TEKTRONIX®

DPO SYSTEM SPECIFICATION AND CALIBRATION

INSTRUCTION MANUAL

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

Serial Number _____

First Printing JUN 1976

PRODUCED BY SPS INFORMATION GROUP

070-1600-00

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DPO SPECIFICATION AND CALIBRATION

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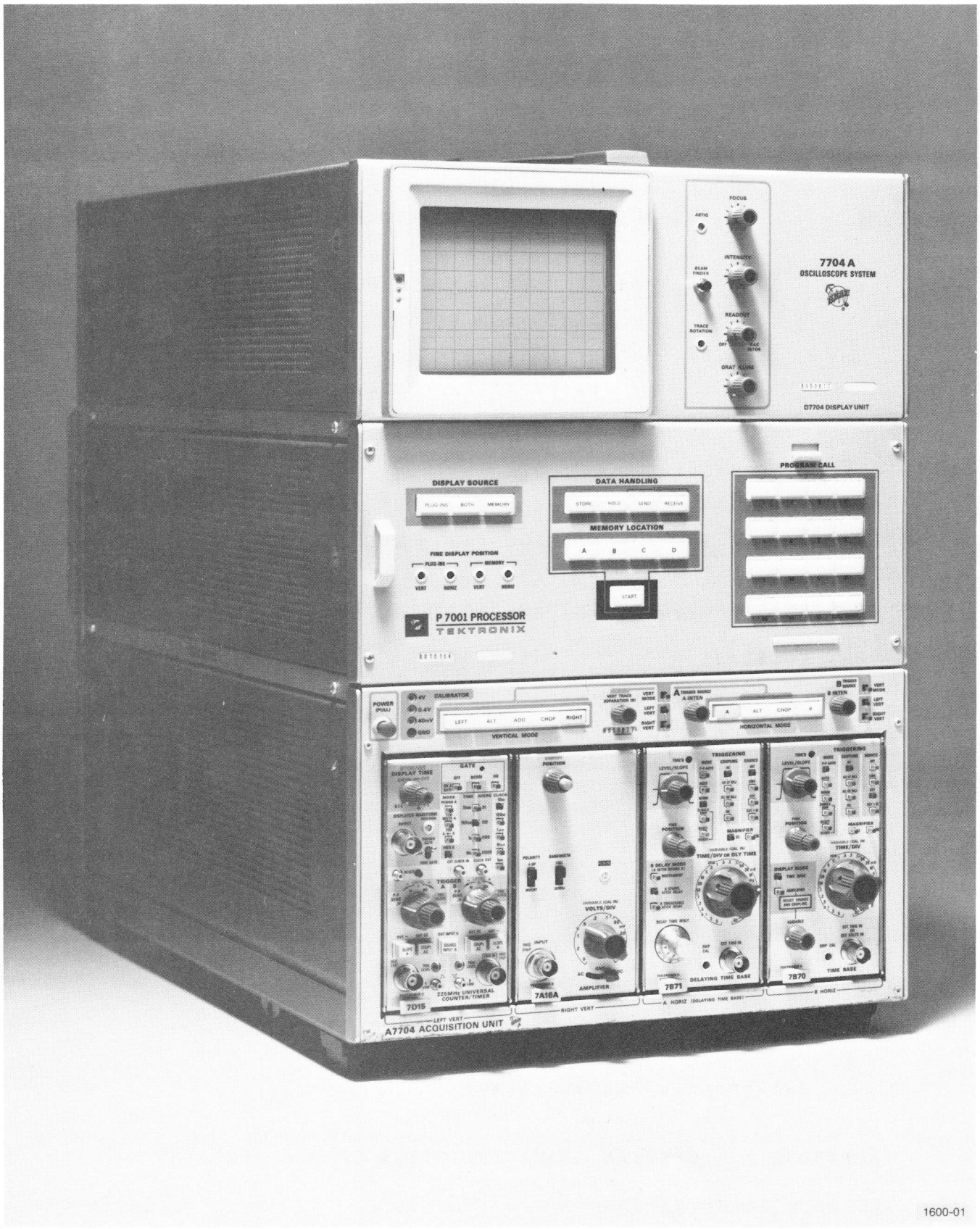

The Digital Processing Oscilloscope

SECTION 1

DPO SPECIFICATIONS

Specifications for the TEKTRONIX Digital Processing Oscilloscope (DPO) are listed in this section. The specifications apply to a 7704A Oscilloscope System and P7001 Processor integrated into a DPO. The DPO will meet the specified electrical characteristics following a complete calibration according to the procedure in Section 2. A warm-up of 20-minutes is necessary and the DPO must be operating within a temperature range of 0 to +50 degrees Celsius, unless otherwise noted.

NOTE

Specifications for the 7704A Oscilloscope System are listed in the 7704A Oscilloscope System Operators Manual. Those specifications are not repeated here, except as it is necessary to change them to apply to the DPO.

FUNCTIONS

Data Acquisition. One to four signals can be acquired and displayed as waveforms and/or converted into digital data and stored in memory. Table 1-1 shows the correct 7704A mode selection for storing waveforms in P7001 Memory Locations A,B,C, or D.

TABLE 1-1

DPO MODE SELECTION

Single Time Base (Mainframe Horizontal Mode "A" or "B")		
		SELECT MEMORY LOCATION:
SINGLE WAVEFORM (any source)		
Single Storage		A or B or C or D
Simultaneous Storage		
from Left Vertical		A & B
from Right Vertical		C & D
MULTIPLE WAVEFORM		
Mainframe Vertical Mode LEFT		
Left Plug-in Mode CHOP		A & B
Mainframe Vertical Mode RIGHT		
Right Plug-in Mode CHOP		C & D
Mainframe Vertical Mode ALT or CHOP*		
Left Plug-in Mode ---	If CH 1	A or B
	If CH 2	A or B
	If ADD	A or B
	If CHOP	A & B
	ALT (do not use)	
Right Plug-in Mode ---	If CH 1	C or D
	If CH 2	C or D
	If ADD	C or D
	If CHOP	C & D
	ALT (do not use)	
Mainframe Vertical Mode ADD		
Left and/or Right Plug-in Mode CHOP		A & B

Dual Time Base (Mainframe Horizontal Mode "CHOP" or "ALT")		
		SELECT MEMORY LOCATION:
Mainframe Vertical Mode ALT		
Left Plug-in Mode ---	If CH 1	A or B
	If CH 2	A or B
	If ADD	A or B
	If CHOP	A & B
	ALT (do not use)	
Right Plug-in Mode ---	If CH 1	C or D
	If CH 2	C or D
	If ADD	C or D
	If CHOP	C & D
	ALT (do not use)	

*For example: to store channel 1 from the left vertical plug-in and both channel 1 and channel 2 from the right vertical plug-in, select memory location A or B and C and D.

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DPO SPECIFICATION

These specifications apply to DPO data acquisition (signal conditioning and conversion to digital data):

Time	6.5 microseconds/data point
Number of data points	512/waveform (max.)
Resolution	10 bits (1 part in 1024)
Vertical System	See Table 1-2
Horizontal (timing)	See specifications in manual of time base used.

The DPO is compatible with 7000-Series plug-in units. Plug-ins are available to make virtually any measurement desired. Tables 1-2, 1-3, and 1-4 list the DPO plug-ins and their performance features. Special characteristics of the plug-ins are noted in Appendix A.

TABLE 1-2

DATA ACQUISITION: VERTICAL SYSTEMS SPECIFICATIONS

PLUG-IN AMPLIFIER	PERFORMANCE FEATURE	MIN. DEFL. FACTOR	BW	Tr	RMS NOISE[2]	ACCURACY[3] w/o PROBE	SIG OUT BW
7A11	Low Capacitance Built-in FET Probe Amplifier	5 mV/div	150 MHz	2.4 ns	<250 µV	2%	70 MHz
7A12	Dual Channel Amplifier with DC Offset	5 mV/div	105 MHz	3.4 ns	<125 µV	2%	60 MHz
7A13	Differential DC Offset High-Freq CMRR Amplifier	1 mV/div	P6053A 100 MHz P6065 65 MHz	3.5 ns 5.4 ns	<200 µV	1.5%	60 MHz 50 MHz
7A14	AC Current Probe Amplifier (2 current probes)	1 mA/div	P6021 50 MHz P6022 105 MHz	7.0 ns 3.4 ns	<100 µA	——	40 MHz 55 MHz
7A15A 7A15AN[4]	Low Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)[1]	75 MHz	4.7 ns	<150 µV	2%	55 MHz
7A16A	Wide Bandwidth Conventional Input Amplifier	5 mV/div	150 MHz	2.4 ns	<250 µV	2%	70 MHz
7A17	Low Cost, Easy to Customize 50 Ω Input Amplifier	50 mV/div	150 MHz	2.4 ns	——	ADJUST	15 MHz
7A18 7A18N[4]	Dual Channel Amplifier	5 mV/div	80 MHz	4.4 ns	<150 µV	2%	55 MHz
7A19	Wide Bandwidth 50 Ohm Input Amplifier	10 mV/div	175 MHz	2.0 ns	<500 µV	3%	80 MHz
7A22	DC-Coupled, High Gain Differential Amplifier	10 µV/div	1 MHz ± 10%	350 ns ± 9%	<8 µV	2%	1 MHz ± 10%
7A24	Dual-Channel, 50-Ohm Input Amplifier	5 mV/div	160 MHz	2.5 ns	<125 µV	2%	60 MHz
7A26	Dual-Channel, Wide-Bandwidth Amplifier	5 mV/div	140 MHz	2.5 ns	<250 µV	2%	60 MHz

[1]Obtained with X10 gain at reduced bandwidth of 10 MHz.

[2]Noise - Measured by computing RMS value of the data stored in a P7001 memory location after removing the mean value of the data. The stored data is supplied by the vertical plug-in, set to its minimum deflection factor and full bandwidth, with a source impedance of 25 Ω or less.

[3]Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. When a probe is used, the gain must be set with the calibration signal applied to the probe tip. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%.

[4]N-Series plug-ins do not include readout capability.

The DPO is compatible with 7000-Series plug-in units. Plug-ins are available to make virtually any measurement desired. Tables 1-2, 1-3, and 1-4 list the DPO plug-ins and their performance features. Special characteristics of the plug-ins are noted in Table 1-5.

TABLE 1-3

DPO TIME BASE PLUG-INS

Time Base	Performance Feature	Max Sweep Rate	Triggering Freq Range
7B50	Delayed Sweep & Ext Amplifier	5 ns/div	DC to 100 MHz
7B51	Delaying Sweep	5 ns/div	DC to 100 MHz
7B52	Delayed & Mixed Sweeps	5 ns/div	DC to 100 MHz
7B53 7B53A 7B53AN*	Delayed & Mixed Sweeps	5 ns/div	DC to 100 MHz
7B70**	Delayed Sweep & Ext Amplifier	2 ns/div	DC to 175 MHz
7B71**	Delaying Sweep	2 ns/div	DC to 175 MHz
7B92 7B92A	Display Switching: Intensified, Delaying, and Delayed Sweeps	0.5 ns/div	DC to 175 MHz
7B80**	Delayed Sweeps, X-Y, and Trigger Hold Off	1 ns/div	DC to 175 MHz
7B85**	Delaying Sweep, Delay Time, and Time Difference Readout	1 ns/div	DC to 175 MHz

*N-series plug-ins do not include readout capability.

**Recommended for use with DPO.

TABLE 1-4

DPO SPECIAL PURPOSE PLUG-INS

Plug-In	Performance Features
7D11	Digital time delay
7D12	A/D Converter; accepts M1 Multifunction, M2 Sample/Hold, and M3 True RMS modules
7D13	Digital Multimeter
7D14	525 megahertz Digital Counter
7D15	Universal Counter/Timer with 10-picosecond period averaging resolution
7K11	CATV Preamplifier; useful with 7L12 or 7L13 to provide 75-ohm environment
7L5	5 megahertz Spectrum Analyzer with CRT readout of center frequency
7L12	100 kilohertz to 1.8 gigahertz Spectrum Analyzer; dynamic range > 70 dB
7L13	1 kilohertz to 1.8 gigahertz Spectrum Analyzer; -110 dBm to +30 dBm sensitivity
7M11	Dual 50-ohm delay line
7M13	Generates readout characters on DPO CRT.
7S11	Vertical sampling plug-in; provides dual-trace when used with 7S12 or 7S14
7S12	TDR and sampler (accepts plug-in heads); includes time base
7S14	General purpose sampler

Memory. The P7001 4K (1K=1024) core memory is capable of storing four digitized waveforms with scale factors and messages in 4096, 10 bit words. The source of waveform information may be the plug-in units or an external controller.

The messages can number up to 12 with 80 characters each in two rows of 40 characters displayed across the top and bottom of the CRT. Messages must originate from an external controller using proper interfacing.

Waveforms, scale factors, and messages can be transferred as digital data between the memory and an external controller using proper interfacing.

Waveforms, scale factors, and messages can be transferred as digital data between the memory and an external controller using proper interfacing.

The following specifications apply:

Cycle Time	Less than 1.5µs. (1.3µs, Option 18 and 19)
Allocation	
Waveform Storage (4) A,B,C,D	512 points/waveform (2048 data points)
Scale Factor Storage A,B,C,D	8 words/waveform (32 words)
Message Storage (12)	80 characters/message (960 characters)

Display. One to four waveforms and scale factors can be displayed as they are acquired. Also, waveforms, scale factors, and messages in memory can be displayed. Dot (display of data points) or vector (linear interpolation between adjacent points) modes can be selected for display of memory waveform data by internal strap options.

The character set is full upper case ASCII alphabet and SPACE, numbers Ø through 9, decimal point, and the following characters:

+, -, <, >, /, μ, Ω, Δ, ↑.

Specifications for display of stored data:

Resolution	10 bits vertical, 9 bits horizontal
Accuracy	Within 1.5% (8 division reference)
Linearity	0.1 division or less compression or expansion of a center-screen two-division signal when positioned anywhere within the graticule area.
Comparison of stored waveform to real-time waveform	Gain is within 1% of real-time waveform. Position adjustments on the front panel allow real-time and stored display to be set for coincidence.

CONTROLS

7704A Oscilloscope System controls remain the same. Controls added by the P7001 Processor:

DISPLAY SOURCE: Selects one of three sources for CRT display.

PLUG-INS (signals from plug-ins)

MEMORY (data from memory)

BOTH (timeshares PLUG-INS and MEMORY)

DATA HANDLING:

STORE: waveform analog information from the plug-ins is converted to digital data and stored in selected memory locations. The storing process is continuous until terminated.

HOLD: STORE operation is terminated and the P7001 set in a safe mode. Data in P7001 memory is not changed unless it is overwritten by a controller interfaced to the DPO.

SEND: directs an external controller to transfer data from a selected memory location.

RECEIVE: directs an external controller to transfer data into a selected memory location.

START: initiates the STORE, SEND, or RECEIVE functions.

MEMORY LOCATION: selects one of four memory locations.

PROGRAM CALL: 16 buttons that can provide front panel access to stored programs in the external controller and indicate when the external controller is busy.

FINE DISPLAY POSITION: front panel screwdriver adjustments that allow the operator to position the memory display to a graticule reference line and position the plug-in display to coincide with the stored waveform display.

PROGRAMMABLE CONTROLS

An external controller can program these modes (with proper interfacing):

DATA HANDLING

MEMORY LOCATION

DISPLAY SOURCE

An external controller can also interrogate the status of DATA HANDLING and MEMORY LOCATION and the PROGRAM CALL pushbuttons, refresh an X-Y display with up to four intensity levels for graphic displays, and reset the time base single sweep.

POWER REQUIREMENTS

Line Voltage (selected on rear panel)	115 VAC nominal; operates between 90 and 132 VAC RMS
	230 VAC nominal; operates between 180 and 264 VAC RMS
Maximum line voltage	250 VAC RMS
Line Frequency	48 Hz to 440 Hz
Power Consumption (Max.) from 60 Hz, 115 V Line	
7704A	180 watts, 2.5A
P7001	120 watts, 1.5A

ENVIRONMENTAL SPECIFICATIONS

Temperature Range	
Operating	0°C to +50°C
Non-operating	-55°C to +75°C
Warmup Time for Rated Accuracy	20 minutes
Maximum Altitude	
Operating	15,000 feet (4570 meters)
Non-operating	50,000 feet (15,240 meters)
Electromagnetic interference	See Option 3

PHYSICAL CHARACTERISTICS

Dimensions	
Height	18.9 inches (47.5 cm)
Width	12 inches (30.6 cm)
Length	22.7 inches (57.7 cm)
Net Weight (without plug-ins)	48 lbs (21.8 kg)

STANDARD ACCESSORIES

175-1178-00 Pin-to-BNC cable

Manuals:

070-1599-00 Digital Processing Oscilloscope Operators

070-1402-00 7704A Oscilloscope System Operators

070-1882-00 P7001 Processor Service

070-1604-00 P7001 Main Interface Service

070-1610-00 P7001 Front Panel/Z Axis Service

070-1810-00 P7001 Sample & Hold Service

070-1809-00 P7001 A-D Converter Service

070-1605-00 P7001 Core Memory Assembly Service

070-1608-00 P7001 Display Generator Service

070-1609-00 P7001 Readout Interface Service

070-1890-00 P7001 Power Supply Service

070-1600-00 DPO System Specification and Calibration

070-1260-00 7704A Oscilloscope System Service

OPTIONS

3 - Provides electromagnetic interference (EMI) shielding to meet MIL-1-1618D limits for radiated interference from 150 kilohertz to 1 gigahertz, and for conducted interference from 150 kilohertz to 25 megahertz. Kit part number is 040-0671-00.

18 - Substitutes 1K Semiconductor Memory.

Delete 4K Core Memory.

Add 1K Semiconductor Memory 670-2981-00.

19 - Substitutes 2K Semiconductor Memory.

Delete 4K Core Memory.

Add 2K Semiconductor Memory 670-3035-00.

Manual changes due to options:

Options 18 and 19

Delete 070-1605-00 P7001 Core Memory Assembly Service.

Add 070-1606-00 P7001 Semiconductor Memory Service.

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DPO CALIBRATION

WARNING

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

SECTION 2

CALIBRATION

INTRODUCTION

This calibration procedure includes all adjustments to calibrate the TEKTRONIX Digital Processing Oscilloscope (DPO). It incorporates the adjustment instructions in the 7704A Oscilloscope System Service manual as well as those in the P7001 card service manuals.

WARNING

The following servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that called out in the operating instructions unless qualified to do so.

DPO System. Some steps in this procedure require that the DPO be interfaced to a Tektronix CP1100 Controller or Digital Equipment Corporation (DEC) PDP-11 minicomputer using the CP1100/DPO Interface. A terminal and input/output device must be interfaced to the controller as well for program entry and control.

The DPO can be calibrated with a system different than the one just described. But if available versions of P7001 Checkout Software can not be loaded, you must program three tests from the Checkout Software. Flowcharts for this are provided in Section 4. Also, you must translate several TEK

BASIC programs to run with the system if it is programmed in a language other than TEK BASIC.

Software is used only where necessary to make an adjustment. Further software checks of P7001 performance can be made with P7001 Checkout Software, if desired.

Related Manuals. DPO operation and service manuals are listed in Section 1, DPO Specification. Software manuals are supplied with the software. They are:

070-1773-00 DPO TEK BASIC V01 Users

070-1774-00 WDI TEK BASIC Software V01-01 Users

070-2033-00 WDI TEK BASIC Software V02 Users

070-1970-00 RSS TEK BASIC Software V01 Users

070-1612-00 P7001 Checkout Software

Tektronix Field Services. Tektronix, Inc., provides complete instrument repair and recalibration. Call the nearest Tektronix Service Center, Field Office, or the Factory Service Center for more information.

Summary of Procedure. Vertical and horizontal data paths and adjustments are shown on Figs. 2-1 and 2-2. The DPO adjustments are grouped according to these functions.

A. Power Supply. The power supply voltages are checked and adjusted first (steps 1 through 8) because they affect the rest of the DPO.

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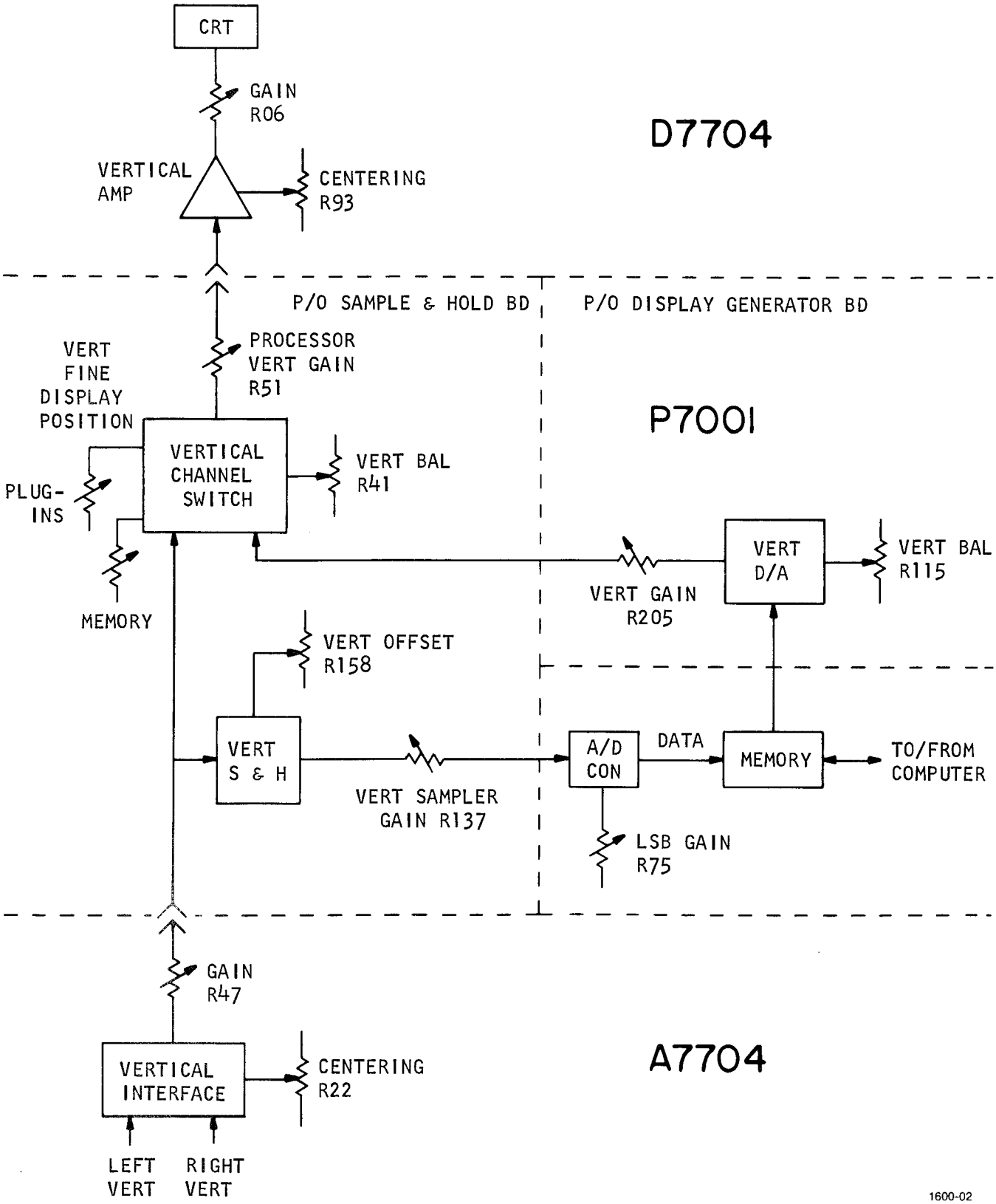

Fig. 2-1. DPO vertical signal datapaths with gain and centering adjustments.

