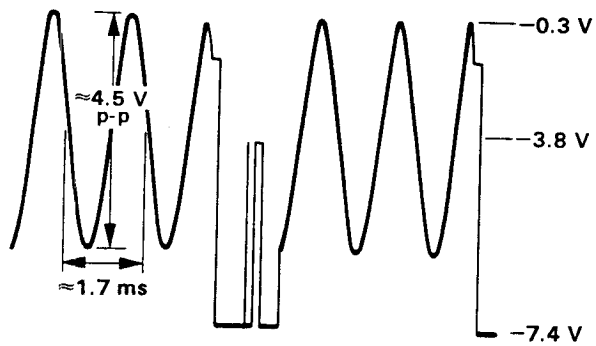


127

NOTE: THE EXACT SINE-WAVE PHASE OF THE FOLLOWING WAVEFORMS DEPENDS ON THE TRIGGERING DURING ACQUISITION OF THE DISPLAY.

128



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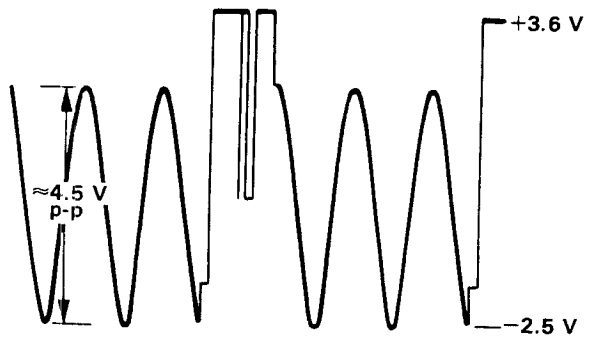

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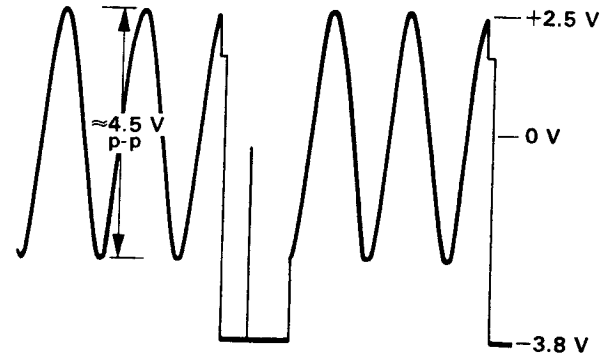

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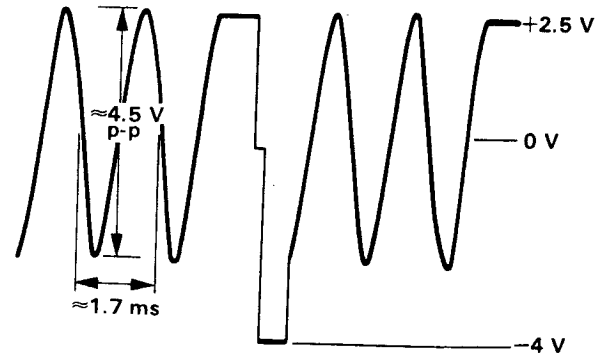

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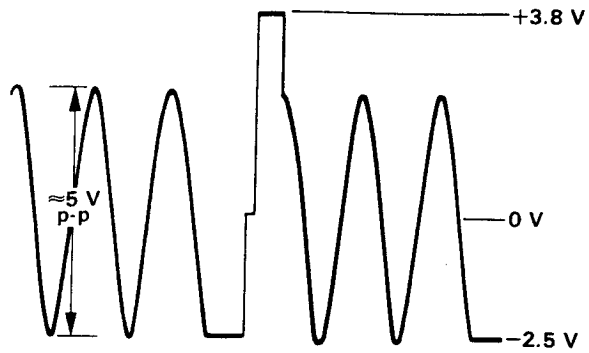

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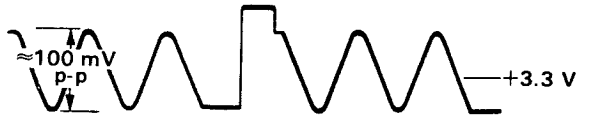

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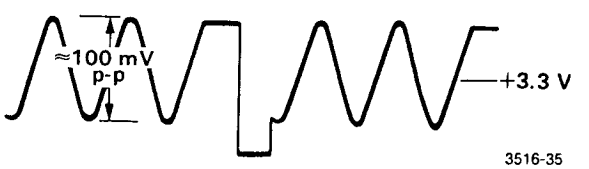

STORAGE DISPLAY X & Y AXIS DIAGRAM 16

ASSEMBLY A16

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C155	6H	1G	P262	8A	3G	R473	6A	4I
C163	8H	1H				R474	8A	4I
C182	1I	2J	Q174	7K	2H	R475	8B	5I
C266	8J	2G	Q184	7H	2J	R476	8A	5I
C268	1I	3H	Q185	7J	1I	R477	8A	5I
C269	8A	3H	Q187	6I	1J	R480	5L	5I
C279	1I	3J	Q345	2H	5F	R550	1G	6F
C282	1K	3I	Q441	1C	4E	R553	4J	5G
C285	1L	3J	Q442	1C	5E	R560	8L	8I
C321	1K	3J	Q570	5F	6H	R561	8L	8I
C348	4H	4F	Q578	4K	6I	R563	5F	6H
C349	5K	3G	Q580	4L	6I	R564	5C	6H
C378	6A	3I	Q680	6M	6J	R565	3D	6H
C437	1D	5E				R566	4G	5H
C441	1C	4E	R159	8I	1I	R567	3C	6H
C442	1I	5E	R160	8H	1I	R568	4D	5H
C444	6G	4F	R163	8G	1H	R569	3D	7H
C447	6F	4F	R164	8H	1H	R570	4C	6H
C448	3B	6E†	R168	8J	1G	R571	4J	6I
C448	3B	5F†	R169	8I	1G	R572	5L	5I
C450	3I	4G	R180	7J	2H	R579	4L	6I
C451	3I	5G	R182	6K	2I	R580	4K	6I
C452	4I	5G	R183	6K	2J	R581	4K	6I
C460	6J	4G	R186	7H	1J	R584	3L	5J
C461	3J	5G	R187	7H	1J	R585	4K	5J
C465	4H	5H	R188	6H	1J	R640	2C	6E
C466	4J	5G	R189	6I	2J	R670	4G	7H
C541	1L	6E	R251	8M	8H	R673	4K	7I
C553	4I	5G	R252	8M	8H	R674	4K	7I
C568	1L	4G	R259	8J	1I	R675	4L	7I
C569	1J	6H	R260	8K	1I	R676	8L	6I
C570	3D	6H	R264	8K	2G	R677	6L	7J
C571	3G	6H	R265	8J	2G	R678	6M	7J
C572	5F	6I	R272	7L	2I	R717	1C	7B
C670	1J	7I	R274	7L	2I	R723	5E	7D
C671	1L	7I	R282	7G	1J			
C676	4K	6I	R283	7G	1J	TP283	6F	3J
C683	1J	6J	R284	6H	1J	TP285	6E	3J
C770	8L	7I	R285	6H	1J			
C771	8L	7I	R287	8L	3G	U158A	8J	2G
			R335	1B	3E	U158B	8J	2G
CR173	7I	2H	R336	1B	3E	U158C	8J	2G
CR174	7J	2H	R344	2G	5F	U158D	8H	2G
CR267	9E	3H	R345	3J	3F	U158E	8I	2G
CR285	7E	3J	R346	1G	4F	U352	4H	4G
CR336	1B	3E	R347	2G	5F	U359	7D	3G
CR443	3B	5F	R348	3J	3F	U365	7C	3H
CR553	1F	5G	R349	5K	3G	U373A	7B	4I
CR566	2B	6F	R350	1G	5F	U373B	6B	4I
CR584	4L	6J	R351	1G	5F	U374A	8A	3I
CR585	4M	6J	R352	4C	5H	U374B	9B	3I
CR586	4L	6J	R353	5C	5I	U374C	6A	3I
CR587	3L	6J	R385	6B	4J	U374D	7B	3I
CR635	1C	6E	R386	6C	4J	U377	5C	4I
CR666	3F	7H	R437	1C	5E	U378C	5L	5J
CR667	4F	7H	R438	1D	5E	U385	5D	3J
CR670	4F	7H	R439	2C	5E	U435	4B	5E
CR684	4M	6J	R440	1C	4E	U444	1D	5F
CR685	4M	6J	R441	1C	4E	U466A	5C	5H
CR686	3M	7J	R443	6F	4F	U466B	4C	5H
CR687	4M	7J	R448	6F	4F	U466C	4H	5H
			R450	8M	8I	U523D	4H	5D
J158	8G	2H	R451	3I	4G	U545	3C	6F
J172	7M	2I	R452	3I	4G	U553A	2C	6G
J262	9G	2G	R453	3I	5G	U553B	1F	6G
J449	1M	5F	R454	4I	5G	U558	4J	5G
J583	3M	6J	R455	4I	5G	U559A	8M	7I
J586	3M	6J	R456	4I	5G	U559B	8L	7I
J683	3M	7J	R460	8B	4G	U571A	4F	6G
J686	4M	7J	R461	8B	4G	U571B	3D	6G
			R462	6J	4G	U653	2F	7G
L155	5H	1G	R463	6J	5G	U659	2B	6F
			R464	3J	5G	U766	5F	7G
P138	6E	1E	R465	3J	5G	U783	8K	7J
P138	6F	1E	R470	6B	4I	VR664	3G	7H
P262	6A	3G	R471	6A	4I	VR665	3G	7H
			R472	6A	4I	W250	8M	3G

Partial A16 also shown on diagrams 15 and 17.

†Alternate location

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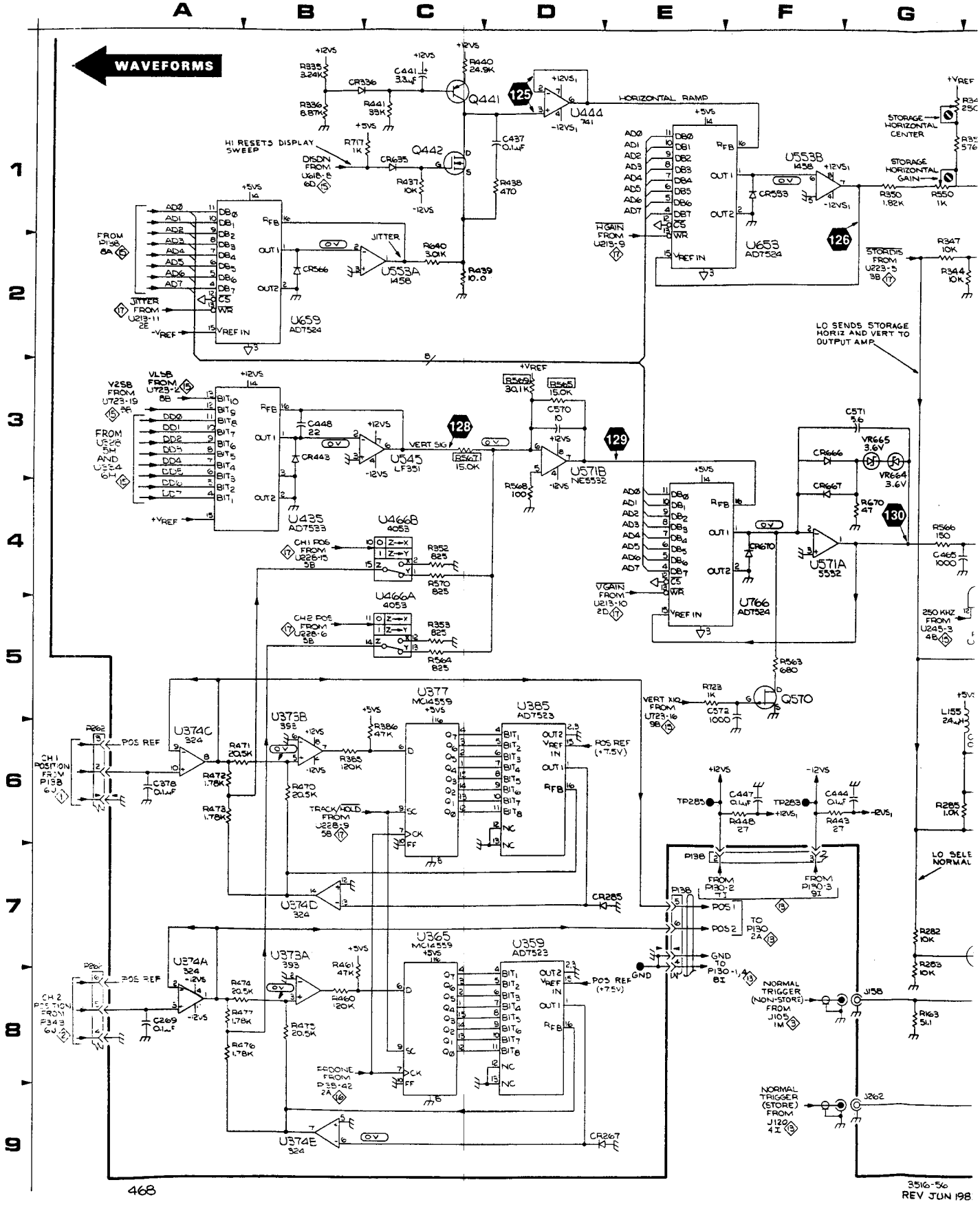
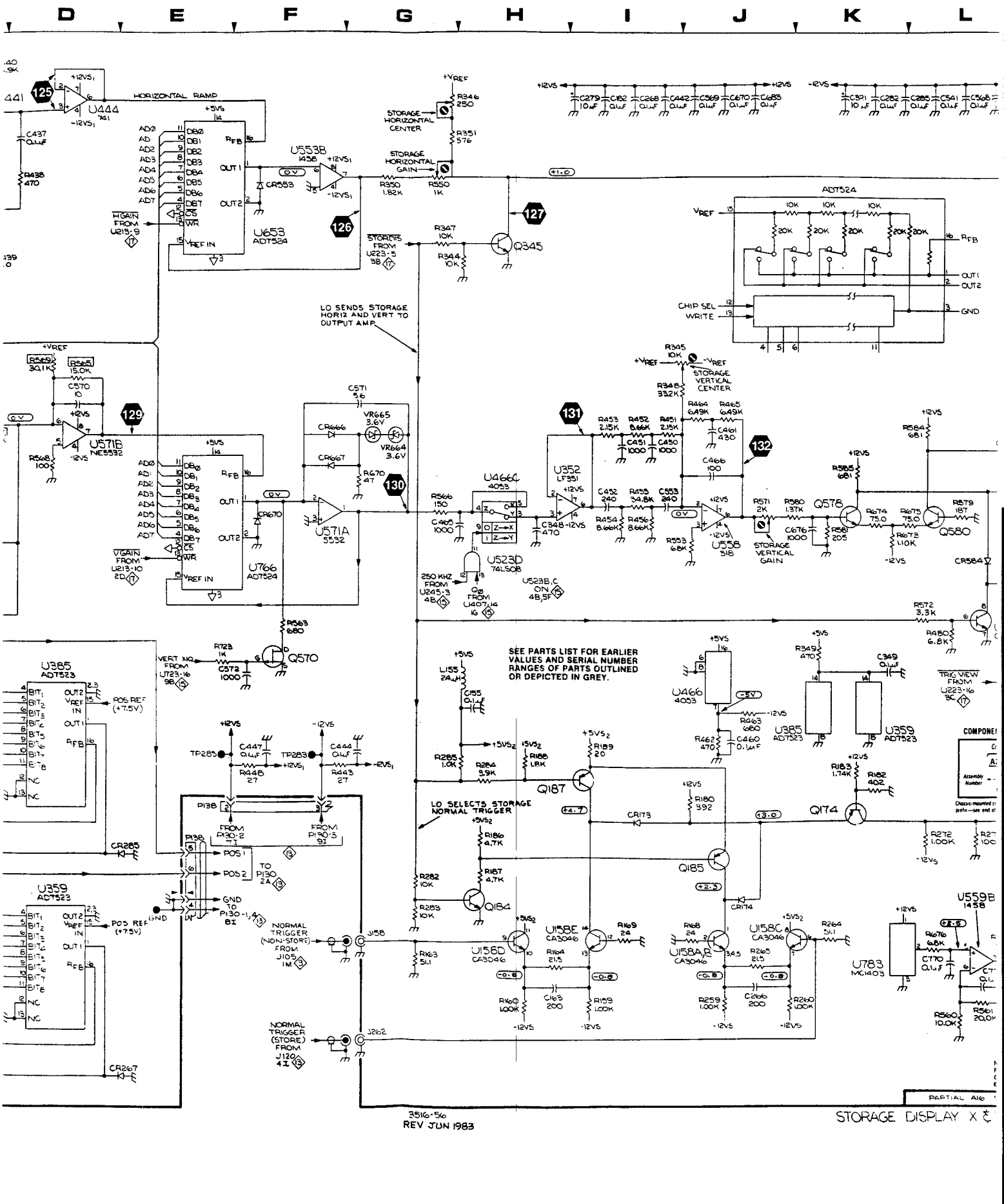
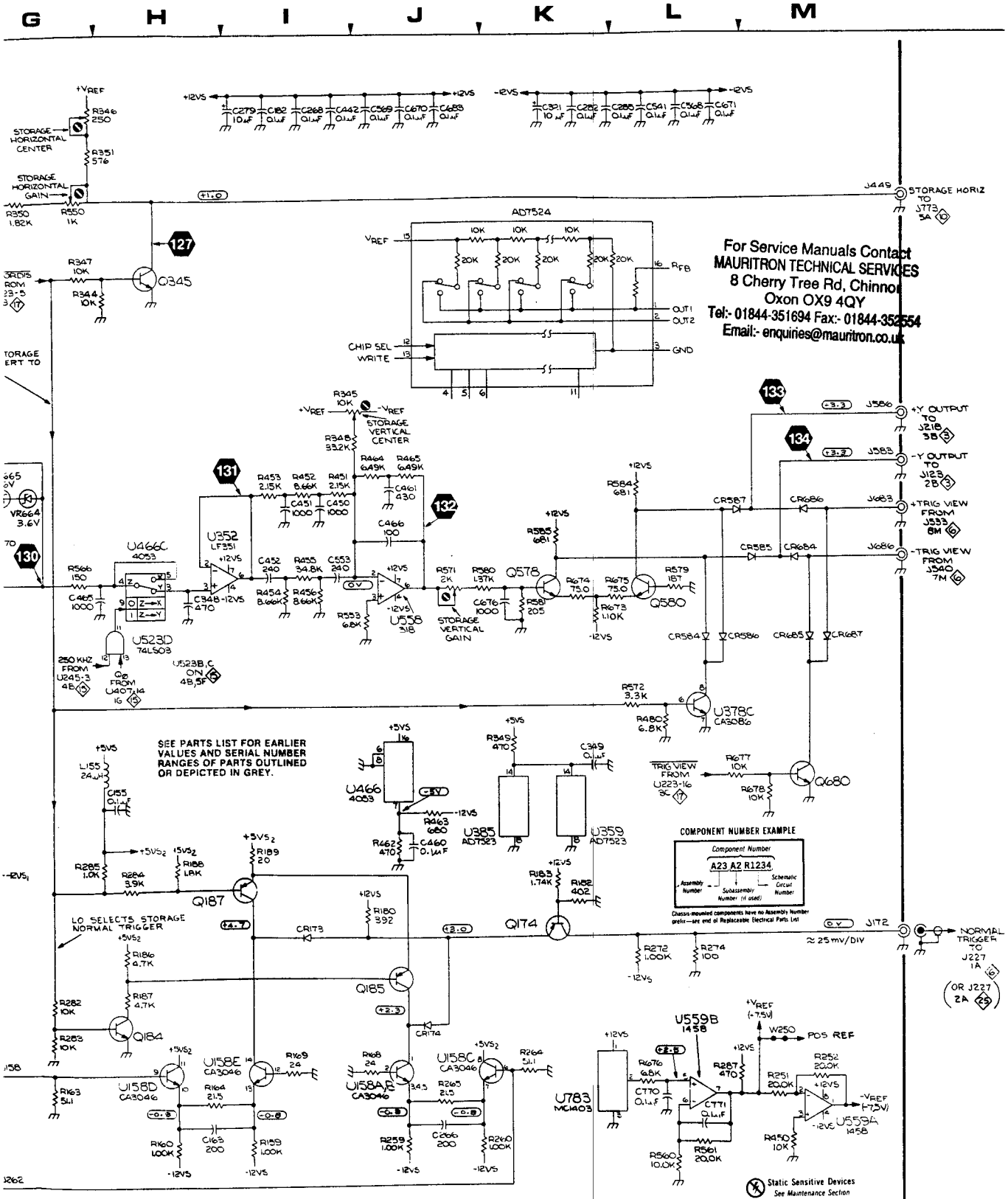



D E F G H I J K L
HORIZONTAL RAMP
U444
741
U553B
1458
U653
AD7524
STORAGE HORIZONTAL CENTER
STORAGE HORIZONTAL GAIN
HGAIN FROM U213-9
STORDIS FROM U223-5
Q345
LO SENDS STORAGE HORIZ AND VERT TO OUTPUT AMP
CHIP SEL
WRITE
STORAGE VERTICAL CENTER
U571B
NE5532
U571A
5532
U766
AD7524
VGAIN FROM U213-10
VR665 3.6V
VR664 3.6V
U466
4053
U352
LF351
U523D
74LS08
250 KHZ FROM U245-3
U558
318
STORAGE VERTICAL GAIN
Q578
Q580
Q570
VERT XIQ FROM U723-16
U385
AD7523
U359
AD7523
POS REF (+7.5V)
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.
TRIG VIEW FROM U223-16
LO SELECTS STORAGE NORMAL TRIGGER
Q187
Q174
Q185
Q184
U158D
CA3046
U158E
CA3046
U158A,B
CA3046
U158C
CA3046
U559B
1458
U783
MC1403
NORMAL TRIGGER (NON-STORE) FROM J105
NORMAL TRIGGER (STORE) FROM J120
J158
J262
TO P130 2A
FROM P130-2
FROM P130-3
GND TO P130-1,4
PARTIAL A16
STORAGE DISPLAY X &
3516-56
REV JUN 1983


G H I J K L M
+VREF
R346 250
STORAGE HORIZONTAL CENTER
R351 576
STORAGE HORIZONTAL GAIN
R350 1.82K
R550 1K
+12VS
-12VS
C279 10uF
C282 0.1uF
C268 0.1uF
C442 0.1uF
C569 0.1uF
C670 0.1uF
C688 0.1uF
C321 10uF
C282 0.1uF
C285 0.1uF
C541 0.1uF
C568 0.1uF
C671 0.1uF
J449
STORAGE HORIZ TO J773 5A
AD7524
VREF
RFB
OUT1
OUT2
GND
CHIP SEL
WRITE
R347 10K
R344 10K
Q345
127
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R345 10K
STORAGE VERTICAL CENTER
R348 33.2K
131
132
130
134
J586 +Y OUTPUT TO J218 3B
J583 -Y OUTPUT TO J123 2B
J683 +TRIG VIEW FROM J533 8M
J686 -TRIG VIEW FROM J540 7M
CR587
CR686
CR585
CR684
CR584
CR586
CR685
CR687
R584 681
R585 681
R579 187
R580 1.37K
R581 205
R571 2K
R572 3.3K
R480 6.8K
R673 110K
R674 75.0
R675 75.0
R676 6.8K
R677 10K
R678 10K
Q578
Q580
Q680
U378C CA3086
U352 LF351
U466C 4053
U523D 74LS08
U558 318
STORAGE VERTICAL GAIN
250 KHZ FROM U245:3 4B
Q6 FROM U407:14 1G
U523B,C ON 4B,5F
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.
L155 24uH
C155 0.1uF
R285 1.0K
R284 3.9K
R189 20
R188 1.8K
Q187
LO SELECTS STORAGE NORMAL TRIGGER
R186 4.7K
R187 4.7K
R282 10K
R283 10K
Q184
CR173
R180 392
Q185
CR174
Q174
R183 1.74K
R182 402
R272 1.00K
R274 100
J172
≈ 25mV/DIV
NORMAL TRIGGER TO J227 1A
(OR J227 2A)
U466 4053
R463 680
R462 470
C460 0.1uF
U385 AD7523
U359 AD7523
R345 470
C349 0.1uF
TRIG VIEW FROM U223-16 3C
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
U158D CA3046
U158E CA3046
U158C CA3046
U158A,B CA3046
R164 21.5
R263 21.5
R163 5.1
R264 5.1
R169 24
R168 24
R160 1.00K
R159 1.00K
R259 1.00K
R260 1.00K
C163 200
C266 200
U783 MC1403
U559B 1458
U559A 1458
W250 POS REF
R287 470
R252 20.0K
R251 20.0K
R450 10K
R560 10.0K
R561 20.0K
CT70 0.1uF
CT71 0.1uF
+VREF (+7.5V)
-VREF (-7.5V)
Static Sensitive Devices
See Maintenance Section
NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATE ON ANOTHER SCHEMATIC (FOR EXAMPLE: 4E)
PARTIAL A16 STORAGE DISPLAY BOARD
STORAGE DISPLAY X & Y AXIS 16
3516-5c
REV JUN 1983
STORAGE DISPLAY X AND Y AXIS
16

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STORAGE DISPLAY CONTROL & LED READOUT DIAGRAM 17

ASSEMBLY A16

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C151	9F	2F	R720D	7H	8C
C248	9F	2F	R720E	7H	8C
C407	9G	3B	R720F	7H	8C
C418	9G	4C	R720G	7H	8C
C653	9G	7E	R720H	7H	8C
C717	9G	7B	R720I	7H	8C
C768	9H	7G	R740A	4H	8E
			R740B	4H	8E
J860	1H	9G	R740C	4H	8E
J860	3M	9G	R740E	4H	8E
			R753	1G	8G
P138	2A	1E	R754	1F	8G
P140	7M	1D	R839	3K	9E
P204	4D	2A	R840	3J	9E
P318	5D	3C			
P404	3D	3A	S512	5J	5B
P404	8D	3A	S612	5J	6B
P710	6M	8B	S707	6D	1B
Q850	3K	8G	S813A	6I	9B
			S813B	6I	9B
R330	5D	3C	S813C	6J	9B
R332	5D	3C	S813D	6J	9B
R660	3K	8G	S813E	6J	9B
R661	1H	8H	S813F	6K	9B
R662	1H	8H	S831A	8L	9E
R663	1H	8H	S831B	8L	9E
R664	1H	8H	S844A	5J	9F
R665	1H	8H	S844B	5J	9F
R666	1H	8H			
R667	1H	7J	TP248	8A	2F
R668	5L	8H			
R669	6L	8H	U207	1B	2B
R709A	6C	1B	U213	2D	3B
R709B	6C	1B	U218	1D	3C
R709C	6C	1B	U223	3B	3C
R709D	6C	1B	U228	6B	3D
R709E	6C	1B	U713	6B	1C
R709F	6C	1B	U717	7G	8C
R709G	6C	1B	U743	4G	8F
R709H	6C	1B	U748	3G	8F
R720B	7H	8C	U753	2H	8G
R720C	7H	8C	U759	2G	8H

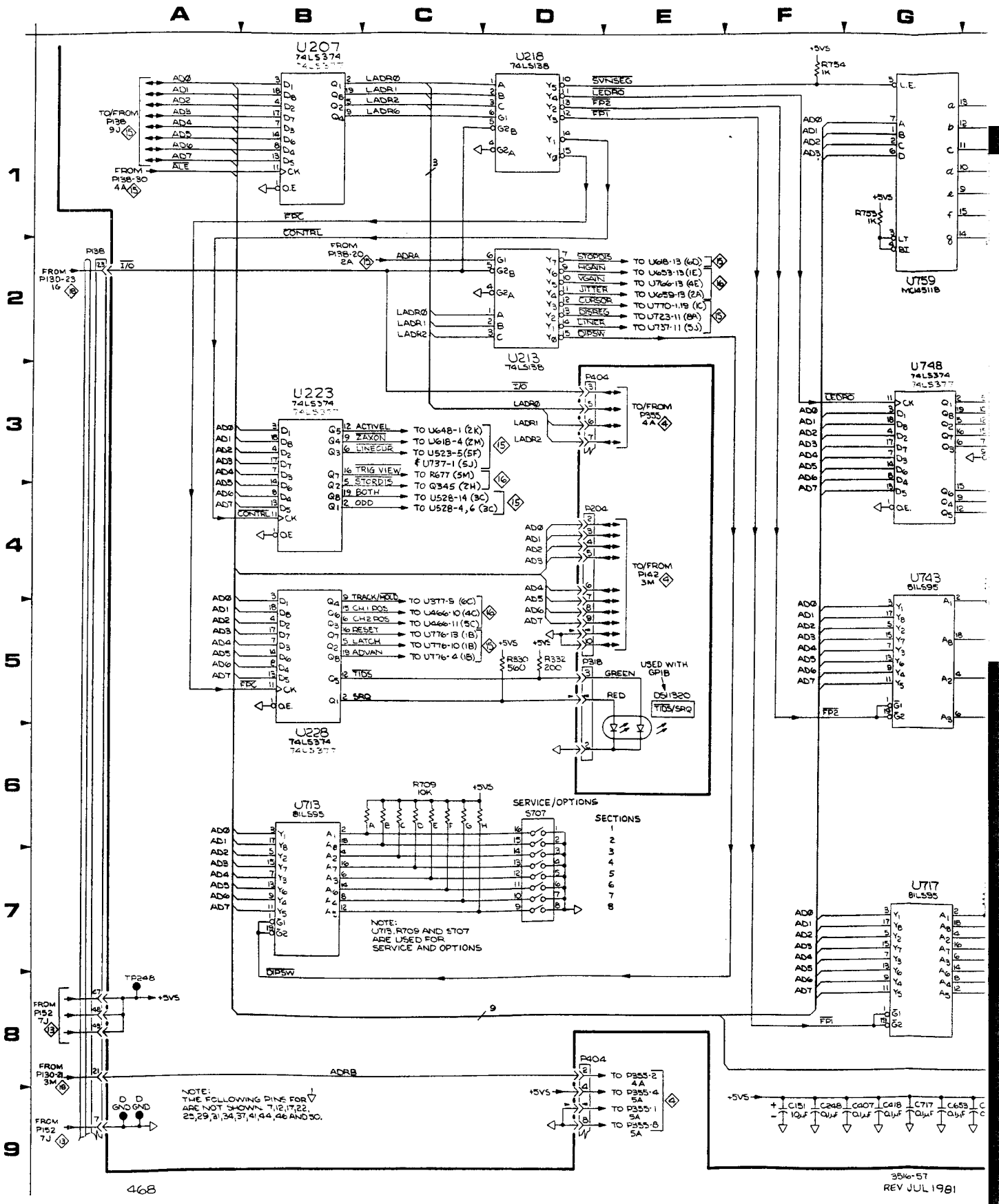
Partial A16 also shown on diagrams 15 and 16.