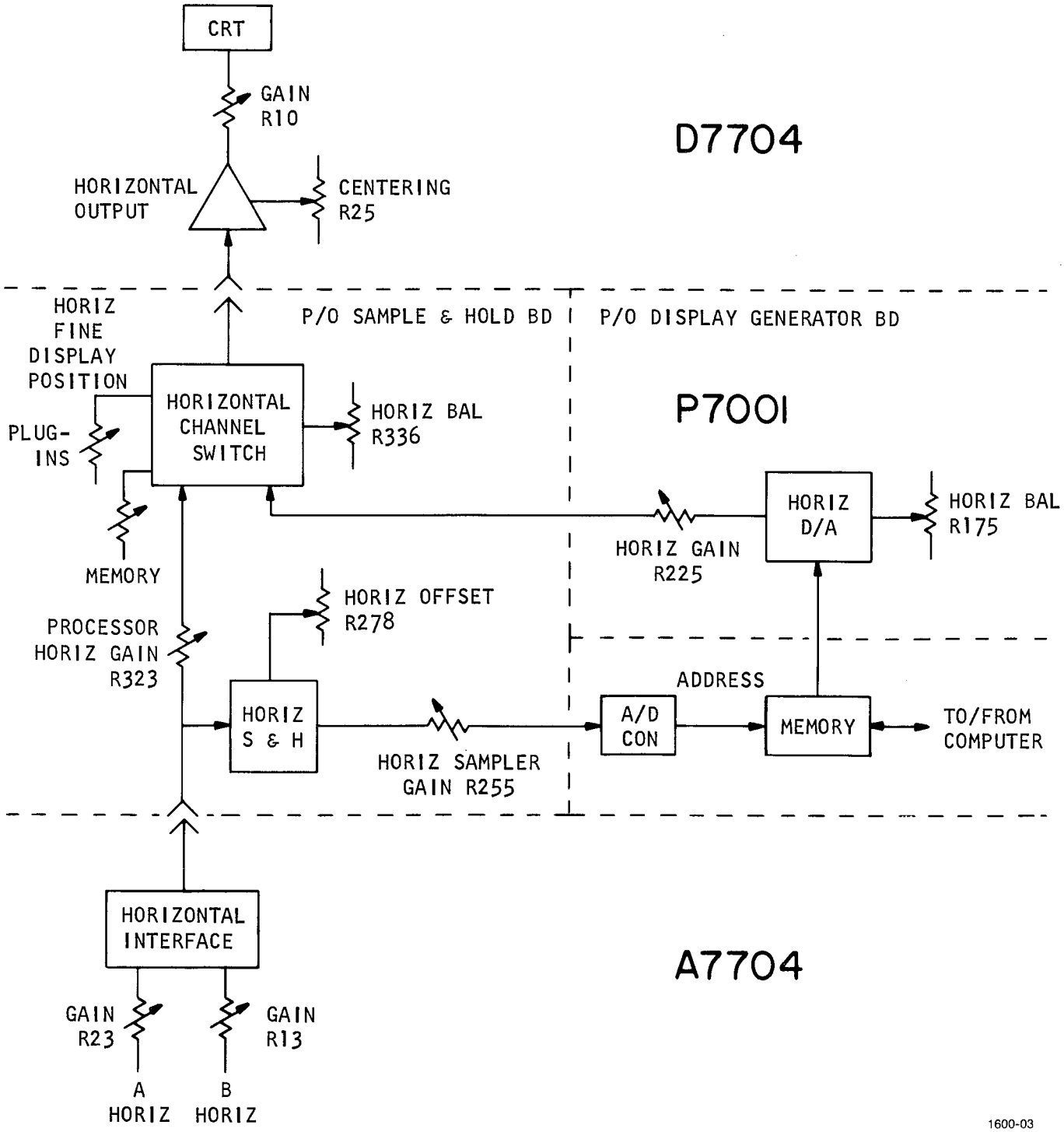

Fig. 2-2. DPO horizontal signal datapaths with gain and centering adjustments.

B. PLUG-INS Display. Steps 9 through 44 adjust the Z-Axis, Vertical System, Triggering, Horizontal System, Calibrator, Output Signals, and Readout System. These 7704A and P7001 Sample and Hold card adjustments set up the path from signal acquisition to real-time display on the CRT.

C. MEMORY Display. The next group of P7001 memory and display generator adjustments (steps 45 through 52) affect the path from MEMORY data to display on the CRT.

D. STORE Mode. The path from signal acquisition through digitizing and storage is adjusted in steps 53 through 68. These adjustments are on the P7001 Z-Axis/Front Panel, Sample and Hold, and A-D Converter cards.

E. DISPLAY POSITION. The front panel adjustments to achieve coincidence between the PLUG-INS and MEMORY display of the same waveform are covered in steps 69 and 70.

Vertical and Horizontal Interface adjustments are covered in Section 3.

Flowcharts are presented in Section 4 to aid in the calibration of a DPO used in a system with a controller other than the CP1100 (or PDP-11). The flowcharts can be used to generate the P7001 Checkout Software waveforms used in this procedure.

Adjustment Locations. Illustrations that show the location of DPO adjustments are provided on pullout pages at the

back of the manual. They are identified by a capital letter for the pullout and a number to identify the figure on the pullout. For example, the first one is Fig. A-1, which shows the location of DPO circuit boards. Figures in the text do not carry a letter but are identified by the order in which they appear in a section: Fig. 2-1, Fig. 2-2, etc.

Components on the adjustment location illustrations are identified by two or three-digit circuit numbers. These are the numbers used to refer to these components in the calibration procedure. Note, however, that 7704A components are given four or five-digit circuit numbers on schematics and in the parts list. The first two digits refer to the circuit board and the last two or three digits are the same circuit numbers found in the adjustment location illustrations and calibration procedure.

Calibration Interval. To assure DPO accuracy, perform the checks and adjustments in this procedure every 1,000 hours of operation or every six months if used infrequently. Thoroughly clean and inspect the instrument before starting. See the maintenance instructions in the P7001 Processor Service (070-1882-00) and 7704A Oscilloscope System Service (070-1260-00) manuals for details.

Partial Calibration. A partial calibration is often desirable after replacing components, or to touch up the adjustment of a portion of the DPO before a complete calibration is due. For a partial calibration, follow the steps under

Preliminary Procedure and then go to the Required Equipment list preceding the desired portion. To prevent unnecessary recalibration of other parts of the instrument, readjust only if the tolerance given in the CHECK part of the step is not met. If readjustment is necessary, also check the calibration of any steps listed in the INTERACTION part of the step.

Complete Calibration Procedure. Performing the full calibration procedure completely checks and adjusts the DPO to its specified performance. However, the limits and tolerances given in this procedure are calibration guides. They should not be interpreted as instrument specifications. These are listed in Section 1, Specification.

If you do not require full performance from the DPO and plug-in combinations, this procedure and the required test equipment list can be shortened accordingly. For example, if a check or adjustment has little or no importance to your measurement requirements, it can be deleted. Vertical deflection accuracy and horizontal timing of a DPO and plug-in combination can be checked using the A7704 Calibration signal. Check both the PLUG-INS and MEMORY (using the STORE Mode) display accuracy.

Completing this procedure will allow 7000-Series plug-in units to be interchanged in the DPO without recalibration. However, if the DPO plug-ins are already calibrated and will

not be interchanged, the PG506 can be substituted for the 067-0587-01 Calibration Fixture where it is called for in the calibration procedure.

REQUIRED TEST EQUIPMENT

All the test equipment listed in Table 2-1 is required to completely check and adjust the DPO. The equipment must be correctly calibrated and operating within its specifications.

Calibration Equipment Alternatives. Other test equpment can be used if its specifications meet or exceed the specifications in Table 2-1. This calibration procedure is written to use the first example given for each item of test equipment. When other equipment is substituted, different control settings or calibration setup may be needed to perform the calibration procedure. Refer to the instruction manual for the test equipment if you need more operating instructions than those given in this procedure.

Special Calibration Fixtures. Special Tektronix calibration fixtures needed for this procedure are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

TABLE 2-1

REQUIRED TEST EQUIPMENT

ITEM	MINIMUM SPECIFICATIONS	SUGGESTED EQUIPMENT
Amplifier (two required)	Tektronix 7A-Series Plug-ins with 1 megohm input impedance. Bandwidth in DPO, DC to 150 megahertz. Identical units required for X-Y phase check	a. Tektronix 7A16A Amplifier b. Any 7A-Series plug-ins (tolerances in some steps may be limited if low-frequency units are used)
Time Base (two required)	Tektronix 7B-Series Plug-ins, X10 magnifier and 2 nanosecond/division sweep rate required in one unit	a. Tektronix 7B70 or 7B71 Time Base. May be shared with 7000-Series test oscilloscope
Signal standardizer calibration fixture		a. Tektronix 067-0587-01 Calibration Fixture b. Calibrated 7A-Series amplifier with PG506 (TM500 Power Module required)
Plug-in extender calibration fixture (needed for trigger circuit checks only)		Tektronix 067-0589-00 Calibration Fixture
P7001 card extender		Tektronix part number 067-0683-00
Test oscilloscope with two vertical channels and two 10X probes	Bandwidth, DC to 75 megahertz; minimum deflection factor, 50 millivolts/division; accuracy, within 3%	a. Tektronix 7704A Oscilloscope with two 7A16A Amplifiers, 7B70 or 7B71 Time Base, and two P6053 Probes b. Tektronix 475 Oscilloscope with two P6075A Probes

TABLE 2-1 (cont.)

REQUIRED TEST EQUIPMENT

ITEM	MINIMUM SPECIFICATIONS	SUGGESTED EQUIPMENT
Digital multimeter	Measure up to 200 volts DC with 0.1% basic accuracy; 20 kilohm range internal current of 100 microamps	a. Tektronix DM501 or DM502 Digital Multimeters (require TM500 Power Module) b. Tektronix 7D13 Digital Multimeter (requires 7000-Series oscilloscope with Readout System) c. Tektronix DM40 or DM43 Digital Multimeters (available with Tektronix 464, 465, 466, 475 Oscilloscopes)
DC voltmeter (VOM)	4000 volts DC range; accuracy checked to within 1% at -2,960 volts	a. Triplett Model 630-NA b. Simpson Model 262 c. Precision voltage divider used with digital multimeter
Time mark generator	Marker outputs: two nanoseconds to one millisecond; marker accuracy, within 0.1%	a. Tektronix TG501 Time Mark Generator (requires TM500 Power Module) b. Tektronix 2901 Time Mark Generator
Leveled sine wave generator	Frequency, 50 kilohertz to 200 megahertz; peak-to-peak output amplitude variable from five millivolts to four volts, leveled within 1%	a. Tektronix TG503 Leveled Sine Wave Generator (use 012-0482-00 cable) b. Tektronix Type 191 Constant Amplitude Signal Generator and Wavetek 1001A Sweep/ Signal Generator

TABLE 2-1 (cont.)

REQUIRED TEST EQUIPMENT

ITEM	MINIMUM SPECIFICATIONS	SUGGESTED EQUIPMENT
Controller (computer)	Interfaced to DPO using CP1100/DPO Interface	a. Tektronix CP1100 or DEC PDP-11 b. Computer interfaced to CP Bus with DPO/CP Bus Interface in DPO
Terminal	Interfaced to controller	Tektronix 4010-1
Input/Output (I/O) device	Interfaced to controller	Tektronix CP220 Reader/Punch Tektronix CP100 Cassette Unit
P7001 Checkout Software		Tektronix part number 062-1566-31 (paper tape) 062-1566-38 (cassette)
TEK BASIC Software		Tektronix CP65511 DPO TEK BASIC (paper tape) CP65681 DPO TEK BASIC (cassette) CP65521 DPO TEK BASIC (fanfold) CP65781 WDI TEK BASIC (cassette) CP81981 RSS TEK BASIC (cassette)
5X attenuator	50 ohm, BNC connectors	Tektronix part number 011-0060-02
Feed-through terminator (two required)	50 ohm, BNC connectors	Tektronix part number 011-0049-01

TABLE 2-1 (cont.)

REQUIRED TEST EQUIPMENT

ITEM	MINIMUM SPECIFICATIONS	SUGGESTED EQUIPMENT
T connector	BNC connectors	Tektronix part number 103-0030-00
Adapter	Adapts BNC to Tektronix connectors	Tektronix part number 131-1315-00
Adapter (two required)	Adapts male Tektronix coaxial connector to male Tektronix connector	Tektronix part number 103-0169-00
Coaxial cable (two required)	50 ohm, 30 inches, BNC connectors	Tektronix part number 012-0057-01
Coaxial Cable	50 ohm, 18 inches, BSM male and BNC female connectors	Tektronix part number 012-0127-00
Coaxial cable	Tektronix coax, 15 inches	Tektronix part number 175-1828-00
Coaxial cable	Pin jacks and BNC male connectors	Tektronix part number 175-1178-00 (standard DPO accessory)
Adjustment tool		Tektronix part number 003-0489-00 (JFD Adjustment Tool 5284)

PRELIMINARY PROCEDURE

NOTE

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

1. Remove the side, top, and bottom panels from the DPO. Remove the four screws from the P7001 front panel. Slowly pull it out and swing to the left.

2. Connect the DPO to a power source that meets the voltage and frequency requirements of this instrument. Use a grounded (3-prong) outlet with one side neutral. The applied voltage should be near the center of the voltage range selected by the Line Selector assembly.

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

3. Set the controls as given under Control Settings preceding each section. Do not turn on the DPO to begin the first adjustment, Memory Volts. Allow at least 20 minutes warmup before proceeding with the steps following Memory Volts.

4. Check the front-panel gain and sweep calibration adjustments of the test oscilloscope and probe compensation. Also, check the front-panel calibration adjustments of DPO plug-ins before using them to make measurements. An example is

the Output Signals section where the DPO is used to measure the amplitude and duration of waveforms coming from the DPO Output Signal connectors.

5. POWER FAIL is generated when DPO power is turned on and can be generated when a plug-in is installed. Check P7001 controls after turning on power or installing a plug-in. POWER FAIL can cause a change in P7001 modes from those preceding the POWER FAIL condition.

6. A DPO equipped with semiconductor memory must have any stored waveforms that are needed for further calibration reloaded after DPO power is interrupted. In step 52, for instance, if adjustment is necessary, DPO power is turned off to remove the circuit card. Since the CAL waveform stored in a preceding step is necessary to make the adjustment, it must be reloaded into DPO semiconductor memory from P7001 Checkout Software after DPO power is turned back on.

NOTE

Titles for external controls of this instrument are capitalized in this procedure (e.g., A INTEN). Internal adjustments are initial capitalized only (e.g., Vert Offset R158).

POWER SUPPLY

P7001

Required Equipment

1. Digital multimeter
2. DC voltmeter (VOM)
3. Adjustment tool

Control Settings

POWER: OFF

1. Check Memory Volts (skip if P7001 has Semiconductor memory)

NOTE

Memory Volts is temperature sensitive. It should be checked after the DPO has been turned off and allowed to cool to an ambient temperature of +20 to +30 degrees C.

a. Set the digital multimeter to 20 volts DC range and connect between the V and G test points. See Fig. A-2.

b. Turn on DPO POWER.

c. CHECK - Meter reading should be within 2% of the voltage given in Fig. A-3.

d. ADJUST - Turn off DPO power. Remove the Core Memory assembly from the P7001. Set the digital multimeter range to 20 kilohms. Connect the high lead to test point V and the low

lead to the junction of R101 and R105 (Fig. A-2). Adjust Memory Volts R103 for the resistance given in Fig. A-3. Disconnect meter leads. Reinstall Core Memory assembly. Repeat steps a, b, and c.

NOTE

Allow at least 20 minutes warmup before making the following adjustments.

2. Adjust P7001 +5.1 Volts

a. Connect the digital multimeter between the +5.1 volt test point and ground (see Fig. B-1).

b. CHECK - Meter reading: +5.1 volts $\pm$0.25 volts.

c. If the +5.1 volt supply is not within tolerance, turn the DPO POWER off and remove the A7704 Power Supply assembly from the rear of the Acquisition unit (the Line Selector assembly is mounted on the Power Supply assembly). Check that the interconnecting cables remain connected as the power unit is slid out of the A7704.

d. Lay the DPO unit on its right side.

WARNING

Caution must be used when operating the A7704 with the power unit removed due to the line voltage and high-voltage/high-current potentials present.

e. Turn the DPO POWER on.

f. ADJUST - +5.1 volts R43 for a meter reading of +5.1 volts. R43 is accessible through the bottom cover of the P7001 Power Supply near the front (see Fig. B-2).

g. Set the DPO upright.

3. Adjust P7001 -50 Volts

a. Set the digital multimeter to the 200 volts DC range and connect between the -50 volt test point and ground (see Fig. B-1).

b. CHECK - Meter reading: -50 volts $\pm$0.5 volt.

c. ADJUST - -50 Volts R233 (see Fig. B-3) for a meter reading of -50 volts.

4. Check Remaining P7001 Power Supply Voltages

a. CHECK - P7001 power supplies for output voltages listed in Table 2-2. Test points are shown in Fig. B-1. Reset meter range as necessary.

TABLE 2-2

P7001 REGULATED POWER SUPPLY VOLTAGES

P7001 Power Supply	Output Voltage Tolerance
-15 V	± 0.18 V
- 5 V	± 0.1 V
+ 5 V	± 0.1 V
+15 V	± 0.3 V
+50 V	± 2.5 V

NOTE: Check power supply voltages in the given sequence because a regulated supply may be the reference for a following regulated supply.

7704A

5. Adjust A7704 +54 Volts

a. If the A7704 power supply was not removed in the previous step, turn the DPO POWER switch off and remove the screws securing the corners of the heat sink assembly to the rear of the instrument. Slide the power unit out of the A7704; leave the interconnecting cables connected.

b. Return the DPO POWER switch to on.

c. Connect the digital multimeter between the +54 Volt test point (see Fig. B-4) and ground.

d. CHECK - Meter reading; +54.2 volts ±0.25 volt.

e. ADJUST - +54 volts R3143 for a meter reading of +54.2 volts. R3143 is accessible through the bottom cover near the front of the power unit; see Fig. C-1.

f. Disconnect the digital multimeter.

g. INTERACTION - if the setting of R3143 is changed, check steps 6, 7 and 8.

6. Adjust A7704 -50 Volts

a. Connect the digital multimeter between pin 6 of P32G and chassis ground.

b. CHECK - Meter reading: -50 volts ±0.2 volt.

c. ADJUST - -50 volts R133 on the 7704A Regulator board (see Fig. B-4) for a meter reading of -50 volts.

d. INTERACTION - Any change in the setting of R133 may affect operation of all circuits within the A7704, D7704, and plug-in units.

7. Check Remaining A7704 Power Supply Voltages

a. CHECK - Table 2-3 lists the low-voltage power supplies in the A7704. Check each supply with the digital multimeter for output voltage within the given tolerance. Reset meter range as necessary.

TABLE 2-3

A7704 POWER SUPPLY VOLTAGES

A7704 Power Supply	Output Voltage Tolerance	Test Point Location (see Fig. B-4)
-50 V	± 0.20 V	Pin 6-P32G
-15 V	± 0.15 V	Pin 1-P32G
+ 5 V	± 0.10 V	Pin 2-P32G
+15 V	± 0.15 V	Pin 4-P32G
+50 V	± 0.50 V	Pin 5-P32G
Control Illum	+0.20 to -0.50 V	Pin 9-P32G

b. Turn off DPO POWER and disconnect all test equipment.

c. Install the power unit in the instrument and turn on DPO POWER.

d. Connect the digital multimeter between ground and Pin 1 of P43 on rear of Horizontal Output board; see Fig. C-2. Set meter range to 200 volts DC.

e. CHECK - Meter reading +155 volts $\pm$ 5 volts.

f. Disconnect all test equipment.

8. Adjust High Voltage

a. Turn off DPO POWER. Connect the DC voltmeter (VOM) set to measure at least -3000 volts, between HV TP at the rear of the D7704 and chassis ground (see Fig. C-3).

b. Turn on DPO POWER switch.

c. CHECK - Meter reads: -2960 volts $\pm$ 29.6 volts.

d. ADJUST - High Voltage R23 on the Z-Axis board (see Fig. C-4) for a meter reading of -2960 volts.

e. Set the DPO POWER switch to off and disconnect the DC voltmeter. Return the DPO POWER switch to on.

PLUG-INS DISPLAY

Z-Axis and Display

Required Equipment

1. Digital multimeter
2. Signal standardizer calibration fixture
3. Time base plug-in (two required)
4. Amplifier plug-in
5. Test oscilloscope system with 10X probe
6. Time mark generator
7. Leveled sine wave generator
8. T connector
9. Adjustment tool

Control Settings

POWER: ON

VERTICAL MODE: RIGHT

VERT TRACE SEPARATION (B): Midrange

A TRIGGER SOURCE: VERT MODE

A INTEN: Fully clockwise

HORIZONTAL MODE: A

B INTEN: Fully clockwise

B TRIGGER SOURCE: VERT MODE

FOCUS: Midrange

INTENSITY: Fully counterclockwise

READOUT: OFF

DISPLAY SOURCE: PLUG-INS

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9. Adjust CRT Grid Bias

a. Install the signal standardizer calibration fixture in the RIGHT VERT compartment and a time base unit in the A HORIZ compartment.

b. Set the time base for a free-running sweep at a 0.2 second/division sweep rate. Set the calibration fixture Test switch to Triggering Gain.

c. Set the test oscilloscope for free-running trace with a sweep rate of one millisecond/division. Set vertical deflection factor to 0.2 volt/division (2 volts/division at probe tip).

d. Ground the test oscilloscope input, then position the trace to the bottom horizontal line of the graticule. Do not change the test oscilloscope position control after setting this ground reference. Set input coupling to DC.

e. Connect the probe tip to TP120 on the D7704 Z-Axis board (see Fig. C-4); connect the probe ground to chassis ground with a short grounding strap.

f. Note the baseline level of the test oscilloscope trace. Then set the INTENSITY control for a baseline level four volts (two divisions) more positive.

g. CHECK - The dot on the CRT is just extinguished.

h. ADJUST - CRT Grid Bias adjustment R35 on the Z-Axis board (see Fig. C-4) so the dot on the CRT screen is just extinguished.

i. Leave the 10X probe connected to TP120 for the next step.

10. Adjust Z-Axis Transient Response

a. Set the test oscilloscope for a vertical deflection factor of one volt/division (10 volts/division at probe tip) at a sweep rate of .05 microsecond/division.

b. Set the time base (A HORIZ) for a free-running sweep at a 0.02 microsecond/division sweep rate.

c. Set the INTENSITY controls for a pulse waveform with a peak-to-peak amplitude of 30 volts as displayed on the test oscilloscope.

d. Set the test oscilloscope time base controls to trigger on the positive slope.

e. CHECK - Test oscilloscope for square corner on displayed pulse.

f. ADJUST - Z-Axis Peaking adjustment R97 and C109 on the Z-Axis board (see Fig. C-4) for best front corner on displayed pulse.

g. Set the calibration fixture Test switch to Vert or HORIZ + Step Resp and the Amplitude control to half-amplitude.

h. Set the time base unit for a free-running sweep at a rate of 0.1 millisecond/division. Reset INTENSITY control for normal trace brightness.

i. Press the BEAM FINDER switch.

j. CHECK - Display is compressed within the graticule area regardless of the setting of the position controls.

k. While pressing the BEAM FINDER switch, center the compressed display on the graticule with the vertical and horizontal position controls.

l. CHECK - Release BEAM FINDER switch; display should remain within the display area.

m. Disconnect test oscilloscope probe. Leave plug-ins installed.

11. Adjust Trace Alignment

a. Change the following control settings:

VERTICAL MODE: ALT

HORIZONTAL MODE: CHOP

b. Install a time base in the LEFT VERT compartment and an amplifier unit in the B HORIZ compartment.

c. Set both time base units for auto, external triggering at a 0.1 millisecond/division sweep rate. Set triggering level for a free-running sweep.

d. Set the calibration fixture Test switch to AUX IN.

e. Set FOCUS and INTENSITY controls for a well-focused, medium-intensity trace.

f. Use the plug-ins Position controls to set the traces on the vertical and horizontal center lines of the graticule.

g. CHECK - The vertical trace aligns with the center vertical line within 0.1 division and the horizontal trace aligns with the center horizontal line within 0.1 division.

h. ADJUST - Front-panel TRACE ROTATION adjustment for horizontal alignment and the Y Axis Align R173 on the Z-Axis board (Fig. C-4), for vertical alignment so the traces align with the vertical and horizontal center lines. The adjustments interact; readjust as necessary.

i. INTERACTION - Check step 12.

12. Adjust Auto-Focus Operation

a. Change VERTICAL MODE to RIGHT and HORIZONTAL MODE to A. Set the calibration fixture Test switch to Vert or Horiz + Step Resp and the Rep Rate switch to 10 kilohertz.

b. Set the A HORIZ time base for auto, internal triggering at a 0.1 microsecond/division sweep rate. Set triggering level for a triggered display.

c. Set the calibration fixture Amplitude control for a three-division display.

d. Set the INTENSITY control for a low-intensity display.

e. Set the FOCUS control and ASTIG adjustment for a well-defined display.

f. Without changing the FOCUS control and ASTIG adjustment, set the INTENSITY control for maximum display intensity.

g. ADJUST - Auto Focus Gain adjustment R127 on the Z-Axis board (see Fig. C-4) for a well-defined, high-intensity display.

h. Connect the test oscilloscope 10X probe tip to the junction of R131-CR157-R155-CR155 on the Z-Axis board (see Fig. C-4). Connect ground clip to chassis ground.

i. Set the test oscilloscope for a vertical deflection factor of 2.0 volts/division (20 volts/division at probe tip), and a 500 nanosecond/division sweep rate. Trigger on negative slope. Position pulse on screen.

j. CHECK - Test oscilloscope display of pulse for aberrations on the negative transition roughly balanced above and below the pulse bottom level as you rotate the INTENSITY control through its range.

k. ADJUST - Reposition the gimmick-capacitor wire around R131 (see Fig. C-4) for best square corner on displayed pulse throughout the rotation of the INTENSITY control.

l. INTERACTION - Check step 10.

m. Disconnect the probe.

13. Adjust Geometry

a. Change VERTICAL MODE to LEFT.

b. Remove the time base from the A HORIZ compartment and install the signal standardizer calibration fixture in its place.

c. Set the calibration fixture Test switch to Vert or Horiz Gain and Rep Rate to 1 kilohertz. Set the LEFT VERT time base to a free-running sweep rate of 1 microsecond/division.

d. CHECK - Vertical bowing and tilt of the vertical lines is less than 0.1 division. Use the calibration fixture Position control to align the vertical traces one at a time, with the graticule lines.

e. ADJUST - Geometry R171 on the Z-Axis board (see Fig. C-4) for minimum bowing or tilt of the vertical lines. Adjustment may need to be compromised to obtain less than 0.1 division bowing or tilt everywhere within the graticule area.

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f. Remove the calibration fixture. Move the time base from the LEFT VERT to the A HORIZ compartment.

14. Adjust Shield Volts (Serial numbers B070000 and above)

a. Turn off DPO power. Short the two vertical output leads with a jumper. The leads connect the Vertical Amp board to the CRT pins under the front of the board (Fig. D-1). Turn on DPO power.

b. Set the digital multimeter to the 200 volt range. Connect the multimeter low lead to ground and the high lead to the shorted CRT pins. Note the reading.

c. Turn off DPO power. Remove the jumper. Turn on DPO power. Press PLUG-INS on the P7001.

d. Connect the digital multimeter high lead to pin 4 on P41U on the D7704 Z-Axis board (Fig. C-4).

e. CHECK - The meter should read within 200 millivolts of the reading in step b.

f. ADJUST - Shield Voltage R176 on the D7704 Z-Axis board (Fig. C-4) so the digital multimeter reads the same as in step b.

g. Remove test leads.

15. Check External Z-Axis Operation

a. Install an amplifier unit in the LEFT VERT compartment. Set trace to graticule center using POSITION control.

b. Connect the output of the leveled sine wave generator to the amplifier-unit input (use a BNC T connector at the amplifier input).

c. Set the amplifier unit for a calibrated deflection factor of 0.5 volt/division.

d. Set the A time base unit for auto, internal triggering at a sweep rate of 10 microseconds/division.

e. Set the leveled sine wave generator for a four-division display at 50 kilohertz. Set INTENSITY for medium intensity display.

f. Connect the signal from the output of the T connector at the amplifier input to the Z-AXIS INPUT connector on the rear panel.

g. CHECK - Top portion of displayed waveform is blanked out.

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

Vertical System

Required Equipment

1. Signal standardizer calibration fixture
2. Time base plug-in unit (two required)
3. Amplifier plug-in unit (two required)
4. Leveled sine wave generator
5. 5X attenuator
6. Adjustment tool
7. TEKTRONIX coaxial to TEKTRONIX coaxial adapter (two required)

Control Settings

POWER: ON

VERTICAL MODE: ALT

A TRIGGER SOURCE: VERT MODE

HORIZONTAL MODE: A

B TRIGGER SOURCE: VERT MODE

READOUT: OFF

DISPLAY SOURCE: PLUG-INS

NOTE

The Vertical Interface adjustments do not need to be checked during routine calibration. However, if components are replaced or if the Acquisition unit is installed in a different system from the original, adjustment may be necessary. The need for adjustment is indicated if the Vertical System gain, centering, and compensation adjustments cannot be performed according to the following procedure. Calibration information for the Vertical Interface is given in Section 3.

16. Adjust Vertical Amplifier Centering

a. Disconnect the leads from J17 and J18 on the Vertical Amplifier board (see Fig. D-1).

b. Install a time base unit in the A HORIZ compartment.

c. Set the time base unit for a free-running sweep at a 1 microsecond/division sweep rate.

d. Set FOCUS, INTENSITY for a well-focused trace with normal brightness.

e. CHECK - CRT display is within 0.2 division of the graticule center line.

f. ADJUST - Centering R93 on the Vertical Amplifier board (see Fig. D-1) to position the trace to the graticule center line.

g. Reconnect the leads to J17 and J18.

h. INTERACTION - Do steps 17, 19, 20, 51, 69, and 70.

17. Adjust Sample and Hold Vertical Balance

a. Disconnect harmonica connector at P50 on P7001 Sample and Hold card.

b. CHECK - CRT display; vertical position of traces is within 0.2 division of the graticule center line.

c. ADJUST - Vert Balance R41 on the P7001 Sample and Hold card (see Fig. D-2) to position the trace to the graticule center line.

d. INTERACTION - Do steps 18, 19, 20, 51, 69, and 70.

e. Reconnect P50 on P7001 Sample and Hold card.

18. Adjust Vertical Amplifier Bias

a. Set the VERTICAL MODE switch to RIGHT.

b. Install the signal standardizer calibration fixture in the RIGHT VERT compartment.

c. Set the calibration fixture Test switch to Vert or Horiz Gain and the Rep Rate to 1 kilohertz.

d. ADJUST - Bias R15 on the Vertical Amplifier board (see Fig. D-1) for maximum deflection between the traces.

e. INTERACTION - Do steps 19, 20, and 51.

19. Adjust Vertical Amplifier Gain

NOTE

When disconnecting the following leads, make note of which lead is connected to which connector so they can be reconnected correctly.

a. Turn DPO POWER off. Disconnect J21 and J30 (see Fig. D-2) from the Sample and Hold card; using the TEKTRONIX to TEKTRONIX coaxial adapter, connect the two leads together. Disconnect J22 and J33 (see Fig. D-2); using a second adapter, connect these two leads together. Turn the DPO POWER on.

b. Position the display to align the bright center trace with the graticule center line.

c. CHECK - Deflection between the second and eighth traces should be six divisions $\pm$ 0.06 division. Note the exact deflection for part g of this step.

d. ADJUST - Gain R06 on the Vertical Amplifier board (see Fig. D-1) for exactly six divisions of deflection between the second and eighth traces.

e. Remove the calibration fixture from the RIGHT VERT compartment and install it in the LEFT VERT compartment.

f. Set the VERTICAL MODE switch to LEFT.

g. CHECK - Deflection between the second and eighth traces should be the same as step c ± 1% (six divisions ± 0.06 division if R06 was adjusted in step d).

h. ADJUST - If necessary, compromise the setting of R06 for optimum gain accuracy for both vertical compartments.

i. Turn off DPO power. Disconnect the four leads from the adapters and reconnect them to J21, J22, J30, and J33. Turn on DPO power.

j. INTERACTION - Do steps 20 and 51.

20. Adjust Processor Vertical Gain

a. CHECK - Deflection between the second and eighth traces should be six divisions ± 0.06 division.

b. ADJUST - Processor Vert Gain R51 on the Sample and Hold card (see Fig. D-2) for exactly six divisions of deflection between the second and eighth traces.

c. INTERACTION - Do step 51.

21. Check Low-Frequency Linearity

a. CHECK - Position the traces, one at a time, to the nearest graticule line and check the deflection from it to the trace two divisions above. There should be no more than 0.1 division compression or expansion between any pair of traces that are two divisions apart.

22. Adjust Vertical High-Frequency Compensation

a. Set the signal standardizer calibration fixture to Vert or Horiz + Step Response. Set Position and Amplitude controls for an eight-division display, centered on the graticule.

b. Set the time base controls for a triggered sweep at 0.2 millisecond/division.

c. Press STORE, A, and START on the P7001. Pause a few seconds and then press HOLD. Set DISPLAY SOURCE to PLUG-INS.

d. Set the calibration fixture Rep Rate to 1 megahertz. Set Position and Amplitude controls for a centered, six-division display.

e. Set the time base to trigger on the positive slope at a sweep rate of 0.2 microsecond/division. Use the X10 Magnifier or delayed sweep to change actual sweep rate to 20 nanoseconds/division. Position the display to look at the first 150 nanoseconds after the positive transition.

f. CHECK - Aberrations in the first 50 nanoseconds after the positive transition do not exceed $\pm$ 0.18 division (3 percent). Total peak-peak aberrations do not exceed 0.18 divisions (3 percent).

g. CHECK - Aberrations during the time from 50 to 150 nanoseconds after the positive transition do not exceed 0.03 division, total peak-peak (1/2 percent).

h. Set DISPLAY SOURCE to BOTH.

i. CHECK - The two waveforms displayed at the Rep Rates and Sweep Rates marked A in Table 2-4. Typical display is shown in Fig. 2-3. Check for cross talk -- ripple and discontinuities in the display caused when the DPO chops between the real-time and stored waveforms. Cross talk is typically less than 0.08 division. Aberrations on the real-time pulse front corner must meet the limits given in CHECK steps above.

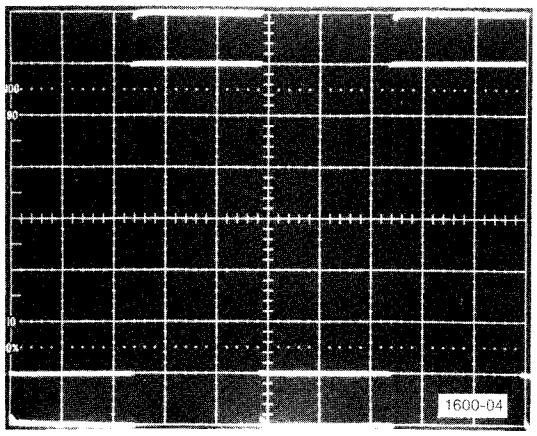

Fig. 2-3. Typical DPO display during high-frequency compensation check.

j. ADJUST - Using portion A of Table 2-4, adjust for minimum cross talk on both displays and best front corner and flat top on the real-time pulse. Adjust to meet the limits given in CHECK steps above.

k. Set the DISPLAY SOURCE to PLUG-INS.

l. ADJUST - Using portion B of Table 2-4 for best rise time, square corner, and flat top on the displayed pulse. The display must meet the limits given in CHECK steps f and g.

m. Move the calibration fixture to the RIGHT VERT compartment and set VERTICAL MODE to RIGHT VERT.

n. CHECK - Repeat steps d through i.

o. ADJUST - Compromise the adjustments in Table 2-4 as necessary for both compartments to meet the limits given in CHECK steps above.

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TABLE 2-4

HIGH FREQUENCY COMPENSATION

	Calibration Fixture Rep Rate	Best Sweep Rate (time/division)	Adjustment	Primary Area of Pulse Affected
A	100 Hz	2 milliseconds	R65*	First 100 microseconds (flat top)
A	1 kHz	0.2 millisecond	R53*	First five microseconds (flat top)
A	10 kHz	20 microseconds	R61*	First one microsecond (flat top)
A	100 kHz	2 microseconds	R23*	First 400 nanoseconds
B	1 MHz	100 nanoseconds	C24*	First 50 nanoseconds
B	1 MHz	50 nanoseconds	R27-C27*	Five to 15 nanoseconds
B	1 MHz	50 nanoseconds	C21**	First 10 nanoseconds
B	1 MHz	20 nanoseconds	R04-C01*	2 to 5 nanoseconds (leading edge)
B	1 MHz	2 nanoseconds	C71**	Front Corner
B	1 MHz	2 nanoseconds	L10-L11*	Front corner (reposition in sockets)

* Located on D7704 Vertical Amp. board (Fig. D-1)

** Located on P7001 Sample & Hold card (Fig. D-2)

23. Check Vertical Amplifier Bandwidth

a. Connect the output of the leveled sine wave generator to the calibration fixture CW IN connector through a 50-ohm coaxial cable and 5X attenuator. Set generator frequency to 3 megahertz.

b. Set the calibration fixture Test switch to Vert or Horiz Freq Resp.

c. Set the time base unit for free-running sweep by selecting auto, external triggering at a 200 nanosecond/division sweep rate. Set triggering level as necessary.

d. Turn the calibration fixture Amplitude control fully clockwise. Set the output amplitude of the leveled sine wave generator for an eight-division display. With the calibration fixture Position control, position the display one division down from the top graticule line. With the generator output amplitude control, increase the amplitude of the display to bring the top of the display up to the top graticule line. Now adjust the calibration fixture Position and Amplitude controls for a centered, eight-division display.

e. Without changing the output amplitude, increase the output frequency of the generator until the display amplitude is reduced to 5.6 divisions (-3 dB point). Make sure the CW Leveled light stays on.

f. CHECK - Generator output frequency must be 180 megahertz or higher.

g. Move the calibration fixture to the LEFT VERT compartment and set the VERTICAL MODE switch to LEFT. Set generator frequency to 3 megahertz.

h. Repeat steps d through f.

24. Check Vertical Channel Isolation

a. Replace the signal standardizer calibration fixture with an amplifier unit.

b. Connect the output of the leveled sine wave generator to the amplifier unit input using a 50-ohm coaxial cable. Terminate in 50 ohms.

c. Set the amplifier unit and generator for an eight-division display at 100 megahertz.

d. Set the VERTICAL MODE switch to RIGHT.

e. CHECK - CRT display for not more than 0.08 division of 100 megahertz signal (channel isolation at least 100:1 at 100 megahertz).

f. Move the amplifier unit to the RIGHT VERT compartment.

g. Set the generator for an eight-division display at 100 megahertz.

h. Set the VERTICAL MODE switch to LEFT.

i. CHECK - CRT display for not more than 0.08 division of 100 megahertz signal (channel isolation at least 100:1 at 100 megahertz).

j. Disconnect generator.

25. Check Vertical Display Modes

a. Install another amplifier unit in the LEFT VERT compartment. Position trace to upper half of graticule.

b. Change VERTICAL MODE to RIGHT and position the trace to lower half of graticule.

c. CHECK - CRT displays two traces in the ALT and CHOP positions of the VERTICAL MODE switch.

d. Set VERTICAL MODE to ADD.

e. CHECK - CRT display for a single trace that can be positioned vertically with either vertical-unit position control.

26. Check Vertical Trace Separation Operation

a. Set the VERTICAL MODE switch to RIGHT.

b. Center the trace vertically with the right-vertical unit position control.

c. Install a time base unit in the B HORIZ compartment.

d. Set both time base units for a free-running sweep at a 0.2 millisecond/division sweep rate.

e. Set the HORIZONTAL MODE switch to CHOP.

f. CHECK - Turn the VERT TRACE SEPARATION (B) control throughout its range and check that the trace produced by the B time base can be positioned above and below the trace produced by the A time base. Also, check with the HORIZONTAL MODE switch set to ALT.

g. Disconnect all test equipment. Remove all plug-in units.

Triggering

Required Equipment

1. Signal standardizer calibration fixture
2. Amplifier plug-in
3. Time base plug-in (two required)
4. Plug-in extender calibration fixture
5. Coaxial cable (BNC and pin-jack connectors)
6. Coaxial cable, 50-ohm with BNC connectors (two required)
7. Terminator, 50-ohm (two required)
8. Test oscilloscope

Control Settings

POWER: ON

VERTICAL MODE: LEFT

VERT TRACE SEPARATION (B): Midrange

A TRIGGER SOURCE: VERT MODE

HORIZONTAL MODE: A

B TRIGGER SOURCE: VERT MODE

READOUT: OFF

DISPLAY SOURCE: PLUG-INS

27. Check Trigger Selector Operation

a. Install the plug-in extender fixture in the A horizontal compartment.

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b. Connect each trigger line from the plug-in extender (A20 and B20) to a test oscilloscope vertical channel with 50-ohm coaxial cable. Terminate into 50 ohms at the test oscilloscope.

c. Set both test oscilloscope vertical channels for a deflection factor of 50 millivolts/division. Ground the input of both channels. Set the test oscilloscope for differential operation between the two channels (added display mode with one channel inverted); select sweep rate of 20 microseconds/division. Set triggering for a free-running sweep. Position trace to graticule center, then set input coupling to DC.

d. CHECK - The test oscilloscope display for a DC level within 0.5 division (25 millivolts) of graticule center in the LEFT, RIGHT, and ADD positions of the VERT MODE switch.

e. Install the signal standardizer calibration fixture in the LEFT VERT compartment. Set the signal standardizer calibration fixture to Triggering Gain. Set the VERTICAL MODE switch to LEFT.

f. CHECK - Test oscilloscope display for nine traces with deflection between the second and eighth traces of six divisions $\pm$ 0.9 division (300 millivolts within 45 millivolts).

g. Move the signal standardizer calibration fixture to the RIGHT VERT compartment. Set the VERTICAL MODE switch to RIGHT.

h. CHECK - Trigger gain of the right vertical compartment as in step f.

i. Remove plug-in extender. Disconnect test oscilloscope. Install an amplifier unit in the LEFT VERT compartment and time base units in both horizontal compartments.

j. Set both time bases for auto, internal triggering at a 0.2 millisecond/division sweep rate.

k. Set the calibration fixture Test switch to Vert or Horiz + Step Resp and the Rep Rate switch to 10 kilohertz.

1. Set FOCUS and INTENSITY for a well-focused trace with normal intensity.

m. Set the calibration fixture for a two-division display in the upper half of the graticule area.

n. Set the VERTICAL MODE switch to LEFT.

o. Connect the CALIBRATOR 0.4 V output to the amplifier unit with the BNC to pin-jack cable.

p. Set the amplifier for a two-division display in the lower half of the graticule area.

q. Set the VERTICAL MODE switch to ALT.