ASSEMBLY A20

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
DS120	4M	1C	U106	1I	1B
DS122	4M	1C	U110	1I	1B
DS124	5M	1C	U112	1J	1B
			U114	1K	1B
P120	4M	2B			

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
DS11320	5E	CHASSIS			


A B C D E F G
1 2 3 4 5 6 7 8 9
U207
74LS374
U218
74LS138
U213
74LS138
U223
74LS374
U228
74LS374
U713
8IL595
U748
74LS374
U743
8IL595
U717
8IL595
U759
MC14511B
P136
P404
P204
P318
P202
P152
P130-21
P130-23
P130-20
P138-30
P138
R754 1K
R753 1K
R709 10K
R330 560
R332 200
S707
SERVICE/OPTIONS
SECTIONS
GREEN
RED
USED WITH GPIB
DS1820
TP248
+5V5
ADØ
AD1
AD2
AD3
AD4
AD5
AD6
AD7
ADRA
ADRB
LADRØ
LADR1
LADR2
FBC
CONTRL
I/O
FP0
FP1
FP2
FBT
LEDRØ
SVNSEG
NOTE:
U713, R709 AND S707 ARE USED FOR SERVICE AND OPTIONS
NOTE:
THE FOLLOWING PINS FOR 1 ARE NOT SHOWN. 7,12,17,22, 25,29,31,34,37,41,44,46 AND 50.
468
3516-57
REV JUL 1981

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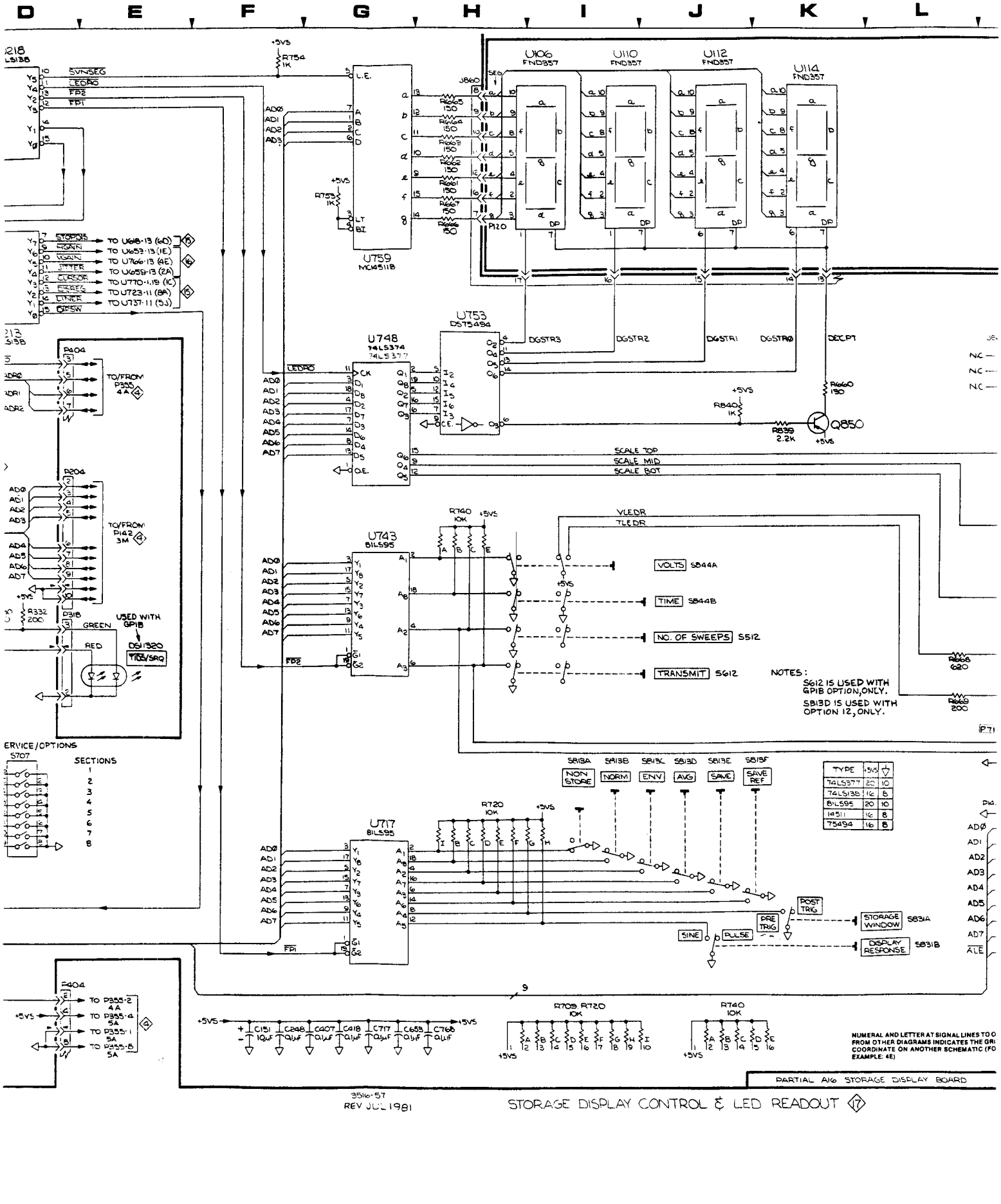

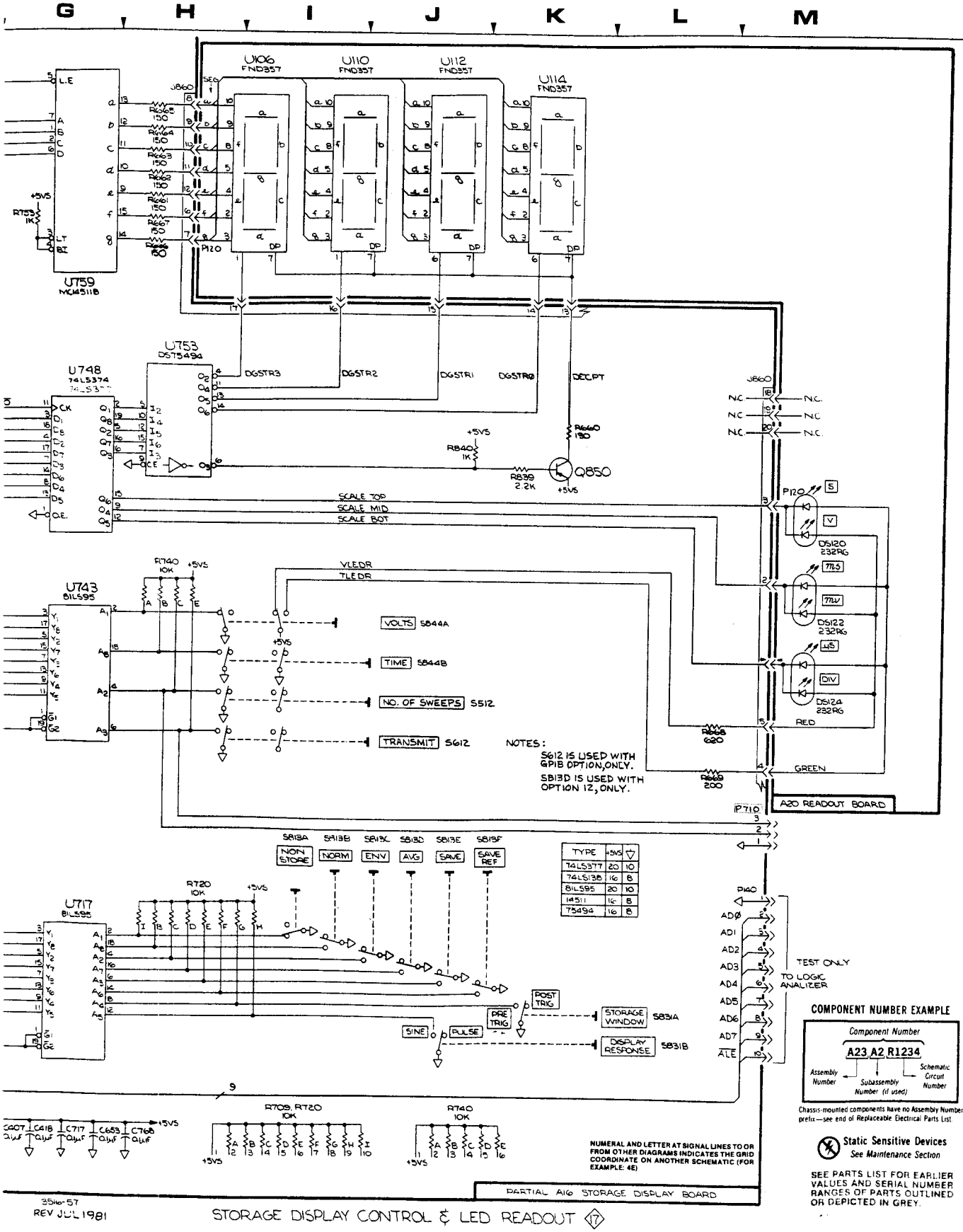

35116-57
REV JUL 1981

STORAGE DISPLAY CONTROL & LED READOUT 17

468 CONTROL SETTINGS FOR ◇18◇

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DC Voltages

STORAGE MODE	NORM

AC Waveforms

SET UP IN SERVICE MODE (see "Service Test" information in the Maintenance Section of Volume I of this manual). Do not install the Service Test ROM.

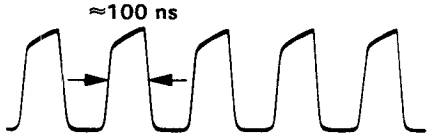
Waveform's p-p amplitude is from ≈0 V to ≈4 V (TTL levels).

SET UP THE KERNAL TEST:

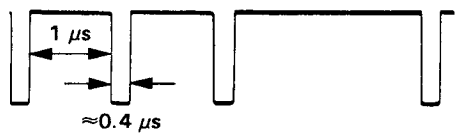
1. With POWER switch OFF, remove U452 and U558 (located on the Microprocessor Circuit Board). Pull the IC evenly on both ends to avoid bending the pins, and observe the "Static Sensitive" precautions. (located in the Maintenance Section of Volume I of this manual).
2. Set POWER switch on.
3. Move P182 (Power-on Restart) momentarily to the RESET position, then return it to the RUN position.

AFTER VERIFYING WAVEFORMS, SECURE POWER AND REPLACE U452 and U558.

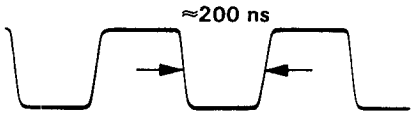
135 136 ≈100 ns



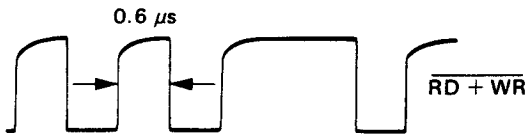
141 1 μs ≈0.4 μs



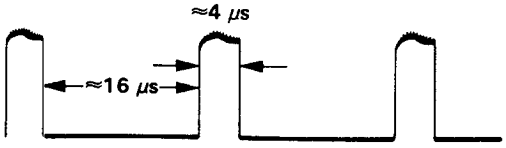
137 ≈200 ns



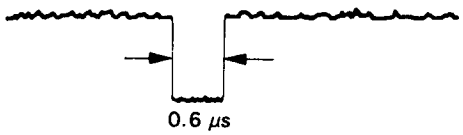
142 0.6 μs $\overline{RD} + \overline{WR}$



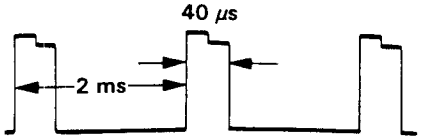
138 ≈4 μs ≈16 μs



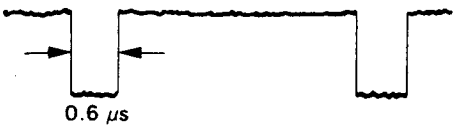
143 $\overline{RD}$ 0.6 μs



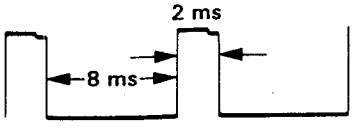
139 40 μs 2 ms



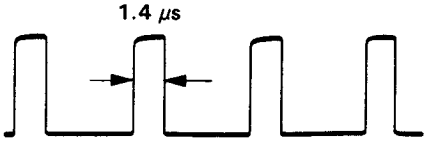
144 $\overline{WR}$ 0.6 μs



140 2 ms 8 ms



145 1.4 μs



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MICROPROCESSOR DIAGRAM 18

ASSEMBLY A21

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C161	8L	1H	TP358	6D	3G
C165	8L	1G	TP477	7G	5I
C174	3C	1I	TP580	1F	4I
C262	8K	2H			
C346	8M	3F	U246A	7M	3F
C352	8K	3G	U246B	7L	3F
C371	8M	3I	U246C	1E	3F
C372	8M	3I	U255A	6G	3G
C378	8M	4I	U255B	8C	3G
C440	8L	4F	U272A	3F	3H
C525	8K	6C	U272A	5B	3H
C540	8L	6D	U272B	1E	3H
C550	8M	6F	U272C	7F	3H
C558	8K	6G	U272D	4B	3H
C578	8L	5I	U272E	7F	3H
			U272F	1G	3H
CR172	3C	1I	U272G	8F	3H
			U272H	6F	3H
P130	1D	1E	U278A	1E	2I
P130	2M	1E	U278B	7F	2I
P130	3M	1E	U278C	1H	2I
P130	4A	1E	U278D	1G	2I
P130	9F	1E	U364	1D	3H
P182	3B	1I	U378	1H	3I
P262	3B	2G	U440	6A	4F
			U446	7B	4F
R172	3B	1I	U452	3F	4G
R173	3C	1I	U472B	2F	4I
R253	6G	2G	U472C	2F	4I
R262	3C	2G	U472D	2F	4I
R263	4C	2H	U472E	2F	4I
R266	6C	2H†	U472F	5B	4I
R368	1C	3H	U472G	8F	4I
R378	1E	4I	U472H	6F	4I
R450A	3E	4F	U478	1F	4I
R450B	3E	4F	U525	6J	6C
R450C	3E	4F	U530	6I	6D
R450D	3E	4F	U540	9J	6E
R450E	3E	4F	U545	8H	6E
R450F	3E	4F	U550	4E	6F
R450G	3E	4F	U558	6M	6G
R450H	3E	4F	U565	1K	6H
TP270	6G	2H	U575	1L	6I

Partial A21 also shown on diagram 13.

†Located on back of board.

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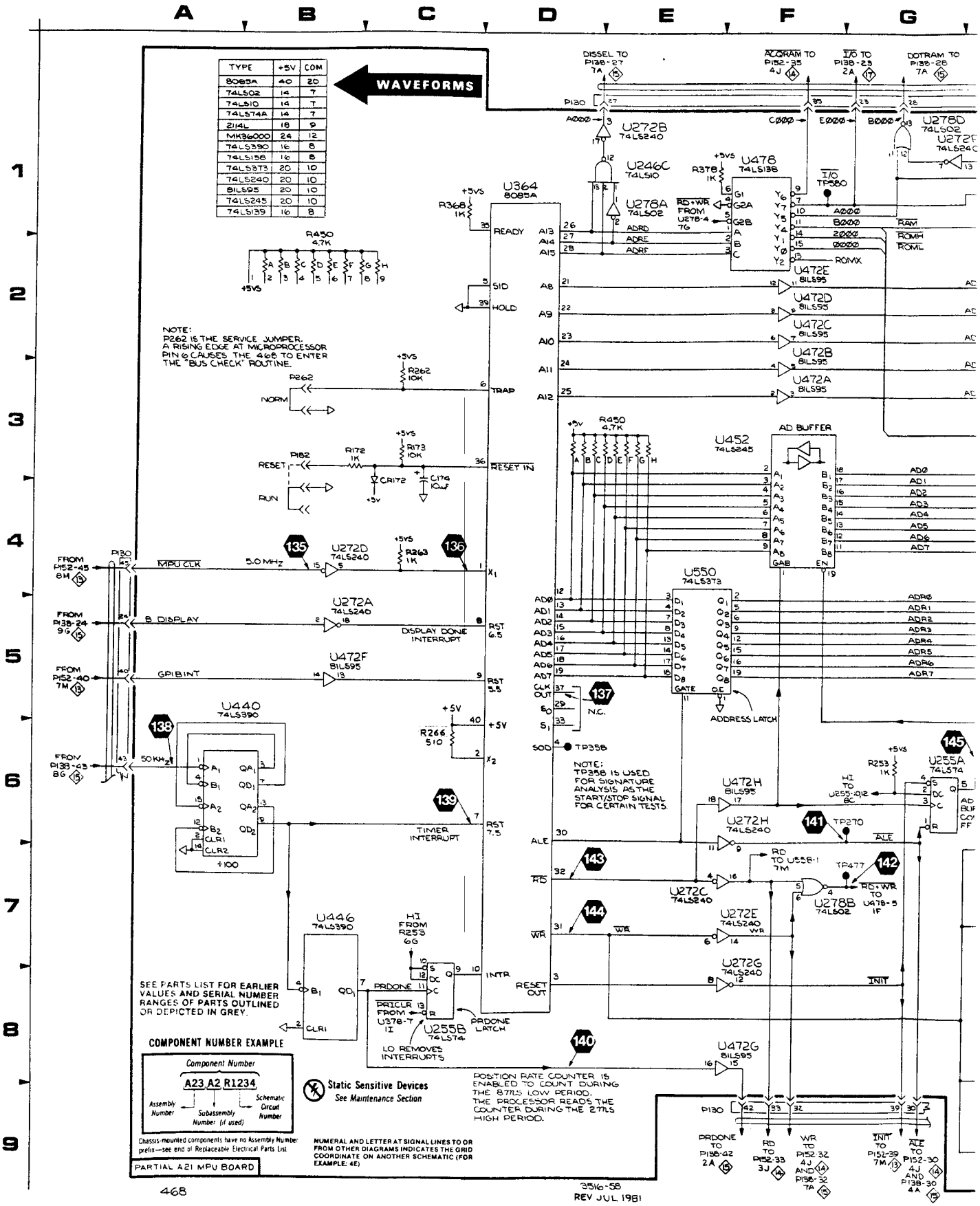
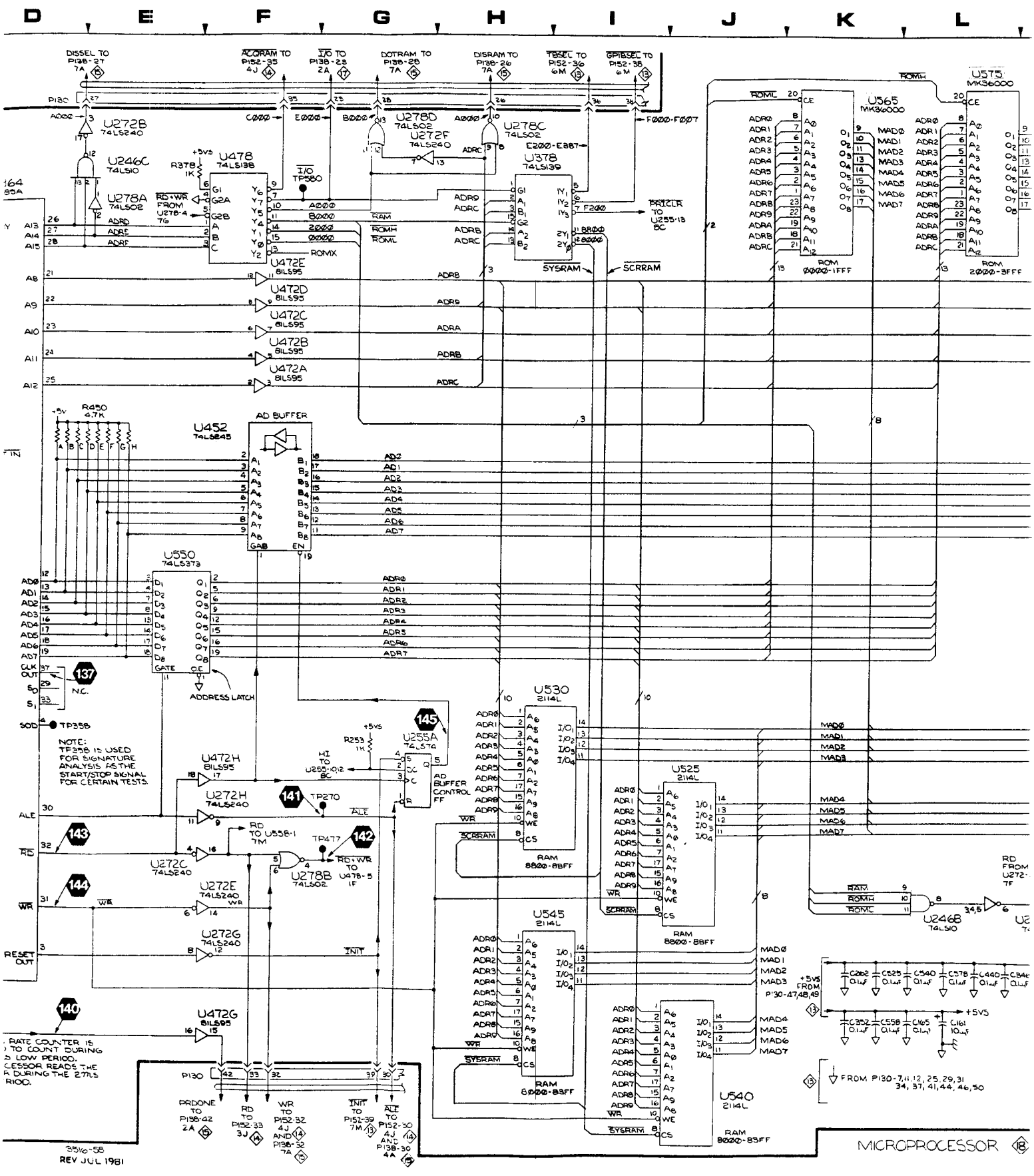


TYPE	+5V	COM
8085A	40	20
74LS02	14	7
74LS10	14	7
74LS74A	14	7
2114L	18	9
MK36000	24	12
74LS390	16	8
74LS138	16	8
74LS373	20	10
74LS240	20	10
8LS95	20	10
74LS245	20	10
74LS139	16	8

3516-58
REV JUL 1981


D E F G H I J K L
U272B 74LS240
U246C 74LS10
U278A 74LS02
U478 74LS138
U278D 74LS02
U272F 74LS240
U278C 74LS02
U378 74LS139
U472E 8ILS95
U472D 8ILS95
U472C 8ILS95
U472B 8ILS95
U472A 8ILS95
U452 74LS245
AD BUFFER
U550 74LS373
U530 2114L
U525 2114L
U545 2114L
U540 2114L
U565 MK36000
U575 MK36000
U255A 74LS74
U272H 74LS240
U272C 74LS240
U272E 74LS240
U272G 74LS240
U278B 74LS02
U472H 8ILS95
U472G 8ILS95
U246B 74LS10
ROM 0000-1FFF
ROM 2000-3FFF
RAM 8800-88FF
RAM 8000-83FF
ADDRESS LATCH
AD BUFFER CONTROL FF
NOTE: TP358 IS USED FOR SIGNATURE ANALYSIS AS THE START/STOP SIGNAL FOR CERTAIN TESTS.
N.C.
RATE COUNTER IS TO COUNT DURING LOW PERIOD. CESSOR READS THE R DURING THE 2.7 µs RIOD.
PRDONE TO P138-42 2A
RD TO P152-33 3J
WR TO P152-32 4J AND P138-32 7A
INIT TO P152-39 7M
ALE TO P152-30 4J AND P138-30 4A
FROM P130-7,11,12,25,29,31 34,37,41,44,46,50
3516-58 REV JUL 1981
MICROPROCESSOR

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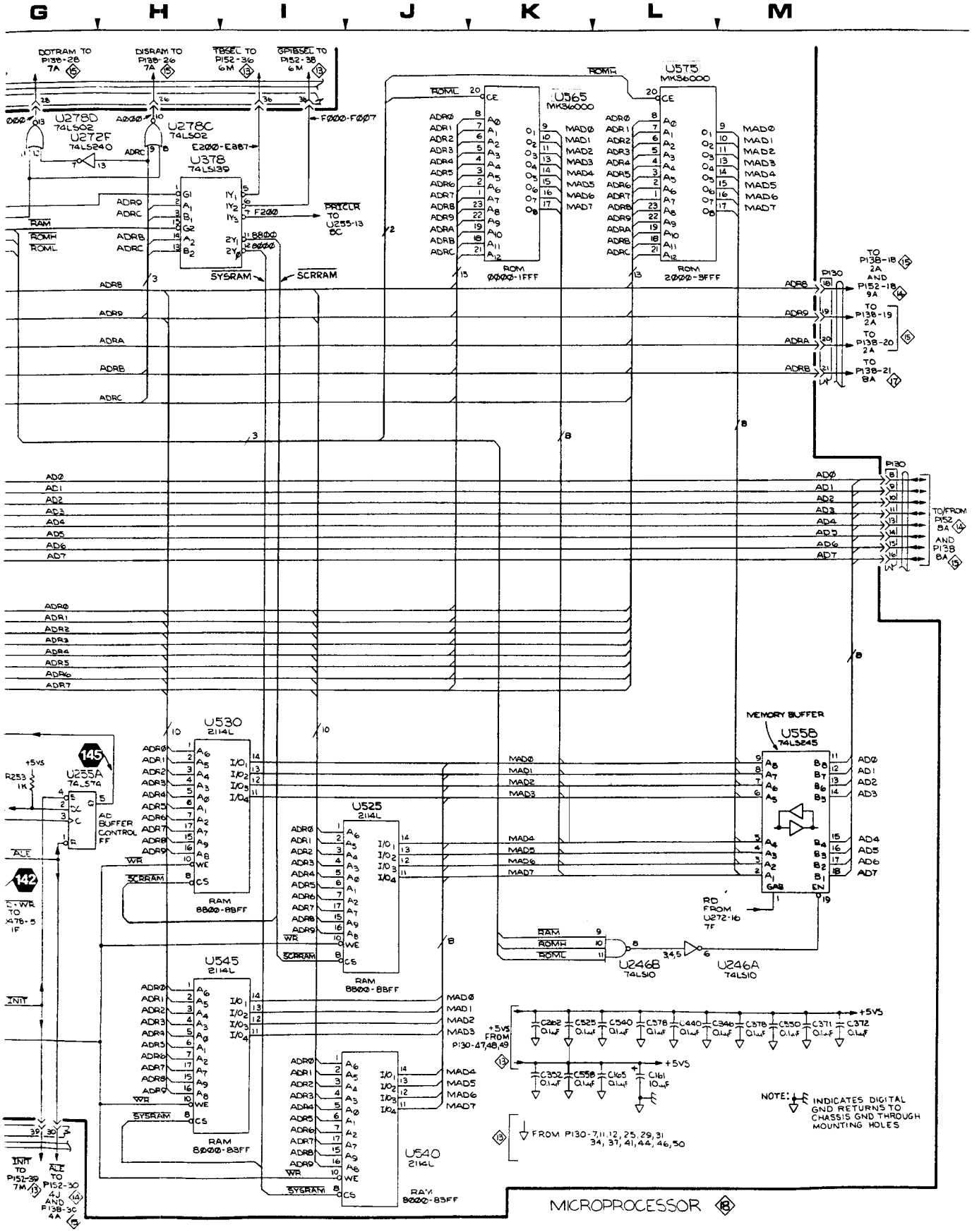

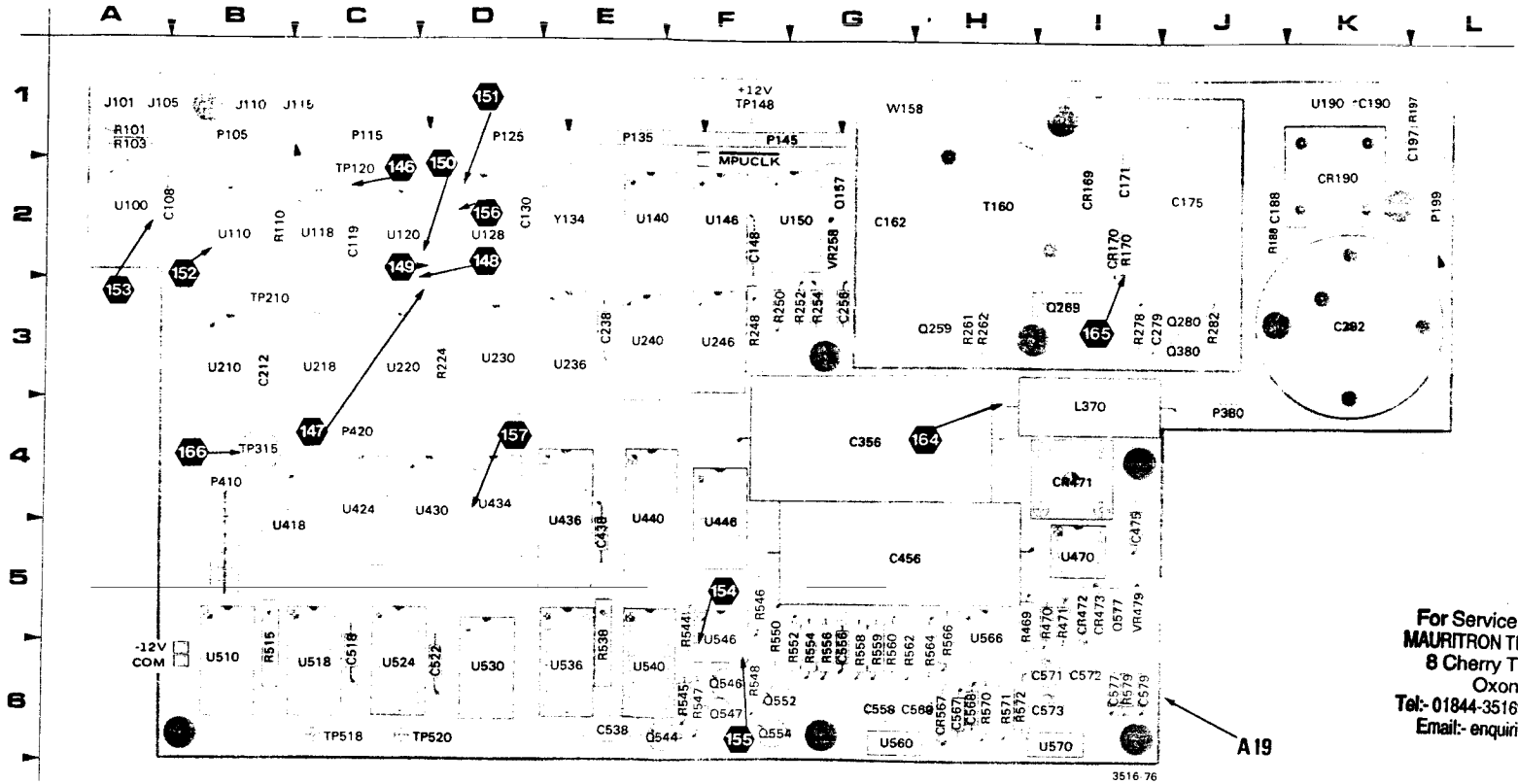

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Figure 8-23. A19 Time Base/Power Supply and A22 Line Selector board.

A19 TIME BASE/POWER SUPPLY BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 19

C108	P115	R224B	R544	U110B	U424
C119	P125	R224D	R545	U118	U430
C130	P125	R224E	R546	U120	U434A
C148	P125	R224F	R547	U128A	U434B
C212	P125	R224G	R548	U128B	U434E
C238	P125	R224H	R550	U140	U434F
C438	P135	R224I	R552	U146	U436
C518	P135	R248A	R554	U150A	U440
C522	P145	R248B	R556	U150B	U446
C538	P420	R248C	R558	U210	U510
C556		R248D	R559	U218A	U518
	Q544	R248E	R560	U218B	U524
J101	Q546	R250	R562	U218C	U530A
J105	Q547	R252		U218D	U530B
J110	Q552	R515A	TP120	U220A	U530C
J115	Q554	R515B	TP210	U220B	U536
		R515D		U230A	U540
P105	R101	R515E	U100A	U230B	U546
P105	R103	R538A	U100B	U236	
P115	R110A	R538B	U100C	U240	Y134
P115	R110B	R538C	U100D	U246	
P115	R224A	R538D	U110A	U418	

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 21

C162	C560	CR472	Q259	R469	TP518
C171	C567	CR473	Q269	R470	TP520
C175	C568	CR567	Q280	R471	
C188	C571		Q380	R564	U190
C190	C572	L370	Q577	R566	U470
C197	C573			R570	U560
C256	C577	P105	R170	R571	U566A
C279	C579	P105	R188	R572	U566B
C292		P145	R197	R579	U570
C356	CR169	P199	R254		
C456	CR170	P380	R261	T160	VR258
C475	CR190		R262		VR479
C558	CR471	Q157	R278	TP148	
			R282	TP315	W158

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 23

P135	P145	P410			

A22 LINE SELECTOR BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 20

J108 J110	J204 J206	J212 J214	J222 J224	J230	S108 S216	S226

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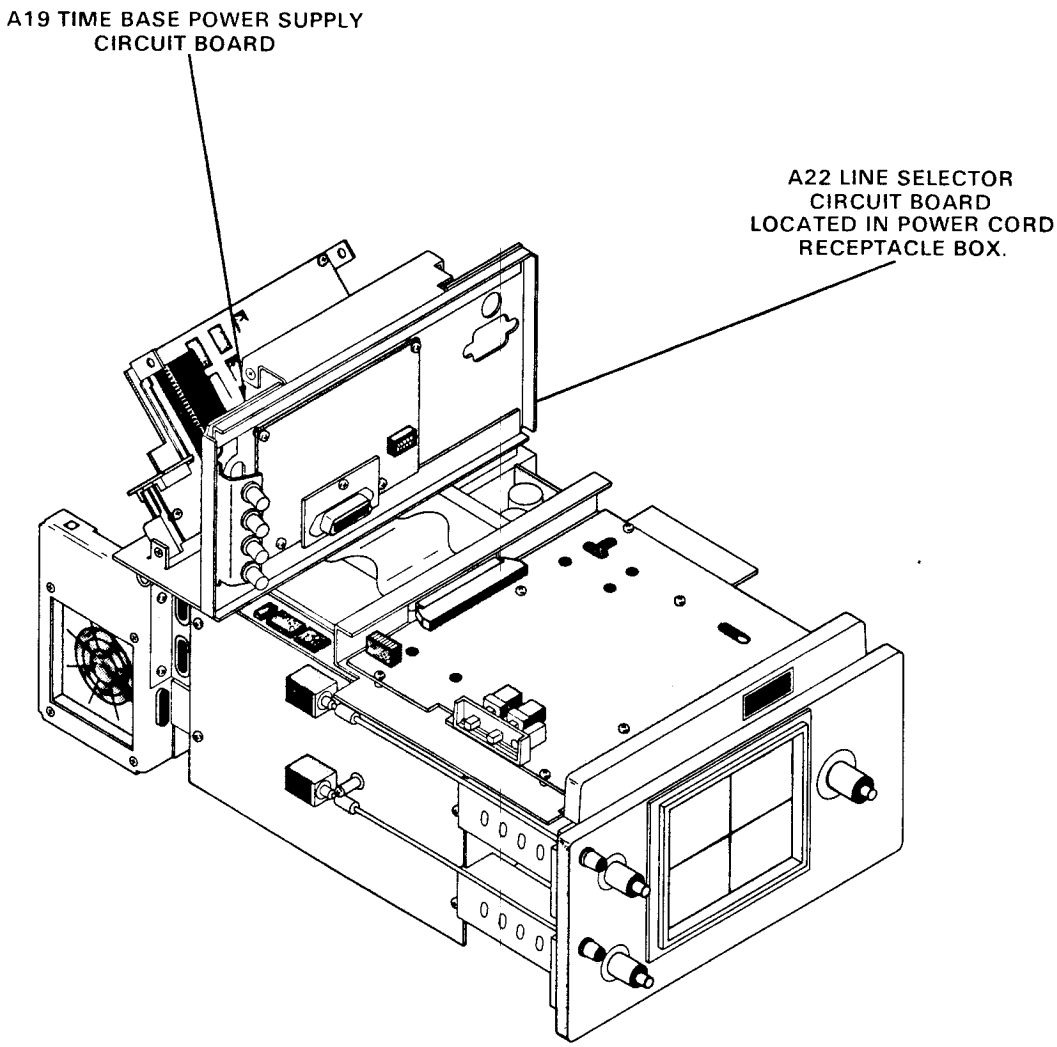


468 CONTROL SETTINGS FOR 19

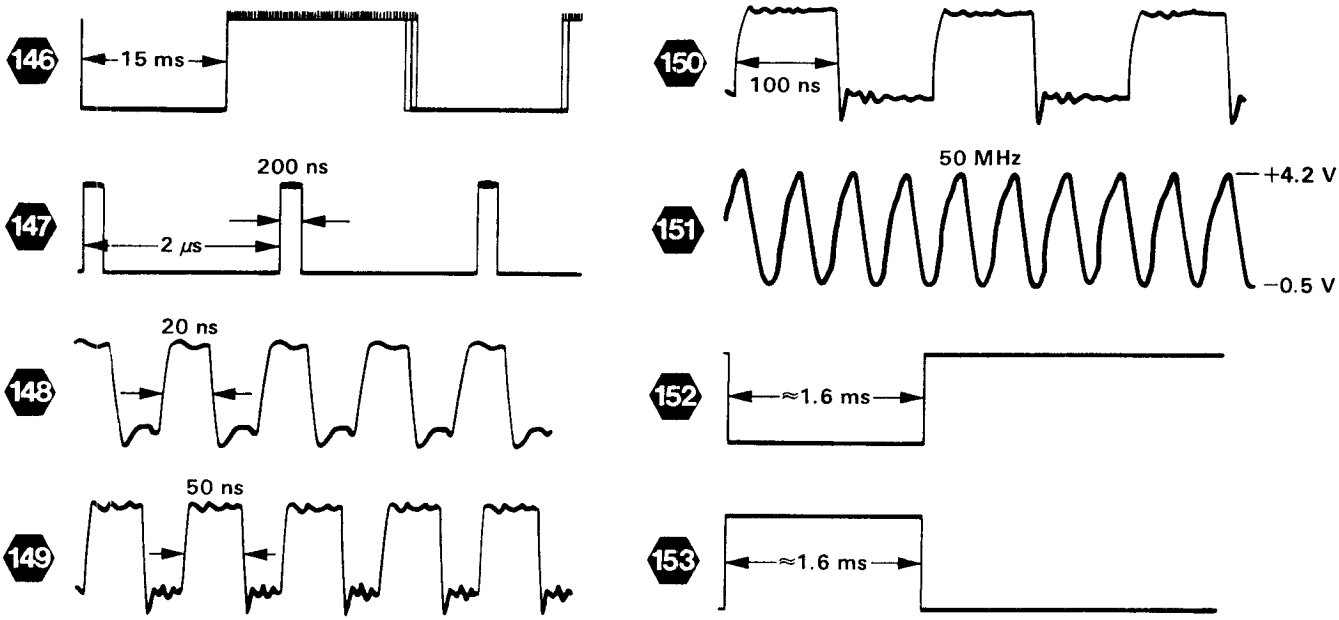
DC Voltages

STORAGE MODE	NORM

AC Waveforms

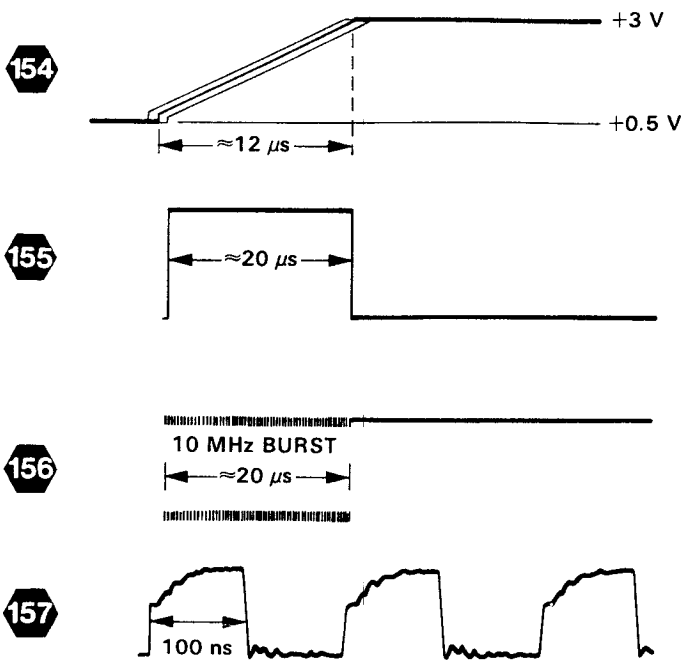
STORAGE MODE	NORM
TIME/DIV	1 ms

Waveform without voltage levels designated have p-p amplitudes from ≈0 V to ≈4 V (TTL levels).