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r. CHECK - Triggered display of both the 1 kilohertz and 10 kilohertz waveforms. Set time base trigger level, if necessary.

s. Set the VERTICAL MODE switch to ADD.

t. CHECK - CRT display for triggered sweep.

u. Set the VERTICAL MODE switch to CHOP.

v. CHECK - CRT for display of one triggered waveform - other free-running.

w. Set the A TRIGGER SOURCE switch to LEFT VERT.

x. CHECK - Sequentially press VERTICAL MODE switch pushbuttons LEFT, ALT, ADD, and CHOP and check that a stable display of only the 1 kilohertz waveform can be obtained.

y. Set the A TRIGGER SOURCE switch to RIGHT VERT.

z. CHECK - Sequentially press VERTICAL MODE switch pushbuttons, ALT, ADD, CHOP, and RIGHT and check that a stable display of only the 10 kilohertz waveform can be obtained.

aa. Set the VERTICAL MODE switch to ALT and the HORIZONTAL MODE switch to B.

bb. CHECK - Triggered display of both the 1 kilohertz and 10 kilohertz waveforms. Set time base triggering level, as necessary.

cc. Set the VERTICAL MODE switch to ADD.

dd. CHECK - CRT display for triggered sweep.

ee. Set the VERTICAL MODE switch to CHOP.

ff. CHECK - CRT for display of one triggered waveform - other free-running.

gg. Set the B TRIGGER SOURCE switch to LEFT VERT.

hh. CHECK - Sequentially press VERTICAL MODE switch pushbuttons LEFT, ALT, ADD, and CHOP and check that a stable display of only the 1 kilohertz waveform can be obtained.

ii. Set the B TRIGGER SOURCE switch to RIGHT VERT.

jj. CHECK - Sequentially press VERTICAL MODE switch pushbuttons ALT, ADD, CHOP, and RIGHT and check that a stable display of only the 10 kilohertz waveform can be obtained.

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

Horizontal System

Required Equipment

1. Signal standardizer calibration fixture
2. Time base plug-in unit (two required)
3. Amplifier plug-in unit
4. Time mark generator
5. Leveled sine wave generator
6. BNC T connector
7. Adjustment tool
8. TEKTRONIX Coaxial to TEKTRONIX Coaxial adapter (two required)
9. 50-ohm coaxial cable with BSM and BNC connectors
10. 50-ohm terminator (two required)
11. Coaxial cable, 50-ohm with BNC connectors (two required)

Control Settings

POWER: OFF

VERTICAL MODE: RIGHT

VERT TRACE SEPARATION (B): Midrange

A TRIGGER SOURCE: VERT MODE

HORIZONTAL MODE: B

B TRIGGER SOURCE: VERT MODE

READOUT: OFF

NOTE

The Horizontal Interface adjustments do not need to be checked during routine calibration. However, if components are replaced or if the Acquisition Unit is used in a different system, adjustment may be necessary. The need for adjustment is indicated if the Horizontal System gain adjustments cannot be performed according to the following procedure. Calibration information for the Horizontal Interface is given in Section 3.

28. Adjust Horizontal Amplifier Gain

NOTE

When disconnecting the following leads, make note of which lead is connected to which connector so they can be re-connected correctly.

a. Disconnect J25 and J34 (see Fig. D-2) on the Sample and Hold card. Connect the two leads together using the TEKTRONIX to TEKTRONIX coaxial adapter. Disconnect harmonica connector P50. Disconnect J25 and J37 and connect these two leads together using another adapter. Turn the DPO POWER switch on.

b. Set the P7001 DISPLAY SOURCE to PLUG-INS.

c. Install a time base unit in the RIGHT VERT compartment.

d. Set the time base controls for a free-running sweep at 1 microsecond/division.

e. Install the signal standardizer calibration fixture in the B HORIZ compartment.

f. Set the calibration fixture Test switch to Vert or Horiz Gain and the Rep Rate switch to 1 kilohertz.

g. Position the display to align the bright center trace with the center vertical line of the graticule. Set FOCUS and INTENSITY for a well-focused trace with normal brightness.

h. CHECK - Deflection between the second and tenth traces is eight divisions $\pm$ 0.08 division. Note the exact deflection for part (1) of this step.

i. ADJUST - Gain R10 on Horizontal Output board (see Fig. C-2) for eight divisions of deflection between the second and tenth traces.

j. Move the calibration fixture to the A HORIZ compartment.

k. Set the HORIZONTAL MODE switch to A.

l. CHECK - Deflection between the second and tenth traces is the same as in part h $\pm$ 1% (eight divisions $\pm$ 0.08 division if R10 was adjusted in step i).

m. ADJUST - If necessary, compromise the setting of R10 for test gain accuracy for both horizontal compartments. If readjustment is necessary, recheck steps e through l.

n. Turn off DPO power. Disconnect the four leads from the adapters and connect them to J25, J26, J34, and J37. Turn on DPO power. Press PLUG-INS on P7001.

o. INTERACTION - Check steps 29, 30, 31, 32, and 49.

29. Adjust Processor Horizontal Gain

a. CHECK - Deflection between the second and tenth traces is eight divisions $\pm$ 0.08 division.

b. ADJUST - Processor Horiz Gain R323 on the P7001 Sample and Hold card (see Fig. D-2) for eight divisions of deflection between the second and tenth traces.

c. INTERACTION - Check steps 30, 31, and 32.

30. Adjust Horizontal Amplifier Centering

a. Disconnect the leads from J15 and J16 on the 7704A Horizontal Output board (see Fig. C-2).

b. Set the calibration fixture Test switch to Triggering Gain.

c. CHECK - Vertical trace should align with the vertical center line of the graticule within 0.2 division.

d. ADJUST - Horizontal Centering adjustment R25 on the Horizontal Output board (see Fig. C-2) to position the trace to the vertical center line.

e. Reconnect the leads to J15 and J16.

f. INTERACTION - Check steps 31, 32, 49, 69, and 70.

31. Adjust Sample and Hold Horizontal Balance

a. CHECK - Vertical trace should align with the vertical center line of the graticule within 0.5 division.

b. ADJUST - Horiz Bal R336 on the P7001 Sample and Hold card (see Fig. D-2) to position the trace to the vertical center line.

c. Move the calibration fixture to B HORIZ compartment. Set HORIZONTAL MODE to B.

d. CHECK - Vertical trace should be positioned the same as in step a within 0.2 division and within 0.5 division of graticule center.

e. ADJUST - Compromise the setting of R336 so the position of the vertical trace is within 0.5 division of graticule center for both horizontal compartments. The position of the traces must match within 0.2 division.

f. Reconnect harmonica connector to J50 on P7001 Sample and Hold card.

g. INTERACTION - A change in the setting of R336 will affect MEMORY display, step 49, and FINE DISPLAY POSITION, steps 59 and 70.

32. Adjust Horizontal Amplifier Thermal Balance

a. Install a time base unit in the A HORIZ compartment.

b. Set the HORIZONTAL MODE switch to CHOP and the VERTICAL MODE switch to LEFT.

c. Set the A time base sweep rate to 50 milliseconds/division. Select X10 sweep magnifier and set triggering controls for a free-running sweep.

d. CHECK - CRT display for not more than 0.1 division movement of the dot. Set the READOUT intensity control for visible characters; check that the displayed characters do not move more than 0.1 division.

e. ADJUST - Thermal Balance adjustment R46 on the Horizontal Output board (see Fig. C-2) for minimum movement of the dot or readout characters.

f. INTERACTION - If the setting of R46 is changed, check steps 30, 31, 49, 69, and 70.

33. Check Low-Frequency Linearity

a. Set the HORIZONTAL MODE switch to B and the VERTICAL MODE switch to RIGHT.

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

c. CHECK - Position the traces, one at a time, to the nearest graticule line and check the deflection from it to the trace two divisions away. There should be no more than 0.1 division of compression or expansion between any pair of traces that are two divisions apart.

34. Adjust High-Frequency Timing

a. Install an amplifier unit in the LEFT VERT compartment. Set deflection factor to 0.5 volt/division.

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

c. Set the A HORIZ time base unit for auto, internal triggering at a 1 millisecond/division sweep rate.

d. Connect 1 millisecond markers from the time mark generator to the amplifier unit input with coaxial cable (50-ohm). Terminate with 50 ohms.

e. Center the display.

f. Set the time base unit sweep calibration adjustment for one marker at each major graticule division between the second and tenth lines (center eight divisions).

g. CHECK - Refer to the performance check/calibration procedure in the time base unit instruction manual for checking high-frequency timing and linearity. Use the procedures and limits given for the three fastest sweep rates which do not exceed two nanoseconds/division. If the given limits are met, go to step n.

h. Set the VERTICAL MODE switch to RIGHT and the HORIZONTAL MODE switch to B.

i. Set the RIGHT VERT time base unit for auto, external triggering at a magnified sweep rate of 0.5 microsecond/division (use basic sweep rate of five microseconds/division, magnified ten times with X10 magnifier or delayed sweep to 0.5 microsecond/division).

j. Connect the calibration fixture Trig Out connector to the external trigger input of the RIGHT VERT time base unit. Use 50-ohm coaxial cable with BSM and BNC connectors.

k. Set the calibration fixture for an eight-division display of the Vert or Horiz + Step Response waveform with the Rep Rate switch set to 100 kilohertz. Horizontally center the display.

l. ADJUST - High-frequency compensation adjustments R85, C85, C91, and C74 on the Horizontal Output board (see Fig. C-2) for optimum square-wave response. Check the leading

edge of the pulse (lower right corner) for aberrations not to exceed ± 1.2 division with total peak-to-peak aberrations not to exceed 1.2 division. See Fig. 2-4 for a typical response waveform.

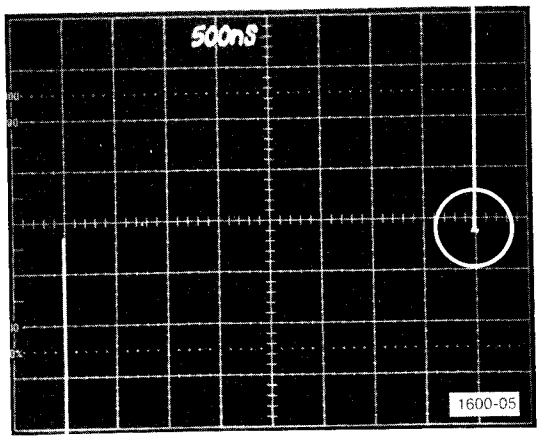

Fig. 2-4. Waveform shows D7704 Horizontal Output board high-frequency compensation correctly adjusted. Circle indicates the portion of the waveform affected by compensation adjustment.

m. Repeat parts b through g of this step.

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

35. Check X-Y Phase Shift

a. Install identical amplifier units in the RIGHT VERT and B HORIZ compartments.

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

c. Connect the leveled sine wave generator to both amplifier units through a T connector at the generator and identical coaxial cables (50-ohm) going to each amplifier. Terminate each cable in 50 ohms.

d. Set the leveled sine wave generator for eight divisions of vertical and horizontal deflection at an output frequency of 50 kilohertz.

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

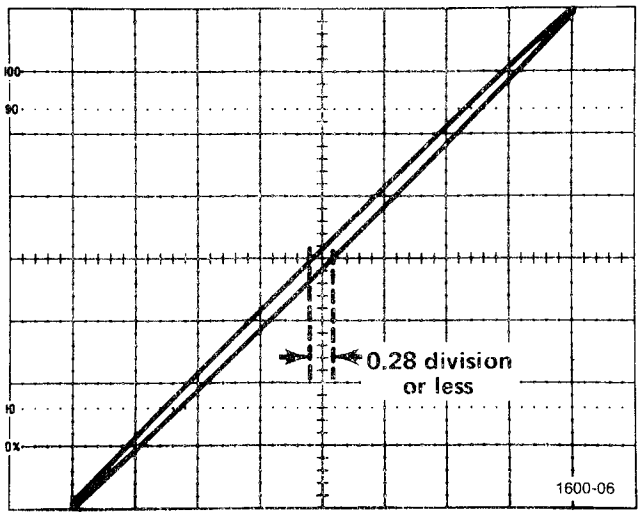

Fig. 2-5. Typical display when checking X-Y phase shift.

f. Move the B HORIZ unit to the A HORIZ compartment and set the HORIZONTAL MODE switch to A (leave signal connected).

g. Repeat parts d and e.

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

Calibrator

Required Equipment

1. Amplifier plug-in (two required)
2. Time base plug-in
3. Digital multimeter
4. Time mark generator
5. Terminator (50-ohm)
6. Coaxial cable (50-ohm)
7. Coaxial cable (BNC and pin-jack connectors)
8. Adjustment tool

Control Settings

POWER: OFF

VERTICAL MODE: ALT

A TRIGGER SOURCE: VERT MODE

HORIZONTAL MODE: A

36. Adjust Calibrator Output Voltage

a. To gain access to the Calibrator adjustments, the P7001 must be removed from the DPO. To remove the P7001, refer to Fig. E-1, and proceed as follows:

1) Disconnect the D7704/P7001 interface connector by pulling straight up on the connector. Place it in the safety holder.

2) Remove the four screws which secure the Display unit to the P7001. Lift up and remove the Display unit from the DPO.

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3) Remove the four screws which secure the P7001 to the Acquisition unit. Loosen the two screws which secure the P7001 Interconnect board. Lift the Interconnect board up about one inch, then retighten the two screws. The Processor may now be removed from the Acquisition unit. When removing the Processor, lift it straight up so as not to damage the Interconnect board connector.

4) Set the Display unit on the Acquisition unit and connect the D7704/A7704 interface connector.

b. Connect the inner lead of C01 to chassis ground. (C01 is the large, metal-cased capacitor located on the Calibrator board behind the HORIZONTAL MODE switch circuit board, see Fig. D-4).

c. Set digital multimeter to 2 volts DC range. Connect the digital multimeter between the CALIBRATOR 0.4 V and GND pin jacks. Turn on DPO power.

d. CHECK - Meter reading: 0.4 volt $\pm$ 0.004 volt.

NOTE

If meter reads near zero, momentarily disconnect the jumper between C01 and ground.

e. ADJUST - 0.4 V adjustment R37 on the Calibrator board (see Fig. D-4) for a meter reading of exactly 0.4 volt.

f. Disconnect the digital multimeter and the connection between C01 and ground.

37. Adjust Calibrator 1 Kilohertz Repetition Rate

NOTE

If a frequency counter with an accuracy of at least 0.1% is available (such as Tektronix DC501), it can be used to accurately adjust the Calibrator repetition rate. Connect the 0.4 V CALIBRATOR pin jack to the input of the counter with the BNC to pin-jack cable. Adjust the 1 kilohertz adjustment R01 on the Calibrator board (see Fig. D-4) for exactly 1 kilohertz. Then go to step 37n.

a. Install an amplifier unit in both vertical compartments and a time base unit in the A HORIZ compartment. Set the deflection factor of each amplifier to 1 volt/division.

b. Set DISPLAY SOURCE to PLUG-INS.

c. Connect the 4 V CALIBRATOR pin jack to the input of one of the amplifier units with the BNC to pin-jack cable. Set FOCUS and INTENSITY for a well-focused display with normal brightness.

d. Connect 1 millisecond markers from the time mark generator to the other amplifier unit with 50-ohm coaxial cable. Terminate amplifier input in 50 ohms.

e. Set the time base for internal triggering on the positive slope at 0.2 millisecond/division.

f. Set the time base triggering level for a stable display of both waveforms.

g. Vertically position the displays so the tips of the markers fall just below the bottom of the square wave.

h. Set the VERTICAL MODE switch to ADD.

i. Set the time base unit triggering so a stable square wave display is presented only when the markers occur during the positive portion of the square wave.

j. Set the time base unit triggering for AC low-frequency reject coupling at a sweep rate of 0.2 second/division.

k. CHECK - The amount of time required for a time mark to drift across the positive level of the square wave, to the negative level and back to the positive level must be at least 0.4 second. This time can be measured directly from the display by observing the number of divisions that the marker moves across the display area before it returns to the positive level; each horizontal division equals 0.2 second.

l. ADJUST - 1 kilohertz R01 on the Calibrator board (see Fig. D-4) for a time of at least 0.4 second for a time mark to drift across the positive level of the square wave to

the negative level and back to the positive level. (A preliminary adjustment can be made with the time base unit triggered only on the square wave at a 0.2 millisecond/ division sweep rate.)

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

n. Reinstall the P7001:

1) Turn the DPO POWER off and disconnect the D7704/A7704 interface connector; remove the Display unit from the Acquisition unit.

2) Loosen the two screws holding the Interconnect board in the P7001 (see Fig. E-1) and slide it up. Instll the P7001 on the Acquisition unit being careful not to damage the Interconnect board connector. Reconnect the P7001 and A7704 by aligning the connectors and carefully pushing the P7001 Interconnect board onto the connector in the Acquisition unit. Retighten the two screws.

3) Install the Display unit and connect the D7704/P7001 interface connector. Replace and tighten all of the screws which secure the D7704, P7001, and A7704 together.

Output Signals

Required Equipment

1. Amplifier plug-in units (two required)
2. Time base plug-in units (two required)
3. Coaxial cable (BNC and pin-jack connectors)
4. 50-ohm coaxial cable
5. 50-ohm terminator

Control Settings

POWER: ON

VERTICAL MODE: RIGHT

A TRIGGER SOURCE: VERT MODE

HORIZONTAL MODE: A

B TRIGGER SOURCE: VERT MODE

DISPLAY SOURCE: PLUG-INS

38. Check Sawtooth Output Signals

a. Install amplifier units in both vertical compartments and time base units in both horizontal compartments.

b. Set the RIGHT VERT amplifier unit for a calibrated deflection factor of 0.1 volt/division with DC input coupling.

c. Connect the rear-panel + SAWTOOTH OUT connector to the RIGHT VERT amplifier unit with a 50-ohm coaxial cable. Terminate cable in 50 ohms.

d. Set the A time base unit for auto, internal triggering at a sweep rate of two milliseconds/division.

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e. Set the B time base unit for a free-running sweep at a sweep rate of 0.5 millisecond/division in the external trigger mode.

f. Set Sweep Selector switch S20 to B. S20 is located behind the right side panel near the rear of the A7704; see Fig. F-1.

g. Set FOCUS and INTENSITY for a well-focused display with normal brightness.

h. CHECK - CRT display for sawtooth waveform with an amplitude of at least five divisions and a duration of at least 2.5 divisions (output amplitude into 50-ohm load, 0.5 volt or greater with duration 5 milliseconds or greater).

i. Set the HORIZONTAL MODE switch to B.

j. Set the Sweep Selector switch to A.

k. Set the B time base unit for auto, internal triggering at a sweep rate of two milliseconds/division.

l. Set the A time base unit for a free-running sweep at a sweep rate of 0.5 millisecond/division in the external trigger mode.

m. CHECK - CRT display for a sawtooth waveform with an amplitude of at least five divisions, and a duration of at least 2.5 divisions (output amplitude into 50-ohm load, 0.5 volt or greater with duration of 5 milliseconds or greater).

n. Disconnect the + SAWTOOTH OUT connector from the amplifier unit.

39. Check Gate Output Signals

a. Leave the RIGHT VERT amplifier unit set for a calibrated deflection factor of 0.1 volt/division with DC input coupling.

b. Connect the rear panel + GATE OUT connector to the RIGHT VERT amplifier unit with a 50-ohm coaxial cable. Terminate with 50 ohms.

c. Set Gate Selector switch S40 to A (Fig. F-1).

d. CHECK - CRT display for gate waveform five divisions $\pm$ 0.5 division in amplitude with a positive level duration of at least 2.5 divisions (output amplitude into 50-ohm load of 0.5 volts $\pm$ 10% with pulse width at least 5 milliseconds).

e. Set the HORIZONTAL MODE switch to A.

f. Set the Gate Selector switch to B.

g. Set the A time base unit for auto, internal triggering at a sweep rate of two milliseconds/division.

h. Set the B time base unit for a free-running sweep at a rate of 0.5 milliseconds/division.

i. CHECK - CRT display for gate waveform five divisions $\pm$ 0.5 division in amplitude with a duration of at least

2.5 divisions (output amplitude into 50-ohm load of 0.5 volt ± 10% with pulse width at least 5 milliseconds).

j. Set the A time base unit for a 10 nanoseconds/division sweep rate. Set the triggering to display the rising portion of the waveform.

k. CHECK - Displayed waveform for not more than two divisions between the 10% and 90% points (risetime of 20 nanoseconds or less).

l. Disconnect the + GATE OUT connector from the amplifier unit.

40. Check Vertical Signal Output

a. Connect the CALIBRATOR 0.4 V pin jack to the RIGHT VERT amplifier unit with the BNC to pin jack cable.

b. Set the A time base unit for auto, internal triggering at a sweep rate of 0.5 millisecond/division.

c. Set the RIGHT VERT amplifier unit for a four-division display.

d. Connect the rear panel VERT SIG OUT connector to the LEFT VERT amplifier unit with a 50-ohm coaxial cable. Terminate in 50 ohms.

e. Set the LEFT VERT amplifier unit for a calibrated deflection factor of 20 millivolts/division with DC input coupling.

f. Set the B TRIGGER SOURCE switch to RIGHT VERT and the VERTICAL MODE switch to LEFT.

g. CHECK - CRT Display for waveform five divisions ± 0.5 division in amplitude (voltage output into 50-ohm load of 100 millivolts within 10%).

h. Disconnect coaxial cable and remove the plug-in units.

7704A Readout System

Required Equipment

1. Amplifier plug-in
2. Time base plug-in
3. Adjustment tool

Control Settings

POWER: OFF

VERTICAL MODE: RIGHT

A TRIGGER SOURCE: VERT MODE

HORIZONTAL MODE: A

41. Adjust Readout Position

a. Remove Q16 from its socket on the 7704A Readout board (see Fig. F-2).

b. Turn on DPO power and set P7001 DISPLAY SOURCE to PLUG-INS.

c. Set the READOUT control for visible characters (all zeros). Set FOCUS as necessary.

d. CHECK - CRT display for two rows of zeros, 40 zeros to a row with no overlap. The two rows of zeros should be located vertically in the middle of the top and bottom division of the graticule (see Fig. 2-6).

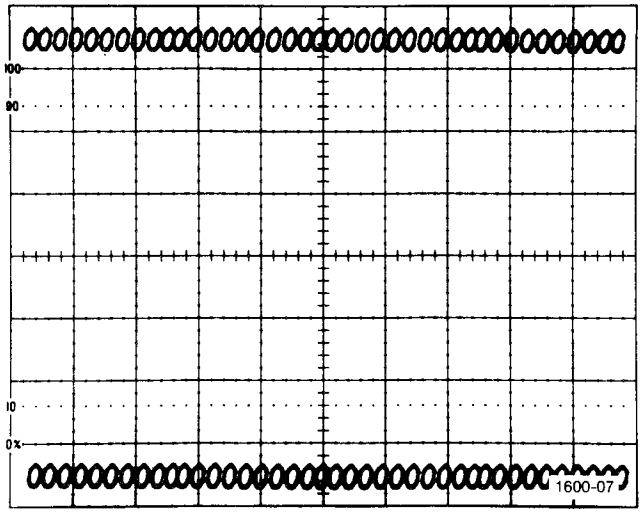

Fig. 2-6. Display with Q16 on A7704 Readout board removed.

NOTE

These tolerances are provided as guides to correct instrument operation and are not instrument specifications.

e. ADJUST - Horiz Bal R336 (Fig. D-2) on the P7001 Sample and Hold card the minimum amount to bring all 40 zeros in both rows on screen.

f. ADJUST - Vertical Separation R90 on the A7704 Readout board (see Fig. F-2) to position the two rows of readout characters to the middle of the top and bottom divisions of the graticule. Vertical system centering adjustments must be set correctly before making this adjustment.

g. INTERACTION - If R336 on P7001 Sample and Hold card is changed, perform steps 49, 69, and 70.

h. Set the DPO POWER switch to off and replace Q16 (Fig. F-2) in its socket; turn on DPO power. Press PLUG-INS.

42. Adjust Full Character Scan

a. Install the amplifier unit in the RIGHT VERT compartment.

b. Set the amplifier unit for a deflection factor of 50 millivolts/division.

c. CHECK - Displayed characters for completeness without overscanning (overscanning causes a bright dot where traces overlap).

d. ADJUST - Full Character Scan R37 on the A7704 Readout board (see Fig. F-2) for fully scanned characters without overscanning. The "m" and the "5" will show the most change.

43. Adjust Column and Row Match

a. Press and hold the amplifier unit trace-identify button.

b. CHECK - Readout display for correct indication of "IDENTIFY". If the readout display blinks or is incorrect, adjustment is required.

c. ADJUST - Column Match R07 and Row Match R22 on the A7704 Readout board (see Fig. F-2) for correct readout of

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"IDENTIFY". Set these adjustments to the center of the adjustment range which provides correct readout indication. Release the amplifier unit trace-identify button.

44. Check Readout Modes

a. Install a time base unit in the A HORIZ compartment.

b. Set the time base unit for a free-running sweep.

c. Set the Readout Mode switch S68 to FR and the Gate Selector switch S40 to A. They are located on the A7704 Signal Out board behind the right side panel near the rear of the A7704; see Fig. F-1.

d. CHECK - Set the time base unit for several sweep rates throughout its range. Check that the readout characters are presented on a free-run basis, independent of the sweep rate.

e. Set the Readout Mode switch to Gated.

f. Set the time base unit for a free-running sweep at a rate of 0.1 second/division.

g. CHECK - Readout characters are blanked out while the sweep is running, and are displayed immediately after the end of the sweep; each character encoded by the plug-in units is displayed only once for each sweep.

h. Return Readout Mode switch to FR (free-run). Remove plug-ins.

MEMORY DISPLAY

NOTE

Memory Volts is adjusted in step 1. Perform the following memory adjustments only if required, such as replacement of parts that affect the adjustments.

Core Memory

Required Equipment

1. Test oscilloscope with two vertical channels and 10X probes.
2. Adjustment tool
3. Controller (computer) interfaced to DPO
4. Terminal interfaced to controller
5. I/O device
6. P7001 Checkout Software

Control Settings

POWER: ON

READOUT: ON

DISPLAY SOURCE: MEMORY

DATA HANDLING: HOLD

MEMORY LOCATION: A

45. Adjust Strobe Delay (skip if P7001 has semiconductor memory)

a. Load P7001 Checkout Software into the controller. Select the Worst Case Test with Scope Loop Switch (WCT/S). A flowchart is provided in Section 4 to help in programming a computer other than the CP1100 (PDP-11) to generate this waveform.

b. Connect the probe for test oscilloscope channel 1 to the $\overline{\text{READ}}$ test point on the P7001 Core Memory assembly. See Fig. F-3.

c. Connect the probe for test oscilloscope channel 2 to the STROBE test point on the P7001 Core Memory assembly (Fig. F-3).

d. Set both test oscilloscope vertical channels for a deflection factor of 0.1 volts/division (1 volt at probe-tip) with AC coupling. Set display to alternate. Use channel 1 as the trigger source. Set the test oscilloscope time base for a sweep rate of 0.02 microseconds/division with automatic triggering. Trigger on negative slope.

e. Position both test oscilloscope waveforms vertically so the 50% amplitude point on the pulses is at graticule center. Use the time base Position control to set the falling edge of the channel 1 READ waveform on the graticule mark at the left edge of the screen. See Fig. 2-7.

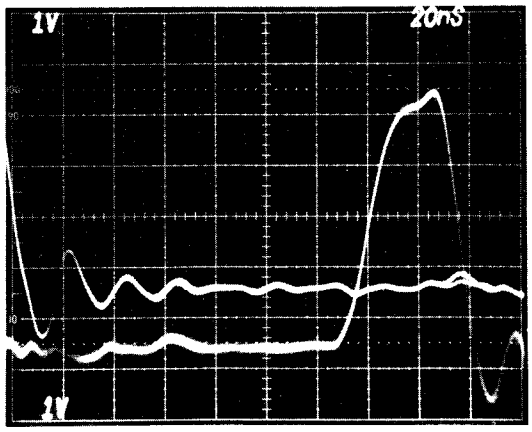

Fig. 2-7. Typical READ and STROBE waveforms observed during adjustment of R34 on P7001 Core Memory assembly.

f. Adjust Strobe Delay R34 (Fig. F-4) slowly ccw until data bit dropping begins. This will be evident as spikes extending down into the DPO CRT display area or random characters in the readout. Set FOCUS, INTENSITY, and READOUT if necessary. See Fig. 2-8. If no data bits are dropped, continue rotating R34 ccw until you reach the end of its range.

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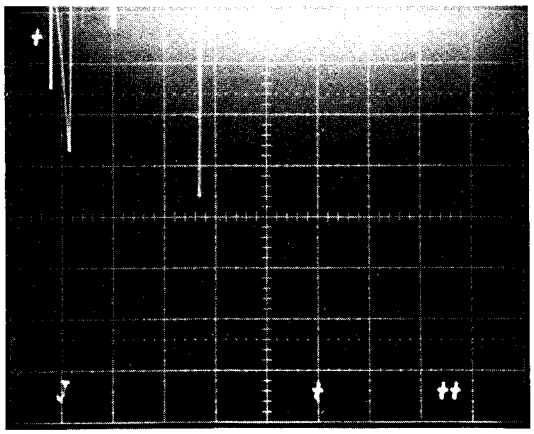


Fig. 2-8. DPO display showing memory bit dropping during Worst Case Test (Strobe Delay R34 misadjusted).

g. Note on the test oscilloscope the time between the 50% point on the falling edge of the READ waveform (channel 1) and the 50% point on the rising edge of the STROBE waveform (channel 2).

h. Adjust R34 cw until data bit dropping begins again. Note the time displayed on the test oscilloscope as in step g.

i. ADJUST - R34 for a time display on the test oscilloscope midway between that obtained in steps g and h.

j. Terminate the Worst Case Test (press CTRL and P simultaneously on the keyboard of the terminal or teletype-

writer). Select the Worst Case Test with no switch option (WCT). The terminal response should be "0 ERROR(S) OCCURRED FOR WORST CASE TEST (WCT)".

k. Disconnect test oscilloscope probes.

Semiconductor Memory

Required Equipment

1. Test oscilloscope with 10X probe
2. Adjustment tool

46. Adjust Address Settling Time (skip if P7001 has core memory)

a. Set the test oscilloscope vertical deflection factor to 0.2 volts/division (2 volts/division at probe tip). Set sweep rate to 0.1 microsecond/division with automatic triggering on the positive slope.

b. Connect the test oscilloscope probe to TP1 (Fig. G-1).

c. CHECK - Pulse width should be 450 nanoseconds (4.5 divisions).

d. ADJUST - R80 (Fig. G-1) for a pulse width of 450 nanoseconds.

47. Adjust Write Timing

a. Connect the test oscilloscope probe to TP2 (Fig. G-1). Trigger on the negative slope.

b. CHECK - Pulse width should be 800 nanoseconds.

c. ADJUST - R81 (Fig. G-1) for a pulse width of 800 nanoseconds.

d. Disconnect the test oscilloscope.

Display Generator

Required Equipment

1. Test oscilloscope with two vertical channels and 10X probes
2. Time base plug-in
3. Signal standardizer calibration fixture
4. P7001 card extender
5. Adjustment tool
6. Controller (computer) interfaced to DPO
7. Terminal interfaced to controller
8. I/O device
9. P7001 Checkout Software

Control Settings

POWER: ON

READOUT: OFF

DISPLAY SOURCE: MEMORY

DATA HANDLING: HOLD

MEMORY LOCATION: A

VERTICAL MODE: RIGHT

A TRIGGER SOURCE: VERT MODE

HORIZONTAL MODE: A

48. Adjust Horizontal Compensation

a. Load P7001 Checkout Software and select XYD Test. See Section 4 if a flowchart is needed. This test will set

the display generator in the X-Y mode and display the controller-generated waveform. The waveform is not stored in P7001 memory. Disconnect harmonica connector (P50) at J50 on P7001 Sample and Hold card (Fig. D-2).

b. Set FOCUS and INTENSITY for a clear, bright trace.

c. CHECK - Diagonal bars of X pattern form straight lines and do not skip sideways where they cross. See Fig. 2-9.

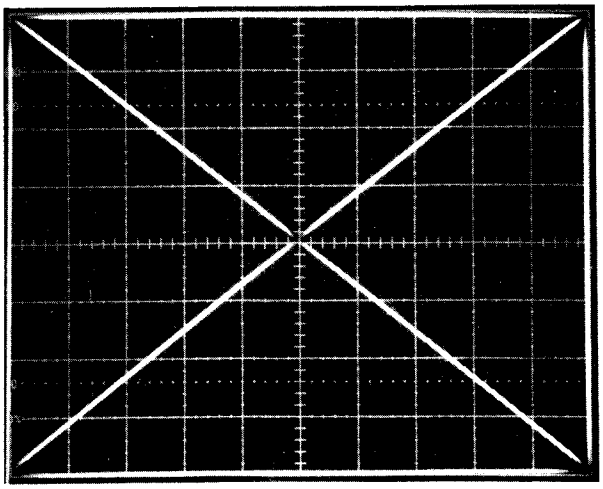


Fig. 2-9. X-Y Display Pattern Test (XYD) waveform from P7001 Checkout Software.

d. ADJUST - Horiz Comp R190 (Fig. G-2) on the P7001 Display Generator Card for the best approximation of an X; the greatest effect is at the center of the X. Figure 2-9 shows proper adjustment. Cancel the XYD Test.

e. INTERACTION - If R190 is changed, perform steps 49 and 50.

49. Adjust Horizontal Balance and Gain

a. Select the CAL Test from P7001 Checkout Software. This will store the CAL waveform in Memory Location A and display it. The CAL waveform is shown with the Calibration Pattern Test flowchart in Section 4. Set DISPLAY SOURCE to BOTH.

b. Install a time base plug-in in the RIGHT VERT compartment. Set for free-running sweep rate of 1 microsecond/division.

c. Install the signal standardizer calibration fixture in the A HORIZ compartment. Set the Test switch to Vert or Horiz Gain. Set Rep Rate to 1 kilohertz. Use the Position control to align the bright center trace with the graticule center line.

d. Set INTENSITY, FOCUS, and A INTEN if necessary to see both waveforms clearly.

e. CHECK - The vertical portions of the CAL waveform at the second and tenth graticule line must match the graticule within 0.12 division. Also, the two waveforms must match within 0.08 division at the second and tenth vertical portions of the traces.

f. ADJUST - Horiz Bal R175 and Horiz Gain R225 on the P7001 Display Generator Card (Fig. G-2) for the best match of the vertical portions of the CAL waveform to the second and tenth graticule lines and the signal standardizer fixture waveform. Repeat step e.

50. Adjust Vertical Compensation

a. Press MEMORY on the P7001.

b. CHECK - The front corners of the two brightened bars of the CAL waveform are square.

c. ADJUST - Vert Comp R109 (Fig. G-2) for square front corners on the brightened bars of the display.

d. INTERACTION - If R109 is changed, repeat steps 48 and 49.

51. Adjust Vertical Balance and Gain

a. Press BOTH on the P7001.

b. Install the signal standardizer fixture in the RIGHT VERT compartment and the time base unit in the A HORIZ compartment. Use the standardizer fixture Position control to set the bright center trace to the graticule center line.

c. CHECK - The horizontal portions of the CAL waveform at the second and eighth graticule lines must match the graticule within 0.09 division. Also, the CAL waveform must

match the second and eighth traces of the signal standardizer waveform within 0.06 division.

d. ADJUST - Vert Bal R115 and Vert Gain R205 (Fig. G-2) on the P7001 Display Generator card for the best match of the CAL waveform to the graticule and the signal standardizer waveform. Repeat step c.

e. Remove all plug-ins from the DPO. Reconnect harmonica connector at J50 on P7001 Sample and Hold card.

52. Adjust Display Generator Trigger Delay

a. Remove Q16 from the A7704 Readout board (Fig. F-2).

b. Press MEMORY. Set READOUT control to display CAL waveform and two rows of characters.

c. CHECK - Display should have no breaks or discontinuities. If this check is met, go to step j.

d. If adjustment is necessary, turn off DPO power and pull out the P7001 Display Generator card several inches. Disconnect the four Tektronix coaxial cables. Note where they were connected. Dress them so the connectors do not touch each other or P7001 circuitry and chassis. Remove the card and install it on the P7001 card extender. Turn on DPO power.

e. Set both test oscilloscope channels to 0.2 volts/division deflection factor (2 volts/division at probe tip). Set sweep rate to 10 microseconds/division.

f. Connect the channel 1 test oscilloscope probe to pin 4, U16 (Fig. G-2), on the Display Generator card. Trigger on the positive slope. Set the 50 percent amplitude point on the positive transition of the pulse to the graticule line at the left edge of the test oscilloscope CRT.

g. Connect test oscilloscope channel 2 probe to pin 1 of U16. Change the display to channel 2 but continue to trigger on the channel 1 waveform.

h. ADJUST - Trigger Delay R18 on the P7001 Display Generator card (Fig. G-2) for a positive transition of the pulse displayed on the test oscilloscope 3.5 divisions from the left edge of the graticule (35 microseconds after trigger).

i. Disconnect test oscilloscope. Turn off DPO power. Reinstall the Display Generator card in the P7001 and reconnect the four Tektronix coaxial cables. Turn on DPO power. Press MEMORY on the P7001. Repeat step c. Readjust R18, if necessary, to pass CHECK step c.

j. Replace Q16 on the A7704 Readout board (Fig. F-2).

Z-Axis

Required Equipment

1. Time Base plug-in
2. Test oscilloscope with 10X probe
3. P7001 card extender
4. Adjustment tool

Control Settings

POWER: OFF

HORIZONTAL MODE: A

READOUT: OFF

53. Adjust P7001 Z-Axis Offset

a. Mount the Z-Axis/Front Panel card on the P7001 card extender with pin 1 of the extender on the bottom. Turn on DPO power. Press PLUG-INS on the P7001.

b. Install a time base plug-in in the A HORIZ compartment. Set controls for a 1 microsecond/division, free-running trace. Change FOCUS, INTENSITY, and A INTEN as necessary.

c. Set the test oscilloscope to 0.2 volts/division deflection factor (2 volts/division at probe tip). Select 5 microseconds/division sweep rate with auto triggering on the negative slope.

d. Connect the test oscilloscope probe to TP2 (Fig. G-3).

e. Press BOTH on the P7001.

f. CHECK - The $\overline{\text{Z-AXIS}}$ pulse displayed on the test oscilloscope remains free of jitter as you rotate A INTEN through its range. Set test oscilloscope triggering carefully to assure that it contributes no jitter to the display.

g. CHECK - Step f with DPO time base set to maximum sweep rate (reset test oscilloscope sweep rate for best display). (Maximum jitter with card installed in P7001 is typically less than 30 nanoseconds.)

h. CHECK - Step f with DPO time base set to 20 milliseconds/division (reset test oscilloscope sweep rate for best display).

i. ADJUST - Offset R30 (Fig. G-3) for stable $\overline{\text{Z-AXIS}}$ pulse. Repeat CHECK steps above.

j. Change HORIZONTAL MODE to B. Move the time base to B HORIZ compartment. Set sweep rate to 1 microsecond/division.

k. CHECK - Repeat CHECK steps above.

l. ADJUST - Offset R30 for stable $\overline{\text{Z-AXIS}}$ pulse. Repeat CHECK steps above. If necessary, sacrifice $\overline{\text{Z-AXIS}}$ pulse stability at minimum intensity to achieve stability at high display intensity.

m. Turn off power. Remove time base. Disconnect test oscilloscope. Reinstall Front Panel/Z-Axis card in P7001. Turn on DPO power.

Readout Interface

Required Equipment

1. Amplifier plug-in
2. Time base plug-in
3. Adjustment tool

Control Settings:

POWER: ON

VERTICAL MODE: RIGHT

A TRIGGER SOURCE: VERT MODE

HORIZONTAL MODE: A

DISPLAY SOURCE: MEMORY

MEMORY LOCATION: B

READOUT: Midrange

54. Adjust Readout Interface Row and Column

a. Install a time base unit in A HORIZ compartment.

b. Install an amplifier plug-in in RIGHT VERT compartment. Set deflection factor to 0.5 volts/division variable (variable control not in calibrated position). Ground input coupling switch and set polarity switch to invert.

c. Set READOUT and FOCUS as necessary.

d. CHECK - For correct, undistorted readout characters after pressing STORE, then START. If readout is OK, go to step h.

e. Adjust Row R90 ccw while repeatedly pressing STORE, then START until you see wrong or distorted characters. R90 is located at the top front of the P7001 Readout Interface card and is identified as ROW on the card. Note the position of R90. Adjust R90 cw until incorrect readout again occurs. Note the position of R90.

f. ADJUST - Row R90 midway between the two points noted in step e.

g. Repeat steps e and f above, adjusting Column R91 instead of Row R90. R91 is identified as COLUMN on the P7001 Readout Interface card and is located just below R90.

h. Remove plug-ins.

A-D Converter

NOTE

Perform steps 55 and 56 only when required, such as replacement of parts in circuitry affected by the adjustments.

Required Equipment

1. Time base plug-in
2. Amplifier plug-in
3. Test oscilloscope with two vertical channels and 10X probes
4. P7001 card extender
5. Tektronix coaxial cable
6. Adjustment tool
7. Controller (computer) interfaced to DPO
8. Terminal interfaced to controller
9. Input/output device
10. TEK BASIC Software
11. P7001 Checkout Software

Control Settings

POWER: OFF

VERTICAL MODE: RIGHT

HORIZONTAL MODE: A

55. Adjust A-D Converter MSB Compensation

a. Pull the A-D Converter card out far enough to disconnect the Tektronix coaxial cable at J80 (Fig. G-4). Disconnect the Tektronix coaxial cable at J55 on the Sample and Hold card (Fig. D-2). Dress both connectors so they do not contact any part of the instrument.

b. Install the P7001 card extender in place of the A-D Converter card and mount the A-D Converter card on it.

c. Connect the Tektronix coaxial cable listed in Table 2-1 between J80 and J55.

d. Turn on DPO power and select PLUG-INS for DISPLAY SOURCE.

e. Install an amplifier in the RIGHT VERT compartment.

f. Install a time base in the A HORIZ compartment. Set the controls for a free-running sweep. Center the trace with the amplifier Position control.

g. Set test oscilloscope channel 1 to 100 millivolts/division (1 volt/division at probe tip) and test oscilloscope channel 2 to 50 millivolts/division (500 millivolts/division at probe tip).

h. Set test oscilloscope sweep rate to 2 microseconds/division.

i. Connect test oscilloscope channel 1 probe to Sample Command TP01 (Fig. G-4) on the A-D Converter card. Set triggering controls for a stable trace, triggered on the negative transition. Then change sweep rate to 100 nanoseconds/division.

j. Connect test oscilloscope channel 2 probe to TP50 (Fig. G-4). Change test oscilloscope display to channel 2 but continue to trigger on channel 1.

k. Use the RIGHT VERT amplifier Position control to move the DPO trace down slightly from graticule center. The test oscilloscope display should resemble Fig. 2-10. Change RIGHT VERT amplifier Position control as necessary.

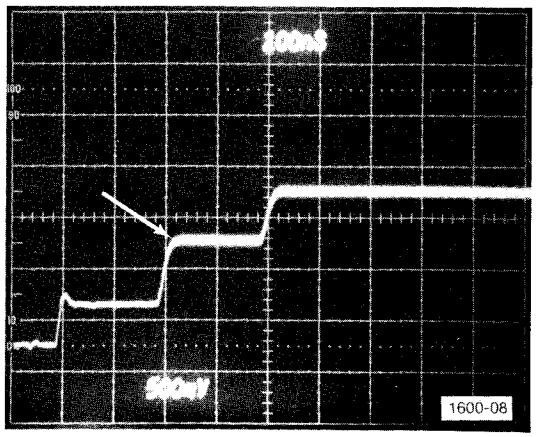


Fig. 2-10. TP50 Waveform on P7001 A-D Converter card showing correct adjustment of MSB Comp C70.

l. CHECK - The front corner of the step indicated in Fig. 2-10. It should match the waveform in Fig. 2-10 at the point indicated.

m. ADJUST - MSB Comp C70 (Fig. G-4) to match Fig. 2-10.

n. Disconnect probes from the A-D Converter card.

o. INTERACTION - Do step 56.

56. Adjust A-D Converter LSB Gain.

a. Move P180 on the Sample and Hold card (Fig. D-2) one pin to the rear.

NOTE

If the DPO has 4K core memory, check that the CAL waveform is displayed when MEMORY LOCATION A is displayed. If not, call the CAL test from P7001 Check-out Software loaded earlier to calibrate the Display Generator card. The CAL waveform is used for STORE mode adjustments farther on in this calibration procedure.

b. Load TEK BASIC Software including the Integrate and Average options.

c. Load this calibration program:

```
 10 LET C=1: INTEGRATE C,C
 20 LET C=(C-MIN(C))/(MAX(C)-MIN(C))
100 LET N=100: GOTO 1000
1000 LET PC=C: HOLD PC
1010 AVERAGE PB,N
1020 LET B=(B-MIN(B))/(MAX(B)-MIN(B))
1030 LET D=(B-C)*100: LET VD$="PERCENT"
1040 LET PD=D: LABEL PD"DIFFERENCE": HOLD PD
```

d. Set DISPLAY SOURCE to PLUG-INS. Set sweep rate to 5 milliseconds/division. Position trace so it begins just to the left of the graticule edge. Check that the trace extends past the right edge of the graticule.