Change 468 Control Settings

TIME/DIV	0.5 μs
CH1 INPUT SIGNAL	6-division, 50-kHz reference sine wave
A TRIG MODE	NORM
A TRIGGER LEVEL	Stable, triggered display



TIME BASE DIAGRAM 19

ASSEMBLY A19

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C108	7A	2B	R538D	4J	6E
C119	7A	2C	R544	7F	5F
C130	7B	2D	R545	7F	6F
C148	7B	2F	R546	6G	5F
C212	7B	3B	R547	7H	6F
C238	8A	3E	R548	7H	6F
C438	8B	5E	R550	6G	5G
C518	8A	6C	R552	6H	6G
C522	8B	6D	R554	6H	6G
C538	7G	6E	R556	6H	6G
C556	7G	6G	R558	7G	6G
			R559	7H	6G
J101	8A	1A	R560	6I	6G
J105	9A	1A	R562	7G	6H
J110	8A	1B			
J115	9A	1C	TP120	1L	2C
			TP210	1J	3B
P105	4E	1B			
P105	4M	1B	U100A	8D	2A
P115	1M	1C	U100B	9D	2A
P115	3M	1C	U100C	8I	2A
P115	4G	1C	U100D	9C	2A
P115	8M	1C	U110A	9E	2B
P125	2A	1D	U110B	6F	2B
P125	3M	1D	U118	1M	2C
P125	4E	1D	U120	1J	2C
P125	5A	1D	U128A	1C	2D
P125	5E	1D	U128B	1B	2D
P135	2A	1E	U140	6B	2E
P135	7A	1E	U146	6D	2F
P145	2M	1F	U150A	2L	2G
P420	8H	4C	U150B	5D	2G
			U210	2K	3B
Q544	7F	6F	U218A	7I	3C
Q546	6G	6F	U218B	2K	3C
Q547	6G	6F	U218C	3H	3C
Q552	6I	6F	U218D	3D	3C
Q554	6H	6F	U220A	1I	3C
			U220B	1C	3C
R101	8A	1A	U230A	1B	3D
R103	9A	1A	U230B	1A	3D
R110A	9E	2B	U236	4B	3E
R110B	6E	2B	U240	8L	3E
R224A	1C	3D	U246	9J	3F
R224B	1C	3D	U418	3F	5C
R224D	1C	3D	U424	3E	4C
R224E	1A	3D	U430	2D	4D
R224F	3D	3D	U434A	9C	4D
R224G	2H	3D	U434B	3M	4D
R224H	3D	3D	U434E	1L	4D
R224I	3E	3D	U434F	5C	4D
R248A	2K	3F	U436	2B	4E
R248B	2K	3F	U440	7L	4E
R248C	9I	3F	U446	7J	5F
R248D	7B	3F	U510	3G	6B
R248E	7C	3F	U518	3H	6C
R250	4E	3F	U524	3M	6C
R252	4D	3G	U530A	4K	6D
R515A	2J	6B	U530B	5K	6D
R515B	3E	6B	U530C	4L	6D
R515D	3F	6B	U536	4K	6E
R515E	3G	6B	U540	5K	6E
R538A	4L	6E	U546	7H	5F
R538B	5J	6E			
R538C	5J	6E	Y134	1A	2E

Partial A19 also shown on diagrams 21 and 23.

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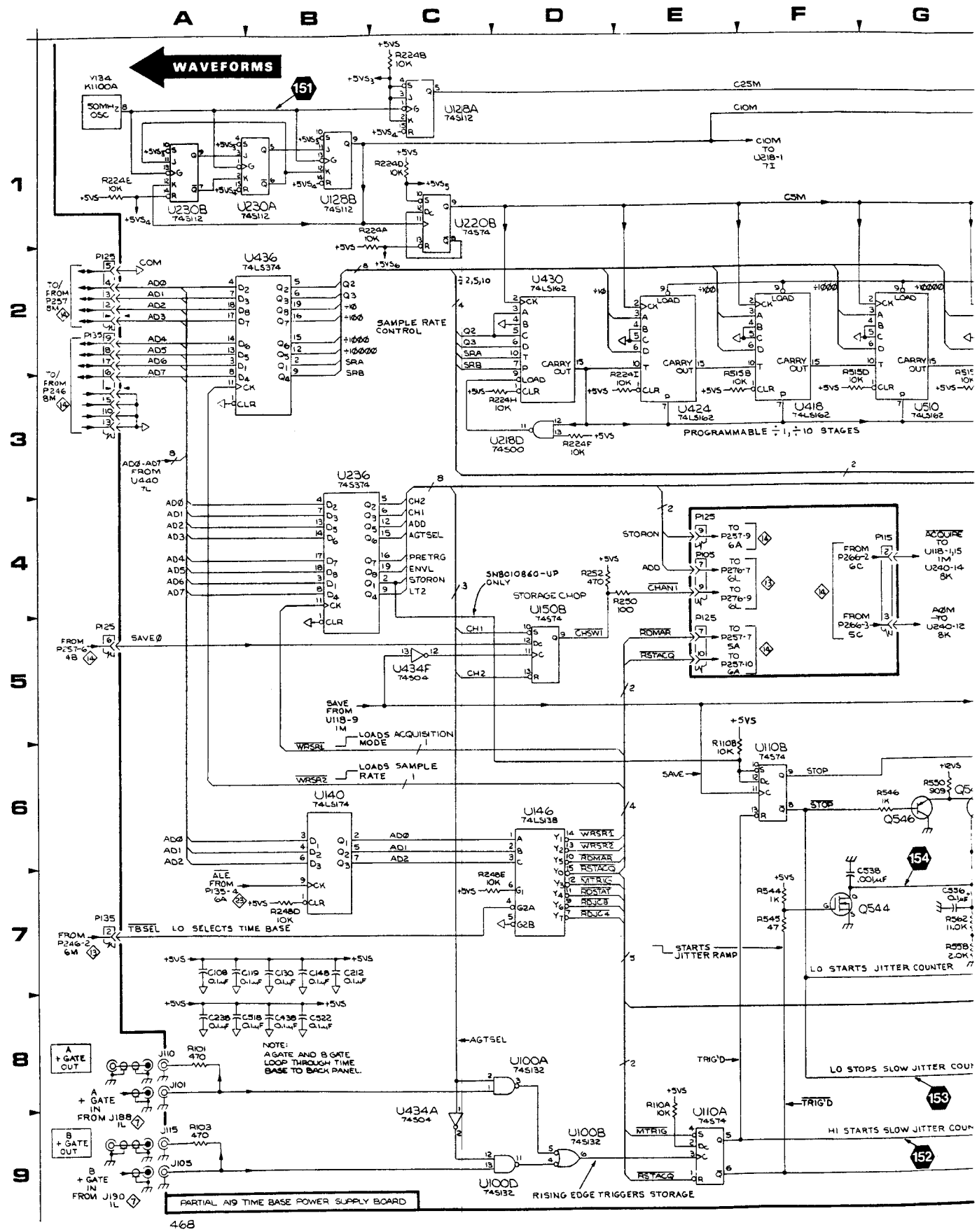

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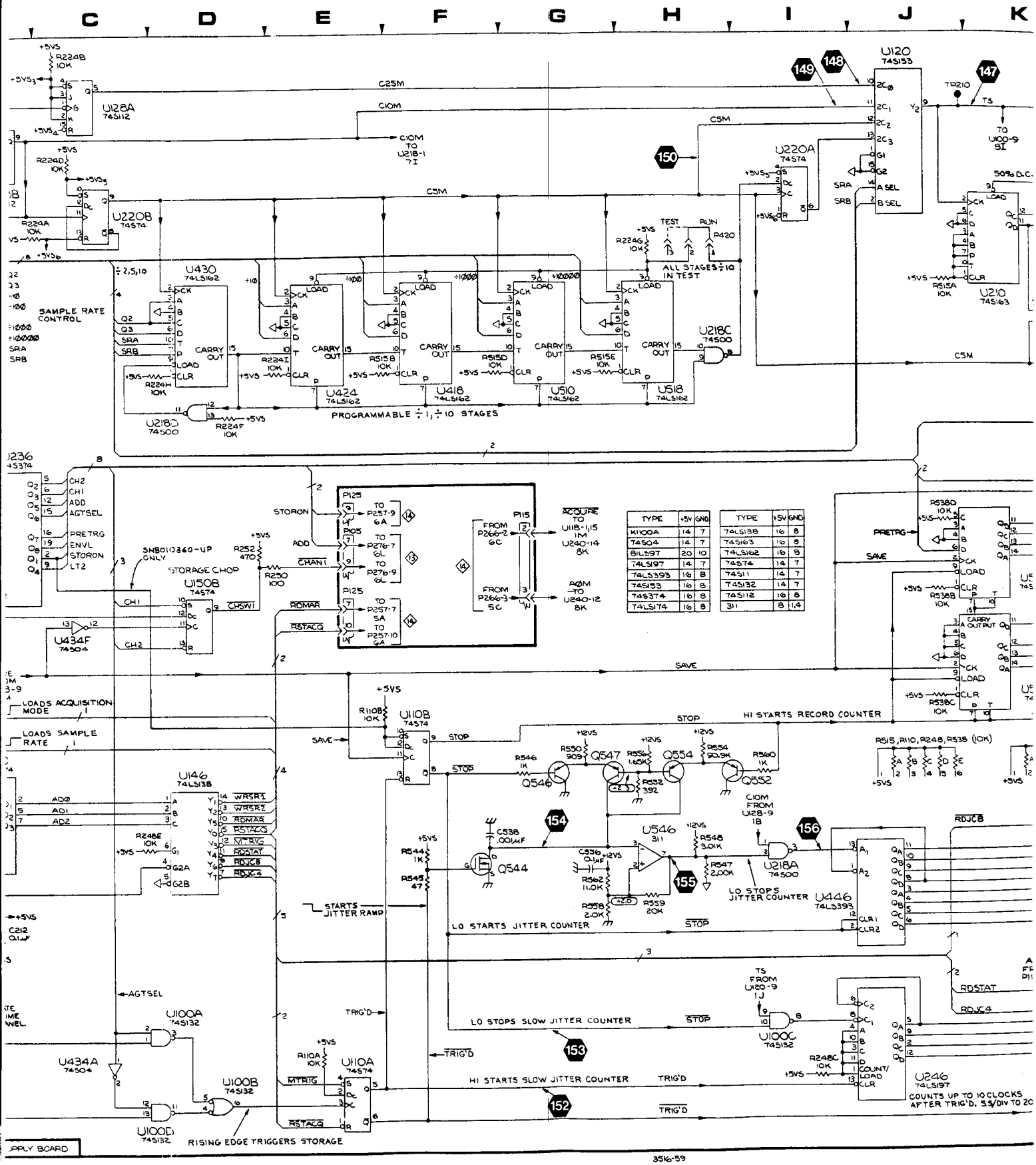
C D E F G H I J K
U120 74S153
U220A 74S74
U220B 74S74
U128A 74S112
U430 74LS162
U424 74LS162
U418 74LS162
U510 74LS162
U518 74LS162
U210 74S163
U218C 74S00
U218D 74S00
PROGRAMMABLE ÷1, ÷10 STAGES
SAMPLE RATE CONTROL
ALL STAGES ÷10 IN TEST
C25M
C10M
C5M
TO U218-1 7I
TO U100-9 9I
50% D.C.
U236 74S374
U150B 74S74
U434F 74S04
U434A 74S04
U146 74LS138
U110B 74S74
U110A 74S74
U100A 74S132
U100B 74S132
U100C 74S132
U100D 74S132
U546 311
U218A 74S00
U446 74LS393
U246 74LS197
COUNTS UP TO 10 CLOCKS AFTER TRIG'D, 5S/DIV TO 20
RISING EDGE TRIGGERS STORAGE
STORAGE CHOP
SNB0103360-UP ONLY
LOADS ACQUISITION MODE
LOADS SAMPLE RATE
STARTS JITTER RAMP
LO STARTS JITTER COUNTER
LO STOPS JITTER COUNTER
LO STOPS SLOW JITTER COUNTER
HI STARTS SLOW JITTER COUNTER
HI STARTS RECORD COUNTER
TRIG'D
STOP
SAVE
PRETRG
AGTSEL
RDJC8
RDJC4
RDSTAT
TYPE +5V GND
K1100A 14 7
74S04 14 7
81LS97 20 10
74LS97 14 7
74LS393 16 8
74S153 16 8
74S374 16 8
74LS174 16 8
TYPE +5V GND
74LS138 16 8
74S163 16 8
74LS162 16 8
74S74 14 7
74S11 14 7
74S132 14 7
74S112 16 8
311 8 1,4

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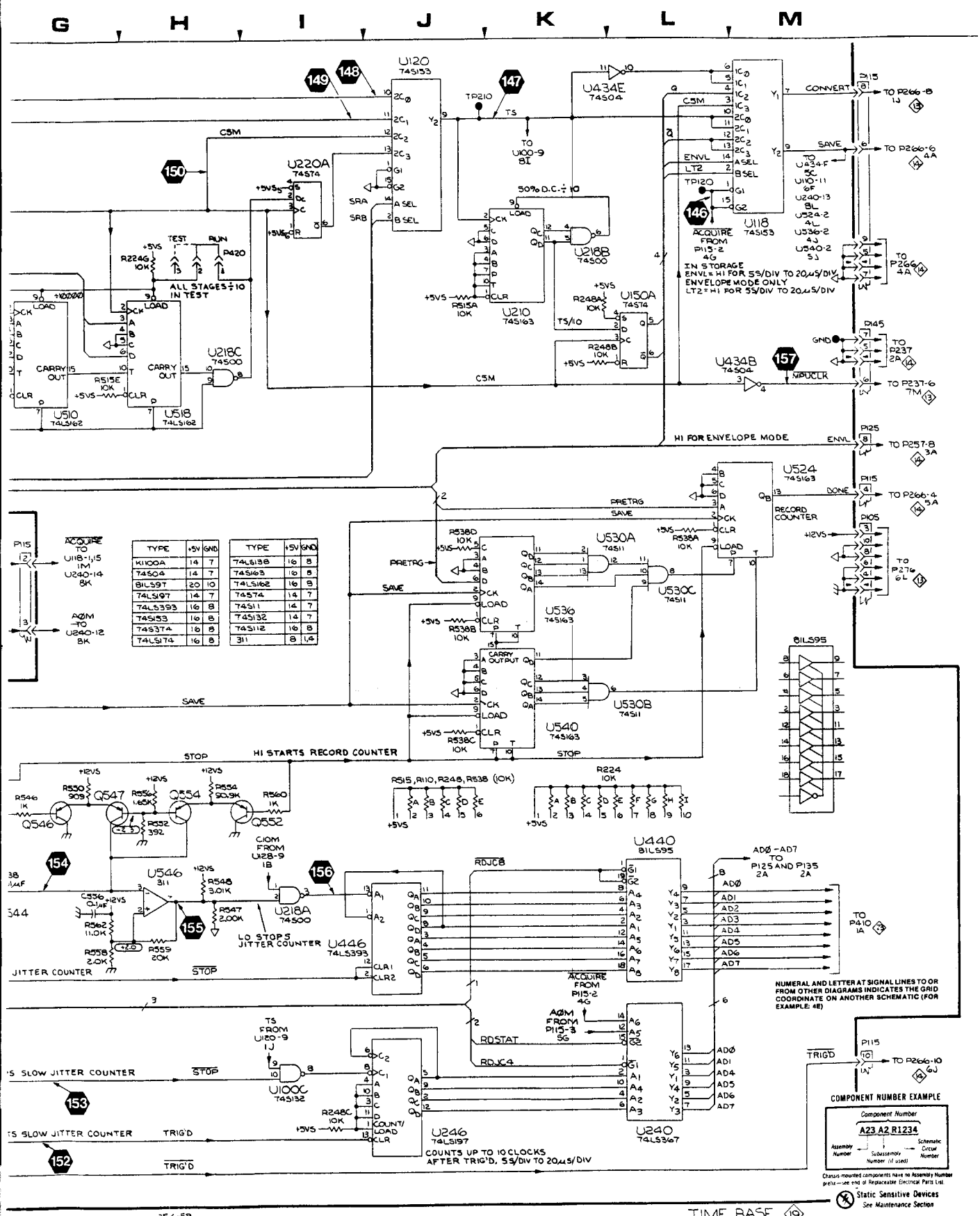

TYPE	+5V	GND
KI100A	14	7
74S04	14	7
81LS97	20	10
74LS197	14	7
74LS393	16	8
74S133	16	8
74S374	16	8
74LS174	16	8

TYPE	+5V	GND
74LS138	16	8
74S163	16	8
74LS162	16	8
74S74	14	7
74S11	14	7
74S132	14	7
74S112	16	8
311	8	4

468 CONTROL SETTINGS FOR 20

DC Voltages

LINE VOLTAGE	115 VAC

AC Waveform

LINE VOLTAGE	115 VAC

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158

f = 120 Hz

159

160

161

162

163

@

MAIN POWER SUPPLY DIAGRAM 20

ASSEMBLY A12

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P110	3B	1B	R211	3B	3B			

Partial A12 also shown on diagrams 4, 6, 7 and 21.

ASSEMBLY A15

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C404	5F	5B	F909	4D	10B	R617	5F	7C
C502	7H	5A				R624	6G	7D
C603	2H	7B	P288	7C	2M	R626	1F	7D
C607	2F	7B	P944	3J	10G	R706	3F	8B
C609	1E	7B				R708	3E	8B
C634	4H	7F	Q390	8D	3M†	R713	1D	8C
C705	1D	8B	Q401	6G	4A†	R714	3E	8C
C707	3F	8B	Q402	6G	4A	R715	2I	8C
C711	3E	8B	Q406	7F	4B	R726	1D	8D
C725	6H	8D	Q501	1G	4A†	R728	5H	8D
C820	6E	9D	Q503	1G	6B	R740	1H	8F
C829	1E	9E	Q606	2F	6B	R741	1H	8G
C840	1E	9F	Q617	5F	7C	R800	4G	9A
C926	3E	10E	Q701	4G	8A†	R803	4G	9B
C935	5E	10F	Q703	3G	8A	R804	4G	9B
C938	2D	10F	Q704	4F	8B	R830	1H	9E
C939	3D	10F	Q718	5G	8C†	R834	1I	9F
			Q740	1I	8F	R932	3D	10E
CR304	6G	4B	Q828	1H	9E	R938	3D	10F
CR508	1F	6B						
CR600	1H	7A	R392	7E	4M	TP637	2I	7F
CR605	1F	7B	R400	7G	5A	TP638	6I	7F
CR611	2F	7C	R403	7G	5B	TP639	4I	7F
CR617	5F	7C	R404	7G	5B	TP642	1I	7G
CR706	1E	8B	R405	7E	5B	TP740	7I	8F
CR728	6H	8E	R492	8E	5M			
CR729	2H	8E	R505	5E	6B	U506A	5F	5B
CR804	4H	9B	R506	5E	6B	U506B	6F	5B
CR813	6D	9C	R507	2G	6B	U712A	1E	8C
CR815	7H	9C	R508	2G	6B	U712B	4F	8C
CR826	1I	9E	R602	2G	7A			
CR840	1H	9F	R608	1E	7B	VR392	7E	4M
CR919	3D	10C	R609	2F	7B	VR604	1E	7B
CR930	4D	10E	R610	6E	6C	VR624	1H	7D
CR942	1D	10F	R611	6E	7C	VR709	2I	8B
			R612	6F	7C	VR725	1D	8D
F802	6D	9A	R613	1F	7C	VR825	1I	9D
F809	3H	10B	R614	2F	7C			

†Chassis mounted

Partial A15 also shown on diagrams 3, 4, 5, 7, 8, 9, 10, 11 and 12.

ASSEMBLY A22

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
J108	1A	1B	J214	1B	1C	S108	1A	2B
J110	1A	1B	J222	1B	3D	S216	1B	2C
J204	1A	2B	J224	1B	1C	S226	1B	2D
J206	2B	2B	J230	1B	2D			
J212	1B	2C						

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
			F14500	1A	CHASSIS	S14520	1A	CHASSIS
DS17105	3B	CHASSIS	P14500	1A	CHASSIS	T14500	1C	CHASSIS
ASSEMBLY A26			DS14086	8C		DS14087	8C	

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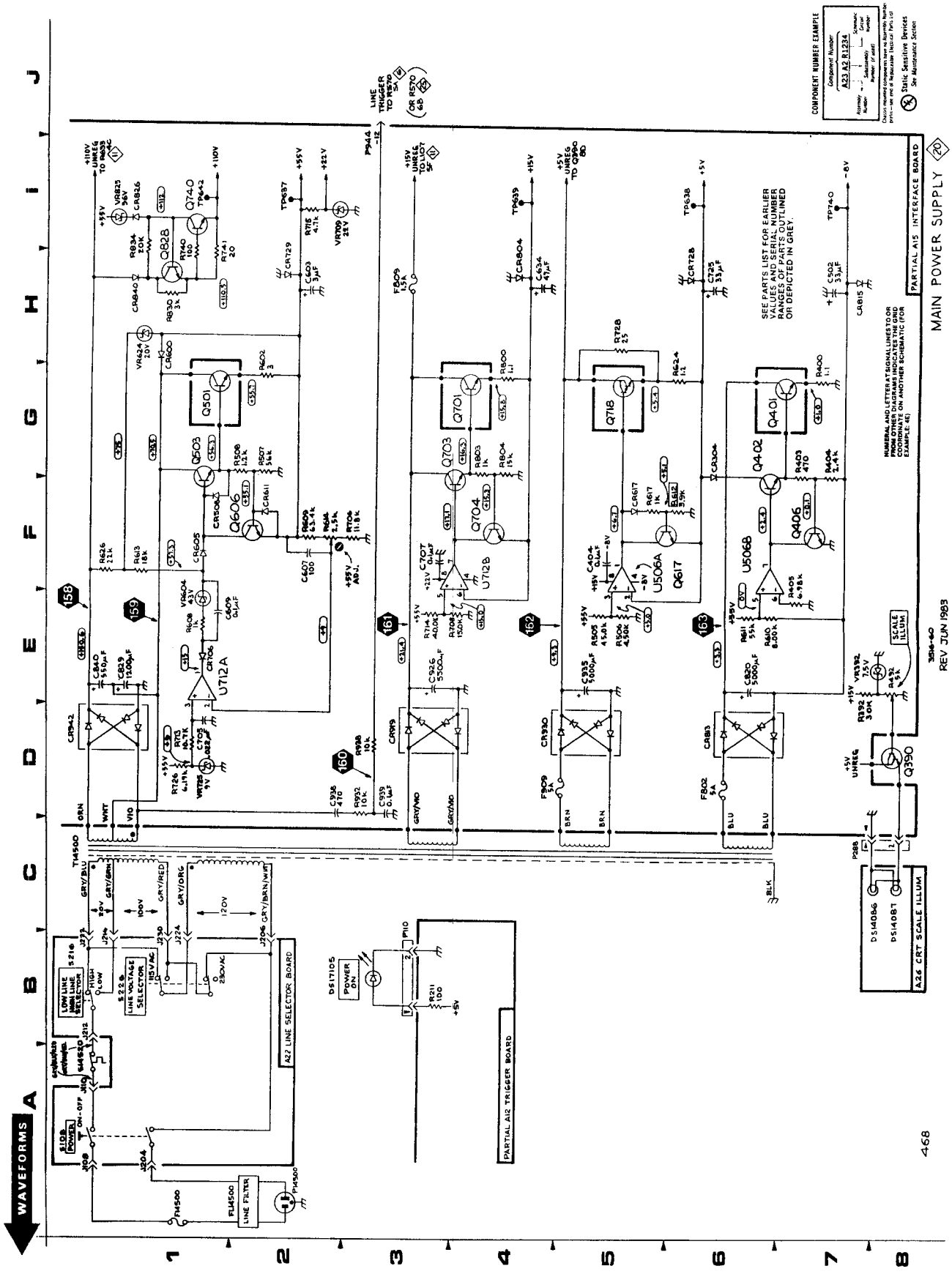

468 CONTROL SETTINGS FOR 21

DC Voltages

LINE VOLTAGE	115 VAC

AC Waveforms

LINE VOLTAGE	115 VAC

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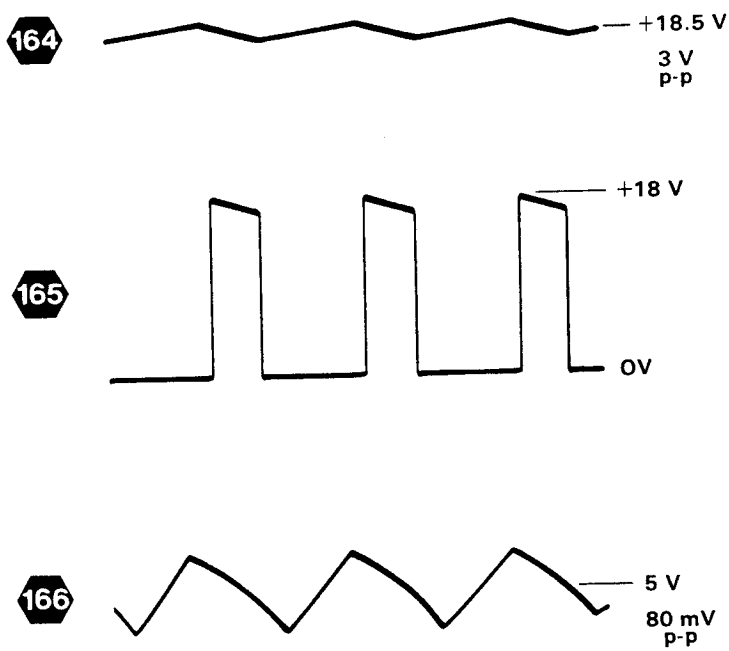


3516-38

STORAGE POWER SUPPLY DIAGRAM 21

ASSEMBLY A12

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
F3007	4B	4L	P3008	2B	4M
F4007	2B	6L	P4008	2B	5M
F4009	2B	5L			

Partial A12 also shown on diagrams 4, 6, 7, and 20.

ASSEMBLY A19

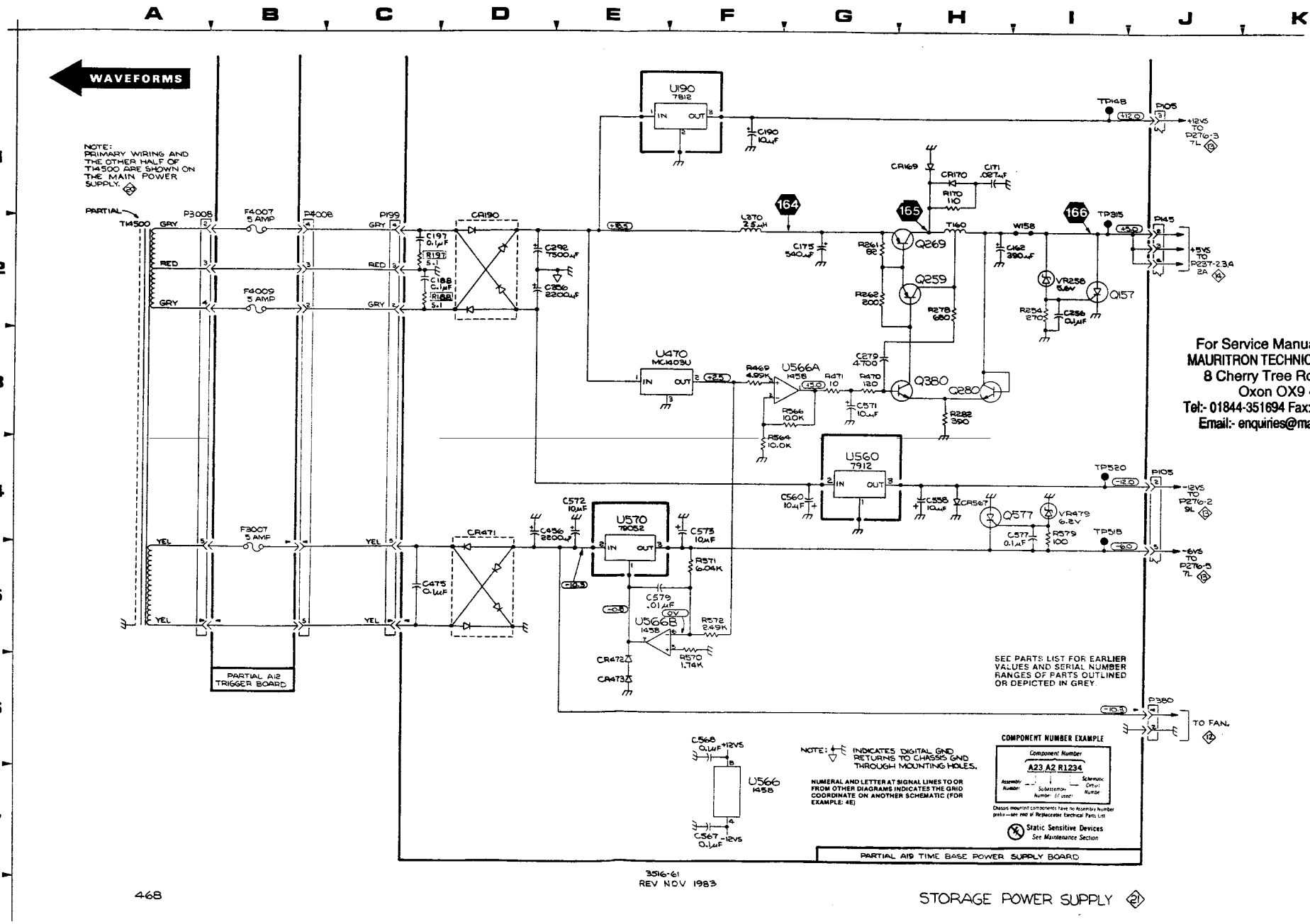
CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C162	2H	2G	Q269	2H	3I
C171	1H	2I	Q280	3H	3J
C175	2G	2J	Q380	3H	3J
C188	2C	2J	Q577	4H	5I
C190	1F	1K			
C197	2C	1K	R170	1H	2I
C256	2I	3G	R188†	2C	2J
C279	3G	3I	R197†	2C	1L
C292	2D	3K	R254	2I	3G
C356	2D	4G	R261	2G	3H
C456	4D	5G	R262	2G	3H
C475	5C	4I	R278	2H	3I
C558	4H	6G	R282	3H	3J
C560	4G	6H	R469	3F	5H
C567	7F	6H	R470	3G	5I
C568	6F	6H	R471	3G	5I
C571	3G	6I	R564	4F	5H
C572	4E	6I	R566	3G	5H
C573	4F	6I	R570	5F	6H
C577	4I	6I	R571	5F	6H
C579	5E	6I	R572	5F	6H
			R579	4I	6I
CR169	1H	2I			
CR170	1H	2I	T160	2H	2H
CR190	2D	2K			
CR471	5D	4I	TP148	1I	1F
CR472	6E	5I	TP315	2I	4B
CR473	6E	5I	TP518	4I	6C
CR567	4H	6H	TP520	4I	6C
L370	2F	3I	U190	1F	1K
			U470	3F	5I
P105	1J	1B	U560	4G	6H
P105	4J	1B	U566A	3G	5H
P145	2J	1F	U566B	5E	5H
P199	2C	2L	U570	4E	6I
P380	6J	4J			
			VR258	2I	2G
Q157	2I	2G	VR479	4I	5I
Q259	2H	3H			
			W158	2I	1G

Partial A19 also shown on diagrams 19 and 23

†See Parts List for serial number ranges.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	LOCATION
T14500	2A	CHASSIS			
U190	1F	CHASSIS			
U560	4G	CHASSIS			
U570	4E	CHASSIS			



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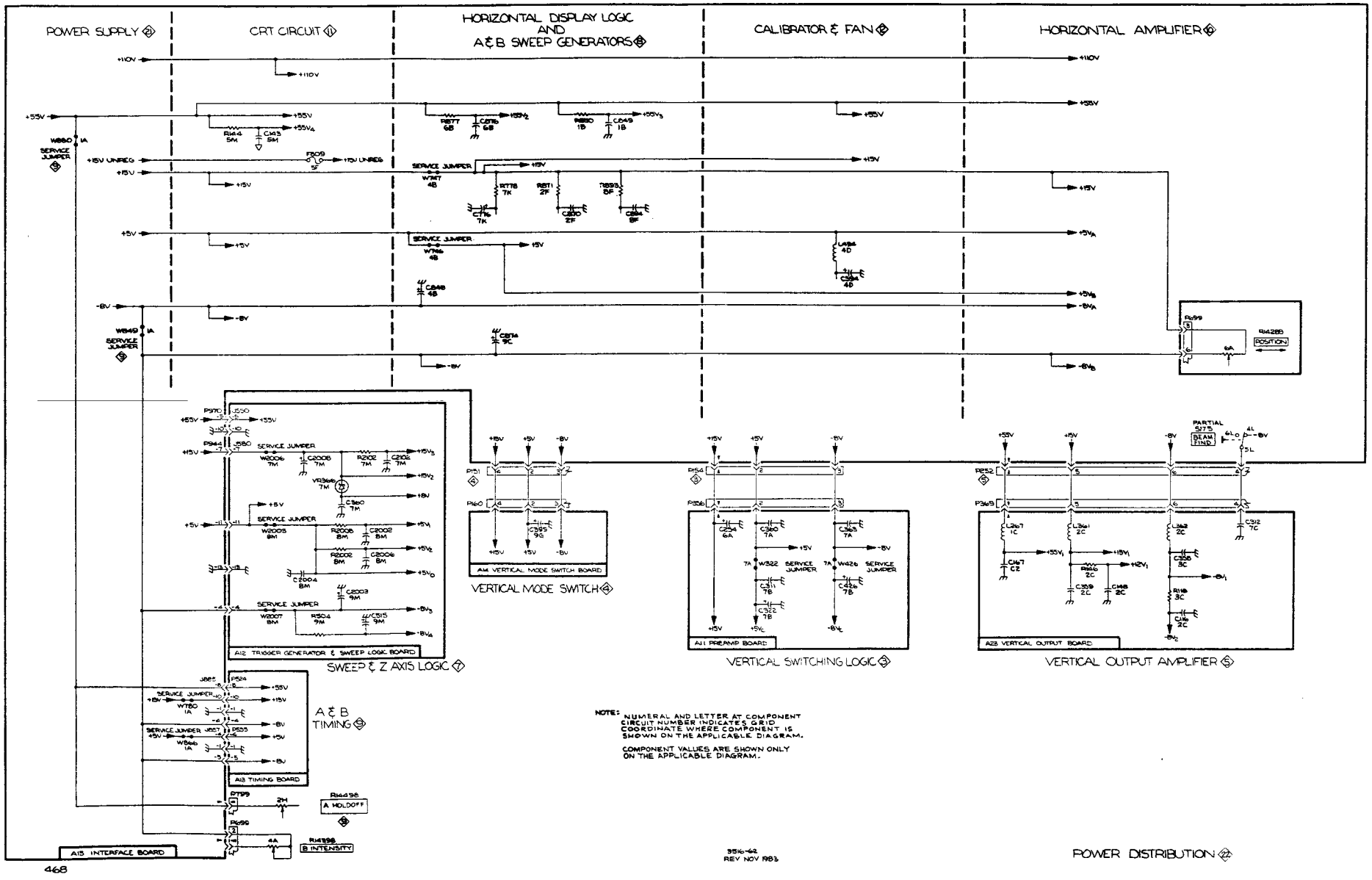
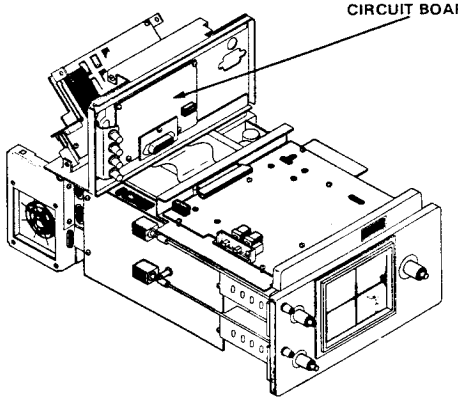


NOTE: NUMERAL AND LETTER AT COMPONENT CIRCUIT NUMBER INDICATES GRID COORDINATE WHERE COMPONENT IS SHOWN ON THE APPLICABLE DIAGRAM.

COMPONENT VALUES ARE SHOWN ONLY ON THE APPLICABLE DIAGRAM.

3516-42
REV NOV 1983

POWER DISTRIBUTION 4



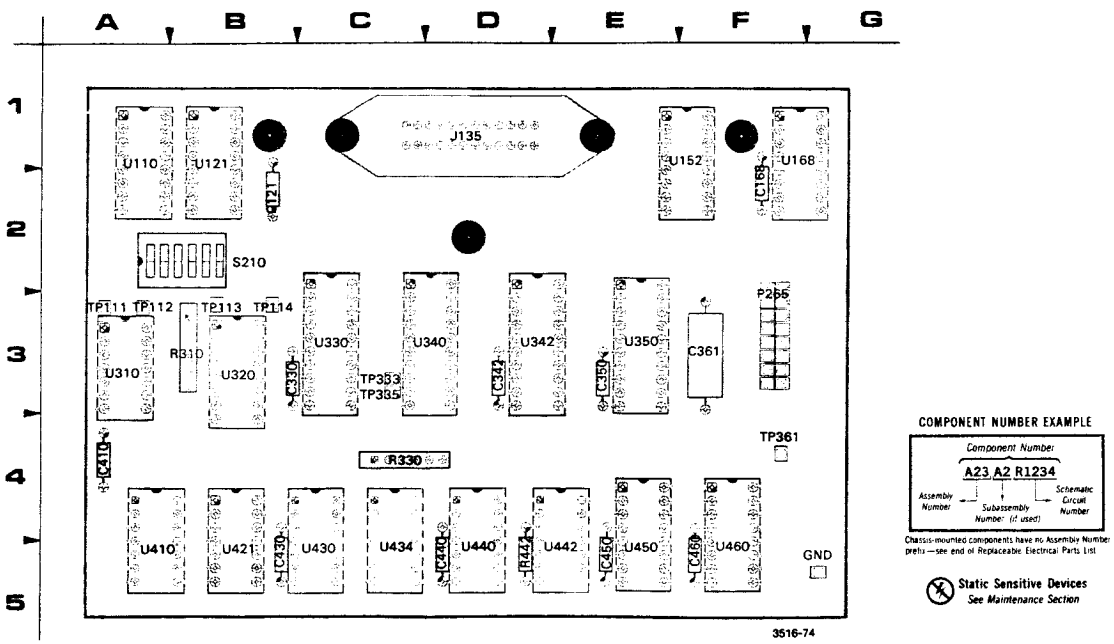


Figure 8-24. A17 GPIB board.

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A17 GPIB BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 23

C121	P265	S210	U310D	U434B
C168	P265		U310E	U434C
C330	P265	TP111	U310F	U440A
C342		TP112	U320	U442A
C350	R310A	TP113	U330	U442B
C361	R310B	TP114	U340	U442C
C410	R310C	TP333	U342	U442D
C430	R310D	TP335	U350	U450
C440	R310E	TP361	U410A	U460
C450	R330A		U410B	
C460	R330B	U110	U421A	
	R330C	U121	U421C	
J135	R330D	U152	U430A	
J135	R330E	U168	U430B	
J135	R442C	U310A	U434A	

GPIB DIAGRAM 23

ASSEMBLY A17

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C121	8D	2B	TP113	5M	3B
C168	8D	2F	TP114	5M	3B
C330	8D	3C	TP333	4F	3C
C342	8D	3D	TP335	4F	3C
C350	8E	3E	TP361	8A	4F
C361	8E	3F			
C410	8D	4A	U110	8M	1A
C430	8D	5B	U121	6M	1B
C440	8D	5D	U152	1I	1F
C450	8E	5E	U168	2I	1F
C460	8E	5F	U310A	6L	3A
			U310D	8H	3A
J135	1M	1D	U310E	4H	3A
J135	5M	1D	U310F	6K	3A
J135	7M	1D	U320	3C	3B
			U330	5C	3C
P265	1A	3F	U340	4E	3D
P265	4M	3F	U342	1E	3D
P265	6A	3F	U350	2E	3E
			U410A	8G	5A
R310A	2B	3B	U410B	7I	5A
R310B	2B	3B	U421A	8H	5B
R310C	2B	3B	U421C	6J	5B
R310D	2B	3B	U430A	6H	5C
R310E	2B	3B	U430B	6K	5C
R330A	2B	4C	U434A	5K	5C
R330B	7H	4C	U434B	6J	5C
R330C	8G	4C	U434C	4I	5C
R330D	5J	4C	U440A	5J	5D
R330E	6F	4C	U442A	4H	5E
R442C	4K	5D	U442B	4H	5E
			U442C	5K	5E
S210	2A	2B	U442D	5I	5E
			U450	5D	5E
TP111	7M	3A	U460	5F	5F
TP112	8M	3A			

ASSEMBLY A19

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P135	6A	1E	P410	1A	4B
P145	4M	4B	P410	4M	4B
P145	6A	4B	P410	6A	4B

Partial A19 also shown on diagrams 19 and 21.

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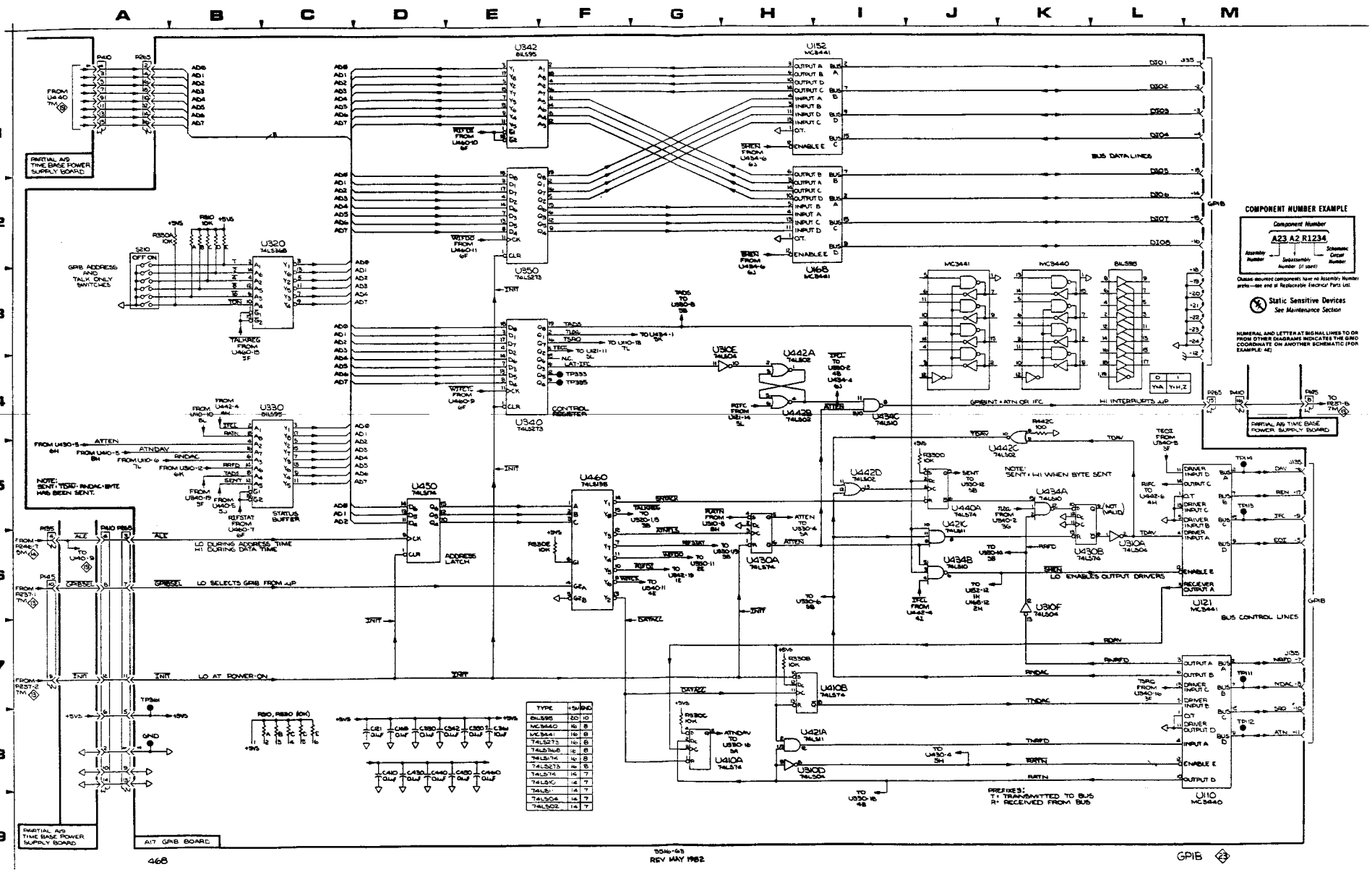

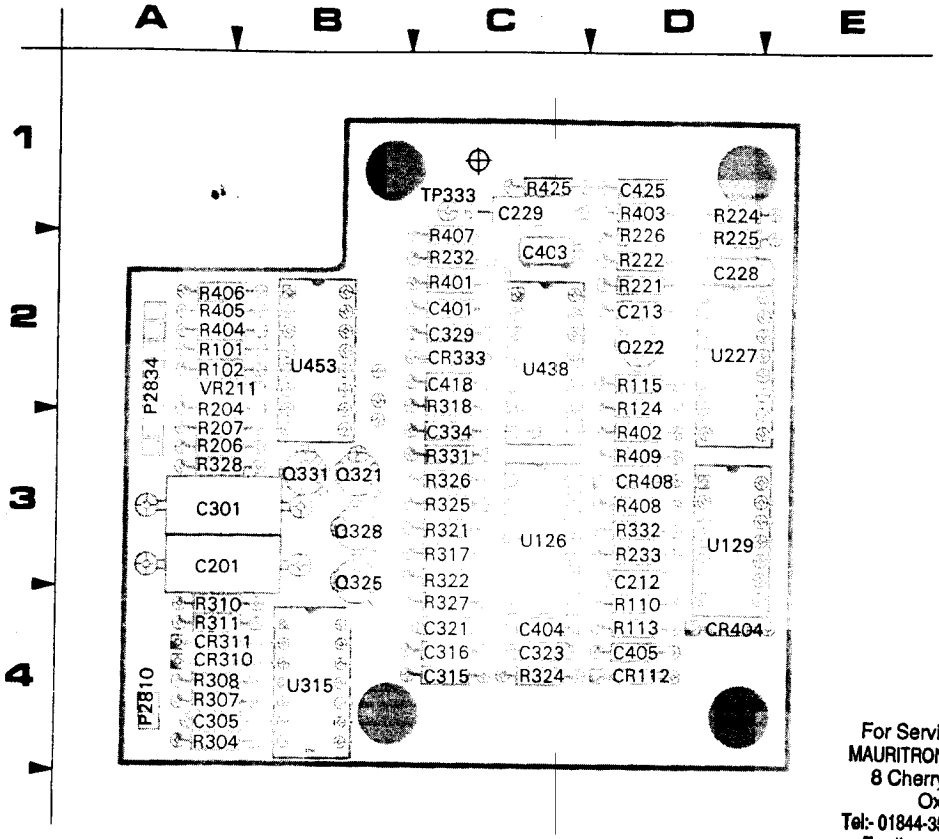

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Figure 8-25 Option 05 A29 TV SYNC Seperator Circuit board.

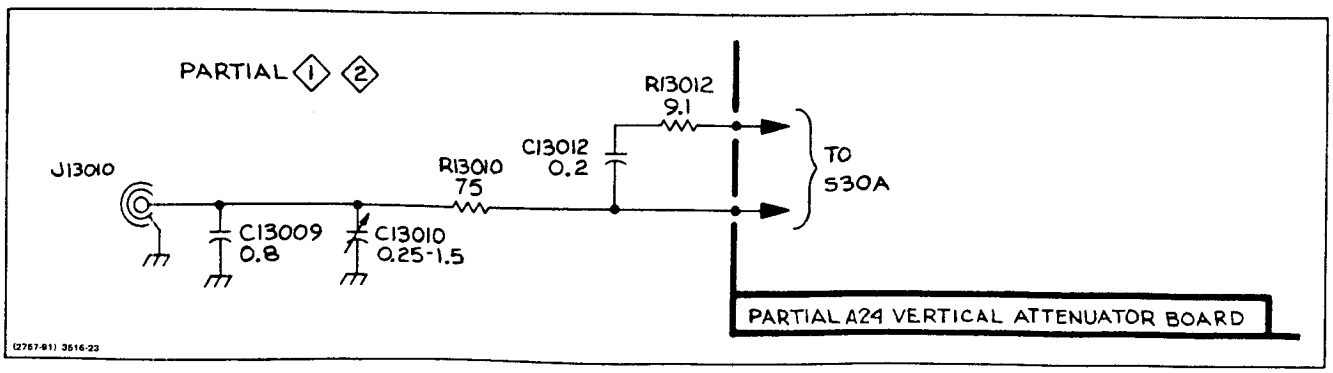

Figure 8-26 Option 05 468 Vertical Input Changes.

OPTION 05 TV SYNC SEPARATOR DIAGRAM 24

ASSEMBLY A29

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C201	4B	3A	Q325	2E	3B	R327	1E	4C
C212	3B	3D	Q328	1E	3B	R328	2G	3A
C213	6D	2D	Q331	2G	3B	R331	1F	3C
C228	6B	2D				R332	1F	3D
C229	5D	1C	R101	2J	2A	R401	5E	2C
C301	3B	3A	R102	2I	2A	R402	6F	3D
C305	2C	4A	R110	6J	4D	R403	5F	1D
C315	2D	4C	R113	6I	4D	R404	7J	2A
C316	2D	4C	R115	5D	2D	R405	7J	2A
C321	2E	4C	R124	6E	2D	R406	7J	2A
C323	2E	4C	R204	3B	3A	R407	5H	2C
C329	1E	2C	R206	3A	3A	R408	3F	3D
C334	1F	3C	R207	4A	3A	R409	3F	3D
C401	5E	2C	R221	6D	2D	R425	4E	1C
C403	5F	2C	R222	6C	2D			
C404	6I	4C	R224	5B	1D	TP333	2H	1C
C405	6J	4D	R225	4C	2D			
C425	5E	1D	R226	5D	2D	U126A	6I	3C
			R232	1H	2C	U126B	7H	3C
CR112	6J	4D	R233	4B	3D	U129A	6G	3D
CR310	3D	4A	R304	1B	4A	U129B	7F	3D
CR311	3D	4A	R307	1C	4A	U227	6B	2D
CR333	1F	2C	R308	1C	4A	U315	2D	4B
CR404	6J	4D	R310	3D	4A	U438A	6E	2C
CR408	4F	3D	R311	3D	4A	U438B	6F	2C
			R317	3E	3C	U453A	5H	2B
P2810	2A	4A	R318	2F	2C	U453B	4D	2B
P2834	1K	2A	R321	1E	3C	U453C	7J	2B
P2834	3A	2A	R322	2E	3C			
P2834	7K	2A	R324	1D	4C	VR211	4B	2A
Q222	6D	2D	R325	2F	3C			
Q321	2F	3B	R326	2G	3C			

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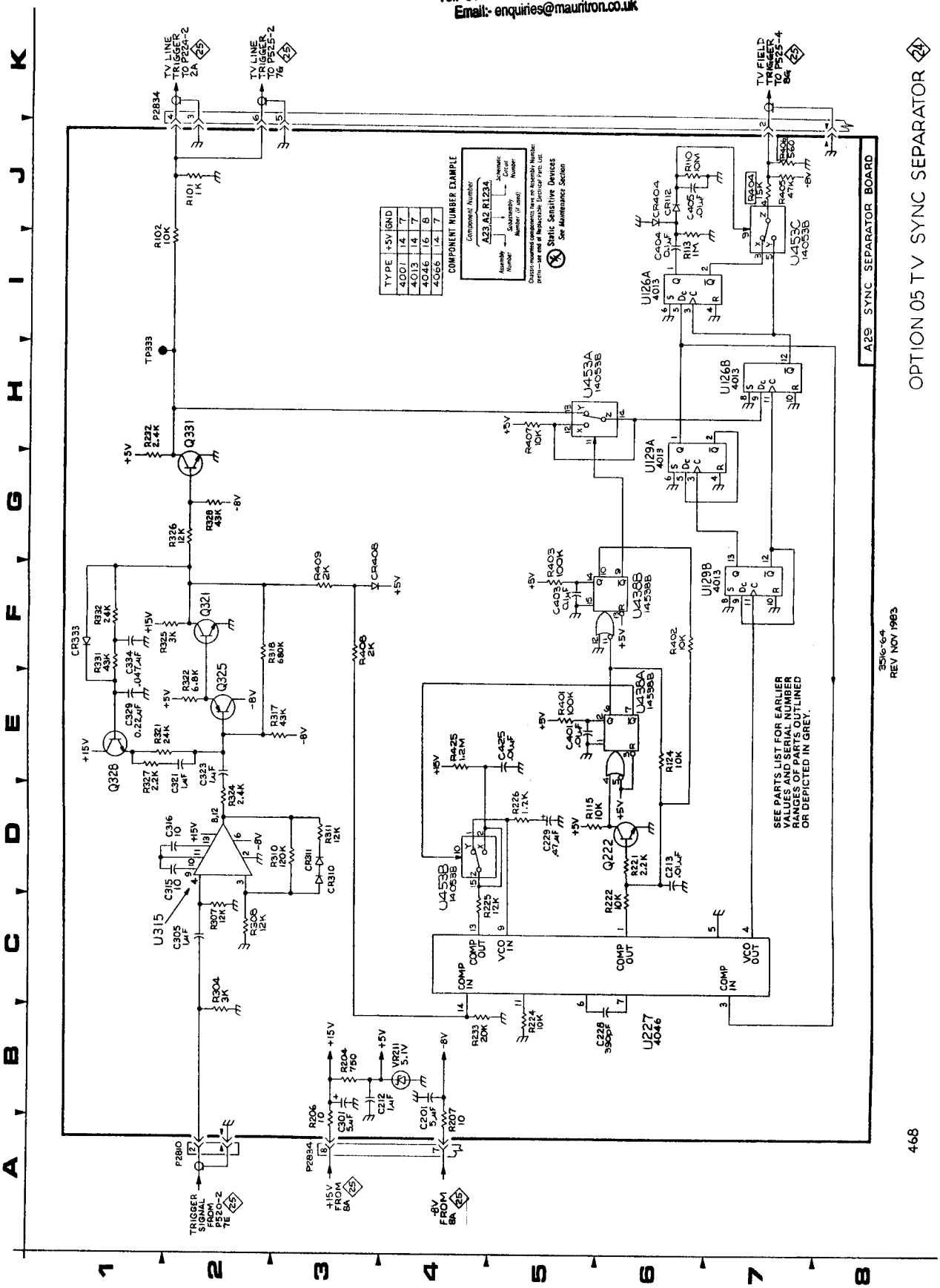

OPTION 05 TRIGGER SWITCHES & TRIGGER PICKOFF DIAGRAM 25

ASSEMBLY A12

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C110	4C	2B	P224	2A	3D	R411	6B	5B
C111	3C	2B	P410	7J	4B	R412	6C	4B
C121	2F	2C	P520	7E	6C	R413	7C	5B
C129	2G	1D	P525	7G	6D	R414	7B	5B
C133	2I	2E				R416	7B	5B
C134	4H	2E	Q230A	2I	2D	R417	7C	5B
C211	3B	2B	Q230B	3I	2D	R418	7C	4B
C222	3F	2C	Q430A	5I	4D	R420	7D	5B
C315	6B	3C	Q430B	7I	4D	R421	7D	5C
C327	6E	4D	Q520	7D	6C	R422	6C	5C
C330	5I	4D	Q521	8D	6C	R423	6D	5C
C333	8H	4E				R424	5E	4C
C413	7C	5B	R112	4C	2B	R428	7G	4D
C415	7B	5B	R120	3G	1C	R430	6G	4D
C423	5D	4C	R130	3H	2D	R431	5H	5D
C505	7B	6A	R132	2H	2D	R432	5I	4E
C509	6B	5B	R133	1I	2D	R433	5I	4E
C510	7B	6B	R134	4I	1E	R514	7B	5B
C516	7C	5B	R210	3C	2B	R521	8D	6C
C519	7D	5B	R219	2F	2C	R523	7D	5C
C525	5F	5C	R229	3H	2D	R524	7F	5C
C570	6B	6I	R232	2I	2D	R570	6B	6I
			R234	4I	2E			
CR228	3H	2D	R310	6B	3B	S120	1G	1C
CR330	7H	4D	R320	6B	3C	S220A	1D	2C
CR519	8D	6B	R328	5B	3D	S320A	4C	4C
			R334	8I	4E	S420	4F	5C
J210	2A	3B	R335	7I	4E			
J219	3A	3C	R410	7C	4B			
J227	2A	3D						
J580	6A	6J						

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	LOCATION
J17106	3A	CHASSIS	S17305	7I	CHASSIS			
J17506	6A	CHASSIS						

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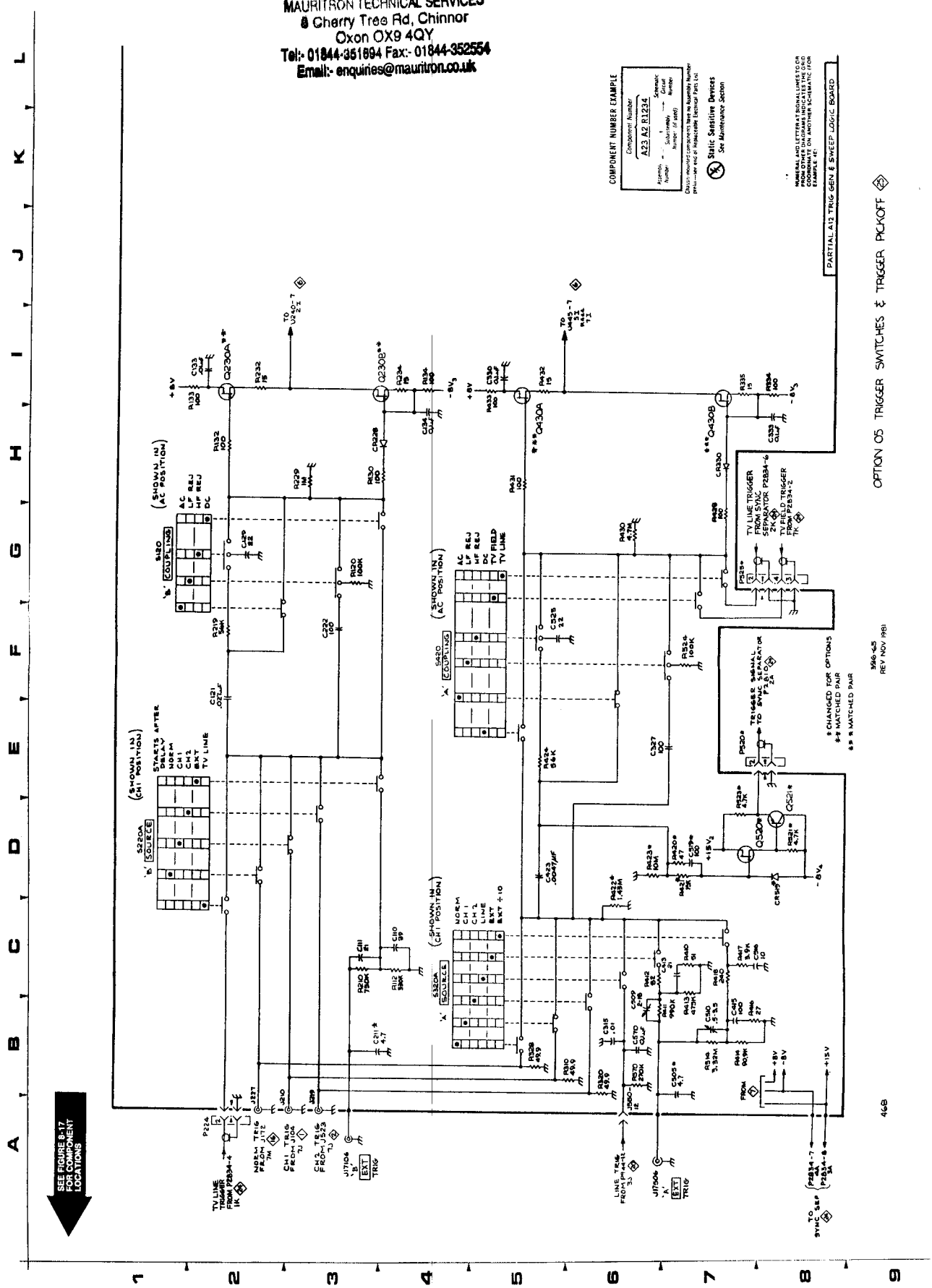
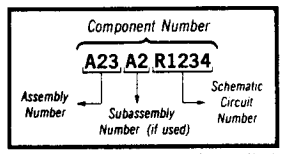


A27 ANALOG X-Y OUTPUT BOARD (OPTION 11)

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 26

C100	F100	R126	U102
C101		R127	U103
C103		R128	U104
C104	J100	R129	U107
C106	J101	R131	U108
C107	J102	R132	U109
C108		R133	U111
C109		R134	U112
C111	K100	R135	U113
C112			U114
C113			U117
C114	P100	S100	U118
C121	P101		U119
C124			U121
C127		TP100	U122
C128	R101	TP101	U123
C134	R103	TP102	U124
	R107	TP103	U126
	R108	TP114	U127
CR100	R109	TP118	U128
CR101	R111		U129
CR102	R112		U131
CR103	R120	U100	
CR104	R121	U101	
CR107			

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

Static Sensitive Devices
See Maintenance Section

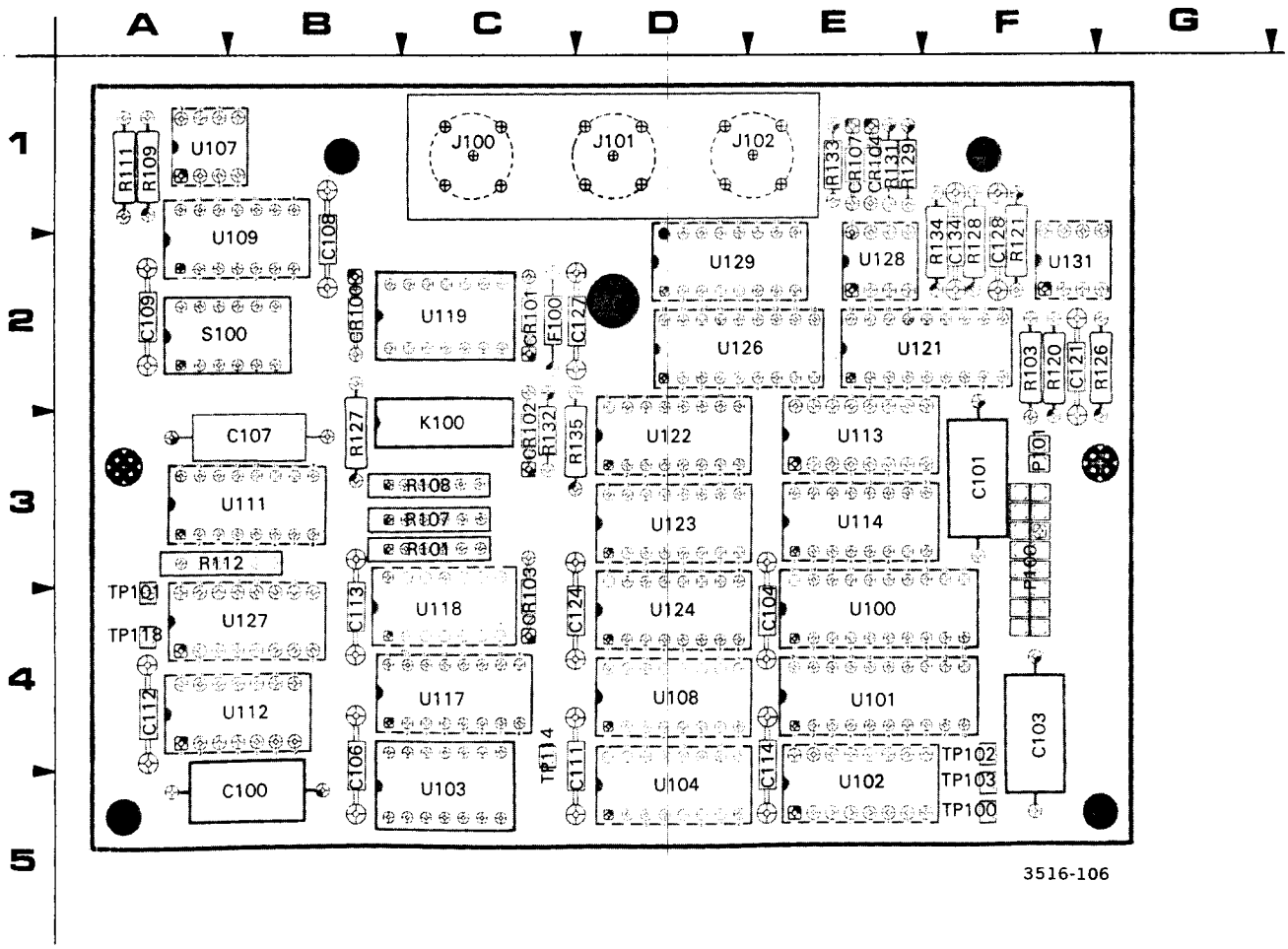


Figure 8-27. A27—Analog X-Y Output Option board.