@

e. Set DISPLAY SOURCE to MEMORY.

f. Type RUN and press RETURN on the terminal to begin the program. The controller will compare the ideal ramp it generates with the ramp coming from the A-D Converter and display the difference.

g. CHECK - DPO display shows spikes mostly about 0.1 percent roughly balanced above and below graticule center. See Fig. 2-11.

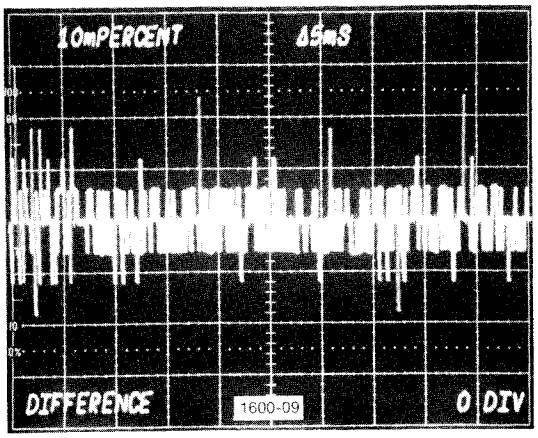
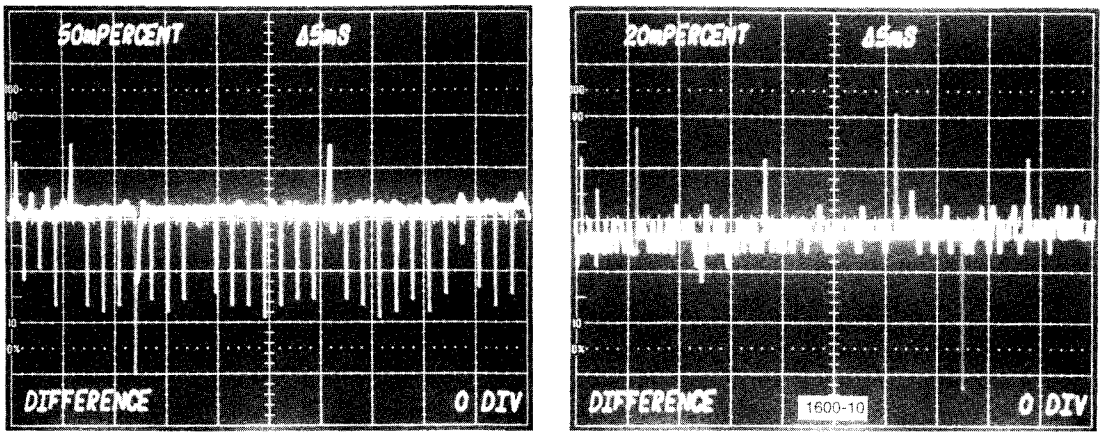


Fig. 2-11. DPO display showing LSB Gain R75 on P7001 A-D Converter card adjusted correctly.

h. ADJUST - LSB Gain R75 (Fig. G-4) on the A-D Converter card to reduce the amplitude of the noise spikes in the DPO display. Press Program Call button 1 after each adjustment to see its effect. See Fig. 2-12. Try readjusting C70 (Fig. G-4) to further reduce the spikes. Note that the display is automatically scaled to show the greatest resolution in percent.



(a) R75 misadjusted too far ccw.

(b) R75 misadjusted too far cw.

Fig. 2-12. DPO display showing incorrect adjustment of R75.

i. Turn off DPO power. Remove extender and reinstall the A-D Converter card. Replace P180 to its normal position, disconnect the Tektronix coaxial cable, and reconnect P55 and P80.

Sample and Hold

Required Equipment

1. Signal standardizer calibration fixture
2. Time base plug-in
3. Test oscilloscope with 10X probe
4. 50-ohm cable, BNC female and BNC male connectors
5. Controller (computer) interfaced to DPO
6. Terminal interfaced to controller
7. I/O device
8. P7001 Checkout Software
9. TEK BASIC Software
10. Adjustment tool

Control Settings

POWER: ON

VERTICAL MODE: RIGHT

A TRIGGER SOURCE: VERT MODE

HORIZONTAL MODE: A

B TRIGGER SOURCE: VERT MODE

READOUT: OFF

DISPLAY SOURCE: MEMORY

DATA HANDLING: STORE

MEMORY LOCATION: B

START: Press

57. Adjust Horizontal Avalanche

a. Install the signal standardizer calibration fixture in the A HORIZ compartment and the time base unit in the RIGHT VERT compartment.

b. Set the calibration fixture Test switch to Vert or Horiz + Step Resp and the Rep Rate to 10 kilohertz.

c. Set the time base for external, auto, AC triggering at a sweep rate of 10 microseconds/division.

d. Set the test oscilloscope for a vertical deflection of 20 millivolts/division, AC internal triggering, at a sweep rate of 5 microseconds/division.

e. Connect the test oscilloscope 10X probe to TP2 (see Fig. D-2).

f. Pull P180 (see Fig. D-2), turn it over, and replace (metal portion of harmonica connector upward). Disconnect P50.

g. Connect the calibration fixture Trig Out connector to the time base Ext Trig In connector with the 50-ohm BSM to BNC cable. Set controls for a triggered display on positive slope.

h. Using the calibration fixture Position and Amplitude controls, obtain a four to six division display that is centered on the CRT graticule of the DPO. Set INTENSITY, FOCUS, and A INTEN as necessary.

i. ADJUST - Horiz Avalanche R223 on the Sample and Hold card (see Fig. D-2) for minimum noise on the stored display of the DPO. There may be more than one adjustment point for minimum noise. If so, adjust for minimum noise at the point nearest free-run (where the noise suddenly increases).

j. INTERACTION - Perform steps 58 and 59.

58. Adjust Horizontal FET Bias

a. ADJUST - Horiz FET Bias R249 on the Sample and Hold card (see Fig. D-2) for maximum pulse amplitude; do not adjust to point where the whole waveform starts to collapse.

b. Observe the waveform on the test oscilloscope. The top of the 6.5 microsecond segments of the waveform droop as R249 is adjusted toward the point where the DPO display collapses. Back off slightly on R249 from that point.

c. INTERACTION - Perform step 59.

59. Adjust Horizontal Sampler Gain and Offset

a. Set P7001 DISPLAY SOURCE to PLUG-INS.

b. Set the time base sweep rate to 2 milliseconds/division. Set the calibration fixture Rep Rate to 1 kilohertz and the Test switch to Vert or Horiz Gain.

c. Use the time base Level/Slope and Variable controls to get a stable display. Set the longer traces on graticule center using the calibration fixture Position control.

d. Set P7001 DISPLAY SOURCE to MEMORY, MEMORY LOCATION to B, and DATA HANDLING to STORE, START. This will rotate the waveform 90 degrees because P180 is reversed. See Fig. 2-13.

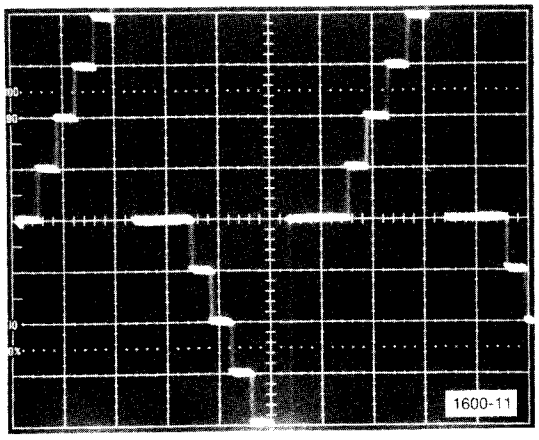


Fig. 2-13. Triggered display of calibration fixture Gain waveform.

NOTE

Calibrate DPO with 1K Semiconductor Memory by comparing display in step d to graticule. Do not attempt steps e, f, and g.

e. The P7001 Checkout Software CAL waveform was stored earlier in MEMORY LOCATION A. If it is not there, load P7001 Checkout Software and call the CALIBRATION PATTERN test. Then repeat step d.

f. With the P7001 still in the STORE B DATA HANDLING mode, set the display generator status word to HOLD, A, B

(000030_8). To do this, set the CP1100 to HALT. Enter 164002_8; press LOAD ADRS. Enter 016000_8; lift DEP. Enter 000030_8; lift DEP. Reinitialize if the controller does not respond: set all toggle switches down and press START, then repeat this toggle sequence.

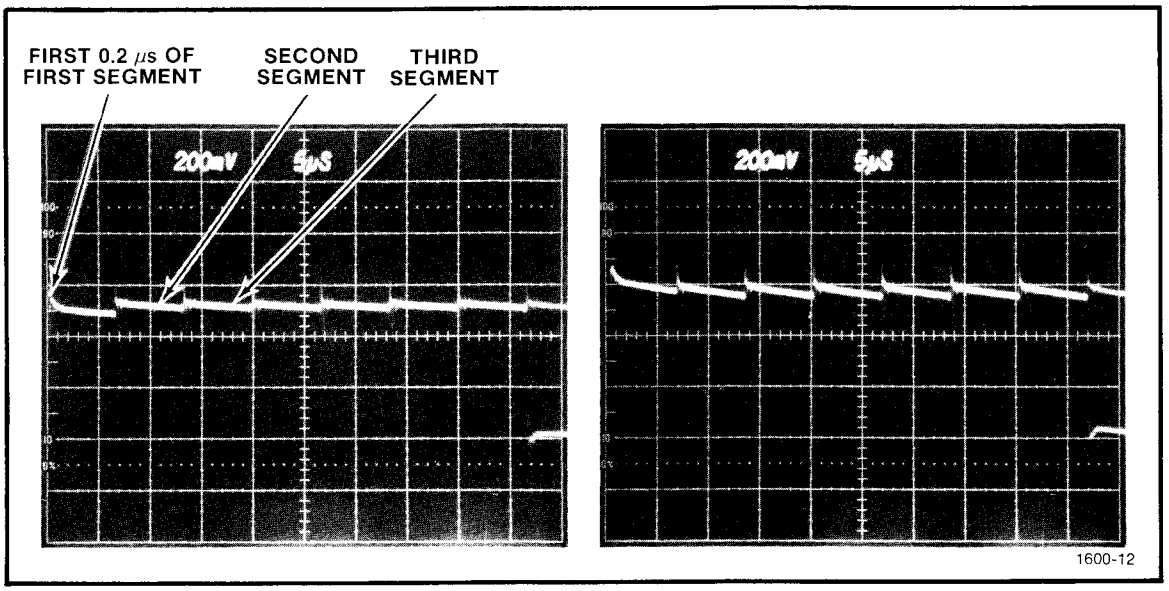
g. CHECK - Deflection of the second and eighth vertical steps of the Memory Location A trace matches the second and eighth vertical steps of the Memory Location D trace within 0.06 division. The Memory Location A trace may be moved horizontally by the time base Position control to better compare the two traces. Do not change calibration fixture Position control.

h. ADJUST - Horiz Sample Gain R255 and Horiz Offset R278 (Fig. D-2) to match as closely as possible the output from Memory Location A to the Output from Memory Location D at the second and eighth vertical steps. (If DPO has 1K semiconductor memory, adjust so display matches second and eighth graticule lines.)

60. Adjust Horizontal Step Response and Compensation

a. Set calibration fixture Test switch to Vert + Step Resp. Set Rep Rate to 10 kilohertz. Set Position and Amplitude controls for 4 to 6-division display centered on the DPO CRT.

b. CHECK - Observe on the test oscilloscope that the level of the second 6.5 microsecond period matches the level of the third 6.5 microsecond period. See Fig. 2-14. Note: There may be no noticeable change between the second and third segments.



(a) Correct adjustment of sampler step response and compensation is shown. Note front corner of first segment.

(b) Sampler step response and compensation misadjusted.

Fig. 2-14. Typical waveforms at TP1 (vertical calibration) and TP2 (horizontal calibration) on P7001 Sample and Hold board.

c. ADJUST - Observing the test oscilloscope, adjust Horiz Step Response C236 (Fig. D-2) on the Sample and Hold Card so that the level of the second 6.5 microsecond period matches the level of the third 6.5 microsecond period. See Fig. 2-14.

d. CHECK - The level of the first 0.2 microsecond of the first segment is level with the second segment. Compare Fig. 2-14(a) and (b).

e. ADJUST - If necessary, alternately adjust Horiz Comp R250 and C236 on the Sample and Hold Card to match the test oscilloscope display to Fig. 2-14(a).

f. Disconnect the test oscilloscope.

g. INTERACTION - If R250 and C236 are changed, repeat step 59.

61. Adjust Horizontal Blowby and 2nd Memory Width

a. Set the calibration fixture Rep Rate to 100 kilohertz.

b. Set the time base sweep rate to 2 microseconds. Set Variable control to calibrated position. Set Level/Slope for a stable trace. Press HOLD, then STORE, B, and START.

c. CHECK - Observe on the DPO that the positive pulse has a square trailing edge, free of overshoot or rounding.

d. ADJUST - Observe on the DPO CRT and adjust if necessary, Horiz Blowby C237 on the Sample and Hold Card (Fig. D-2) for a square trailing edge on the positive pulse, free of overshoot or rounding.

e. CHECK - The pulse top displayed on the DPO is flat.

f. ADJUST - If a small step or dip appears in the first 2 microseconds (1 division) after the (+) or (-) transition, adjust Horiz 2nd Memory Width C273 (Fig. D-2) for a flat top on the waveform. If it is impossible to obtain a flat top by adjusting C273, readjust R250 then repeat steps a through f.

g. INTERACTION - If C237 or C273 are changed, repeat steps 59, 60, and 61 until you see no further interaction.

h. Return P180 to its normal position.

62. Adjust Sample and Hold Vertical Avalanche

a. Remove the 50-ohm cable connecting the calibration fixture and the time base unit. Move the calibration fixture to the RIGHT VERT compartment and the time base unit to the A HORIZ compartment.

b. Connect the test oscilloscope 10X probe to TP1 on the Sample and Hold card (see Fig. D-2).

c. Set the DPO time base controls for AC, internal triggering in the auto mode at a sweep rate of 10 microseconds/division.

d. Set the calibration fixture Test switch to Vert or Horiz + Step Resp and the Rep Rate switch to 10 kilohertz.

e. With the calibration fixture Position and Amplitude controls obtain a four to six division display that is centered on the CRT graticule of the DPO.

f. Press MEMORY, STORE, B, then START on the DPO.

g. ADJUST - Vert Avalanche R105 on the Sample and Hold card (see Fig. D-2) for minimum noise on the stored display of the DPO. If there is more than one adjustment point for minimum noise, adjust for minimum noise at the point nearest free-run (where the noise suddenly increases).

h. INTERACTION - Perform steps 63 and 64.

63. Adjust Vertical FET Bias

a. ADJUST - Vert FET Bias R129 on the Sample and Hold card (see Fig. D-2) for maximum pulse amplitude; do not adjust to point where the first portion of the positive pulse starts to collapse.

b. Observe the weveform on the test oscilloscope; back off slightly on R129 if the 6.5 microsecond segments on the top of the waveform are beginning to droop.

c. INTERACTION - Perform step 64.

64. Adjust Vertical Sampler Gain and Offset

a. Set DISPLAY SOURCE to PLUG-INS.

b. Set the time base sweep rate to 2 milliseconds/ division.

c. Set the calibration fixture Rep Rate to 1 kilohertz and the Test switch to Vert or Horiz Gain.

d. Use the Variable Sweep Rate and Trigger Level controls to obtain a stable trace. Use the Position control to set the longer steps on the graticule center line. Adjust A7704 A INTEN if needed. See Fig. 2-13.

e. Switch DISPLAY SOURCE to MEMORY, MEMORY LOCATION to B, DATA HANDLING to STORE and press START.

NOTE

Calibrate DPO with 1K Semiconductor Memory by comparing display in step e to graticule. Do not attampt steps f through h.

f. Use your computer to set the display generator status word to HOLD, A, B (000030_8) as in step 59, f. The DPO will continuously store the calibration fixture waveform in Memory Location B, read back out of B, and display what is being stored in B. The DPO will also continuously display the CAL waveform stored in Memory Location A.

g. Set the time base Position control so the second and eighth vertical steps of the calibration fixture waveform (Memory Location B) and the CAL waveform (Memory Location A) are adjacent. Do not move calibration fixture Position control.

h. CHECK - Deflection of the calibration fixture waveform matches deflection of the CAL waveform at the second and eighth vertical steps within 0.06 division.

i. ADJUST - Vert Sampler Gain R137 and Vert Offset R158 on the Sample and Hold card (Fig. D-2) to match as closely as possible the deflection of the calibration fixture waveform to the deflection of the CAL waveform at the second and eighth vertical steps. For 1K semiconductor memory, match as closely as possible the deflection of the calibration fixture waveform to the graticule at the second and eighth steps.

65. Adjust Vertical Step Response and Compensation

a. Set MEMORY LOCATION to B, DATA HANDLING to STORE and press START.

b. Set calibration fixture TEST switch to VERT + STEP RESP and Rep Rate to 10 kilohertz. Set Position and Amplitude controls to obtain a 4 to 6-division display centered on the DPO CRT.

c. CHECK - Observe the test oscilloscope display and check that the level of the second 6.5 microsecond period matches the level of the third 6.5 microsecond period. See Fig. 2-14.

Note: There may be no noticeable change between the amplitude of the second and third segments.

d. ADJUST - Vert Step Response C119 (Fig. D-2) to match test oscilloscope display to Fig. 2-14 (a).

e. CHECK - The level of the first 0.2 microsecond of the first segment is the same as the level of the second segment. Compare the incorrect waveform and the correct waveform shown in Fig. 2-14.

f. ADJUST - Vert Comp R130 and C119 on the Sample and Hold card to match the waveform shown in Fig. 2-14 (a). Compare the correct and incorrect adjustments shown in Fig. 2-14.

g. Disconnect the test oscilloscope.

66. Adjust Vertical 2nd Memory Width and Blowby

a. Set calibration fixture Rep Rate to 100 kilohertz.

b. Set the time base Sweep Rate to 2 microseconds/division. Return to calibrated sweep. Set triggering level for stable trace.

c. CHECK - Observe on the DPO that the positive pulse has a square trailing edge, free of overshoot or rounding.

d. ADJUST - Observe on the DPO and adjust Vert Blowby C118 on the Sample and Hold card (Fig. D-2) for a square trailing edge on the positive pulse, free of overshoot or rounding.

e. CHECK - The pulse top displayed on the DPO should be flat.

f. ADJUST - If a small step or dip appears in the first one to two microseconds after the (+) or (-) transition, adjust Vert 2nd Memory Width C157 on the Sample and Hold card (Fig. D-2) for a flat top on the waveform. If it is impossible to obtain a flat top by adjusting C157, it may be necessary to readjust Vert Comp R130 slightly. If you readjust R130, repeat steps c and d.

g. INTERACTION - If it has been necessary to make any adjustments in steps 65 or 66, repeat steps 64 through 66 until you see no further interaction.

67. Adjust Delay Set and Check Vertical Response

a. Set the calibration fixture Rep Rate to 1 megahertz.

b. Set the DISPLAY SOURCE switch to BOTH.

c. Set the time base for a sweep rate of two nanoseconds/division. Set controls to trigger on positive slope of pulse.

d. Center the rise of the positive pulse on the CRT graticule center line with the time base Position control.

e. CHECK - The rise of the displayed pulses should coincide within 0.1 division at the 50% amplitude point.

f. ADJUST - Delay Set adjustment R205 on the Sample and Hold card (see Fig. D-2) so the rise of the two displays coincide horizontally. Do not reset the time base Position control during the adjustment. Check stored waveform for a risetime of 1.6 nanoseconds with aberrations $\pm$ 0.18 division, total 0.18 division (3 percent). This is affected by Vertical Interface compensation.

g. Set the time base for a sweep rate of one microsecond/division.

h. ADJUST - If required, adjust Horiz Offset R278 on the Sample and Hold card (see Fig. D-2) to obtain coincidence.

i. Repeat parts c through h until coincidence is obtained at both sweep rates.

j. Remove calibration fixture plug-in.

68. Check Data Acquisition

a. Install an amplifier plug-in in RIGHT VERT compartment. Set deflection factor to 10 millivolts/division. Connect input to CALIBRATION GND and 40mV output jacks using the BNC to pin-jack cable.

b. Set the time base sweep rate to 0.1 millisecond/division. Set triggering level for stable trace. Set Position control for a display that begins just to the left of the graticule and ends beyond the right of the graticule.

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c. Use the amplifier Position control to place the bottom of the waveform on the graticule line two divisions from the bottom of the graticule.

d. Load and run this TEK BASIC program (load TEK BASIC Software with Average option, if necessary):

```
100 AVERAGE PD,100: HOLD PD,Z
110 DIMENSION M(153): DIMENSION N(153): DIMENSION V(3)
120 FOR I=0 TO 153
130 LET M(I)=PD(I+51)
140 NEXT I
150 FOR J=0 TO 153
160 LET N(J)=PD(J+307)
170 NEXT J
180 LET V(0)=ABS(MAX(M)-.04)
190 LET V(1)=ABS(MIN(M)-.04)
200 LET V(2)=ABS(MAX(N)): LET V(3)=ABS(MIN(N))
210 IF V(0)>=V(1) THEN 250
220 LET V(0)=V(1)
250 IF V(2)>=V(3) THEN 300
260 LET V(2)=V(3)
300 IF V(0)>=V(2) THEN 350
310 LET V(0)=V(2)
350 DISPLAY 100*V(0)/.04;" PERCENT ERROR"
```

Turn on READOUT; press MEMORY. The percentage of error will be displayed on the DPO CRT. Compare to accuracy specification in Table 1-2.

e. Replace P50 on P7001 Sample and Hold card (Fig. D-2).