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X-Y PLOTTER DIAGRAM 26

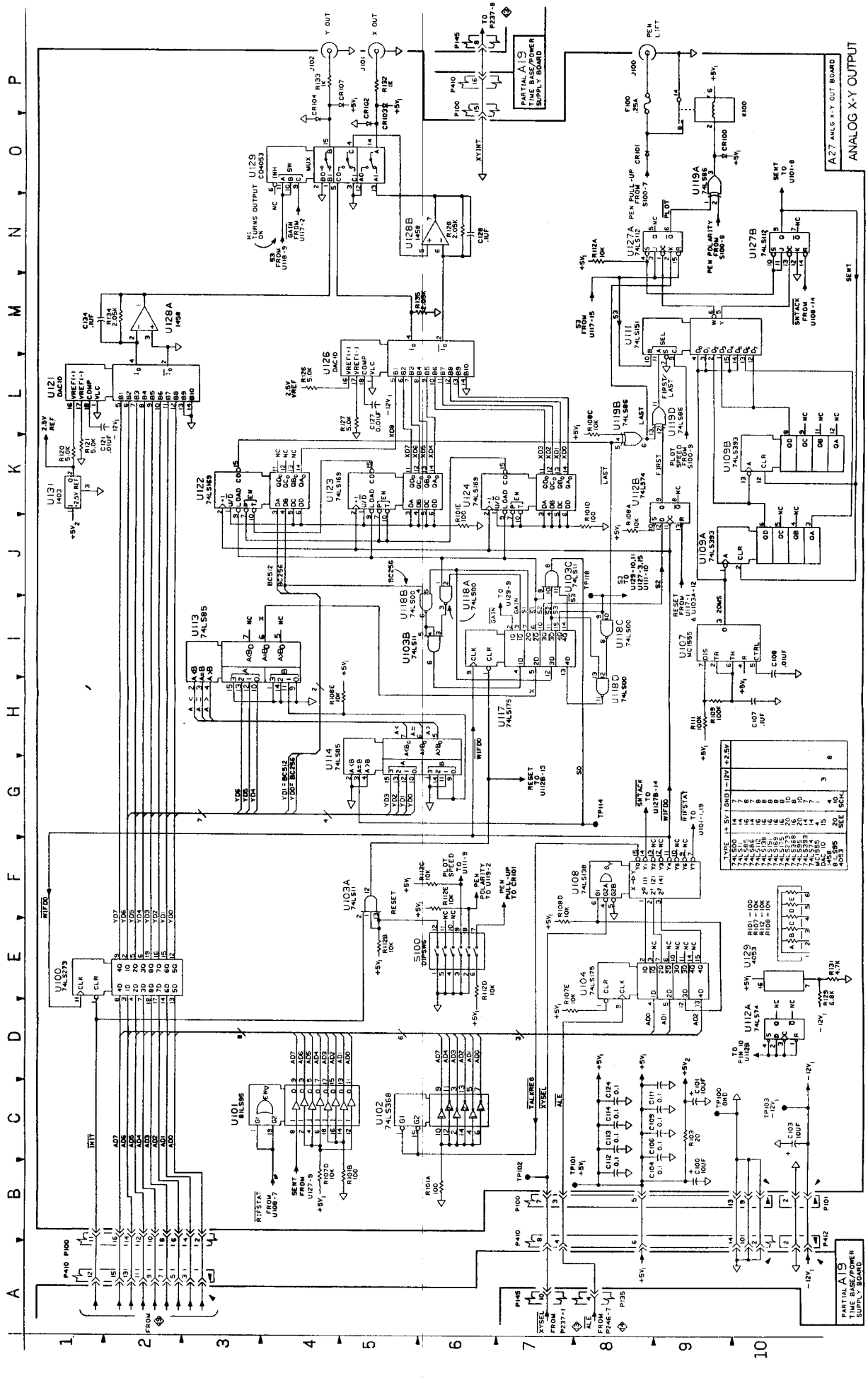
ASSEMBLY A19

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P410	1A	4B	P410	7B	4B	P412	10B	5A
P410	6P	4B						

Partial A19 also shown on diagrams 19, 21 and 23.

ASSEMBLY A27

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C100	9B	5B	R101A	6B	3C	TP118	8J	4A
C101	9C	3F	R101B	5B	3C			
C103	10C	4F	R101D	8J	3C	U100	1E	4E
C104	9C	4E	R101E	6J	3C	U101	3C	4E
C106	9C	4B	R103	9C	2F	U102	5C	5E
C107	10H	3B	R107D	4B	3C	U103A	5F	5C
C108	10I	2B	R107E	7E	3C	U103B	5I	5C
C109	9C	2A	R108A	8J	3C	U103C	7J	5C
C111	9C	4C	R108C	8L	3C	U104	8E	5D
C112	8B	4A	R108D	7F	3C	U107	9I	1A
C113	8C	4B	R108E	4H	3C	U108	8F	4D
C114	8C	4E	R109	9H	1A	U109A	9J	2B
C121	2L	2F	R111	9H	1A	U109B	9K	2B
C124	8C	4C	R112A	8N	3A	U111	8M	3B
C127	5L	2C	R112B	5E	3A	U112B	8K	4B
C128	6N	2F	R112C	6F	3A	U113	3I	3E
C134	1M	2F	R112D	6E	3A	U114	5G	3E
			R112E	6F	3A	U117	7H	4C
CR100	9O	2B	R120	1K	2F	U118A	6J	4C
CR101	8O	2C	R121	1K	2F	U118B	5I	4C
CR102	5O	3C	R126	4L	2G	U118C	8I	4C
CR103	5P	4C	R127	5L	3B	U118D	8H	4C
CR104	4O	1E	R128	6N	2F	U119A	9O	2C
CR107	5P	1E	R129	10E	1E	U119B	8L	2C
			R131	10E	1E	U121	1L	2E
F100	8P	2C	R132	5P	3C	U122	3K	3D
			R133	4P	1E	U123	4K	3D
J100	8P	1C	R134	2M	2F	U124	6K	4D
J101	5P	1D	R135	6M	3C	U126	4L	2D
J102	4P	1E				U127A	8N	4B
			S100	6E	2B	U127B	10N	4B
K100	10P	3C				U128A	2M	2E
			TP100	9C	5F	U128B	5N	2E
P100	1A	3F	TP101	8B	4A	U129	3O	2D
P100	6P	3F	TP102	7B	4F	U131	1K	2F
P100	7B	3F	TP103	10C	5F			
P101	10B	3F	TP114	8G	4C			


A27 ANLG X-Y OUT BOARD
ANALOG X-Y OUTPUT
3516-107
REV NOV 1983
468 OPTION 11

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REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

SPECIAL NOTES AND SYMBOLS

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

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 *Name & Description*

Assembly and/or Component
Attaching parts for Assembly and/or Component
- - - * - - -
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
- - - * - - -
Parts of Detail Part
Attaching parts for Parts of Detail Part
- - - * - - -

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

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

ABBREVIATIONS

"	INCH
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	COVER
CPLG	COUPLING
CRT	CATHODE RAY TUBE
DEG	DEGREE
DWR	DRAWER
ELCTRN	ELECTRON
ELEC	ELECTRICAL
ELCTLT	ELECTROLYTIC
ELEM	ELEMENT
EPL	ELECTRICAL PARTS LIST
EQPT	EQUIPMENT
EXT	EXTERNAL
FIL	FILLISTER HEAD
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FR	FRAME or FRONT
FSTNR	FASTENER
FT	FOOT
FXD	FIXED
GSKT	GASKET
HDL	HANDLE
HEX	HEXAGON
HEX HD	HEXAGONAL HEAD
HEX SOC	HEXAGONAL SOCKET
HLCPS	HELICAL COMPRESSION
HLEXT	HELICAL EXTENSION
HV	HIGH VOLTAGE
IC	INTEGRATED CIRCUIT
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IMPLR	IMPELLER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATOR
INTL	INTERNAL
LPHLDR	LAMPHOLDER
MACH	MACHINE
MECH	MECHANICAL
MTG	MOUNTING
NIP	NIPPLE
NON WIRE	NOT WIRE WOUND
OBD	ORDER BY DESCRIPTION
OD	OUTSIDE DIAMETER
OVH	OVAL HEAD
PH BRZ	PHOSPHOR BRONZE
PL	PLAIN or PLATE
PLSTC	PLASTIC
PN	PART NUMBER
PNH	PAN HEAD
PWR	POWER
RCPT	RECEPTACLE
RES	RESISTOR
RGD	RIGID
RLF	RELIEF
RTNR	RETAINER
SCH	SOCKET HEAD
SCOPE	OSCILLOSCOPE
SCR	SCREW
SE	SINGLE END
SECT	SECTION
SEMICOND	SEMICONDUCTOR
SHLD	SHIELD
SHLDR	SHOULDERED
SKT	SOCKET
SL	SLIDE
SLFLKG	SELF-LOCKING
SLVG	SLEEVING
SPR	SPRING
SQ	SQUARE
SST	STAINLESS STEEL
STL	STEEL
SW	SWITCH
T	TUBE
TERM	TERMINAL
THD	THREAD
THK	THICK
TNSN	TENSION
TPG	TAPPING
TRH	TRUSS HEAD
V	VOLTAGE
VAR	VARIABLE
W/	WITH
WSHR	WASHER
XFMR	TRANSFORMER
XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

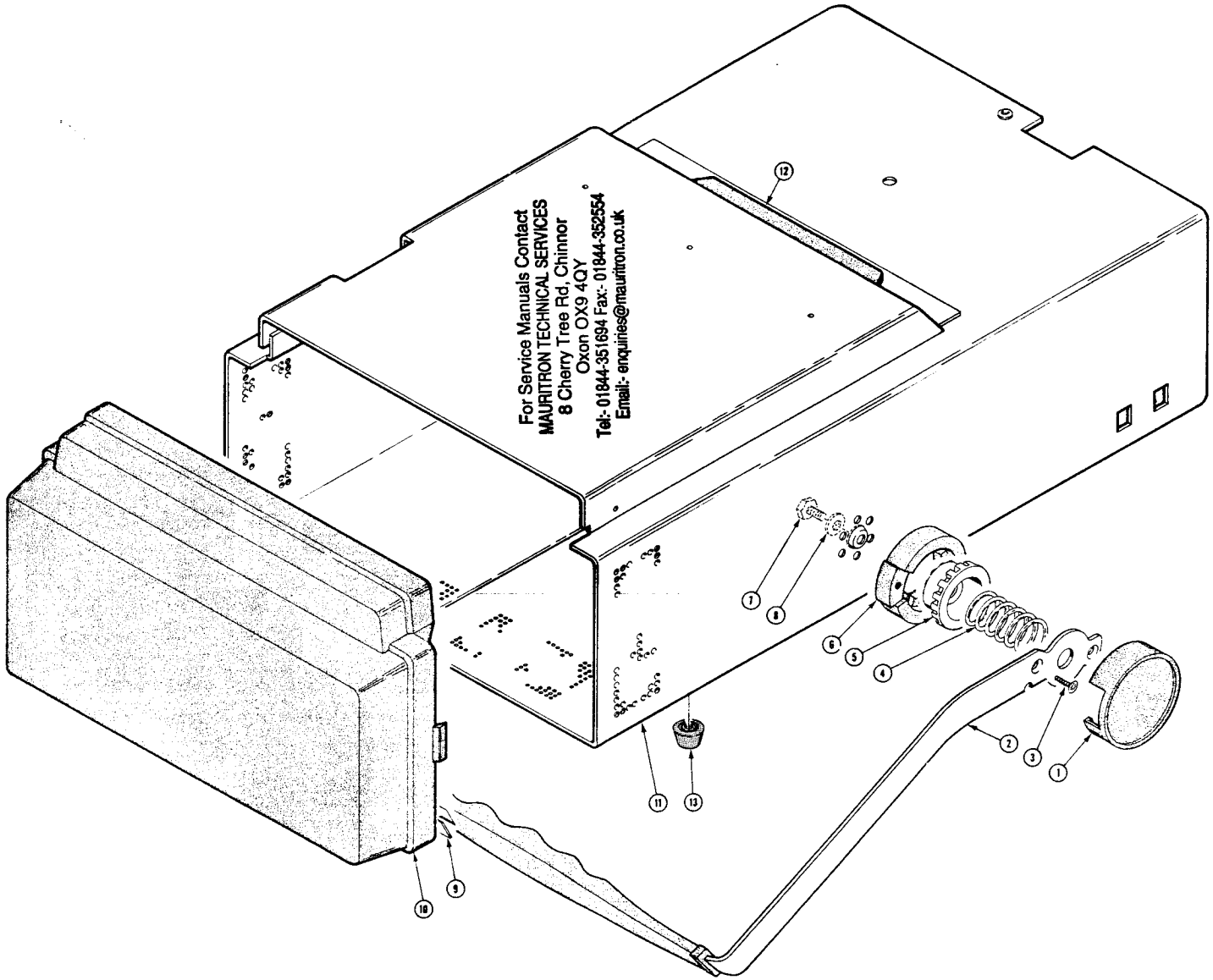
Mfr. Code	Manufacturer	Address	City, State, Zip
000BK	STAUFFER SUPPLY	105 SE TAYLOR	PORTLAND, OR 97214
000CY	NORTHWEST FASTENER SALES, INC.	7923 SW CIRRUS DRIVE	BEAVERTON, OR 97005
000EX	O'HARA METAL PRODUCT COMPANY	542 BRANNAN STREET	SAN FRANCISCO, CA 94107
000HA	BAHRS DIE & STAMPING CO., INC.	4375 ROSS PLAIN RD.	CINCINNATI, OH 45236
00779	AMP, INC.	P.O. BOX 3608	HARRISBURG, PA 17105
01295	TEXAS INSTRUMENTS, INC. SEMICONDUCTOR GROUP	P.O. BOX 5012	DALLAS, TX 75222
01536	CAMCAR DIV OF TEXTRON INC. SEMS PRODUCTS UNIT	1818 CHRISTINA ST.	ROCKFORD, IL 61108
02768	ILLINOIS TOOL WORKS, INC., FASTEX DIV.	195 ALGONQUIN ROAD	DES PLAINES, IL 60016
05006	TWENTIETH CENTURY PLASTICS, INC.	415 E WASHINGTON BLVD.	LOS ANGELES, CA 90015
05129	KILO ENGINEERING COMPANY	2015 D	LA VERNE, CA 91750
06540	AMATOM ELECTRONIC HARDWARE, DIV. OF MITE CORP.	446 BLAKE ST.	NEW HAVEN, CT 06515
06776	ROBINSON NUGENT INC.	800 E. 8TH ST., BOX 470	NEW ALBANY, IN 47150
07700	TECHNICAL WIRE AND PRODUCTS, INC.	129 DERMODY ST.	CRANFORD, NJ 07016
09922	BURNDY CORPORATION	RICHARDS AVENUE	NORWALK, CT 06852
11897	PLASTIGLIDE MFG. CORPORATION	P O BOX 867, 1757 STANFORD ST.	SANTA MONICA, CA 90406
12327	FREEWAY CORPORATION	9301 ALLEN DRIVE	CLEVELAND, OH 44125
12360	ALBANY PRODUCTS CO., DIV. OF PNEUMO DYNAMICS CORPORATION	145 WOODWARD AVENUE	SOUTH NORWALK, CT 06586
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON STREET	DOVER, NH 03820
12881	METEX CORPORATION	970 NEW DURHAM ROAD	EDISON, NJ 08817
13103	THERMALLOY COMPANY, INC.	2021 W VALLEY VIEW LANE P O BOX 34829	DALLAS, TX 75234 LOS GATOS, CA 95030
13511	AMPHENOL CARDRE DIV., BUNKER RAMO CORP.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
22526	BERG ELECTRONICS, INC.	30 LORRAINE AVE.	MT VERNON, NY 10553
23050	PRODUCT COMPONENTS CORP	S BEDFORD STREET	BURLINGTON, MA 01803
24011	ELECTRONIZED CHEMICALS CORPORATION	2620 ENDRESS PLACE	GREENWOOD, IN 46142
24931	SPECIALITY CONNECTOR CO., INC.	1501 W SEPULVEDA BLVD. P.O. BOX 3158	TORRANCE, CA 90510
26233	USM CORP NYLOC FASTENER DIV.	1805 N. SPAULDING AVE.	CHICAGO, IL 60647
27143	ATLAS SPRING AND MFG. CO.	2222 WELLINGTON COURT	LISLE, IL 60532
27264	MOLEX, INC.	147 N. MICHIGAN AVE.	KENILWORTH, NJ 07033
28520	HEYMAN MFG. CO.	509 HINDRY AVE.	INGLEWOOD, CA 90301
28817	CAL-METEX CORP., SUBSIDIARY OF METEX CORP.	5224 NE 42ND AVENUE	PORTLAND, OREGON 97218
52905	SIMPLEX MFG. COMPANY	17333 HEALY	DETROIT, MI 48212
70278	ALLIED STEEL AND CONVEYORS, DIV. OF SPARTON CORP.	571 W. POLK ST.	CHICAGO, IL 60607
70485	ATLANTIC INDIA RUBBER WORKS, INC.	P O BOX 2244, 40 BRISTOL ST.	WATERBURY, CT 06720
71159	BRISTOL SOCKET SCREW, DIV. OF AMERICAN CHAIN AND CABLE CO., INC.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	P O BOX 858	FORT DODGE, IA 50501
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
71785	TRW, CINCH CONNECTORS	446 MORGAN ST.	CINCINNATI, OH 45206
73743	FISCHER SPECIAL MFG. CO.	34 FOREST STREET	ATTLEBORO, MA 02703
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	31 BROOK ST. WEST	HARTFORD, CT 06110
74445	HOLO-KROME CO.	5000 TIEDEMAN ROAD	CLEVELAND, OH 44144
75497	LAMSON AND SESSIONS CO.	5700 W. ROOSEVELT RD.	CHICAGO, IL 60650
77250	PHEOLL MANUFACTURING CO., DIVISION OF ALLIED PRODUCTS CORP.	ST. CHARLES ROAD	ELGIN, IL 60120
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	47-16 AUSTEL PLACE	LONG ISLAND CITY, NY 11101
79136	WALDES, KOHINOOR, INC.	2100 S. O BAY ST.	MILWAUKEE, WI 53207
79807	WROUGHT WASHER MFG. CO.	P O BOX 500	BEAVERTON, OR 97077
80009	TEKTRONIX, INC.	P. O. BOX 278,1345 MIAMI ST.	TOLEDO, OH 43605
80033	PRESTOLE EVERLOCK, INC.	271 MAYHILL ST.	SADDLE BROOK, NJ 07662
83294	ARROW FASTENER CO., INC.	2530 CRESCENT DR.	BROADVIEW, IL 60153
83385	CENTRAL SCREW CO.	2527 GRANT AVENUE	SAN LEANDRO, CA 94579
85471	BOYD, A. B., CO.	2032 E. WESTMORELAND ST.	PHILADELPHIA, PA 19134
86445	PENN FIBRE AND SPECIALTY CO., INC.	701 SONORA AVENUE	GLENDALE, CA 91201
86928	SEASTROM MFG. COMPANY, INC.		
87308	N. L. INDUSTRIES, INC., SOUTHERN SCREW DIV.	P. O. BOX 1360	STATESVILLE, NC 28677

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
89663	REESE, J. RAMSEY, INC.	71 MURRAY STREET	NEW YORK, NY 10007
91260	CONNOR SPRING AND MFG. CO.	1729 JUNCTION AVE.	SAN JOSE, CA 95112
93907	TEXTRON INC. CAMCAR DIV	600 18TH AVE	ROCKFORD, IL 61101
95987	WECKESSER CO., INC.	4444 WEST IRVING PARK RD.	CHICAGO, IL 60641
97464	INDUSTRIAL RETAINING RING CO.	57 CORDIER ST.	IRVINGTON, NJ 07111
S3109	C/O PANEL COMPONENTS CORP.	P.O. BOX 6626	SANTA ROSA, CA 95406
S3629	PANEL COMPONENTS CORP.	2015 SECOND ST.	BERKELEY, CA 94170
T1105	J PHILLIP INDUSTRIES INC	5713 NORTHWEST HIGHWAY	CHICAGO, IL 60646

For Service Manuals Contact
MAURITRON TECHNICAL SERVICES
8 Cherry Tree Rd, Chinnor
Oxon OX9 4QY
Tel:- 01844-351694 Fax:- 01844-352554
Email:- enquiries@mauritron.co.uk

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-	367-0172-04			1		HANDLE CARRYING:PLASTIC	80009	367-0172-04
-1	200-0602-00			2		.COVER,HDL LATCH:2.12 DIA X 0.7,ACETAL	80009	200-0602-00
-2	367-0172-00			1		.HANDLE,CARRYING:12.722 L,BLACK VINYL	80009	367-0172-00
						.**********(ATTACHING PARTS)**********		
-3	213-0227-00			4		.SCR,TPG,THD FOR:6-32 X 0.50 DEG,FLH ST	83385	ORD BY DESCR
						.**********(END ATTACHING PARTS)*********		
-4	214-0516-00			2		.SPRING,HLCPS:0.959 DIA X 1.250 INCH LONG	80009	214-0516-00
-5	214-0515-02			2		.HUB,HDL INDEX:1.42 DIA X 0.565 THK,AL CD	80009	214-0515-02
-6	214-1987-00			2		.INDEX,HDL RING:	80009	214-1987-00
						.**********(ATTACHING PARTS)**********		
-7	213-0139-01			2		.SCREW,SLFLKG:10-24 X 0.375,HEX HD,STL	26233	P38AS 1024 6C
-8	210-1182-00	B010100	B010499	2		.WSHR,SPR TNSN:0.218 ID X 0.69 INCH OD	80009	210-1182-00
	210-0805-00	B010500		2		.WASHER,FLAT:0.204 ID X 0.438 INCH OD,ST	12327	ORD BY DESCR
						.**********(END ATTACHING PARTS)*********		
-9	334-3723-00			1		.MARKER,IDENT:	80009	334-3723-00
-10	200-1723-00			1		COVER,SCOPE:FRONT	80009	200-1723-00
-11	437-0267-01			1		CABINET,SCOPE:W/TOP	80009	437-0267-01
-12	352-0263-00	B010100	B010684	1		.HLDR,POUCH ASSY:TEK BLUE POLYCARBONATE	80009	352-0263-00
	352-0263-01	B010685		1		.HLDR,POUCH ASSY:TEK BLUE POLYCARBONATE	80009	352-0263-01
-13	348-0080-01			4		.FOOT,CABINET:BOTTOM	80009	348-0080-01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8 Cherry Tree Rd, Chinnor
Oxon OX9 4QY
Tel:- 01844-351694 Fax:- 01844-352554
Email:- enquiries@mauritron.co.uk
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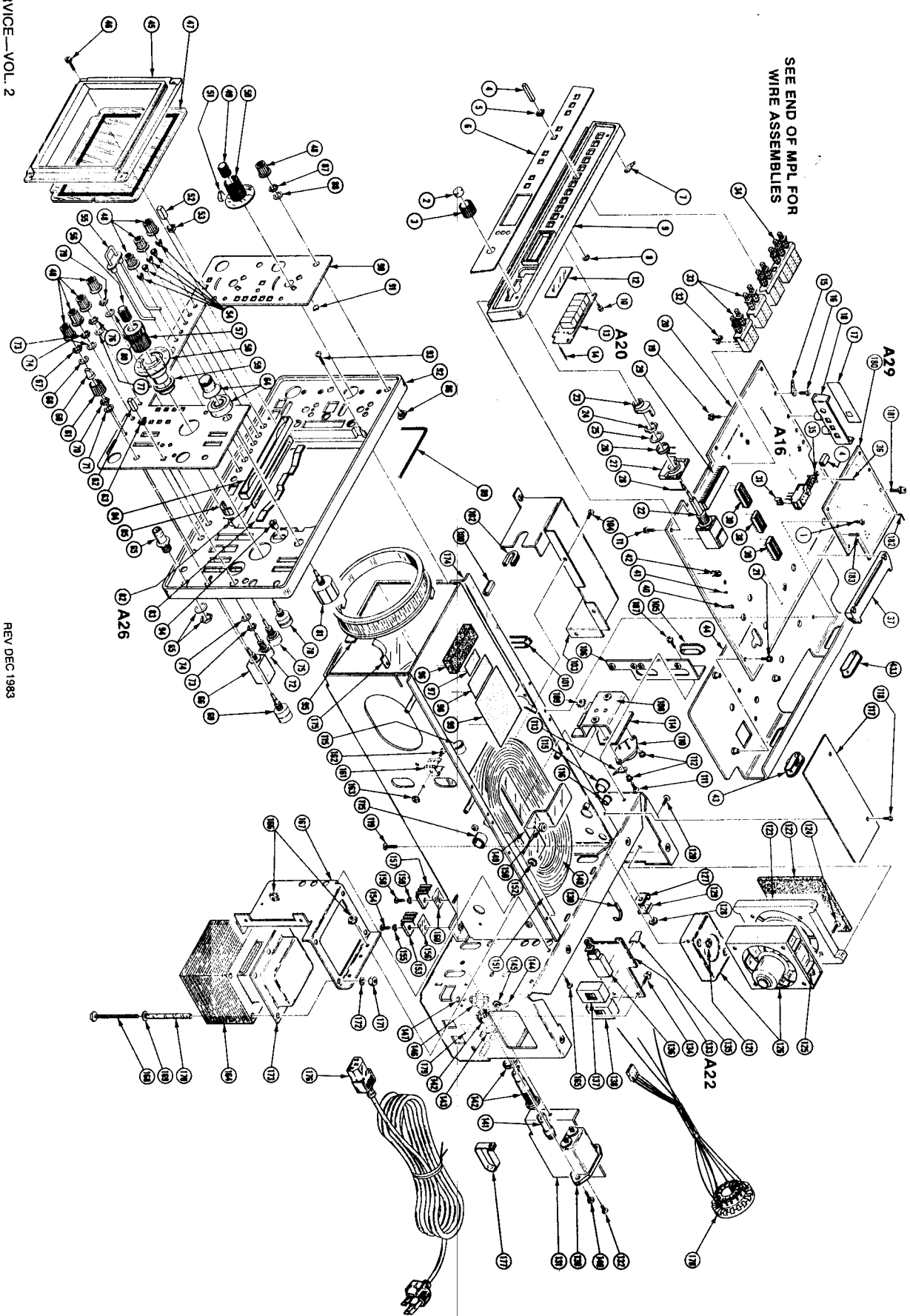
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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-	672-0878-00			1		CKT BOARD ASSY:TOP	80009	672-0878-00
						**********(ATTACHING PARTS)**********		
-1	213-0146-00			4		SCR,TPG,THD FOR:6-20 X 0.313 INCH,PNH STL	83385	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
	----- -----			-		CKT BOARD ASSY INCLUDES:		
-2	366-1820-00			1		.PUSH BUTTON:GRAY,0.227 OD X 0.3 H	80009	366-1820-00
-3	366-1821-00			1		.KNOB:GY,W/WHITE DOT,0.252 ID X 0	80009	366-1821-00
	213-0153-00			1		..SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	ORD BY DESCR
-4	366-1559-00	B010100	B029999	11		.PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
	366-1559-00	B030000	B044276	12		.PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
	366-1559-00	B044277		7		.PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
	366-1512-00	B044277		5		.PUSH BUTTON:GRAY,0.18 SQ X 0.83 INCH LG	80009	366-1512-00
-5	426-1072-00	B010100	B029999	10		.FRAME,PUSH BTN:PLASTIC	80009	426-1072-00
	426-1072-00	B030000		11		.FRAME,PUSH BTN:PLASTIC	80009	426-1072-00
-6	333-2624-00	B010100	B029999	1		.PANEL,FRONT:	80009	333-2624-00
	333-2606-00	B030000		1		.PANEL,FRONT:	80009	333-2606-00
						.**********(ATTACHING PARTS)**********		
-7	210-0201-00			1		.TERMINAL,LUG:0.12 ID,LOCKING,BRZ TIN PL	86928	ORD BY DESCR
-8	354-0195-00			3		.RING,RETAINING:	97464	6100-12-ST-PA
						.**********(END ATTACHING PARTS)**********		
-9	426-1176-00			1		.FRAME SECT,CAB.:FRONT	80009	426-1176-00
						.**********(ATTACHING PARTS)**********		
-10	211-0180-00			2		.SCR,ASSEM WSHR:2-56 X 0.25 INCH,PNH BRS	83385	ORD BY DESCR
-11	211-0244-00			3		.SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						.**********(END ATTACHING PARTS)**********		
-12	331-0397-00			1		.WINDOW,READOUT:0.55 X 1.495 X 0.06,ACRILI	80009	331-0397-00
-13	----- -----			1		.CKT BOARD ASSY:READOUT(SEE A20 REPL)		
-14	131-0589-00			20		..TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-15	210-0207-00			1		.TERMINAL,LUG:0.375 INCH DIAMETER	12697	01136902
						.**********(ATTACHING PARTS)**********		
-16	211-0244-00			1		.SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						.**********(END ATTACHING PARTS)**********		
-17	386-4307-00			1		.PANEL,SIDE:	80009	386-4307-00
-18	386-4299-00			1		.SUBPANEL,SIDE:	80009	386-4299-00
						.**********(ATTACHING PARTS)**********		
-19	211-0244-00			2		.SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						.**********(END ATTACHING PARTS)**********		
	348-0666-00	B010220		1		.SHLD,GSKT,ELEK:SOLID,9.0 L	80009	348-0666-00
-20	----- -----			1		.CKT BOARD ASSY:TOP(SEE A16 REPL)		
						.**********(ATTACHING PARTS)**********		
-21	211-0244-00			7		.SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						.**********(END ATTACHING PARTS)**********		
	----- -----			-		.CKT BOARD ASSY INCLUDES:		
-22	----- -----			1		..SW-VAR RES ASSY:(SEE A16R881/A16S881 REP		
-23	105-0847-00			1		...ACTUATOR,SPRING:PLASTIC	80009	105-0847-00
-24	220-0495-00			1		...NUT,PLAIN,HEX.:0.375-32 X 0.438 INCH BR	73743	ORD BY DESCR
-25	210-1131-00			1		...WASHER,FLAT:0.375 ID X 0.562 INCH OD,NY	80009	210-1131-00
-26	214-3013-00			1		...SPR,HLCL,TRSN:0.5 DIA ID X 0.526 DIA OD	80009	214-3013-00
-27	352-0581-00			1		...HOLDER,SPR RTN:	80009	352-0581-00
-28	131-0595-00			2		...CONTACT,ELEC:1.37 INCH LONG	22526	47355
-29	131-1632-00			1		..CONNECTOR,RCPT,:CKT CD MTG,20 CONTACT,FE	22526	65001-025
-30	136-0634-00	B010100	B033329	11		..SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
-31	361-0383-00			4		..SPACER,PB SW:CHARCOAL,0.33 INCH LONG	80009	361-0383-00
-32	361-0608-00			8		..SPACER,PUSH SW:PLASTIC	80009	361-0608-00
-33	----- -----			2		..SWITCH,PUSH:(SEE A16S831,A16S844 REPL)		
-34	----- -----			1		..SWITCH,PUSH:(SEE A16S813 REPL)		
-35	----- -----			1		..SWITCH,PUSH:(SEE A16S512 REPL)		
-36	131-0608-00			37		..TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-37	131-1780-00			1		..CONNECTOR,RECP,:RT-ANGLE HDR,2/25 MALE	22526	65483-005
-38	136-0260-02	B010100	B033329	11		..SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW C	09922	DILB16P-108T
-39	136-0670-00	B010100	B033329	2		..SKT,PL-IN ELEK:MICROCKT,18 PIN,LOW PROFI	73803	CS9002-18
-40	214-0579-00			7		..TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-41	136-0252-07			45		..SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-42	131-1003-00			9		..CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-43	348-0253-00			1		.GROMMET,PLASTIC:BLACK,OBLONG,3.0X0.925	80009	348-0253-00
-43.1	348-0688-00			1		.GROMMET,PLASTIC:BLACK,OVAL,1.235 OVAL	80009	348-0688-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-44	386-4289-00			1		.PLATE,MOUNTING:CIRCUIT BOARD	80009	386-4289-00
	348-0507-00	B010220		1		..SHLD GSKT,ELEK:MESH TYPE,0.25 X 0.14	12881	01-604-1756
-45	200-1411-00			1		RTNR,IMPLOSION:5.422 X 4.743 X 0.441,GRAY	80009	200-1411-00
-46	213-0313-00			4		.THUMBSCREW:4-40 X 0.45 INCH,KNURLED	80009	213-0313-00
-47	337-1674-00			1		SHLD,ELCTRN TUB:CRT	80009	337-1674-00
-48	366-0494-00			8		KNOB:GRAY WITH SETSCREW	80009	366-0494-00
	213-0246-00			8		.SETSCREW:5-40 X 0.093 ITL BK OXD,HEX	71159	ORD BY DESCR
-49	366-1031-02			2		KNOB:RED,VAR,0.127 ID X 0.392 OD	80009	366-1031-02
	213-0246-00			2		.SETSCREW:5-40 X 0.093 ITL BK OXD,HEX	71159	ORD BY DESCR
-50	366-1426-01			2		KNOB:GRAY,VOLT/DIV,0.191 ID X 1.	80009	366-1426-01
	213-0153-00			2		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	ORD BY DESCR
-51	366-0215-02			2		KNOB:LEVER SWITCH	80009	366-0215-02
-52	366-1559-00			16		PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
-53	426-1072-00			16		FRAME,PUSH BTN:PLASTIC	80009	426-1072-00
-54	358-0599-00			5		BUSHING,SLEEVE:0.125 ID X 0.234 THK,PLSTC	28520	B-187-125
-55	195-0276-01			1		LEAD,ELECTRICAL:0.062 DIA,BRS,W/MLD COLLAR	80009	195-0276-01
-56	366-1346-02			1		KNOB:RED	80009	366-1346-00
	213-0153-00			1		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	ORD BY DESCR
-57	366-1219-01	B010100	B010599	1		KNOB:GRAY--DLYD SWP	80009	366-1219-01
	213-0890-00			2		.SETSCREW:6-32 X 0.25 L,STL BLK OXD	83294	ORD BY DESCR
-58	354-0442-01			1		RING,KNOB SKIRT:CLEAR,1.45 OD	80009	354-0442-01
	213-0005-00	B010100	B010599	2		.SETSCREW:8-32 X 1.25 INCH,HEX SOC ST	74445	ORD BY DESCR
-59	401-0080-01			1		BRG,KNOB SKIRT:0.789 ID X 8.66"OD PLASTIC	80009	401-0080-01
-60	366-1278-00			2		KNOB:GRAY	80009	366-1278-00
	213-0153-00			2		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	ORD BY DESCR
-61	366-1280-00			2		KNOB:GRAY	80009	366-1278-00
	213-0153-00			2		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	ORD BY DESCR
-62	366-1559-07			1		PUSH BUTTON:SIL GY,OFF	80009	366-1559-07
-63	426-1072-00			1		FRAME,PUSH BTN:PLASTIC	80009	426-1072-00
-64	331-0328-00			1		DIAL,CONTROL:10 TURN FOR 0.25 DIA SHAFT	05129	461-S-70
-65	131-0955-00			2		CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
-66	---- ----			1		RESISTOR,VAR:(SEE R14498 REPL)		
						**********(ATTACHING PARTS)**********		
-67	210-0583-00			1		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-68	210-0940-00			1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
-69	---- ----			2		RESISTOR,VAR:(SEE R17305,R17010 REPL)		
						**********(ATTACHING PARTS)**********		
-70	210-0583-00			1		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-71	210-0940-00			1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
-72	---- ----			1		RESISTOR,VAR:(SEE R14499 REPL)		
						**********(ATTACHING PARTS)**********		
-73	210-0583-00			2		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-74	210-0940-00			2		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
-75	---- ----			1		RESISTOR,VAR:(SEE R14398 REPL)		
						**********(ATTACHING PARTS)**********		
-76	210-0583-00			1		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-77	210-0940-00			1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
-78	---- ----			1		RESISTOR,VAR:(SEE R14288 REPL)		
						**********(ATTACHING PARTS)**********		
-79	210-0583-00			1		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-80	210-0940-00			1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
-81	---- ----			1		RESISTOR,VAR:(SEE R16002 REPL)		
-82	---- ----			1		CKT BOARD ASSY:CRT SCALE ILLUM(SEE A26 REP		
-83	378-0728-00			1		.REFLECTOR,LIGHT:SCALE ILLUMINATION	80009	378-0728-00
-84	352-0329-00			1		.LAMPHOLDER:SCALE ILLUMINATION	80009	352-0329-00
-85	386-2340-00			4		SUPPORT,CRT:FRONT	80009	386-2340-00
-86	358-0540-00			2		BSHG,MACH.THD:0.25-32 X 0.128 ID X 0.24"	80009	358-0540-00
						**********(ATTACHING PARTS)**********		
-87	210-0583-00			2		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-88	210-0940-00			2		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		

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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-89	348-0276-00			FT		SHLD,GSKT,ELEK:0.026 OD NPRN W/WIRE NET CO	28817	01-0404-3719
-90	333-2604-00			1		PANEL,FRONT:	80009	333-2604-00
	333-2629-00			1		PANEL,FRONT:	80009	333-2629-00
	----- -----			-		(OPTION 05 ONLY)		
-91	378-0635-00			4		LENS,LIGHT:WHITE	80009	378-0635-00
	334-1418-00			2		PLATE,INDENT:BLANK	80009	334-1418-00
-92	426-1607-00			1		FRAME,CABINET:FRONT	80009	426-1607-00
						**********(ATTACHING PARTS)**********		
-93	213-0183-00			4		SCR,TPG,THD FOR:6-20 X 0.5 TYPE B,PNH,STL	83385	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
	210-0201-00	B010220		1		TERMINAL,LUG:0.12 ID,LOCKING,BRZ TIN PL	86928	ORD BY DESCR
-94	352-0477-00			8		HOLDER,LED:	80009	352-0477-00
-95	----- -----			1		COIL,TUBE DEFL:(SEE L14175 REPL)		
-96	348-0090-00			1		PAD,CUSHIONING:2.03 X 0.69 X 0.312	85471	OBD
-97	334-3448-00			1		MARKER,IDENT:MARKED NOTICE	80009	334-3448-00
-98	334-1379-00			1		LABEL:CRT,ADHESIVE BACK	80009	334-1379-00
-99	334-1951-00			1		MARKER,IDENT:CRT WARNING	80009	334-1951-00
-100	129-0828-00			4		SPACER,POST:0.632 L,W/4-40 THD ONE END	80009	129-0828-00
-101	348-0688-00			1		GROMMET,PLASTIC:BLACK,OVAL,1.235 OVAL	80009	348-0688-00
-102	348-0115-00			1		GROMMET,PLASTIC:U-SHP,0.548 X 0.462 INCH	80009	348-0115-00
-103	337-1688-03			1		SHIELD,ELEC:HIGH VOLTAGE	80009	337-1688-03
						**********(ATTACHING PARTS)**********		
-104	211-0661-00			5		SCREW,MACHINE:4-40 X 0.25 INCH,PNH,STL	78189	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
-105	348-0253-00			2		GROMMET,PLASTIC:BLACK,OBLONG,3.OXO.925	80009	348-0253-00
-106	407-2582-00			1		BRACKET,CKT BD:PREAMPL	80009	407-2582-00
						**********(ATTACHING PARTS)**********		
-107	211-0244-00			5		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
-108	407-1153-00			1		BRACKET,XSTR:ALUMINUM	80009	407-1153-00
						**********(ATTACHING PARTS)**********		
-109	210-0586-00			2		NUT,PL,ASSEM WA:4-40 X 0.25,STL,CD PL	78189	211-041800-00
						**********(END ATTACHING PARTS)*********		
110	----- -----			1		TRANSISTOR:(SEE Q1108 REPL)		
						**********(ATTACHING PARTS)**********		
-111	211-0012-00			2		SCREW,MACHINE:4-40 X 0.375,PNH STL CD PL	83385	ORD BY DESCR
-112	358-0214-00			2		INSULATOR,BSHG:0.25 DIA X 0.188 INCH L	24011	ORD BY DESCR
-113	210-0205-00			1		TERMINAL,LUG:SE #8	86928	5442-7
						**********(END ATTACHING PARTS)*********		
-114	214-1610-00			1		HEAT SINK,ELEC:TRANSISTOR	80009	214-1610-00
-115	348-0064-00			4		GROMMET,PLASTIC:0.625 INCH DIA	80009	348-0064-00
-116	348-0056-00			2		GROMMET,PLASTIC:0.375 INCH DIA	80009	348-0056-00
-117	337-2848-00			1		SHIELD,ELEC:VERTICAL OUTPUT AMPL	80009	337-2848-00
						**********(ATTACHING PARTS)**********		
-118	213-0088-00			2		SCR,TPG,THD CTG:4-24 X 0.25 INCH,PNH STL	83385	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
	119-0830-04			1		FAN,TUBEAXIAL:12VDC,2.4 W,5250 RPM	80009	119-0830-04
						**********(ATTACHING PARTS)**********		
-119	211-0086-00			2		SCREW,MACHINE:4-40 X 0.75 100° DEG,FLH ST	83385	ORD BY DESCR
-120	211-0038-00			4		SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG	83385	ORD BY DESCR
-121	210-0586-00			2		NUT,PL,ASSEM WA:4-40 X 0.25,STL,CD PL	78189	211-041800-00
						**********(END ATTACHING PARTS)*********		
-122	378-2042-00	B010100	B044999	1		.FILTER,AIR:2.9 SQ X 0.25 THK	80009	378-2042-00
	378-2042-02	B045000		1		.FILTER ELEM,AIR:2.9 SQ X 0.25 THK	80009	378-2042-02
-123	426-1698-00			1		.MOUNT,FAN MOTOR:	80009	426-1698-00
						.**********(ATTACHING PARTS)**********		
-124	211-0507-00			2		.SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	ORD BY DESCR
-125	210-0457-00			2		.NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	83385	ORD BY DESCR
						.**********(END ATTACHING PARTS)*********		
-126	----- -----			1		.FAN,TUBE AXIAL:(SEE B1001 REPL)		
-127	343-0136-00			1		CLAMP,LOOP:0.234 INCH MOUNTING HOLE	80009	343-0136-00
						**********(ATTACHING PARTS)**********		
-128	210-0586-00			1		NUT,PL,ASSEM WA:4-40 X 0.25,STL,CD PL	78189	211-041800-00
-129	210-0863-00			1		WSHR,LOOP CLAMP:0.187 ID U/W 0.5 W CLP,STL	95987	C191
						**********(END ATTACHING PARTS)*********		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-130	343-0089-00			2	CLAMP,LOOP:LARGE	80009	343-0089-00
	343-0006-00			2	CLAMP,LOOP:0.750 INCH DIA,PLASTIC	95987	3-4-6B
-131	337-2717-00			1	SHIELD,ELEC:CIRCUIT BOARD AND WIRING	80009	337-2717-00
					**********(ATTACHING PARTS)**********		
-132	211-0008-00			1	SCREW,MACHINE:4-40 X 0.250,PNH,STL,POZ	83385	ORD BY DESCR
					**********(END ATTACHING PARTS)*********		
-133	----- -----			1	CKT BOARD ASSY:LINE SEL SW(SEE A22 REPL)		
					**********(ATTACHING PARTS)**********		
-134	211-0244-00			4	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
-135	131-2427-00			9	.TERM,QIK DISC:CKT BD,BRASS	00779	G2409-1
-136	----- -----			1	.SWITCH,PUSH:(SEE A22S108 REPL)		
-137	----- -----			1	.SWITCH,SLIDE:(SEE A22S216 REPL)		
-138	----- -----			1	.SWITCH,SLIDE:(SEE A22S226 REPL)		
					.**********(END ATTACHING PARTS)*********		
-139	----- -----			1	FILTER,RFI:(SEE FL14500 REPL)		
					**********(ATTACHING PARTS)**********		
-140	211-0507-00			2	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	ORD BY DESCR
					**********(END ATTACHING PARTS)*********		
-141	200-2264-00			1	CAP.,FUSEHOLDER:3AG FUSES	S3629	FEK 031 1666
-142	204-0832-00			1	BODY,FUSEHOLDER:3AG,5 X 20MM FUSES	S3629	031.1673(MDLFEU)
	361-0322-00			1	SPACER,SLEEVE:0.505 ID X 0.10 INCH LONG	80009	361-0322-00
-143	210-1039-00			1	WASHER,LOCK:INT,0.521 ID X 0.625 INCH O	24931	ORD BY DESCR
-144	210-0202-00			2	TERMINAL,LUG:0.146 ID,LOCKING,BRZ,TIN PL	78189	2104-06-00-2520N
					**********(ATTACHING PARTS)**********		
-145	210-0457-00			2	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	83385	ORD BY DESCR
					**********(END ATTACHING PARTS)*********		
-146	----- -----			1	SWITCH,THRMSTC:(SEE S14520 REPL)		
					**********(ATTACHING PARTS)**********		
-147	211-0504-00			2	SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	ORD BY DESCR
					**********(END ATTACHING PARTS)*********		
-148	----- -----			1	DELAY LINE,ELEC:(SEE DL208 REPL)		
-149	407-1138-00			1	BRKT,DELAY LINE:ALUMINUM	80009	407-1138-00
					**********(ATTACHING PARTS)**********		
-150	210-0457-00			1	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	83385	ORD BY DESCR
					**********(END ATTACHING PARTS)*********		
-151	337-1763-01			1	SHIELD,ELEC:TRANSFORMER	80009	337-1763-01
					**********(ATTACHING PARTS)**********		
-152	210-0457-00			1	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	83385	ORD BY DESCR
					**********(END ATTACHING PARTS)*********		
-153	----- -----			2	TRANSISTOR:(SEE Q401,Q701 REPL)		
					**********(ATTACHING PARTS)**********		
-154	211-0012-00			2	SCREW,MACHINE:4-40 X 0.375,PNH STL CD PL	83385	ORD BY DESCR
-155	210-0071-00			2	WASHER,SPR TNSN:0.146 ID X 0.323" OD,STL	78189	4706-05-01-0531
					**********(END ATTACHING PARTS)*********		
-156	342-0163-00			2	INSULR,PLATE:XSTR,0.675 X 0.625 X 0.001"	80009	342-0163-00
-157	----- -----			1	TRANSISTOR:(SEE Q501 REPL)		
					**********(ATTACHING PARTS)**********		
-158	211-0012-00			1	SCREW,MACHINE:4-40 X 0.375,PNH STL CD PL	83385	ORD BY DESCR
-159	210-0071-00			1	WASHER,SPR TNSN:0.146 ID X 0.323" OD,STL	78189	4706-05-01-0531
					**********(END ATTACHING PARTS)*********		
-160	342-0163-00			1	INSULR,PLATE:XSTR,0.675 X 0.625 X 0.001"	80009	342-0163-00
-161	344-0250-00			1	CLIP,ELECTRICAL:COMPONENT MOUNTING	80033	E50005-007
					**********(ATTACHING PARTS)**********		
-162	211-0008-00			1	SCREW,MACHINE:4-40 X 0.250,PNH,STL,POZ	83385	ORD BY DESCR
-163	210-0586-00			1	NUT,PL,ASSEM WA:4-40 X 0.25,STL,CD PL	78189	211-041800-00
					**********(END ATTACHING PARTS)*********		
-164	----- -----			1	TRANSFORMER:(SEE T14500 REPL)		
					**********(ATTACHING PARTS)**********		
-165	211-0507-00			2	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	ORD BY DESCR
-166	210-0457-00			3	NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	83385	ORD BY DESCR
					**********(END ATTACHING PARTS)*********		
	----- -----			-	TRANSFORMER ASSY INCLUDES:		

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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-167	407-1066-00			1		.BRACKET,XFMR:ALUMINUM	80009	407-1066-00
						.**********(ATTACHING PARTS)**********		
-168	212-0523-00			4		.SCREW,MACHINE:10-32 X 2.750,HEX HD STL	83385	ORD BY DESCR
-169	210-0812-00			4		.WASHER,NONMETAL:#10,FIBER	86445	ORD BY DESCR
-170	166-0457-00			4		.INSUL SLVG,ELEC:0.19 ID X 1.875"LONG MYLA	80009	166-0457-00
-171	220-0561-00			4		.NUT,PLAIN,HEX.:10-32 X 0.25 INCH,BRS	80009	220-0561-00
-172	210-0056-00			4		.WASHER,LOCK:SPLIT,0.195 ID X 0.32" OD,P	83385	ORD BY DESCR
						.**********(END ATTACHING PARTS)**********		
	200-1544-00			1		.COVER,ELEC XFMR:3.0 X 2.5 X 0.65,STEEL	000HA	C-100
-174	441-1520-00			1		CHASSIS,SCOPE:MAIN	80009	441-1520-00
-175	214-0291-00			1		.CONTACT,SPRING:1.188 X 0.375 X 0.25 INCH	80009	214-0291-00
-176	161-0104-00			1		CABLE ASSY,PWR,:3 WIRE,98.0 L,W/RTANG CONN	S3109	ORD BY DESCR
	161-0104-08			1		CABLE ASSY,PWR:3,18 AWG,240V,98.0 L	T1105	ORD BY DESCR
	----- -----			-		(A4 NORTH AMERICAN OPTION)		
	161-0104-05			1		CABLE ASSY,PWR:3,18 AWG,240V,98.0 L	S3109	ORD BY DESCR
	----- -----			-		(A3 AUSTRALIAN OPTION)		
	161-0104-06			1		CABLE ASSY,PWR:3 X 0.75MM SQ,220V,98.0L	S3109	ORD BY DESCR
	----- -----			-		(A1 EUROPEAN OPTION)		
	161-0104-07			1		CABLE ASSY,PWR:3 X 0.75MM SQ,240V,98.0 L	S3109	ORD BY DESCR
	----- -----			-		(A2 UNITED KINGDOM OPTION)		
-177	343-0702-00			1		CLAMP,LOOP:STAINLESS STEEL	80009	343-0702-00
-178	136-0750-00			1		SKT,PL-IN ELEK:CRT W/WIRING HARNESS	80009	136-0750-00
-179	334-3379-00			1		MARKER,IDENT:MARKED GROUND SYMBOL	80009	334-3379-00
-180	----- -----			1		CKT BOARD ASSY:TV SYNC SEPARATOR		
	----- -----			-		(OPT. 5 ONLY - SEE A29 REPL)		
						**********(ATTACHING PARTS)**********		
-181	211-0116-00			4		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
-182	131-0589-00			10		.TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-183	214-0579-00			1		.TERM,TEST POINT:BRS CD PL	80009	214-0579-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
3-1	384-1408-00			2		EXTENSION SHAFT:3.8 L,MOLDED PLASTIC	80009	384-1408-00
-2	384-0457-00			1		EXTENSION SHAFT:6.7 L X 0.123 OD EPOXY-GL	80009	384-0457-00
-3	384-1187-00	B010100	B044999	2		EXTENSION SHAFT:3.40 INCH LONG	80009	384-1187-00
	384-1187-01	B045000		2		EXTENSION SHAFT:3.32 L X 0.125 OD ALUMINUM	80009	384-1187-01
-4	384-1179-00			1		EXTENSION SHAFT:9.312 INCH LONG	80009	384-1179-00
-5	384-1174-00			1		EXTENSION SHAFT:1.80 INCH LONG	80009	384-1174-00
-6	376-0029-00	B010100	B044999	5		CPLG,SHAFT,RGD:0.128 ID X 0.312 OD X 0.5"L	80009	376-0029-00
	376-0053-00	B045000		5		CPLG,SHAFT,RGD:0.128 ID X 0.312 OD	80009	376-0053-00
-7	131-1428-00			1		CONTACT,ELEC:GROUNDING CLIP	80009	131-1428-00
						**********(ATTACHING PARTS)**********		
-8	211-0097-00			1		SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL	83385	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
-9	337-1711-03			1		SHIELD,ELEC:HIGH VOLTAGE	80009	337-1711-03
						**********(ATTACHING PARTS)**********		
-10	211-0008-00			3		SCREW,MACHINE:4-40 X 0.250,PNH,STL,POZ	83385	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
-11	342-0175-00			1		INSULATOR,FILM:3.65 X 4.70 INCH	80009	342-0175-00
-12	---- ----			2		TRANSISTOR:(SEE Q390,Q718 REPL)		
						**********(ATTACHING PARTS)**********		
-13	211-0062-00			2		SCREW,MACHINE:2-56 X 0.312,PNH,STL	83385	ORD BY DESCR
-14	210-0938-00			2		WASHER,FLAT:0.109 ID X 0.25 INCH OD,STL	75497	AN960-3
-15	210-1156-00			2		WASHER,SHLDR:0.09 ID X 0.085 D,NYL,0.2 O	80009	210-1156-00
						**********(END ATTACHING PARTS)*********		
-16	342-0166-00			2		INSULATOR,PLATE:TRANSISTOR	80009	342-0166-00
-17	---- ----			1		CKT BOARD ASSY:INTERFACE(SEE A15 REPL)		
						**********(ATTACHING PARTS)**********		
-18	211-0244-00			7		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
-19	129-0413-01			4		SPACER,POST:0.538 L,W/4-40 TAP 1 END	80009	129-0413-01
-20	210-0994-00			4		WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5702-201-20
						**********(END ATTACHING PARTS)*********		
	---- ----			-		CKT BOARD ASSY INCLUDES:		
-21	131-0608-00			41		.TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-22	214-0579-00			17		.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-23	136-0514-00	B010100	B033329	2		.SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	09922	DILB8P-108
-24	136-0252-07			173		.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-25	124-0092-00			2		.TERMINAL BOARD:3 NOTCH,CERAMIC,CLIP MTD	80009	124-0092-00
-26	124-0118-00			1		.TERMINAL BOARD:1 NOTCH,CERAMIC,CLIP MTD	80009	124-0118-00
-27	361-0007-00			3		.SPACER,SLEEVE:0.250 INCH DIA,PLASTIC	80009	361-0007-00
-28	136-0499-12			1		.CONNECTOR,RCPT,:12 CONTACT	00779	4-380949-2
-29	131-1261-00	B010100	B044709	24		.CONTACT,ELEC:F-SHAPED	00779	1-380953-0
	131-0787-00	B044710		24		.CONTACT,ELEC:0.64 INCH LONG	22526	47359
-30	136-0269-02	B010100	B033329	3		.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CL	09922	DILB149P-108
-31	136-0499-14			1		.CONNECTOR,RCPT,:14 CONTACT	00779	4-380949-4
-32	344-0154-00			4		.CLIP,ELECTRICAL:FUSE,CKT BD MT	80009	344-0154-00
-33	131-1003-00			7		.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-34	337-1759-00			1		.SHLD,ELECTRICAL:SWEEP	80009	337-1759-00
-35	---- ----			1		.RESISTOR VAR:(SEE A15R335 REPL)		
						.**********(ATTACHING PARTS)**********		
-36	210-0583-00			1		.NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-37	210-0046-00			1		.WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
-38	210-0940-00			1		.WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	ORD BY DESCR
						.**********(END ATTACHING PARTS)*********		
-39	386-2433-00			1		.SUPPORT,VAR RES:CIRCUIT BOARD MOUNTING	80009	386-2433-00
-40	---- ----			1		.SWITCH,PUSH:(SEE A15S678 REPL)		
-41	361-0382-00			4		.SPACER,PB SW:BROWN,0.275 INCH LONG	80009	361-0382-00
-42	---- ----			1		.RESISTOR,VAR:(SEE A14R492 REPL)		
-43	361-0607-00			3		.SPACER,SWITCH:PLASTIC	80009	361-0607-00
-44	---- ----			1		.RESISTOR,VAR:(SEE A15R378 REPL)		
-45	---- ----			1		.RESISTOR,VAR:(SEE A15R377 REPL)		
-46	---- ----			1		.RESISTOR,VAR:(SEE A15R252 REPL)		
-47	---- ----			1		.SWITCH,PUSH:(SEE A15S175 REPL)		
-48	---- ----			1		.MULTPLIER:(SEE U136 REPL)		
						.**********(ATTACHING PARTS)**********		
-49	220-0736-00			2		.NUT,PL,EXT WSHR:8-32 X 0.344 HEX,NYLON	23050	ORD BY DESCR
						.**********(END ATTACHING PARTS)*********		

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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
3-50	342-0159-00			1		INSULATOR,FILM:5.10 X 12.4 INCH	80009	342-0159-00
-51	384-1236-03			1		EXTENSION SHAFT:14.354 L,PLSTC,BLK,1.5 OFS	80009	384-1236-03
-52	407-2477-00			1		BRACKET,SUPPORT:SWITCH SHAFT,ALUMINUM	80009	407-2477-00
						**********(ATTACHING PARTS)**********		
-53	211-0244-00	B010100	B044698	1		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
	211-0008-00	B044699		1		SCREW,MACHINE:4-40 X 0.250,PNH,STL,POZ	83385	ORD BY DESCR
-54	210-0586-00			1		NUT,PL,ASSEM WA:4-40 X 0.25,STL,CD PL	78189	211-041800-00
-55	210-0551-00			1		NUT,PLAIN,HEX.:4-40 X 0.25 INCH,STL	000BK	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
-56	426-0785-00			1		FR,PUSH BUTTON:GRAY PLASTIC	80009	426-0785-00
-57	129-0413-01	B010100	B010599	1		SPACER,POST:0.538 L,W/4-40 TAP 1 END	80009	129-0413-01
-58	386-2660-00			1		SUPPORT,CKT BD:ACETAL	80009	386-2660-00
-59	211-0244-00			1		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
-60	210-0994-00	B010100	B010599	1		WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5702-201-20
-61	----- -----			1		CKT BOARD ASSY:TRIG GEN & SW LOG(SEE A12 R		
						**********(ATTACHING PARTS)**********		
-62	211-0244-00			4		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						**********(END ATTACHING PARTS)*********		
	----- -----			-		CKT BOARD ASSY INCLUDES:		
-63	386-2376-00			1		.PLATE,LEVER MTG:SLIDE SWITCH	80009	386-2376-00
						.**********(ATTACHING PARTS)**********		
-64	210-0657-01			2		.EYELET,METALLIC:0.089 OD X 0.218 IN LONG	80009	210-0657-01
						.**********(END ATTACHING PARTS)*********		
-65	131-0608-00			23		.TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-66	200-0945-01			3		.COVER,HALF XSTR:DUAL TO-18,W/2-56 THD	80009	200-0945-01
						.**********(ATTACHING PARTS)**********		
-67	211-0062-00			3		.SCREW,MACHINE:2-56 X 0.312,PNH,STL	83385	ORD BY DESCR
						.**********(END ATTACHING PARTS)*********		
-68	200-0945-00			3		.COVER,HALF XSTR:DUAL TO-18,ALUMINUM	80009	200-0945-00
-69	136-0499-10			1		.CONNECTOR,RCPT,:10 CONTACT	00779	4-380949-0
-70	136-0499-14			1		.CONNECTOR,RCPT,:14 CONTACT	00779	4-380949-4
-71	136-0634-00	B010100	B033329	3		.SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
-72	214-0579-00			4		.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-73	136-0252-07			106		.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-74	131-1003-00			8		.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-75	131-0590-00			10		.CONTACT,ELEC:0.71 INCH LONG	22526	47351
-76	355-0175-00			1		.STUD,SELF-LKG:4-40 X 0.35 INCH LONG	80009	355-0175-00
	----- -----			-		.SWITCH,SL ACTR ASSY:(SEE S320 REPL)		
	351-0355-01			1		..GUIDE,SLIDE SW:W/SPRINGS AND ROLLERS	80009	351-0355-01
-77	351-0355-00			1		...GUIDE,SLIDE SW:	80009	351-0355-00
-78	214-1126-01			2		...SPRING,FLAT:0.7 X 0.125,CU BE GRN CLR	80009	214-1126-01
-79	214-1127-00			2		...ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-80	105-0806-00			1		..ACTUATOR,SL SW:6 OF 6 POSITIONS	80009	105-0806-00
-81	131-2235-02			2		..CONTACT,ELEC:	80009	131-2235-02
	----- -----			1		.SWITCH,SL ACTR ASSY:(SEE S420 REPL)		
	351-0355-01			1		..GUIDE,SLIDE SW:W/SPRINGS AND ROLLERS	80009	351-0355-01
-82	351-0355-00			1		....GUIDE,SLIDE SW:	80009	351-0355-00
-83	214-1126-01			2		....SPRING,FLAT:0.7 X 0.125,CU BE GRN CLR	80009	214-1126-01
-84	214-1127-00			2		....ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-85	105-0805-00			1		..ACTUATOR,SL SW:4 OF 6 POSITIONS	80009	105-0805-00
-86	131-2235-02			2		..CONTACT,ELEC:	80009	131-2235-02
	----- -----			1		.SWITCH,SL ACTR ASSY:(SEE S120 REPL)		
	351-0355-01			1		..GUIDE,SLIDE SW:W/SPRINGS AND ROLLERS	80009	351-0355-01
-87	351-0355-00			1		....GUIDE,SLIDE SW:	80009	351-0355-00
-88	214-1126-01			2		....SPRING,FLAT:0.7 X 0.125,CU BE GRN CLR	80009	214-1126-01
-89	214-1127-00			2		....ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-90	105-0804-00			1		..ACTUATOR,SL SW:4 OF 5 POSITIONS	80009	105-0804-00
-91	131-2235-02			2		..CONTACT,ELEC:	80009	131-2235-02
	----- -----			-		.SWITCH,SL ACTR ASSY:(SEE S220 REPL)		
	351-0355-01			1		..GUIDE,SLIDE SW:W/SPRINGS AND ROLLERS	80009	351-0355-01
-92	351-0355-00			1		....GUIDE,SLIDE SW:	80009	351-0355-00
-93	214-1126-01			2		....SPRING,FLAT:0.7 X 0.125,CU BE GRN CLR	80009	214-1126-01
-94	214-1127-00			2		....ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
3-95	105-0807-00			1		..ACTUATOR,SL SW:5 OF 6 POSITIONS	80009	105-0807-00
-96	131-2235-02			2		..CONTACT,ELEC:	80009	131-2235-02
-97	384-1160-00			4		.EXTENSION SHAFT:LEVER SWITCH	91260	ORD BY DESCR
-98	376-0142-00			4		.ADPT,SHAFT,CPLG:SLIDE TO SHAFT	80009	376-0142-00
						.**********(ATTACHING PARTS)**********		
-99	354-0165-00			4		.RING,RETAINING:0.114 FREE ID X 0.025 INCH	97464	1000-15
						.**********(END ATTACHING PARTS)**********		
-100	214-1770-00			4		.LEVER,SLIDE SW:	80009	214-1770-00
-101	407-1157-00			1		BRACKET,ELEC SW:ALUMINUM	80009	407-1157-00
-102	384-1136-00			3		EXTENSION SHAFT:0.95 INCH LONG	80009	384-1136-00
-103	384-1059-00			4		EXTENSION SHAFT:6.58 INCH LONG	80009	384-1059-00
	672-0866-00			1		CKT BOARD ASSY:TIMING	80009	672-0866-00
						**********(ATTACHING PARTS)**********		
-104	211-0244-00			1		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
-105	129-0386-00			1		POST,ELEC-MECH:HEX,1.593 INCH LONG	80009	129-0386-00
						**********(END ATTACHING PARTS)**********		
	----- -----			-		.CKT BOARD ASSY INCUDES:		
-106	384-1568-00			1		.EXTENSION SHAFT:8.39 L X 0.081 OD	80009	384-1568-00
-107	131-0963-00			1		.CONTACT,ELEC:GROUNDING	000EX	ORD BY DESCR
	----- ----			1		.SWITCH,CAM ACTR AS:(SEE S249 REPL)		
						.**********(ATTACHING PARTS)**********		
-108	211-0678-00			7		.SCR,ASSEM WSHR:4-40 X 0.281 L,PNH STEEL	01536	ORD BY DESCR
						.**********(END ATTACHING PARTS)**********		
	----- -----			-		.CAM SWITCH ASSY INCLUDES:		
-109	337-2621-00			1		..SHIELD,ELEC:SWITCH	80009	337-2621-00
						..**********(ATTACHING PARTS)**********		
-110	211-0678-00			1		..SCR,ASSEM WSHR:4-40 X 0.281 L,PNH STEEL	01536	ORD BY DESCR
						..**********(END ATTACHING PARTS)**********		
-111	200-2442-00			1		..COVER,CAM SW:45 ELEMENT	80009	200-2442-00
						..**********(ATTACHING PARTS)**********		
-112	211-0101-00			1		..SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,ST	83385	ORD BY DESCR
-113	211-0678-00			6		..SCR,ASSEM WSHR:4-40 X 0.281 L,PNH STEEL	01536	ORD BY DESCR
						..**********(END ATTACHING PARTS)**********		
-114	210-0406-00			2		..NUT,PLAIN,HEX:4-40 X 0.188,BRS,CD PL	73743	12161-50
-115	131-0963-00			1		..CONTACT,ELEC:GROUNDING	000EX	ORD BY DESCR
-116	214-1139-02	B010100	B010804	2		..SPRING,FLAT:GREEN COLORED	80009	214-1139-02
	214-1139-02	B010805		1		..SPRING,FLAT:GREEN COLORED	80009	214-1139-02
	214-1139-03	B010100	B010804	2		..SPRING,FLAT:RED COLORED	80009	214-1139-03
	214-1139-03	B010805		3		..SPRING,FLAT:RED COLORED	80009	214-1139-03
-117	214-1752-00			4		..ROLLER,DETENT:	80009	214-1752-00
-118	401-0180-00			1		..BEARING,CAM SW:FRONT & REAR	80009	401-0180-00
						..**********(ATTACHING PARTS)**********		
-119	354-0390-00			1		..RING,RETAINING:0.338 ID X 0.025" THK,STL	79136	5100-37MD
						..**********(END ATTACHING PARTS)**********		
-120	384-0878-22			1		..SHAFT,CAM SW:1.754 L X 0.248 OD	80009	384-0878-22
-121	105-0844-01			1		..ACTUATOR,CAM SW:TIME/DIV,FRONT	80009	105-0844-01
-122	210-0406-00			8		..NUT,PLAIN,HEX:4-40 X 0.188,BRS,CD PL	73743	12161-50
-123	407-1199-00			1		..BRACKET,COVER:ABS	80009	407-1199-00
-124	401-0178-01			1		..BEARING,CAM SW:CENTER/REAR	80009	401-0178-01
-125	105-0845-01			1		..ACTUATOR,CAM SW:TIME/DIV,REAR	80009	105-0845-01
126	214-1416-00			1		..SPRING,HLCPS:0.176 OD X 0.835 INCH LONG	27143	OBD
-127	210-1160-00			1		..WASHER,FLAT:0.129 ID X 0.031 THK,TEFLON	86928	5612-32-31
-128	354-0392-00			1		..RING,RETAINING:	79136	5555-12MD
-129	384-0882-08			1		..SHAFT,CAM SW:7.535 L X 0.125 OD	80009	384-0882-08
-130	210-0406-00			4		..NUT,PLAIN,HEX:4-40 X 0.188,BRS,CD PL	73743	12161-50
-131	401-0180-00			1		..BEARING,CAM SW:FRONT & REAR	80009	401-0180-00
-132	376-0039-00			1		.ADPT,SHAFT,CPLG:0.128 AND 0.082"DIA SHAFT	80009	376-0039-00
-133	361-0515-00			1		.SPACER,SWITCH:PLASTIC	80009	361-0515-00
-134	----- -----			1		.RESISTOR,VAR:(SEE R272 REPL)		
-135	----- -----			1		.CKT BOARD ASSY:TIMING(SEE A13 REPL)		
-136	131-1261-00	B010100	B044709	26		..CONTACT,ELEC:F-SHAPED	00779	1-380953-0
	131-0787-00	B044710		26		..CONTACT,ELEC:0.64 INCH LONG	22526	47359
-137	131-0604-00			44		..CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-138	----- -----			1		..SWITCH,PUSH:(SEE S410 REPL)		