FINE DISPLAY POSITION

Required Equipment

1. Amplifier plug-in
2. Time base plug-in
3. Coaxial cable (BNC and pin-jack connectors)
4. Adjustment tool

Control settings

POWER: ON

VERTICAL MODE: RIGHT

HORIZONTAL MODE: A

A TRIGGER SOURCE: VERT MODE

DISPLAY SOURCE: MEMORY

DATA HANDLING: HOLD

MEMORY LOCATION: A

69. Adjust MEMORY - VERT and HORIZ

a. The CAL waveform stored in P7001 memory location A in step 59 should be displayed. If necessary, reload P7001 Checkout Software and select the CALibrate Pattern.

b. CHECK - The CAL waveform should match the graticule at the second and eighth horizontal graticule lines and at the second and tenth vertical graticule lines within 1.5%.

c. ADJUST - FINE DISPLAY POSITION - MEMORY controls on the P7001 front panel so the stored display is positioned on the graticule scale.

70. Adjust PLUG-INS - VERT and HORIZ

a. Install an amplifier plug-in in RIGHT VERT compartment. Set deflection factor to 10 millivolts/division. Connect input to CALIBRATOR 40 mV output.

b. Install time base in A HORIZ compartment. Set the time base for a sweep rate of 0.5 millisecond/division. Set triggering controls for a stable display. Set amplifier Position control to center display.

c. Change the following P7001 controls:

DISPLAY SOURCE: BOTH

DATA HANDLING: STORE

MEMORY LOCATION: D

START: Press

d. Two displayed waveforms coincide within 1%.

e. ADJUST - FINE DISPLAY POSITION - PLUG-INS on the P7001 front panel to superimpose the two displays.

f. Remove plug-ins and cable. Replace DPO covers. Close P7001 front panel and replace screws.

SECTION 3

A7704 INTERFACE ADJUSTMENTS

Several interface adjustments are provided to match the Acquisition Unit to the Display Unit. These adjustments do not need to be changed during recalibration unless Display Unit adjustments cannot be made according to the calibration procedure because their range is insufficient. Also, if components are replaced in the interface circuits or if the Acquisition Unit is used with a different Display Unit, adjustment may be required.

Vertical

Required Equipment

1. Test oscilloscope
2. Signal standardizer calibration fixture
3. Time base plug-in
4. Adapter, BNC to Tektronix coaxial connector (two required)
5. Coaxial cable, 50-ohm (two required)
6. Terminator, 50-ohm (two required)
7. Adjustment tool

Control Settings

POWER: OFF

VERTICAL MODE: RIGHT

HORIZONTAL MODE: A

1. Adjust Vertical Centering

a. Check the deflection accuracy of the test oscilloscope using the DPO CALIBRATOR output.

b. Set the test oscilloscope for differential operation (added vertical display mode with one channel inverted). Set deflection factor of both channels for 50 millivolts/division. Ground the inputs.

c. Set the test oscilloscope sweep rate to 1 microsecond/division with free-running sweep.

d. Establish a zero-volt reference level for the test oscilloscope display by positioning the trace to the graticule center line. Do not change the test oscilloscope position controls after setting this level.

e. Set the vertical channels of the test oscilloscope for DC input coupling.

f. Disconnect coaxial connectors P17 and P18 from the Vertical Amplifier board (see Fig. D-1).

g. Connect P17 and P18 to the vertical channels of the test oscilloscope with the adapters and coaxial cables. Terminate with 50 ohms at the test oscilloscope inputs. Connect P18 to the inverted test oscilloscope vertical channel. Turn on DPO power. Set P7001 DISPLAY SOURCE to PLUG-INS.

h. CHECK - Displayed DC level is within 0.2 division (10 millivolts) of the zero-volt reference level.

i. ADJUST - Centering R22 on the Vertical Interface board (see Fig. D-3) for the same DC level as the zero-volt reference level.

j. Change the VERTICAL MODE switch between LEFT and RIGHT. If necessary, compromise the setting of R22 for correct operation in both VERTICAL MODE switch positions.

k. INTERACTION - Perform steps 17 and 64 in Section 2.

2. Adjust Vertical Gain

a. Install the signal standardizer calibration fixture in the RIGHT VERT compartment.

b. Set the VERTICAL MODE switch to RIGHT.

c. Set the calibration fixture Test switch to Vert or Horiz Gain and the Rep Rate switch to 1 kilohertz.

d. Position the test oscilloscope display to align the bright center trace with the center vertical line of the graticule.

e. CHECK - Deflection from the second to eighth traces should be six divisions $\pm$ 0.06 division.

e. ADJUST - Gain R47 on the Vertical Interface board (see Fig. D-3) for six divisions deflection between the second and eighth traces (300 millivolts within 45 millivolts).

f. Set the DPO POWER switch to off.

g. Disconnect P17 and P18 from the test oscilloscope and connect them to their respective jacks on the Vertical Amplifier board.

h. Turn on DPO power. Set P7001 DISPLAY SOURCE to PLUG-INS.

i. INTERACTION - Perform steps 20 and 64 in Section 2.

3. Adjust Vertical Compensation

a. Install a time base in the A HORIZ compartment. Set sweep rate to 2 nanoseconds/division. Trigger on positive slope.

b. Set the signal standardizer calibration fixture to Vert or Horiz + Step Response and Rep Rate to 1 megahertz. Set Position and Amplitude for a centered, six-division display.

c. Press STORE, D, START, and MEMORY.

d. CHECK - Aberrations following the positive transition of the displayed pulse are less than $\pm$ 0.18 division (3 percent). Total peak-peak aberrations do not exceed 0.18 division (3 percent).

e. ADJUST - R84 (if variable) and C81 (Fig. D-3) for best rise time, minimum aberrations, and flat top on the displayed pulse. Aberrations must meet the limits given in the CHECK step above.

f. Move the calibration fixture to the LEFT VERT compartment. Set VERTICAL MODE to LEFT.

g. CHECK - Aberrations are within limits given in the CHECK step above.

h. ADJUST - R34 (if variable) and C31 (Fig. D-3) for best rise time, minimum aberrations, and flat top on the displayed pulse. Aberrations must meet the limits given in CHECK step d above.

i. Remove DPO plug-ins.

j. INTERACTION - Perform step 22 in Section 2 if any vertical compensation adjustments are changed.

Horizontal

Required Equipment

1. Signal standardizer calibration fixture
2. Test oscilloscope
3. Plug-in extender calibration fixture
4. Adapter, BNC to Tektronix coaxial connector (two required)
5. Coaxial cable, 50-ohm (two required)
6. Terminator, 50-ohm (two required)
7. Adjustment tool

Control Settings

POWER: OFF

HORIZONTAL MODE: A

1. Adjust Horizontal Gain (Channel A)

a. Check the deflection accuracy of the test oscilloscope using the DPO CALIBRATOR output.

b. Set the test oscilloscope for differential operation (added vertical display mode with one channel inverted). Set deflection factor of both channels for 50 millivolts/division.

c. Set the test oscilloscope sweep rate to 1 microsecond/division with free-running sweep.

d. Disconnect coaxial connectors P15 and P16 from the Horizontal Output board (see Fig. C-2).

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e. Connect P15 and P16 (P16 to inverted channel) to the vertical channels of the test oscilloscope with the adapters and cables. (If the test oscilloscope does not have a 50-ohm input impedance, use 50-ohm terminations at the vertical-channel inputs.)

f. Install the plug-in extender calibration fixture in the A HORIZ compartment and plug the signal standardizer calibration fixture into it. Turn on DPO power.

g. Set the calibration fixture Rep Rate to 10 kilohertz. Set Test switch to Vert or Horiz Gain.

h. Position the test oscilloscope display to align the bright center trace with the center horizontal line of the graticule.

i. CHECK - Deflection from the second to eighth traces on the test oscilloscope should be six divisions $\pm$ 0.06 division.

j. ADJUST - A Horiz Gain R23 on the Horizontal Interface board (see Fig. D-3) for exactly six divisions of deflection between the second and eighth traces on the test oscilloscope display.

k. INTERACTION - Do step 2 in this section.

2. Adjust Horizontal Gain (Channel B)

a. Remove the calibration fixtures and install them in the B HORIZ compartment.

b. Set the HORIZONTAL MODE switch to B.

c. Position the test oscilloscope display to align the bright center trace with the center horizontal line of the graticule.

d. CHECK - Deflection from the second to eighth traces should be six divisions ± 0.06 division.

e. ADJUST - B Horiz Gain R13 on the Horizontal Interface board (see Fig. D-3) for exactly six divisions between the second and eighth traces on the test oscilloscope display. If the gain of either channel A or B can not be set to exactly six divisions, set them to the same deflection as close to six divisions as possible.

f. Set the DPO POWER switch to off.

g. Disconnect P15 and P16 from the test oscilloscope and connect each to its respective jack on the Horizontal Output board.

h. Remove the calibration fixtures.

i. INTERACTION - Perform steps 29 and 59 in Section 2.

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SECTION 4

P7001 CHECKOUT SOFTWARE TESTS

Three software tests are used to calibrate the DPO: X-Y Display Pattern (Fig. 2-9), Worst Case Test (Fig. 2-8), and Calibration Pattern (Fig. 4-1). These waveforms are part of P7001 Checkout Software, which is available to run on CP1100 Controllers and PDP-11 minicomputers. As an aid in programming other computers, flowcharts for these tests are presented here. It is assumed that the DPO is interfaced to the CP Bus using the DPO/CP Bus Interface and that the computer is interfaced to the CP Bus. For information on such an interface, see the DPO Interface Concepts Manual (070-1971-00).

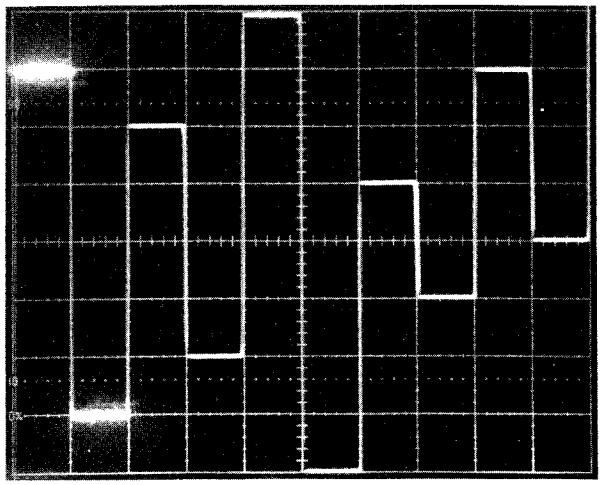


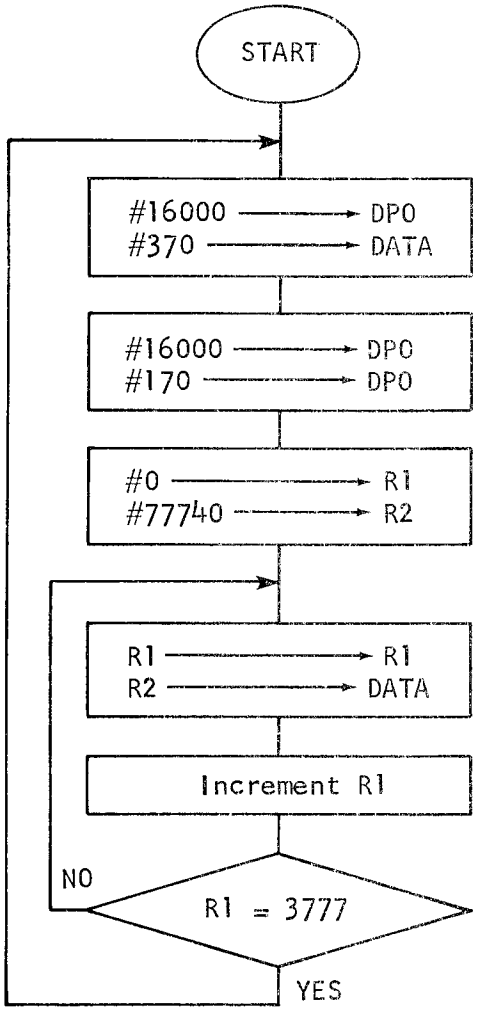
Fig. 4-1. Display of Calibration Pattern (CAL) waveform.

WORST CASE TEST

NOTE

This program can be used to calibrate Strobe Delay R34 on the Core Memory assembly. It will provide the necessary display, although the program does not duplicate the P7001 Checkout Software Worst Case Test.

DPO = DPO Address Register
DATA = Data Register
# = Data as it appears on the CP BUS written as octal number.
R1 = Register
R2 = Register



Clear DPO Waveform locations A, B, C, D in P7001 memory HOLD Waveform locations A, B, C, D.

Stores 1777 (Full-scale) in all memory address for Waveforms A, B, C, D. Displayed trace is one division above top of CRT graticule (not visible).

1600-13

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WORST CASE TEST
(cont)

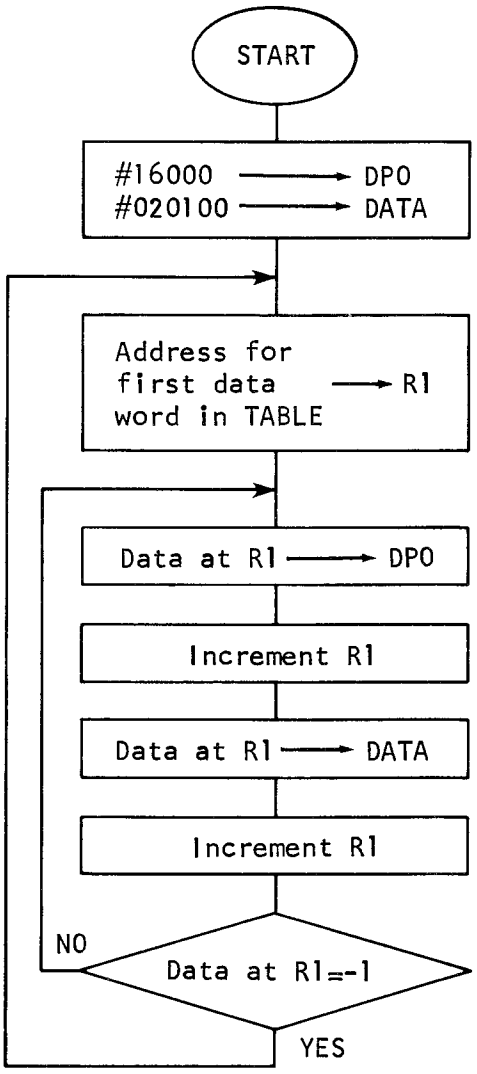
DATA* IN TABLE	DPO CRT COORDINATES	DATA IN TABLE	DPO CRT COORDINATES
146 54640	146, 1315	545 46300	545, 1146
230 54640	230, 1315	546 31500	546, 632
231 23140	231, 463	630 31500	630, 632
313 23140	313, 463	631 63140	631, 1463
314 71500	314, 1632	713 63140	713, 1463
377 71500	377, 1632	714 40000	714, 1000
400 6300	400, 146	776 40000	776, 1000
462 6300	462, 146	777 77740	777, 1777
463 46300	463, 1146	-1	

*Data as it appears on the CP BUS written as octal number.

1600-14

X-Y DISPLAY PATTERN

# = Number*
DPO = DPO Address Register
DATA = DPO Data Register
R1 = Register



DPO Display Generator device address

DPO Display Generator status word for X-Y Display, Waveform D

DATA* IN TABLE	DPO CRT COORDINATES
17000 0	0,0 (dark)
17000 71520	0,1632
17377 40020	400,1000
17777 6320	777,146
17777 71520	777,1632
17377 40020	377,1000
17000 6320	0,146
17777 6320	777,146
17777 71500	777,1632 (dark)
17000 71520	0,1632
-1	

*Data as it appears on the CP BUS written as octal number

1600-15

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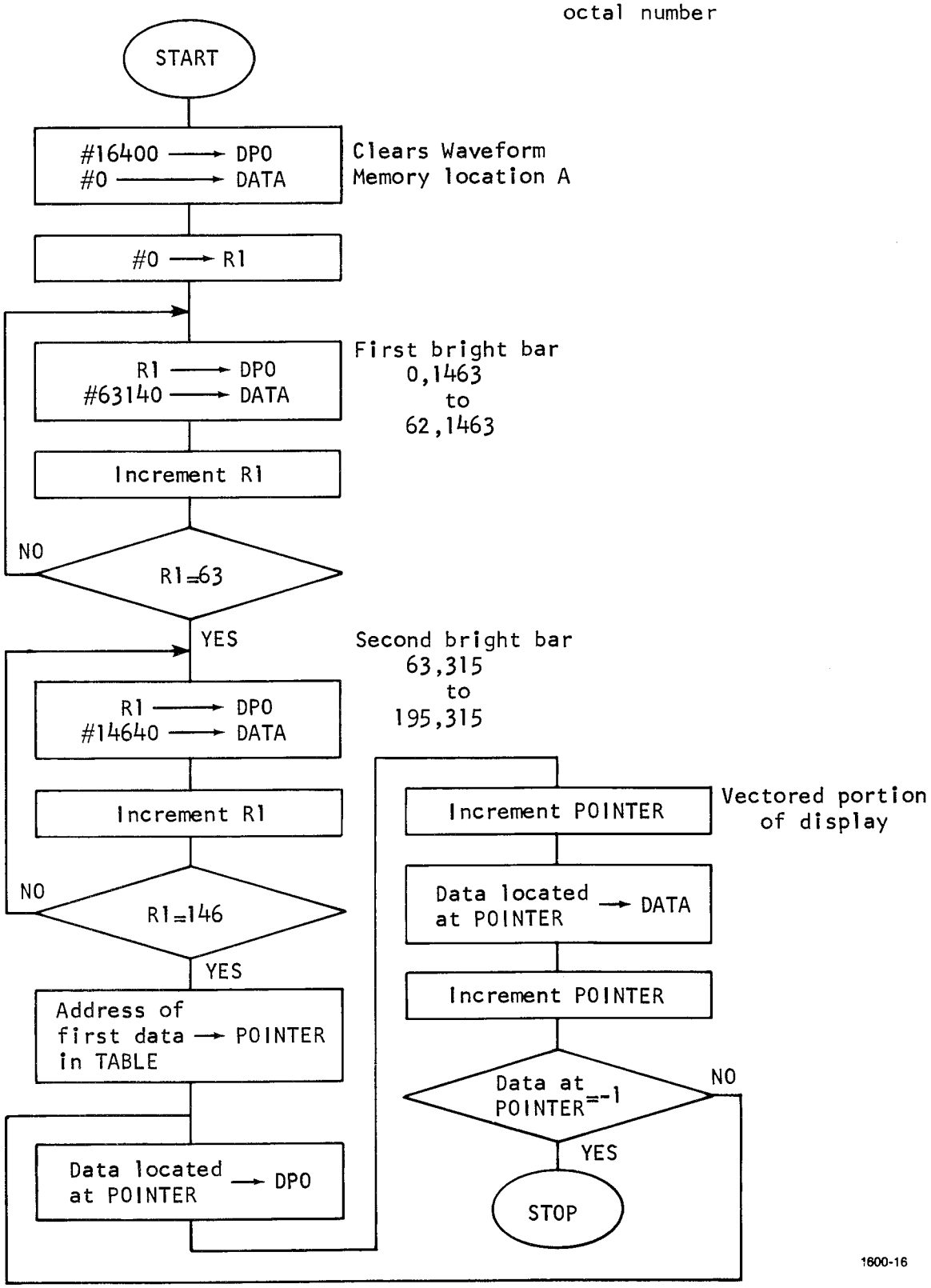
CALIBRATION PATTERN (CAL)

DPO = DPO Address Register
DATA = DPO Data Register
R1 = Register
# = Data as it appears on the CP BUS written as octal number



APPENDIX A

SPECIAL CHARACTERISTICS OF DPO PLUG-INS

PLUG-IN	SPECIAL CHARACTERISTICS
All vertical plug-ins	Allow the store interval to complete if either mainframe or plug-in mode is set to CHOP or ALT; do not use end of sweep interrupt as indication of complete storage for single sweep. (End of sweep interrupt occurs on the first transition that blanks the CRT after sweep has started.)
7A15	When using 100X probe, X1 amplifier readout must be corrected in all 7000-Series mainframes.
7A15N 7A18N 7B53N 7B53AN	TEK BASIC Software assumes 1-volt and/or 1-second no matter what deflection factor or sweep rate is selected because N-Series plug-ins do not provide scale factors.
7B92 7B92A	Do not use with P7001 Processor below serial number B06 because 5 nanosecond or faster sweeps are not stored completely. This makes TEK BASIC Software signal averaging impossible.
7D11 7D14 7D15	Adjust intensity for a continuous, 10 division stored display to store the trace completely when the plug-in is in the vertical compartment.
7D12-M2	Incorrect readout may be stored when using this plug-in combination. Solution: If 7D12 is in the left vertical or B horizontal compartment, store traces from other plug-ins in waveform locations C and D only. If 7D12 is in the right vertical or A horizontal compartment, store traces from other plug-ins in waveform locations A and B only.
7D15	Units stored using the GET command in TEK BASIC Software will read Hz X100 or something similar and must be corrected using software.

APPENDIX A (cont.)

7L12 7L13	Avoid baseline clipper action when software signal averaging is required. Adjust intensity of the displayed trace so the baseline is displayed. This provides a continuous, 10 division sweep and allows software signal averaging to complete if started. Unlike other plug-ins, zero reference is calibrated and fixed on the display. It is always 4 divisions above graticule center and the value is indicated by the reference level. When using TEK BASIC Software, use a BASIC program for storing the zero reference; avoid using the automatic feature for storing the zero reference.
7M13	Readout information can only be stored in ASCII variables even though readout shows apparently valid numbers or scale factors.
7S11 7S12	Serial numbers B08 and below and serial numbers B10 and B11 exhibit excessive noise because of improper blanking.
7S14	Store waveforms one at a time: select channel 1 and store; then select channel 2 and store.