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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
3-139	361-0542-00			8		..SPACER,SWITCH:PLASTIC	71590	J-64281
-140	131-0608-00			24		..TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-141	----- -----			1		..SWITCH,PUSH:(SEE S469 REPL)		
-142	136-0252-07			12		..SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-143	210-0202-00			1		TERMINAL,LUG:0.146 ID,LOCKING,BRZ,TIN PL	78189	2104-06-00-2520N
						**********(ATTACHING PARTS)**********		
-144	211-0507-00			1		SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	ORD BY DESCR
-145	210-0457-00			1		NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	83385	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
-146	343-0144-00			1		CLAMP,LOOP:0.125 INCH ID,BLK NYLON	95987	1-8-2
						**********(ATTACHING PARTS)**********		
-147	210-0457-00			1		NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	83385	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
-148	386-4225-00			1		SUPPORT,CLAMP:ALUMINUM	80009	386-4225-00
-149	407-1128-00			1		BRKT,CRT SHIELD:REAR,NYLON	80009	407-1128-00
						**********(ATTACHING PARTS)**********		
-150	211-0507-00			2		SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	ORD BY DESCR
-151	210-0804-00			2		WASHER,FLAT:0.17 ID X 0.375 INCH OD,STL	12327	ORD BY DESCR
-152	220-0419-00			2		NUT,PLAIN,SQ:6-32 X 0.312 INCH,STL	83385	ORD BY DESCR
-153	210-0202-00			1		TERMINAL,LUG:0.146 ID,LOCKING,BRZ,TIN PL	78189	2104-06-00-2520N
						**********(END ATTACHING PARTS)**********		
-154	----- -----			1		CKT BOARD ASSY:VERTICAL OUTPUT(SEE A23 REP		
						**********(ATTACHING PARTS)**********		
-155	211-0244-00			2		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
-156	220-0456-00			1		NUT,PLAIN,HEX.:6-32 X 0.25 INCH,STL	73743	9038
-157	210-0055-00			1		WASHER,LOCK:SPLIT,0.145 ID X 0.253 OD,S	83385	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
	----- -----			-		CKT BOARD ASSY INCLUDES:		
-158	136-0514-00	B010100	B033329	2		.SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	09922	DILB8P-108
-159	131-0608-00			6		.TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-160	----- -----			1		.MICROCIRCUIT,LI:(SEE U239 REPL)		
-161	407-1149-00			1		.BRACKET,GND:MICROCIRCUIT,BRASS	80009	407-1149-00
-162	136-0252-07			47		.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-163	361-0008-00			4		SPACER,SLEEVE:0.11 ID X 0.25 OD X 0.28"H	80009	361-0008-00
-164	343-0217-00			1		CLAMP,COIL:Y-AXIS	80009	343-0217-00
						**********(ATTACHING PARTS)**********		
-165	211-0147-00			2		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	ORD BY DESCR
-166	210-0994-00			2		WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5702-201-20
						**********(END ATTACHING PARTS)**********		
-167	----- -----			1		COIL,TUBE,DEFL:(SEE L14176 REPL)		
-168	200-1459-00			1		COVER,CRT:REAR	80009	200-1459-00
						**********(ATTACHING PARTS)**********		
-169	211-0244-00			2		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
-170	343-0945-00			1		RETAINER,SPRT:CRT	80009	343-0945-00
-171	386-2246-00			2		SUPPORT,CRT:REAR	80009	386-2246-00
-172	348-0145-00			1		GROMMET,PLASTIC:U-SHP,1.0 X 0.42 INCH	80009	348-0145-00
-173	337-1644-00			1		SHLD,ELECTRICAL:CRT NECK	80009	337-1644-00
-174	384-1007-01			2		EXTENSION SHAFT:8.428 L X 0.124 OD PLSTC	80009	384-1007-01
-175	376-0029-00			2		CPLG,SHAFT,RGD:0.128 ID X 0.312 OD X 0.5"L	80009	376-0029-00
-176	----- -----			1		CKT BOARD ASSY:VERTICAL PREAMP(SEE A11 REP		
						**********(ATTACHING PARTS)**********		
-177	211-0244-00			9		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
	----- -----			-		CKT BOARD ASSY INCLUDES:		
-178	----- -----			2		.RESISTOR,VAR:(SEE R145,345 REPL)		
-179	361-0607-00			4		.SPACER,SWITCH:PLASTIC	80009	361-0607-00
-180	214-0579-02			5		.TERM,TEST POINT:BRASS	80009	214-0579-02
-181	136-0269-02	B010100	B039999	2		.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CL	09922	DILB149P-108
-182	136-0260-02	B010100	B039999	2		.SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CL	09922	DILB16P-108T
-183	136-0252-07	B010100	B039999	90		.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-184	131-0608-00			17		.TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-185	131-1003-00			14		.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-186	----- -----			1		.SWITCH,PUSH:(SEE S310 REPL)		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
3-187	361-0411-00			4		.SPACER,PUSH SW:0.13 W X 0.375 INCH L,PLST	71590	J64285-00
-188	---- ----			2		.RESISTOR,VAR:(SEE R270,470 REPL)		
-189	361-1035-00			2		.SPACER,VAR RES:0.262 L,NYLON	80009	361-1035-00
-190	---- ----			1		.SWITCH,PUSH:(SEE S586 REPL)		
	200-0945-00	B040000		6		.COVER,HALF XSTR:DUAL TO-18,ALUMINUM	80009	200-0945-00
	200-0945-01	B040000		6		.COVER,HALF XSTR:DUAL TO-18,W/2-56 THD	80009	200-0945-01
	211-0001-00	B040000		6		.SCREW,MACHINE:2-56 X 0.25 INCH,PNH STL	87308	ORD BY DESCR
-191	376-0051-01			2		CPLG,SHAFT,FLEX:0.127 ID X 0.375 OD	80009	376-0051-01
-192	384-1560-00			1		EXTENSION SHAFT:4.834 L GL FILLED NYLON	80009	384-1560-00
-193	384-1542-00			1		EXTENSION SHAFT:11.682 L X 0.187 SQ,PLSTC	80009	384-1542-00
-194	337-2793-00			1		SHIELD,ELEC:PREAMP CKT BOARD	80009	337-2793-00
-195	384-1149-00			2		EXTENSION SHAFT:7.0 INCH LONG	80009	384-1149-00
	672-0867-00			1		CKT BOARD ASSY:VERTICAL MODE	80009	672-0867-00
						**********(ATTACHING PARTS)**********		
-196	211-0244-00			3		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
-197	129-0457-00			2		SPACER,POST:1.07L,W/4-40 TAP 1 END	80009	129-0457-00
-198	213-0055-00			2		SCR,TPG,THD FOR:2-32 X 0.188 INCH,PNH STL	93907	ORD BY DESCR
-199	210-0938-00			2		WASHER,FLAT:0.109 ID X 0.25 INCH OD,STL	75497	AN960-3
-200	210-0586-00			4		NUT,PL,ASSEM WA:4-40 X 0.25,STL,CD PL	78189	211-041800-00
						**********(END ATTACHING PARTS)**********		
	---- ----			-		CKT BOARD ASSY INCLUDES:		
-201	200-1439-00			2		.COVER,CHASSIS:ATTENUATOR	80009	200-1439-00
						.**********(ATTACHING PARTS)**********		
-202	211-0244-00			8		.SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						.**********(END ATTACHING PARTS)**********		
-203	---- ----			2		.CKT BOARD ASSY:ATTENUATOR(SEE A24 REPL)		
						.**********(ATTACHING PARTS)**********		
-204	211-0244-00			4		.SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
-205	129-0299-00			8		.POST,ELEC-MECH:HEX,0.333 INCH LONG	80009	129-0299-00
-206	210-1307-00			8		.WASHER,LOCK:0.115 ID,SPLIT,0.025 THK	86928	A384-25N
						.**********(END ATTACHING PARTS)**********		
	---- ----			-		.CKT BOARD ASSY INCLUDES:		
-207	131-1030-00	B010100	B044999	20		..CONT ASSY,ELEC:CAM SWITCH,BOTTOM	80009	131-1030-00
	131-1030-00	B045000		18		..CONT ASSY,ELEC:CAM SWITCH,BOTTOM	80009	131-1030-00
	131-1030-04	B045000		2		..CONT ASSY,ELEC:CAM SWITCH,BOTTOM	80009	131-1030-04
						..**********(ATTACHING PARTS)**********		
-208	210-3082-00			20		..EYELET,METALLIC:0.047 OD X 0.133 L,BRASS	80009	210-3082-00
						..**********(END ATTACHING PARTS)**********		
-209	337-1406-00			1		..SHLD,ELECTRICAL:CAM CONTACTS	80009	337-1406-00
-210	136-0252-07			48		..SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-211	131-1031-00			20		..CONTACT ASSY,EL:CAM SWITCH,TOP	80009	131-1031-00
-212	136-0333-00			4		..SOCKET,PIN TERM:U/W 0.03 DIA PINS	00779	1-331677-4
-213	131-0679-02			2		..CONNECTOR,RCPT,:BNC,MALE,3 CONTACT	24931	28JR270-1
						..**********(ATTACHING PARTS)**********		
-214	220-0695-00			2		..NUT,PLAIN,DODEC:0.500-28 X 0.90 INCH,BRS	73743	ORD BY DESCR
-215	210-1039-00			2		..WASHER,LOCK:INT,0.521 ID X 0.625 INCH O	24931	ORD BY DESCR
-216	210-0845-00			2		..WASHER,FLAT:0.500 ID X 0.625 INCH OD,ST	89663	634-R
						..**********(END ATTACHING PARTS)**********		
-217	441-1058-02			2		..CHASSIS,SCOPE:ATTENUATOR	80009	441-1058-02
						..**********(ATTACHING PARTS)**********		
-218	211-0001-00			4		..SCREW,MACHINE:2-56 X 0.25 INCH,PNH STL	87308	ORD BY DESCR
-219	210-0053-00			4		..WASHER,LOCK:INTL,0.092 ID X 0.175"OD	83385	ORD BY DESCR
-220	210-1008-00			4		..WASHER,FLAT:0.09 ID X 0.188" OD,BRS	12360	ORD BY DESCR
-221	210-0405-00			4		..NUT,PLAIN,HEX:2-56 X 0.188,BRS,CD PL	73743	12157-50
						**********(END ATTACHING PARTS)**********		
-222	105-0243-00			2		.ACTUATOR,SWITCH:AC,DC	80009	105-0243-00
-223	213-0214-00			2		.SCREW,CAP SCH:2-56 X 0.375"HEX HD STL	70278	ORD BY DESCR
-224	131-0963-00			2		.CONTACT,ELEC:GROUNDING	000EX	ORD BY DESCR
	---- ----			2		.SW CAM ACTR AS:(SEE S295,495 REPL)		
						.**********(ATTACHING PARTS)**********		
-225	211-0244-00			8		.SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						.**********(END ATTACHING PARTS)**********		
	---- ----			-		.CAM SW ASSY INCLUDES:		
-226	210-0406-00			20		..NUT,PLAIN,HEX:4-40 X 0.188,BRS,CD PL	73743	12161-50
-227	131-0963-00			2		..CONTACT,ELEC:GROUNDING	000EX	ORD BY DESCR
-228	214-1139-02			2		..SPRING,FLAT:GREEN COLORED	80009	214-1139-02

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
3-229	214-1752-00			4		..ROLLER,DETENT:	80009	214-1752-00
-203	401-0180-00			2		..BEARING,CAM SW:FRONT & REAR	80009	401-0180-00
						..**********(ATTACHING PARTS)**********		
-231	354-0390-00			2		..RING,RETAINING:0.338 ID X 0.025" THK,STL	79136	5100-37MD
						..**********(END ATTACHING PARTS)**********		
-232	384-0878-02			2		..SHAFT,CAM SW:	80009	384-0878-02
-233	105-0282-01			2		..ACTUATOR,CAM SW:DC,GND,AC	80009	105-0282-01
-234	401-0178-00			2		..BEARING,CAM SW:CENTER	80009	401-0178-00
						..**********(ATTACHING PARTS)**********		
-235	354-0443-00			2		..RING,RETAINING:0.328 FREE ID X 0.448 OD	97464	200-37
						..**********(END ATTACHING PARTS)**********		
-236	384-0880-00			2		..SHAFT,CAM SW:REAR	80009	384-0880-00
-237	105-0846-01			2		..ACTUATOR,CAM SW:TIME/CM,DRUM TYPE	80009	105-0846-01
-238	401-0180-00			2		..BEARING,CAM SW:FRONT & REAR	80009	401-0180-00
-239	214-1139-03			6		..SPRING,FLAT:RED COLORED	80009	214-1139-03
-240	214-1752-00			4		..ROLLER,DETENT:	80009	214-1752-00
-241	----- -----			1		.CKT BOARD ASSY:VERTICAL MODE(SEE A14 REPL		
-242	----- -----			1		..SWITCH,PUSH:(SEE S272 REPL)		
-243	361-0411-00			4		..SPACER,PUSH SW:0.13 W X 0.375 INCH L,PLS	71590	J64285-00
-244	131-1031-00			12		..CONTACT ASSY,EL:CAM SWITCH,TOP	80009	131-1031-00
-245	337-0896-00			2		..PLATE,ELEC SHLD:CKT BOARD MOUNT,BRS	80009	337-0896-00
-246	131-0589-00			8		..TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-247	131-0608-00			47		..TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-248	136-0634-00	B010100	B033329	6		..SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
-249	136-0252-07			21		..SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-250	131-1426-00			1		..TERM SET,PIN:(36) 0.025 SQ RTANG,0.25L	22526	65524-136
-251	131-1425-00			1		..TERM SET,PIN:(36) 0.025 SQ RTANG,0.150L	22526	65521-136
-252	337-2825-00			1		SHIELD,ELEC:MODE SWITCH CKT BOARD	80009	337-2825-00
						**********(ATTACHING PARTS)**********		
-253	210-0586-00			2		NUT,PL,ASSEM WA:4-40 X 0.25,STL,CD PL	78189	211-041800-00
						**********(END ATTACHING PARTS)**********		
-254	384-1370-00	B010100	B044276	5		EXTENSION SHAFT:4.68" L,MOLDED PLSTC	80009	384-1370-00
	384-1061-00	B044277		5		EXTENSION SHAFT:4.357L INCH LONG	80009	384-1061-00
-255	----- -----			2		CKT BOARD ASSY:PROBE CODING(SEE A25 REPL)		
						**********(ATTACHING PARTS)**********		
-256	211-0065-00			4		SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	77250	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
	----- -----			-		CKT BOARD ASSY INCLUDES:		
-257	131-0608-00			3		.TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357

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8 Cherry Tree Rd, Chinnor
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Tel:- 01844-351694 Fax:- 01844-352554
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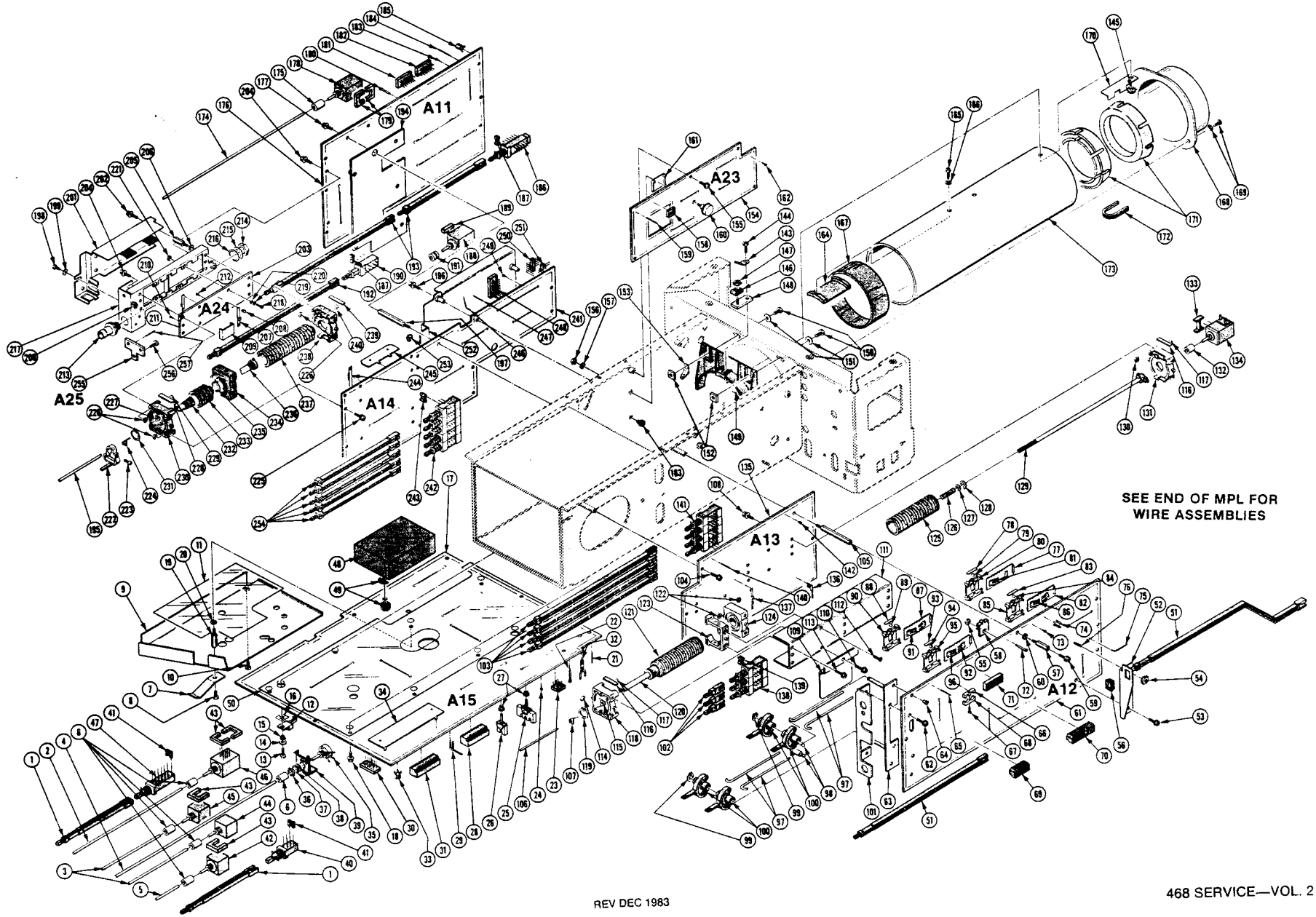
A11
A23
A24
A25
A14
A13
A15
A12
SEE END OF MPL FOR
WIRE ASSEMBLIES

FIG. 4 U CHANNEL ASSY.

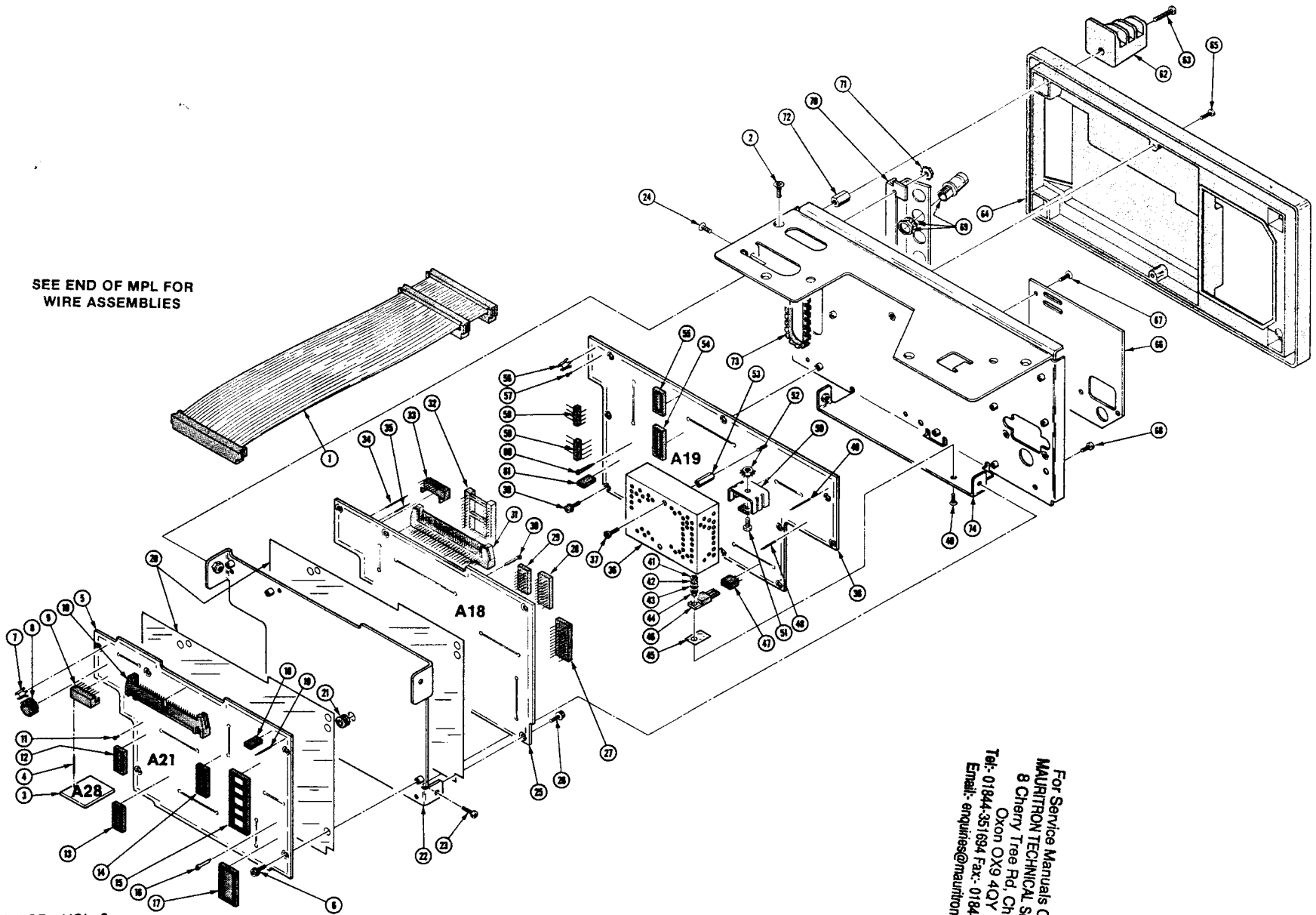

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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
4-1	175-3274-00			1		CA ASSY,SP,ELEC:50,28 AWG,8.75 L,RIBBON	22526	OBD
-2	212-0040-00			4		SCREW,MACHINE:8-32 X 0.375 100 DEG,FLH ST	83385	ORD BY DESCR
-3	---- ----			1		CKT BOARD ASSY:INTERCONNECT(SEE A28 REPL)		
-4	131-0589-00			16		.TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-5	---- ----			1		CKT BOARD ASSY:PROCESSOR(SEE A21 REPL)		
						**********(ATTACHING PARTS)**********		
-6	211-0244-00			4		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
	---- ----			-		CKT BOARD ASSY INCLUDES:		
-7	131-1003-00			5		.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-8	214-2593-00			2		.HEAT SINK,XSTR:(1) TO-5 ALUMINUM	13103	2257B
-9	131-2529-00			1		.CONN,RCPT,ELEC:CKT BOARD,8 CONTACT,FEM	27264	22-16-2081
-10	131-1780-00			1		.CONNECTOR,RECP,:RT-ANGLE HDR,2/25 MALE	22526	65483-005
-11	136-0252-07			38		.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-12	136-0260-02	B010100	B033329	1		.SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CL	09922	DILB16P-108T
-13	136-0670-00	B010100	B033329	4		.SKT,PL-IN ELEK:MICROCKT,18 PIN,LOW PROFIL	73803	CS9002-18
-14	136-0634-00	B010100	B033329	5		.SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
-15	136-0623-00	B010100	B033329	1		.SOCKET,PLUG-IN:40 DIP,LOW PROFILE	09922	DILB40P-108
-16	214-0579-00			6		.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-17	136-0578-00	B010100	B033329	2		.SKT,PL-IN ELEK:MICROCKT,24 PIN,LOW PRFL	09922	DILB24P-108
-18	131-0993-00			2		.BUS,CONDUCTOR:2 WIRE BLACK	00779	850100-01
-19	131-0608-00			5		.TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
	136-0751-00	B033333		2		SKT,PL-IN ELEK:MICROCKT,24 PIN	09922	DILB24P108
	136-0752-00	B033333		2		SKT,PL-IN ELEK:MICROCIRCUIT,20 DIP	09922	DILB20P-108
-20	342-0506-00			2		INSULATOR,FILM:DIGITAL CIRCUIT BOARD	80009	342-0506-00
-21	348-0020-00			1		GROMMET,RUBBER:0.25 INCH	70485	374
-22	386-4287-00			1		PLATE,MOUNTING:CIRCUIT BOARD	80009	386-4287-00
						**********(ATTACHING PARTS)**********		
-23	211-0008-00			2		SCREW,MACHINE:4-40 X 0.250,PNH,STL,POZ	83385	ORD BY DESCR
-24	211-0559-00			2		SCREW,MACHINE:6-32 X 0.375"100 DEG,FLH ST	83385	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
-25	---- ----			1		CKT BOARD ASSY:MEMORY(SEE A18 REPL)		
						**********(ATTACHING PARTS)**********		
-26	211-0244-00			5		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
	---- ----			-		CKT BOARD ASSY INCLUDES:		
-27	136-0621-00	B010100	B010639	4		.SOCKET,PLUG-IN:22 CONTACT	09922	DILB22P-108
	136-0621-00	B010640	B033329	5		.SOCKET,PLUG-IN:22 CONTACT	09922	DILB22P-108
	136-0621-00	B033333		1		.SOCKET,PLUG-IN:22 CONTACT	09922	DILB22P-108
-28	136-0634-00	B010100	B033329	9		.SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
-29	136-0269-02	B010100	B033329	1		.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CL	09922	DILB149P-108
-30	214-0579-00			5		.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-31	131-1780-00			1		.CONNECTOR,RECP,:RT-ANGLE HDR,2/25 MALE	22526	65483-005
-32	136-0716-00			1		.SKT,PL-IN ELEK:MICROCKT,64 CONT	06776	ICN649-S5-G30
-33	131-2529-00			1		.CONN,RCPT,ELEC:CKT BOARD,8 CONTACT,FEM	27264	22-16-2081
-34	131-0589-00			2		.TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-35	131-0608-00			50		.TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
	136-0728-00	B033333		1		SKT,PL-IN ELEK:MICROCKT,14 CONTACT	09922	DILB14P-108
-36	337-2724-00	B010100	B021364	1		SHIELD,ELEC:PRIMARY CIRCUIT	80009	337-2724-00
						**********(ATTACHING PARTS)**********		
-37	211-0008-00	B010100	B021364	2		SCREW,MACHINE:4-40 X 0.250,PNH,STL,POZ	83385	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
-38	---- ----			1		CKT BD ASSY:TIME BASE/PWR SPLY(SEE A19 REP		
						**********(ATTACHING PARTS)**********		
-39	211-0244-00			10		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
-40	211-0038-00			3		SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG	83385	ORD BY DESCR
-41	210-0406-00			3		NUT,PLAIN,HEX:4-40 X 0.188,BRS,CD PL	73743	12161-50
-42	210-0004-00			3		WASHER,LOCK:#4 INTL,0.015 THK,STL CD PL	000BK	ORD BY DESCR
-43	210-0994-00			3		WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5702-201-20
-44	210-1171-00			3		WSHR,SHOULDERED:0.116 ID X 0.138 INCH OD	52905	A7148516P2
-45	342-0202-00			3		INSULATOR,PLATE:TRANSISTOR	01295	10-21-023-106
						**********(END ATTACHING PARTS)**********		
	---- ----			-		CKT BOARD ASSY INCLUDES:		
-46	---- ----			3		.MICROCIRCUIT:(SEE A19U190,U560,U570 REPL)		

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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
4-47	136-0760-00	B010100	B010158	3	.SKT,PL-IN ELEK:TRANSISTOR,3 CONTACT		
-48	131-0608-00			55	.TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-49	131-0589-00			5	.TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-50	214-1967-00			1	.HEAT SINK,DIODE:FINGER TYPE	13103	6107B-14
					.**********(ATTACHING PARTS)**********		
-51	211-0504-00			1	.SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	ORD BY DESCR
-52	210-0457-00			1	.NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	83385	ORD BY DESCR
					.**********(END ATTACHING PARTS)**********		
-53	129-0674-00	B010100	B021364	2	.SPACER,POST:0.814,4-40 BOTH ENDS,BRASS	80009	129-0674-00
-54	136-0634-00	B010100	B033329	3	.SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
-55	136-0260-02	B010100	B033329	3	.SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CL	09922	DILB16P-108T
-56	131-1003-00			4	.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-57	136-0252-07			28	.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-58	131-1425-00			1	.TERM SET,PIN:(36) 0.025 SQ RTANG,0.150L	22526	65521-136
-59	131-1426-00			1	.TERM SET,PIN:(36) 0.025 SQ RTANG,0.25L	22526	65524-136
-60	214-0579-00			7	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-61	131-0993-00			1	.BUS,CONDUCTOR:2 WIRE BLACK	00779	850100-01
	348-0023-00	B010100	B021364	1	.PLUG,HOLE:	02768	207090201000101
-62	348-0339-00			4	FOOT,CABINET:W/CORD WRAP	80009	348-0339-00
					**********(ATTACHING PARTS)**********		
-63	212-0020-00			4	SCREW,MACHINE:8-32 X 1.0 INCH,PNH STL	93907	ORD BY DESCR
					**********(END ATTACHING PARTS)**********		
-64	200-2448-04			1	COVER,REAR:	80009	200-2448-04
					**********(ATTACHING PARTS)**********		
-65	211-0516-00	B010100	B010599	2	SCREW,MACHINE:6-32 X 0.875 INCH,PNH STL	83385	ORD BY DESCR
	211-0514-00	B010600		2	SCREW,MACHINE:6-32 X 0.750 INCH,PNH STL	83385	ORD BY DESCR
					**********(END ATTACHING PARTS)**********		
	348-0349-00			FT	SHLD GSKT,ELEC:0.187 INCH DIA,2.75 FT L	07700	2143951
-66	333-2614-00			1	PANEL,REAR:	80009	333-2614-00
					**********(ATTACHING PARTS)**********		
-67	211-0502-00			2	SCREW,MACHINE:6-32 X 0.188",FLH STL	83385	ORD BY DESCR
-68	212-0023-00			2	SCREW,MACHINE:8-32 X 0.375,PNH,STL CD PL	83385	ORD BY DESCR
					**********(END ATTACHING PARTS)**********		
-69	131-1315-01			4	CONN,RCPT,ELEC:BNC,FEMALE	24931	28JR 306-1
-70	407-2463-00			1	BRACKET,CONN:BNC	80009	407-2463-00
					**********(ATTACHING PARTS)**********		
-71	210-0458-00			2	NUT,PL,ASSEM WA:8-32 X 0.344 INCH,STL	83385	ORD BY DESCR
					**********(END ATTACHING PARTS)**********		
-72	129-0842-00			4	SPACER,POST:0.42 L,W/8-32 INT THD THRU	80009	129-0842-00
-73	255-0334-00			FT	PLASTIC CHANNEL:12.75 X 0.175 X 0.155,NYL	11897	122-37-2500
-74	386-4290-01			1	SUBPANEL,REAR:W/BRACKETS	80009	386-4290-01
					CABLE LISTINGS		
	175-2552-00			1	CA ASSY,SP,ELEC:8,26 AWG,15.0 L,RIBBON	80009	175-2552-00
	---- ----			-	(FROM A13P135 TO A14P130)		
	352-0166-00			2	.HLDR,TERM CONN:8WIRE,BLACK 0.1 SPACING	80009	352-0166-00
	175-2691-00			1	CA ASSY,SP,ELEC:8,26 AWG,5.0 L,RIBBON	80009	175-2691-00
	---- ----			-	(FROM A11P306 TO A14P307)		
	352-0166-00			2	.HLDR,TERM CONN:8WIRE,BLACK 0.1 SPACING	80009	352-0166-00
	175-2905-00			1	CA ASSY,SP,ELEC:3,26 AWG,11.0 L,RIBBON	80009	175-2905-00
	---- ----			-	(FROM A11P356 TO A15P154)		
	352-0161-00			2	.HLDR,TERM CONN:3 WIRE,BLACK	80009	352-0161-00
	175-2910-00			1	CA ASSY,SP,ELEC:2,26 AWG,8.0 L,8-N	80009	175-2910-00
	---- ----			-	(FROM R14498 TO A15P956)		
	352-0161-00			1	.HLDR,TERM CONN:3 WIRE,BLACK	80009	352-0161-00
	175-2911-00			2	CA ASSY,SP,ELEC:2,26 AWG,3.5 L,RIBBON	80009	175-2911-00
	---- ----			-	(FROM A14P1118 TO AP1440)		
	352-0161-00			4	.HLDR,TERM CONN:3 WIRE,BLACK	80009	352-0161-00
	175-2915-00			1	CA ASSY,SP,ELEC:2,26 AWG,3.5 L,RIBBON	80009	175-2915-00
	---- ----			-	(FROM DS17105 TO A12P110)		
	---- ----			1	.LT EMITTING DIO:(SEE DS17105 REPL)		
	352-0169-00			2	.HLDR,TERM CONN:2 WIRE BLACK	80009	352-0169-00
	175-2916-00			1	CA ASSY,SP,ELEC:4,26 AWG,4.0 L,RIBBON	80009	175-2916-00
	---- ----			-	(FROM DS16001,DS16003 TO A13P111)		
	---- ----			2	.LT EMITTING DIO:(SEE DS16001,DS16002 REPL		

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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
	352-0162-00			1		.HLDR,TERM CONN:4 WIRE BLACK	80009	352-0162-00
	352-0163-00			1		.CONN BODY,PL,EL:5 WIRE BLACK	80009	352-0163-00
	175-2917-00			1		CA ASSY,SP,ELEC:4,26 AWG,4.0 L,RIBBON	80009	175-2917-00
	----- -----			-		(FROM DS17206,DS17127 TO A12P310)		
	----- -----			1		.LT EMITTING DIO:(SEE DS17206 REPL)		
	----- -----			1		.LT EMITTING DIO:(SEE DS17127 REPL)		
	352-0162-00			1		.HLDR,TERM CONN:4 WIRE BLACK	80009	352-0162-00
	352-0163-00			1		.CONN BODY,PL,EL:5 WIRE BLACK	80009	352-0163-00
	175-2918-00			1		CA ASSY,SP,ELEC:4,26 AWG,8.0 L,RIBBON	80009	175-2918-00
	----- -----			-		(FROM DS15034,DS15038 TO A14P1100)		
	----- -----			2		.LT EMITTING DIO:(SEE DS15034,DS15038 REPL		
	352-0162-00			1		.HLDR,TERM CONN:4 WIRE BLACK	80009	352-0162-00
	352-0169-00			2		.HLDR,TERM CONN:2 WIRE BLACK	80009	352-0169-00
	175-2919-00			1		CA ASSY,SP,ELEC:2,26 AWG,8.0 L,RIBBON	80009	175-2919-00
	----- -----			-		(FROM DS15036 TO A14P190)		
	----- -----			1		.LT EMITTING DIO:(SEE DS15036 REPL)		
	352-0169-00			2		.HLDR,TERM CONN:2 WIRE BLACK	80009	352-0169-00
	198-4399-00			2		WIRE SET,ELEC	80009	198-4399-00
	----- -----			-		(FROM R14288A,B & R14398 TO A15P699)		
	----- -----			-		(FROM R14499,R14498 TO A15P799)		
	352-0164-00			2		.CONN BODY,PL,EL:6 WIRE BLACK	80009	352-0164-00
	175-2922-00			1		LEAD ASSY,ELEC:3,22 AWG,3.5 L,RIBBON	80009	175-2922-00
	----- -----			-		(FROM Q1108 TO A15P108)		
	352-0161-00			1		.HLDR,TERM CONN:3 WIRE,BLACK	80009	352-0161-00
	198-4400-00			1		WIRE SET,ELEC:	80009	198-4400-00
	----- -----			-		(FROM R17002 TO A13P117)		
	352-0161-00			1		.HLDR,TERM CONN:3 WIRE,BLACK	80009	352-0161-00
	175-2927-00			2		CA ASSY,SP,ELEC:5,26 AWG,3.5 L,RIBBON	80009	175-2927-00
	----- -----			-		(FROM R17305/S17305 TO A12P410)		
	----- -----			-		(FROM R17010/S17010 TO A12P112)		
	352-0163-00			2		.CONN BODY,PL,EL:5 WIRE BLACK	80009	352-0163-00
	175-3104-00			1		CA ASSY,SP,ELEC:10,26 AWG,9.0 L,RIBBON	80009	175-3104-00
	----- -----			-		(FROM A15P252 TO A23P369)		
	----- -----			-		(FROM A14P160 TO A15P151)		
	352-0162-00			2		.HLDR,TERM CONN:4 WIRE BLACK	80009	352-0162-00
	352-0164-00			2		.CONN BODY,PL,EL:6 WIRE BLACK	80009	352-0164-00
	175-3147-00			1		CA ASSY,SP,ELEC:4,26 AWG,9.0 L,RIBBON	80009	175-3147-00
	----- -----			-		(FROM A11R270,R470 TO A14P196)		
	352-0163-00			1		.CONN BODY,PL,EL:5 WIRE BLACK	80009	352-0163-00
	175-3400-00			1		CABLE ASSY,RF:2,50 OHM COAX,9.0 L,9-01/02	80009	175-3400-00
	----- -----			-		(FROM A12 TO A16)		
	175-3422-00			1		CA ASSY,SP,ELEC:6,26 AWG,16.0 L,RIBBON	80009	175-3422-00
	----- -----			-		(FROM A13P145 TO A14P120)		
	352-0164-00			2		.CONN BODY,PL,EL:6 WIRE BLACK	80009	352-0164-00
	175-3427-00			1		CA ASSY,SP,ELEC:5,22 AWG,14.0 L,RIBBON	80009	175-3427-00
	----- -----			-		(FROM A12P4008 TO A19P199)		
	352-0201-00			2		.CONN BODY,PL,EL:5 WIRE BLACK	80009	352-0201-00
	179-2744-00			1		WIRING HARNESS:MAIN	80009	179-2744-00
	352-0161-00			2		.HLDR,TERM CONN:3 WIRE,BLACK	80009	352-0161-00
	352-0169-09			4		.CONN BODY,PL,EL:2 WIRE WHITE	80009	352-0169-09
	179-2745-00			1		WIRING HARNESS:STORAGE PICKOFF	80009	179-2745-00
	----- -----			-		(FROM A11 TO REAR ASSY BNC'S)		
	175-2920-00			1		CA ASSY,SP,ELEC:8,26 AWG,8.0 L,RIBBON	80009	175-2920-00
	----- -----			-		(FROM A14P355 TO A16P404)SUBPART OF 672-08		
	352-0166-00			2		.HLDR,TERM CONN:8WIRE,BLACK 0.1 SPACING	80009	352-0166-00
	175-2924-00			1		CA ASSY,SP,ELEC:10,26 AWG,6.0 L,RIBBON	80009	175-2924-00
	----- -----			-		(FROM A14P142 TO A16P204)SUBPART OF 672-08		
	352-0168-00			2		.CONN BODY,PL,EL:10 WIRE BLACK	80009	352-0168-00
	175-3148-00			1		CA ASSY,SP,ELEC:8,26 AWG,9.0 L,RIBBON	80009	175-3148-00
	----- -----			-		(FROM A14P138,P343 TO A16P262)		
	----- -----			-		(SUBPART OF 672-0878-00)		
	352-0161-00			2		.HLDR,TERM CONN:3 WIRE,BLACK	80009	352-0161-00
	352-0164-00			1		.CONN BODY,PL,EL:6 WIRE BLACK	80009	352-0164-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
	175-5135-00			5		CA ASSY,SP,ELEC:10,26 AWG,3.0 L,RIBBON	80009	175-5135-00
	---- ----			-		(FROM A18P237 TO A19P145)SUBPART OF 672-08		
	---- ----			-		(FROM A18P246 TO A19P135)SUBPART OF 672-08		
	---- ----			-		(FROM A18P257 TO A19P125)SUBPART OF 672-08		
	---- ----			-		(FROM A18P266 TO A19P115)SUBPART OF 672-08		
	---- ----			-		(FROM A18P276 TO A19P105)SUBPART OF 672-08		
	352-0168-00			10		.CONN BODY,PL,EL:10 WIRE BLACK	80009	352-0168-00
	175-2925-00			1		CA ASSY,RF:50 OHM COAX,6.0 L,9-05	80009	175-2925-00
	---- ----			-		(FROM A18 TO A19)SUBPART OF 672-0879-00		
	175-2926-00			1		CABLE ASSY,RF:50 OHM COAX,6.0 L,9-04	80009	175-2926-00
	---- ----			-		(FROM A18 TO A19)SUBPART OF 672-0879-00		
	198-2850-00			1		WIRE SET,ELEC:	80009	198-2850-00
	---- ----			-		(SUBPART OF A15)		
	198-2862-00			1		WIRE SET,ELEC:	80009	198-2862-00
	---- ----			-		(FROM A26 TO A15P288)SUBPART OF A26		
	352-0169-02			1		.CONN BODY,PL,EL:2 WIRE RED	80009	352-0169-00
	195-0373-00			1		LEAD,ELECTRICAL:18 AWG,3.0 L	80009	195-0373-00
	---- ----			-		(FL14500 TO GND)		
	195-0598-00			1		LEAD,ELECTRICAL:26 AWG,2.0 L,9-1	80009	195-0598-00
	---- ----			-		(FROM A23 TO V1400)		
	195-0599-00			1		LEAD,ELECTRICAL:26 AWG,3.0 L,9-2	80009	195-0599-00
	---- ----			-		(FROM A15 TO V1400)		
	195-0600-00			1		LEAD,ELECTRICAL:26 AWG,3.0 L,9-5	80009	195-0600-00
	---- ----			-		(FROM A15 TO V1400)		
	195-0601-00			1		LEAD,ELECTRICAL:26 AWG,2.0 L,9-6	80009	195-0601-00
	---- ----			-		(FROM A23 TO V1400)		
	195-0602-00			1		LEAD,ELECTRICAL:22 AWG,4.5 L,8-01	80009	195-0602-00
	---- ----			-		(FROM A22J108 TO FUSEHOLDER)		
	195-0604-00			1		LEAD,ELECTRICAL:22 AWG,2.0 L,8-0	80009	195-0604-00
	---- ----			-		(FROM FL14500 TO F14500)		
	195-0606-00			1		LEAD,ELECTRICAL:18 AWG,4.5 L,8-02	80009	195-0606-00
	---- ----			-		(FROM A22J110 TO S14520)		
	195-0607-00			1		LEAD,ELECTRICAL:18 AWG,4.5 L,8-04	80009	195-0607-00
	---- ----			-		(FROM A22J212 TO S14520)		
	195-0609-00			1		LEAD,ELECTRICAL:22 AWG,1.5 L,9-1	80009	195-0609-00
	---- ----			-		(CONNECTS TO R14498)		
	195-0717-00			1		WIRE,ELECTRICAL:22 AWG,4.0 L,9-8	80009	195-0717-00
	---- ----			-		(FROM FL14500 TO A22J204)		
	198-4401-00			1		WIRE SET,ELEC:	80009	198-4401-00
	---- ----			-		(FROM A17P265 TO A19P410. OPTION 2 ONLY)		
	352-0484-00			2		.HLDR,TERM CONN:16 WIRE,DBL ROW,BLACK	22526	65043-124
	179-2791-00			1		WIRING HARNESS:TV SYNC	80009	179-2791-00
	---- ----			-		(OPTION 05 ONLY)		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
5-1	200-2448-05			1		COVER,REAR:PLASTIC	80009	200-2448-05
-2	366-1559-00			1		PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
-3	----- -----			1		LT EMITTING DIODE:(SEE DS11320 CHASSIS REP		
-4	386-4308-00			1		PANEL,SIDE:W/GPIB	80009	386-4308-00
-5	----- -----			1		SWITCH PUSH:(SEE A16S612 REPL)		
-6	361-0383-00			2		SPACER,PB SW:CHARCOAL,0.33 INCH LONG	80009	361-0383-00
-7	198-4401-00			1		WIRE SET,ELEC:	80009	198-4401-00
	----- -----			-		(FROM P265 TO P410)		
	175-3358-00			1		CA ASSY,SP,ELEC:3,26 AWG,5.0 L,RIBBON	80009	175-3358-00
	----- -----			-		(FROM P318 TO DS11320)		
-8	----- -----			1		CKT BOARD ASSY:GPIB(SEE A17 REPL)		
						**********(ATTACHING PARTS)**********		
-9	211-0244-00			5		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
	----- -----			-		EACH CIRCUIT BOARD CONTAINS:		
-10	131-1426-00			1		.TERM SET,PIN:(36) 0.025 SQ RTANG,0.25L	22526	65524-136
-11	131-1425-00			1		.TERM SET,PIN:(36) 0.025 SQ RTANG,0.150L	22526	65521-136
	131-0589-00			2		.TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-12	214-0579-00			8		.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-13	136-0252-07			64		.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-14	136-0269-02			1		.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CL	09922	DILB149P-108
-15	136-0260-02	B010100	B033329	2		.SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CL	09922	DILB16P-108T
-16	136-0634-00	B010100	B033329	4		.SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
	386-4288-00			1		.PLATE,CONN MTG:W/CONNECTOR	80009	386-4288-00
-17	129-0572-00			2		..SPACER,POST:0.29 LONG X 0.25 HEX	80009	129-0572-00
-18	131-2203-01			1		..CONN,RCPT,ELEC:CKT BD,24 CONT,FEMALE	71785	57-20240-11
-19	386-4288-01			1		..PLATE,CONN MTG:ALUMINUM	80009	386-4288-01

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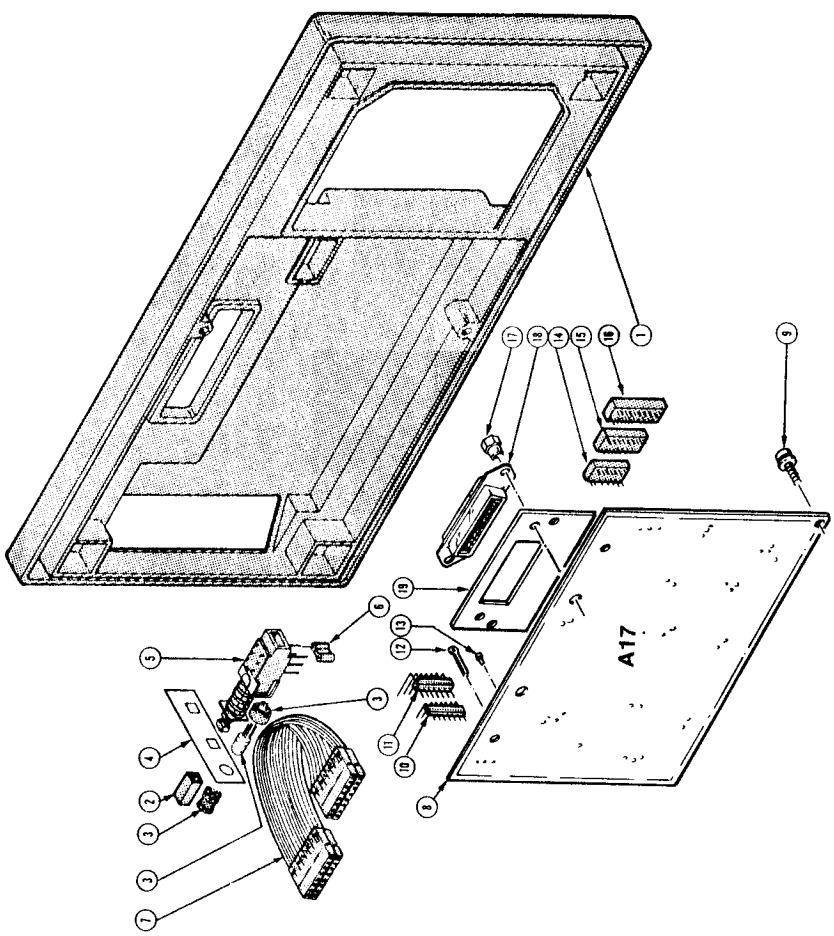

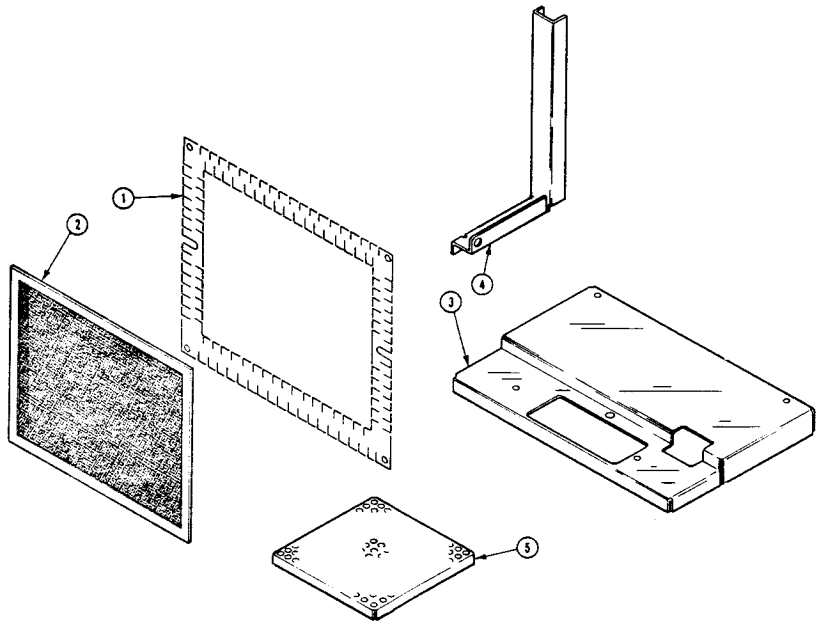

FIG. 6 OPTION 4

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
6-1	131-1310-00			1		CONTACT,ELEC:MESH FILTER GROUND	80009	131-1310-00
-2	378-0726-00			1		FILTER,MESH:EMI	80009	378-0726-00
-3	337-2792-00			1		SHIELD,ELEC:GPIB CKT BOARD	80009	337-2792-00
						**********(ATTACHING PARTS)**********		
	211-0007-00			4		SCREW,MACHINE:4-40 X 0.188,PNH STL,CD PL	83385	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
	129-0236-00			2		SPACER,POST:0.188 HEX X 0.375 INCH LONG	06540	9726-A-0440
	129-0260-00			2		POST,ELEC-MECH:0.255 HEX X 0.500 INCH L	80009	129-0260-00
-4	337-2794-00			1		SHIELD,ELEC:MAIN CKT BOARD	80009	337-2794-00
						**********(ATTACHING PARTS)**********		
	211-0244-00			4		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	ORD BY DESCR
						**********(END ATTACHING PARTS)**********		
-5	337-2791-00	B010100	B044716	1		SHIELD,ELEC:FAN MOTOR	80009	337-2791-00
	337-1921-00	B044717		1		SHIELD,ELEC:FAN MOTOR	80009	337-1921-00
	337-1922-00	B044717		1		SHIELD,ELEC:FAN MOTOR	80009	337-1921-00

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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
7-1	366-1559-00			1		PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
-2	426-1072-00			1		FRAME,PUSH BTN:PLASTIC	80009	426-1072-00
-3	333-2606-00			1		PANEL,FRONT:	80009	333-2606-00
-4	---- ----			1		SWITCH,PUSH:(SEE A16S813 OPTION 12 ONLY RE		
	---- ----			-		(OPTION 12 BECAME PART OF THE STANDARD		
	---- ----			-		.INSTRUMENT AT SERIAL NUMBER B030000. ALL		
	---- ----			-		.INDIVIDUAL SUBPARTS HAVE BEEN NOTED.		

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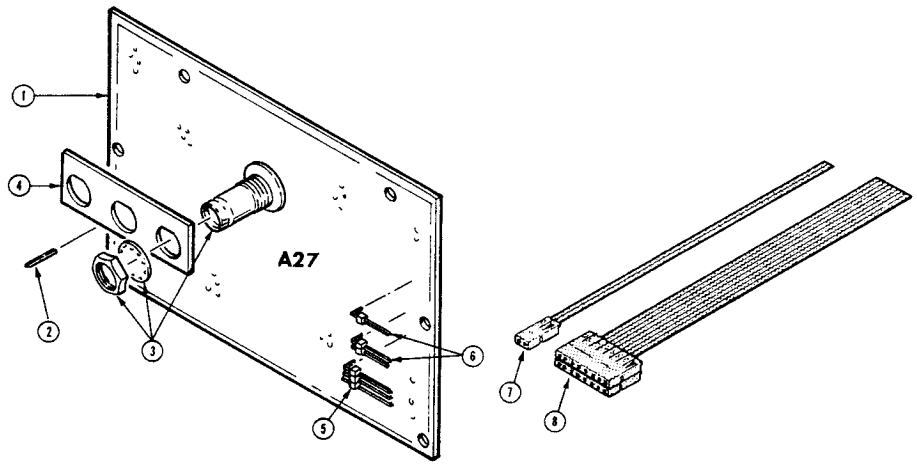

FIG. 8. OPTION 0D, 11

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
8-1	----- -----			1		CKT BOARD ASSY:ANALOG X-Y OUTPUT		
	----- -----			-		(SEE A27 REPL)		
-2	----- -----			6		TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD		
	----- -----			-		(SEE A27TP100,101,102,103,114,118 REPL)		
-3	131-1097-00			3		CONNECTOR,RCPT,:BNC,FEMALE,CKT BOARD MT	24931	28JR220-2
-4	333-2916-00			1		PANEL,REAR:	80009	333-2916-00
-5	131-1426-00			1		TERM SET,PIN:(36) 0.025 SQ RTANG,0.25L	22526	65524-136
	----- -----			-		(8 USED AT LOCATION P100)		
-6	131-1425-00			1		TERM SET,PIN:(36) 0.025 SQ RTANG,0.150L	22526	65521-136
	----- -----			-		(8 USED AT LOCATION P100.2 AT P101)		
-7	175-5426-00			1		CA ASSY,SP,ELEC:2,26 AWG,4.0 L,RIBBON	80009	175-5426-00
-8	198-4401-00			1		WIRE SET,ELEC:	80009	198-4401-00

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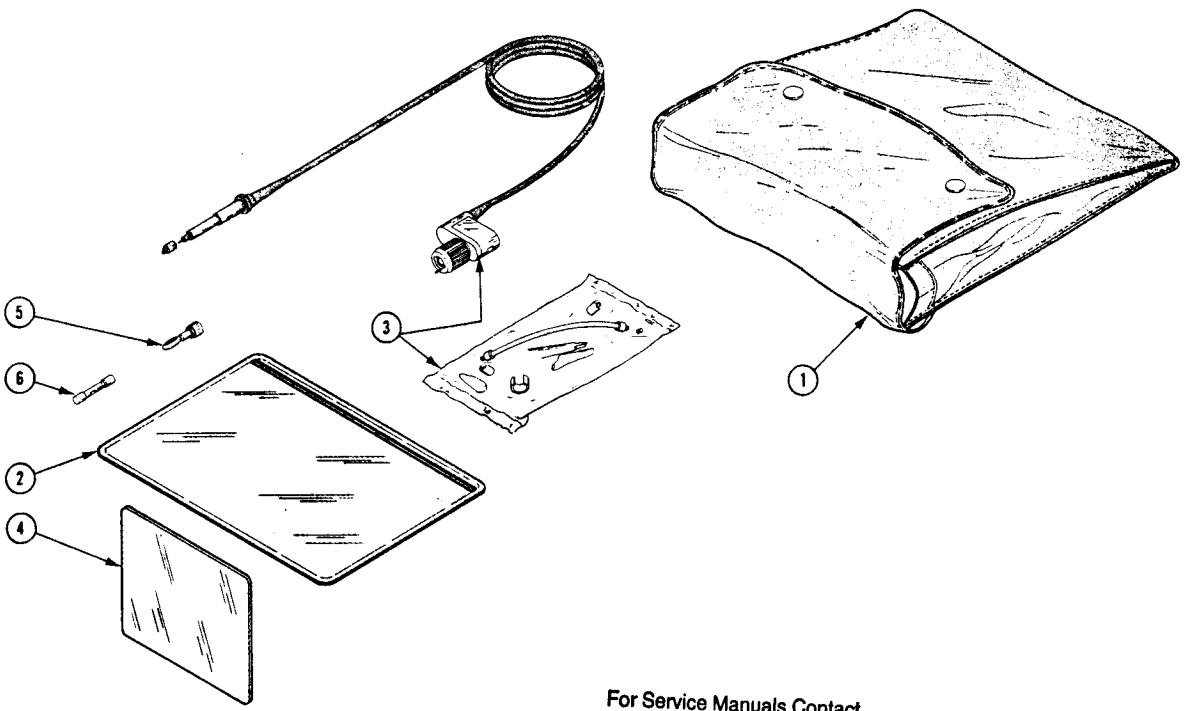
Email:- enquiries@mauritron.co.uk

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
						STANDARD ACCESSORIES		
9-1	016-0594-00			1		POUCH,ACCESSORY:W/HARDWARE(W/DM)	80009	016-0594-00
-2	016-0537-00			1		POUCH,ACCESSORY:VINYL,W/ZIPPER	05006	ZIP-6X91D
-3	010-6105-03			2		PROBE,VOLTAGE:P6105,2 METER,10X,W/ACCESS	80009	010-6105-03
-4	337-1674-01			1		SHLD,IMPLOSION:CLEAR	80009	337-1674-01
-5	134-0016-01			1		PLUG,TIP:W/BINDING POST	80009	134-0016-01
-6	159-0160-00			2		FUSE,CARTRIDGE:3AG,1.5 A,250 V,18 SEC,UL	71400	MDX 1-1/2
	----- -----			-		(FOR 115V OPERATION)		
	159-0040-00			1		FUSE,CARTRIDGE:3AG,0.7A,SLOW-BLOW	71400	MDL 7/10
	----- -----			-		(FOR 230V OPERATION)		
	070-3515-00			1		MANUAL,TECH:SERVICE VOL. 01	80009	070-3515-00
	070-3516-00			1		MANUAL,TECH:SERVICE VOL. 02	80009	070-3516-00
	070-2906-00			1		MANUAL,TECH:OPERATORS	80009	070-2906-00



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MANUAL CHANGE INFORMATION

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

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

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

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MANUAL CHANGE INFORMATION

Date: 1-21-82 Change Reference: REV. C13/881

Product: 468 SERVICE VOLUME II Manual Part No.: 070-3516-00

DESCRIPTION

EFF SN 700001 & up (TEKTRONIX HOLLAND N.V. ORIGIN)

NOTE

The following changes do not affect U.S. manufactured instruments.

REPLACEABLE ELECTRICAL PARTS CHANGES

CHANGE TO:

A11R136	315-0271-00	RES.,FXD,CMPSN:270 OHM,5%,0.25W
A11R237	315-0271-00	RES.,FXD,CMPSN:270 OHM,5%,0.25W
A11R435	315-0271-00	RES.,FXD,CMPSN:270 OHM,5%,0.25W
A11R532	315-0271-00	RES.,FXD,CMPSN:270 OHM,5%,0.25W
A13C126	281-0096-00	CAP.,VAR,AIR DI:5.5 - 18PF,350V
A13C228	283-0333-00	CAP.,FXD,CER DI:35PF,5%,1000V

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REMOVE:

A11VR187	152-0166-00	SEMICOND DEVICE:ZENER,0.4W,6.2V,5%
A11VR388	152-0166-00	SEMICOND DEVICE:ZENER,0.4W,6.2V,5%

ADD:

A11R187	315-0241-00	RES.,FXD,CMPSN:240 OHM,5%,0.25W
A11R388	315-0241-00	RES.,FXD,CMPSN:240 OHM,5%,0.25W
A11VR189	152-0217-00	SEMICOND DEVICE:ZENER,0.4W,8.2V,5%,1N756A
A11VR389	152-0217-00	SEMICOND DEVICE:ZENER,0.4W,8.2V,5%,1N756A
A15C162	290-0047-00	CAP.,FXD,ELCTLT:150UF,250V

DIAGRAMS SECTION CHANGES

Figure 8-4. A11 VERTICAL PREAMPLIFIER board

ADD:

VR189 between C186 and VR187 at location 3J (add to lookup table for components located on schematic Diagram 1).

VR389 between C386 and VR388 at location 6J (add to lookup table for components located on schematic Diagram 2).

REPLACE:

VR187 with R187 at location 3K, (add to lookup table for components located on schematic Diagram 1).

VR388 with R388 at location 6K, (add to lookup table for components located on schematic Diagram 2).

Product: 468 SERVICE VOLUME II Date: 8-6-81 Change Reference: C13/881

DESCRIPTION

DIAGRAM 1 CHANGES (A11 board)

CHANGE:

R136 (location 4H) value to 270 Ω.

R237 (location 7H) value to 270 Ω.

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REPLACE:

VR187 with R187 (240 Ω) at location 3A.

ADD:

VR189 (8.2V ZENER DIODE) in parallel with C186 (location 3A), cathode to pin 6 of Q285A.

DIAGRAM 2 CHANGES (A11 board)

CHANGE:

R435 (location 4H) value to 270 Ω.

R532 (location 7H) value to 270 Ω.

REPLACE:

VR388 with R388 (240 Ω) at location 3A.

ADD:

VR389 (8.2V ZENER DIODE) in parallel with C386 (location 3A) cathode to pin 6 of Q485A.

Figure 8-18 A15 INTERFACE board

ADD: At location 2I, C162 at left of S175 (add to lookup table for Diagram 20, also affects Diagram 22)

DIAGRAM 9 A & B TIMING SWITCH (A13 board)

CHANGE: C126 (location 5B) value to 5.5 - 18PF.

C228 (location 5B) value to 35 PF.

DIAGRAM 11 CRT CIRCUIT (A15 board)

ADD: C162 (location 2C) 150 UF, positive lead to S175 BEAM FIND switch terminal 2R and negative lead to ground.

DIAGRAM 22 POWER DISTRIBUTION (15 board)

ADD: In power distribution for CRT CIRCUIT ◇11◇, C162 (positive lead to +15 V supply and negative lead to ground).

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manual change information

Oct. 1980/81 H4335/4420/
Date: Febr. 1983 Change Reference: H4424/4487/4492
Product: 468 4-12-1982 Manual Part No.: 070-3516-00

DESCRIPTION

MECHANICAL PARTS LIST

To improve the reliability of the instrument, most of the transistor and IC sockets have been removed.
Therefore, you may notice a difference between the number of sockets mentioned in the list of "Replaceable Mechanical Parts" and the actual usage of these parts.

ELECTRICAL PARTS LIST CORRECTION

Change to:

H4397	Q285	Transistor Dual Fet	151-1032-00	
	Q485	Transistor Dual Fet	151-1032-00	
	R289	Resistor 470 ohm	315-0471-00	
	R488	Resistor 470 ohm	315-0471-00	
	R160	Resistor 2K ohm	315-0202-00	
	R376	Resistor 2K ohm	315-0202-00	
H4419	R990	Resistor 100 ohm 5%	315-0101-00	
H4445	A19 C188	Capacitor 2uF 50V	283-0212-00	
	A19 C197	Capacitor 2uF 50V	283-0212-00	
H449	A12 R418	Resistor 180 ohm 5% $\frac{1}{4}$W	315-0181-00	468 option 5

Add:

H4445	A19 R188	Resistor 5,1 ohm $\frac{1}{4}$W 5%	307-0113-00	
	A19 R197	Resistor 5,1 ohm $\frac{1}{4}$W 5%	307.0113.00	

(Location is on Storage Time Base circuit boards assembly 670-6380-01)

Change to:

H4335	R136	Resistor 270 ohm	315-0271-00
	R237	Resistor 270 ohm	315-0271-00
	R435	Resistor 270 ohm	315-0271-00
	R532	Resistor 270 ohm	315-0271-00
	C126	Capacitor Var.	281-0096-00
	C228	Capacitor 36pF	283-0636-00

Add:

H4335	C116	Capacitor 51pF	281-0798-00

(Location is on Vert. Preamp. circuit baord 670-6381-00!)

Change to:

H4343	VR187	Z-diode 8,2V 0,4W	152-0217-00
	VR388	Z-diode 8,2V 0,4W	152-0217-00

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manual change information

Oct. 1980/81
Date: Febr. 1983 Change Reference: H4335/4420 H4424/4487/4492
Product: 468 4-12-1982 Manual Part No.: 070-3516-00

DESCRIPTION

Add:

H4343	R187	Resistor 240 ohm 5%	315-0241-00
	R388	Resistor 240 ohm 5%	315-0241-00
	C159	Capacitor elec. 100uF 125V	290-0215-01

Change to:

H4363	Q157	8 A SCR	151-0521-01

(Location: Storage Power Supply circuit board, Ass.no. 670-6380-00)

Add:

H4363	R364	Resistor 510 ohm	315-0511-00

Change to:

H4487	A11 R271	Resistor 10 ohm ¼W 5%	315-0100-00
	A11 R272	Resistor 10 ohm ¼W 5%	315-0100-00

Change to:

H4492	A11 C144	Cap. fxd Cer. Dl. Selectable 33pF - 39pF	
		33pF	281-0819-00
		35pF	281-0625-00
		39pF	281-0603-00

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manual change information

Date: August 1981 Change Reference: H 4367

Product: 468 Manual Part No.:

DESCRIPTION

Electrical Parts List Correction

Change to:

R165	Res. Var. 5K	311-1227-00
R172	Res. Var. 5K	311-1227-00
R371	Res. Var. 5K	311-1227-00
R373	Res. Var. 5K	311-1227-00
R176	Res. Var. 100Ω	311-1222-00
R477	Res. Var. 100Ω	311-1222-00
R205	Res. Var. 500Ω	311-1224-00
R232	Res. Var. 500Ω	311-1224-00
R436	Res. Var. 500Ω	311-1224-00
R240	Res. Var. 1K	311-1225-00
R438	Res. Var. 1K	311-1225-00
R269	Res. Var. 2,5K	311-1226-00
R569	Res. Var. 2,5K	311-1226-00
R273	Res. Var. 10K	311-1228-00
R566	Res. Var. 10K	311-1228-00
R573	Res. Var. 10K	311-1228-00
R134	Res. Var. 20K	311-1230-00
R148	Res. Var. 20K	311-1230-00
R330	Res. Var. 20K	311-1230-00
R349	Res. Var. 20K	311-1230-00
R154	Res. Var. 5K	311-1227-00
R351	Res. Var. 5K	311-1227-00
R443	Res. Var. 100Ω	311-1222-00
R267	Res. Var. 100Ω	311-1235-00
R270	Res. Var. 5K	311-1227-00
R409	Res. Var. 25K	311-1231-00
R551	Res. Var. 50K	311-1232-00
R571	Res. Var. 100Ω	311-1222-00
R681	Res. Var. 100Ω	311-1222-00
R970	Res. Var. 100Ω	311-1222-00
R572	Res. Var. 1K	311-1225-00
R578	Res. Var. 25K	311-1226-00
R599	Res. Var. 50Ω	311-1221-00
R319	Res. Var. 500Ω	311-1224-00
R321	Res. Var. 5K	311-1227-00
R325	Res. Var. 10K	311-1228-00
R329	Res. Var. 10K	311-1228-00
R335	Res. Var. 50K	311-1232-00

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manual change information

Date: 20 Sept.1984 Change Reference: H4530

Product: 468/R468 Manual Part No.: 070-3516-00

DESCRIPTION

CHANGE TO:

A15 R523	321-0132-00	RES FIXD	232 OHM 1% .125W

ADD:

A15 CR342	152-0327-00	SEM. COND. DEV. SILICON
A15 CR523	152-0327-00	30V , 150MA

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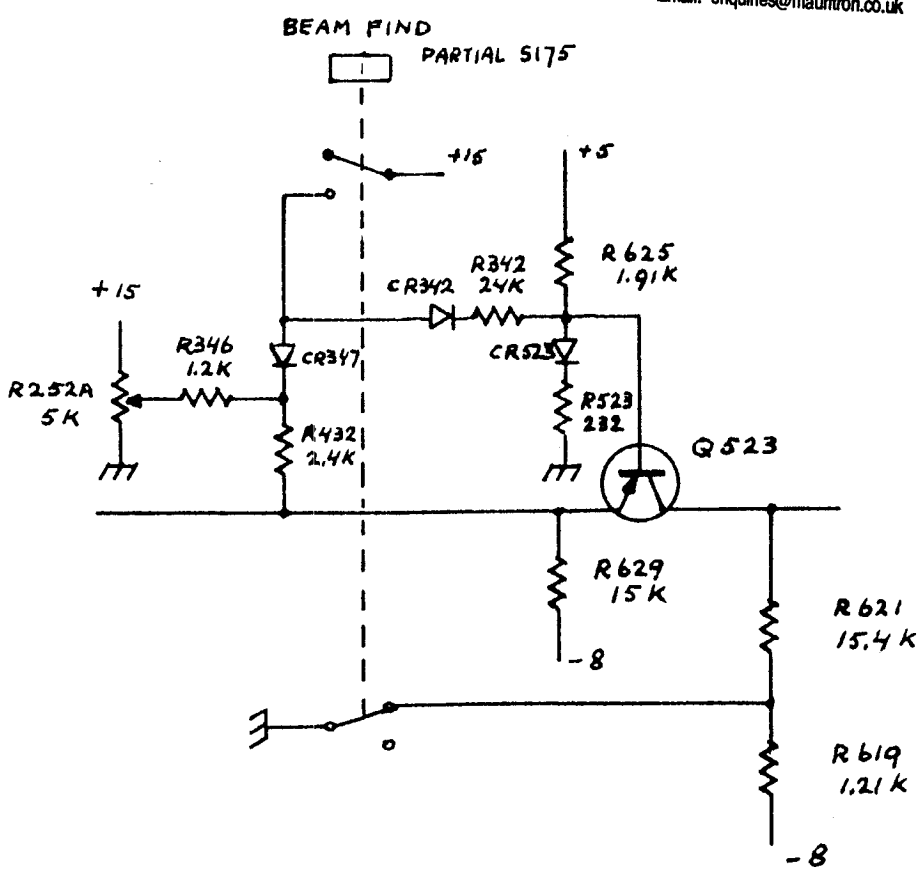

PARTIAL CRT CIRCUIT A15