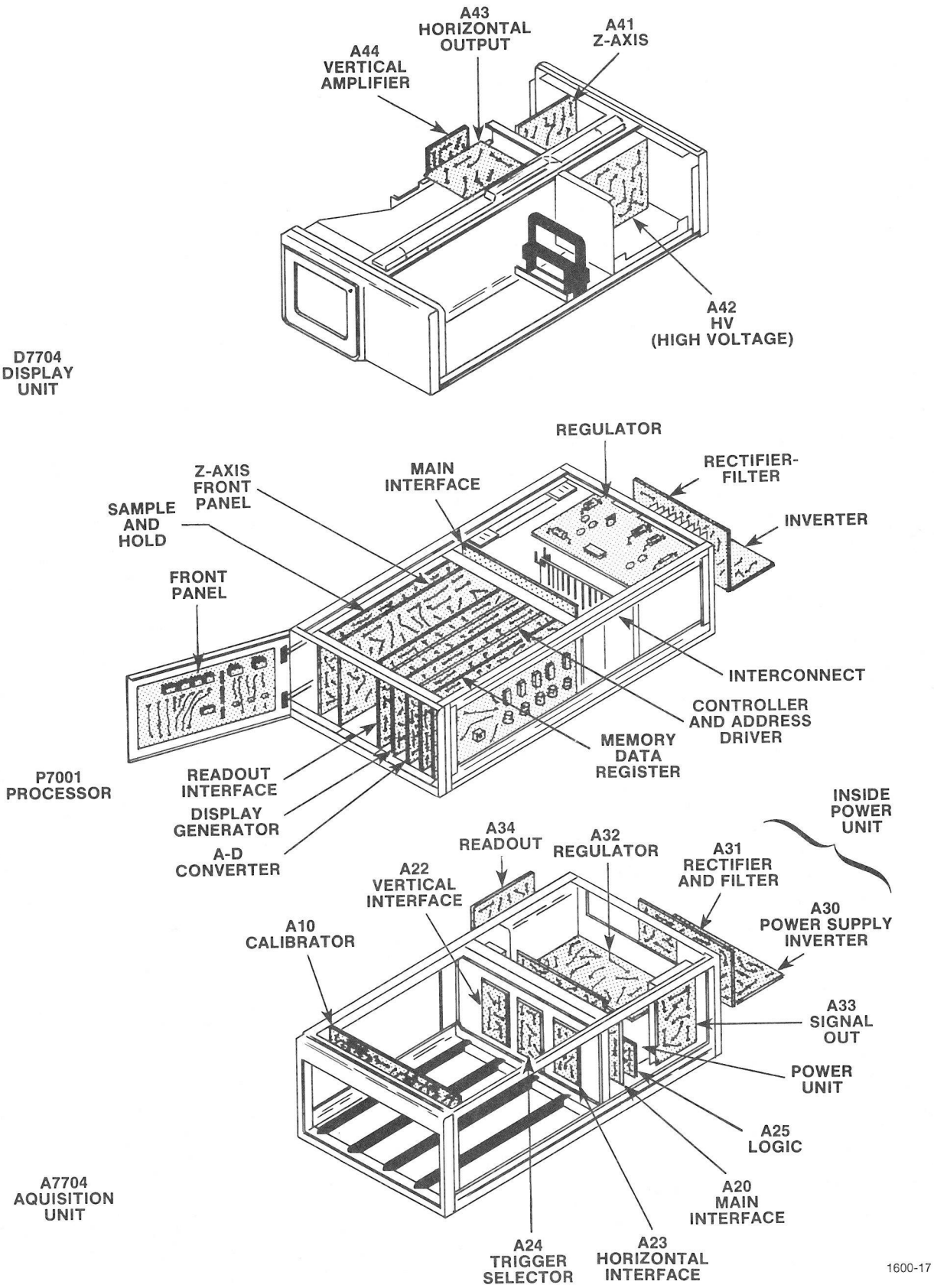


Fig. A-1. DPO circuit boards.

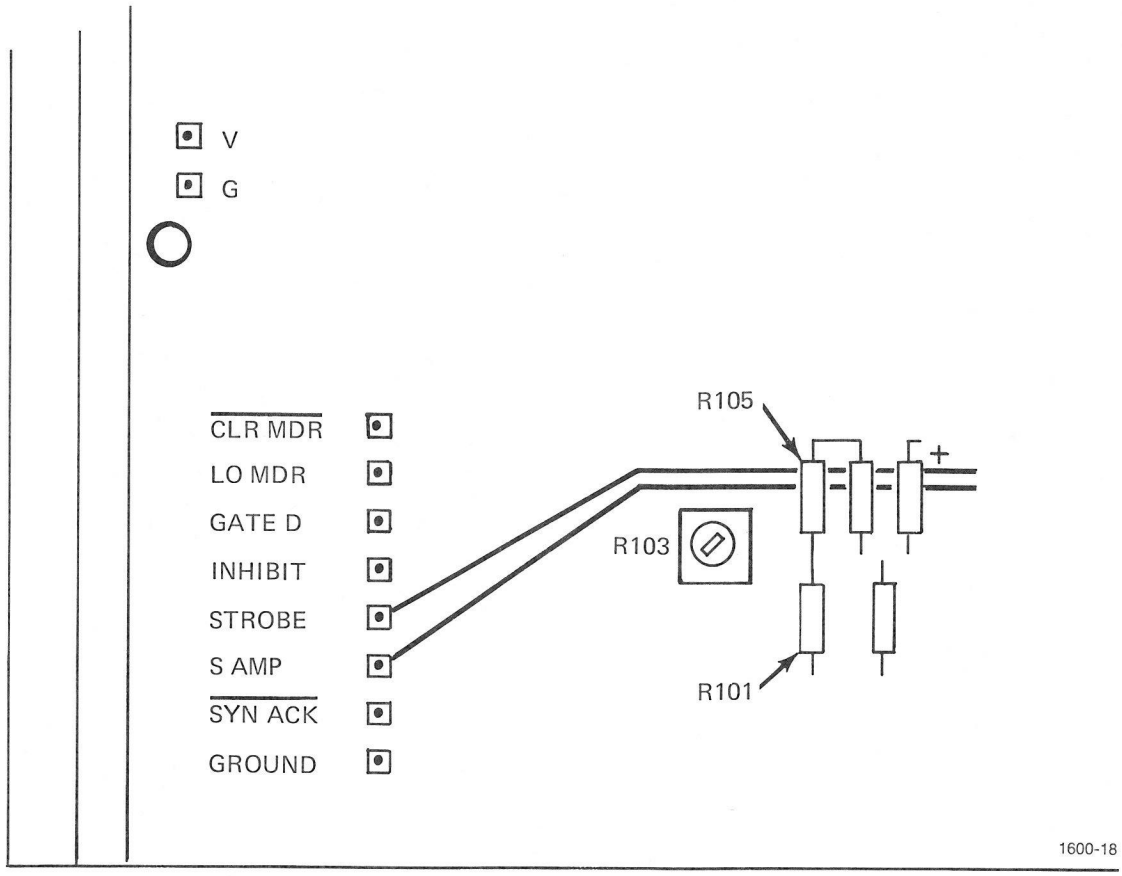


Fig. A-2. Test points for Memory Volts adjustment on P7001 Memory Data Register.

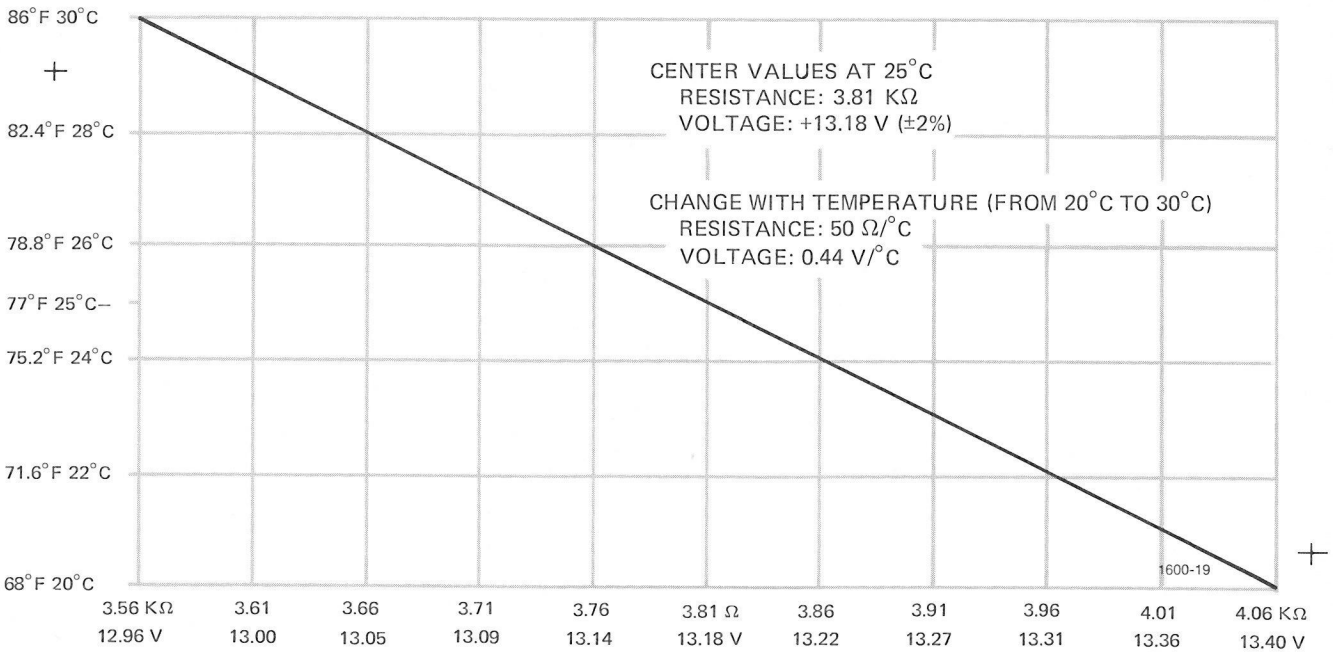


Fig. A-3. Graph of Memory Volts and resistance vs. temperature.

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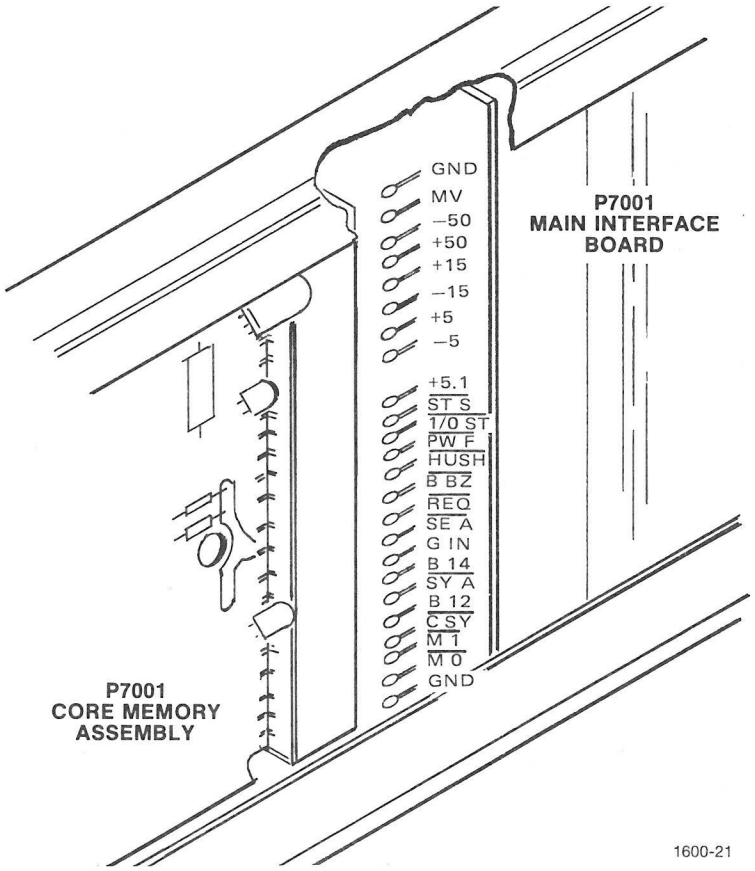

Fig. B-1. P7001 power supply test points on P7001 Main Interface.

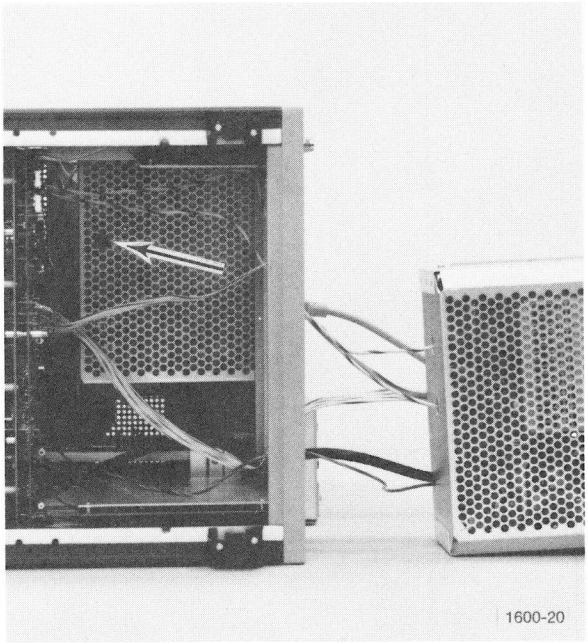

Fig. B-2. P7001 +5.1 Volts adjustment.

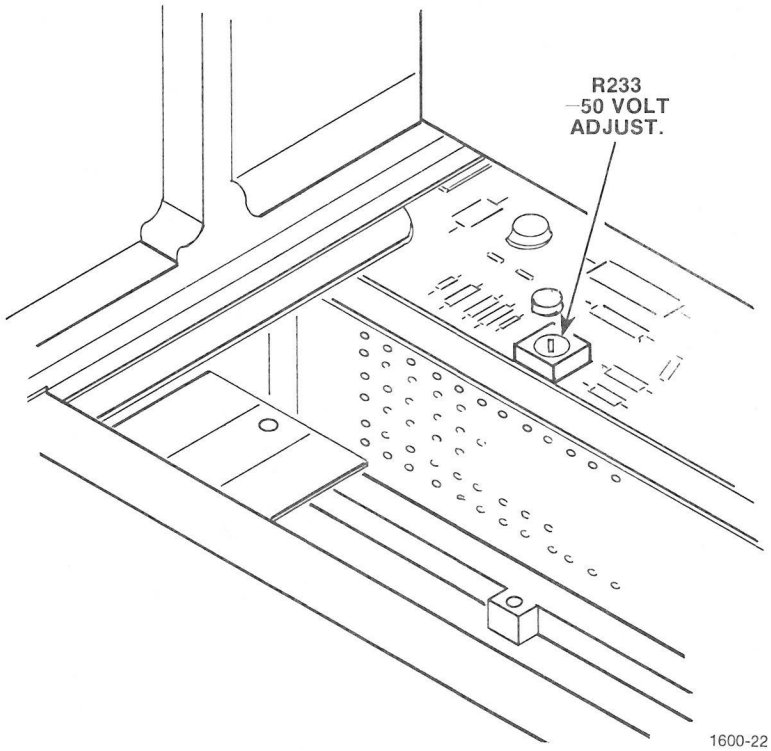

Fig. B-3. P7001 −50 Volts adjustment on P7001 Regulator board.

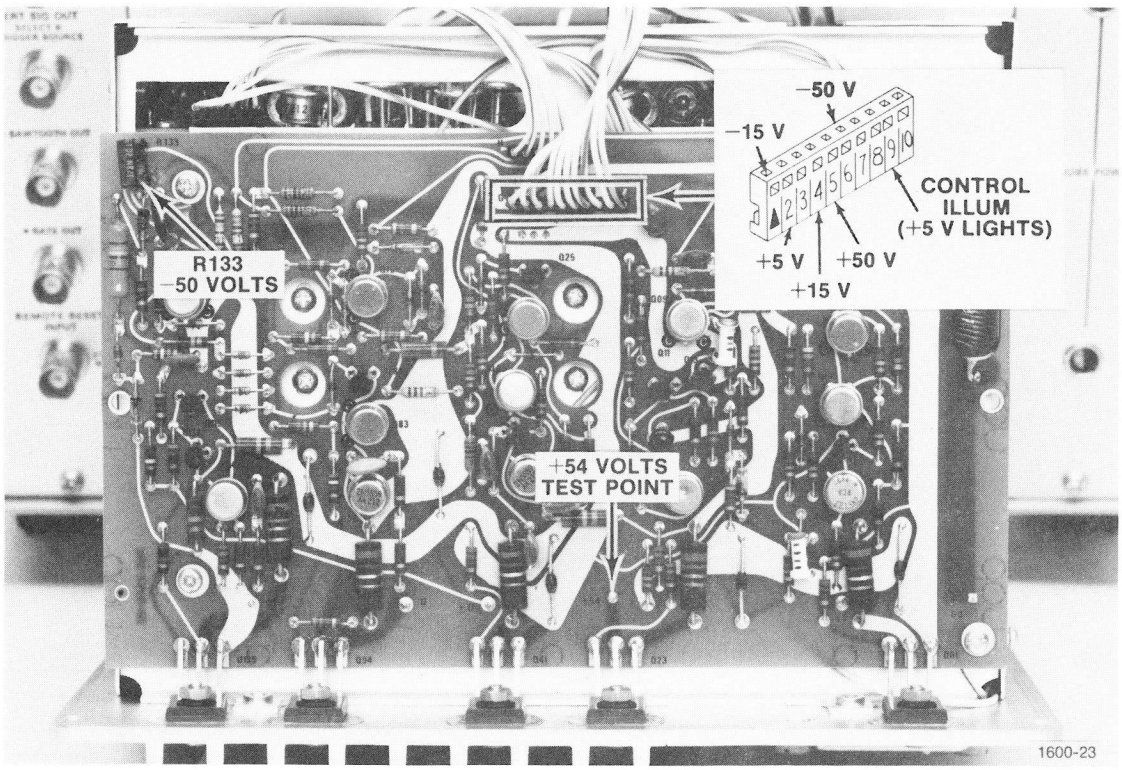

Fig. B-4. A7704 Regulator board (top of power unit).

Fig. B-1 thru B-4

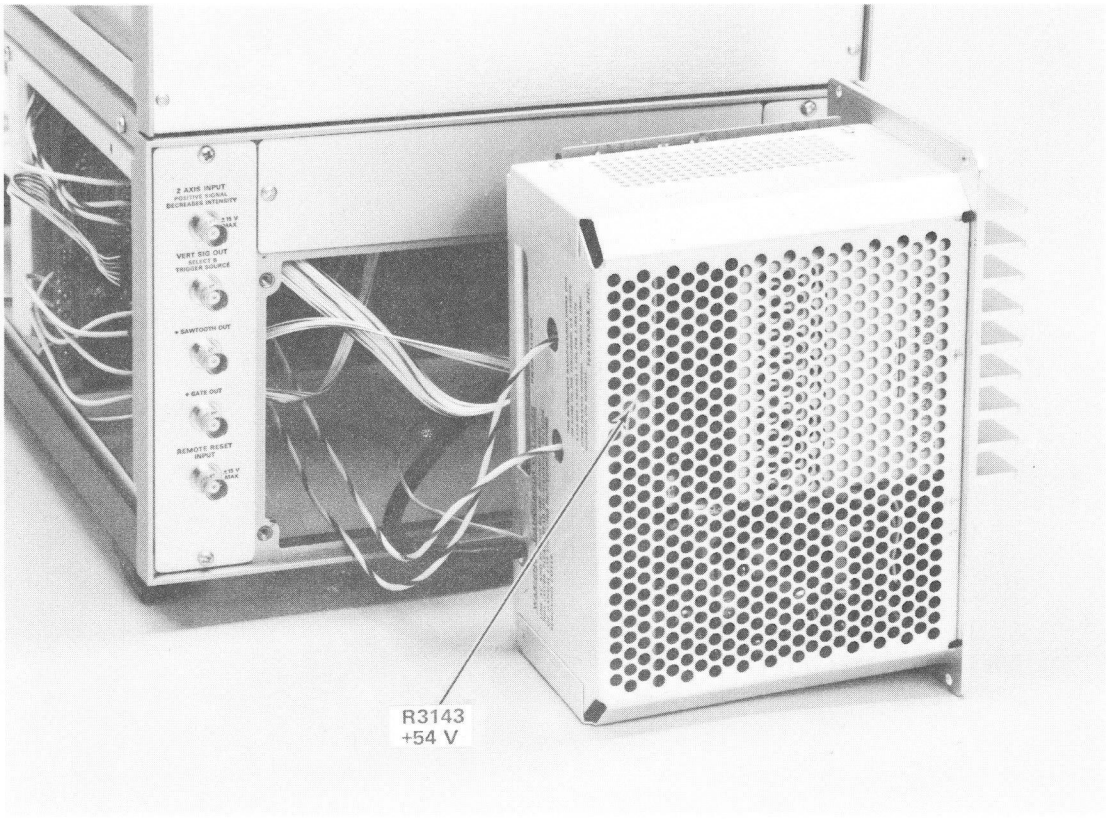

Fig. C-1. +54 Volts adjustment R3143 on A7704 Rectifier and Filter board.

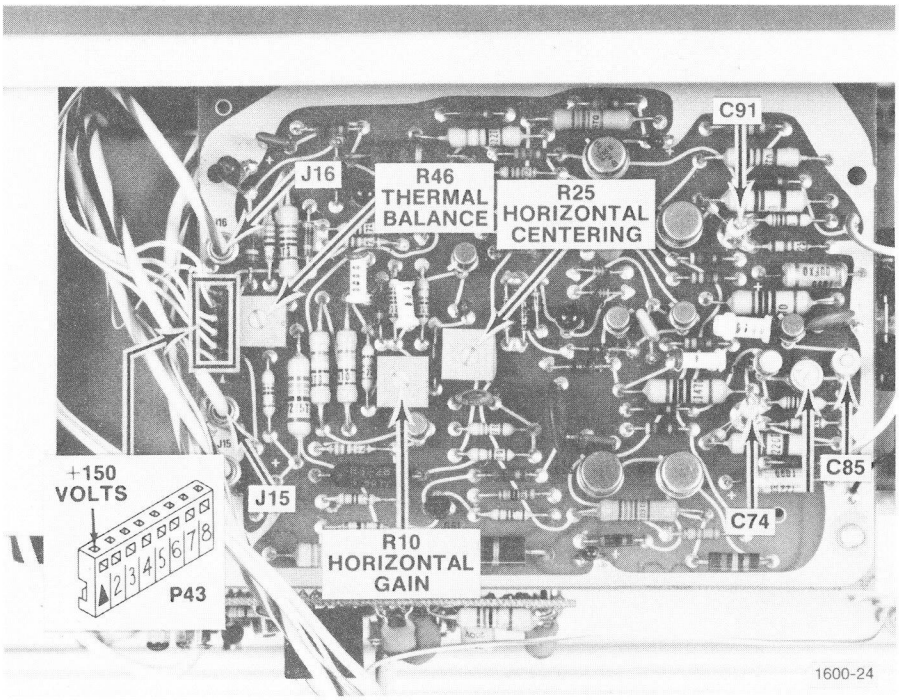

Fig. C-2. D7704 Horizontal Output board.

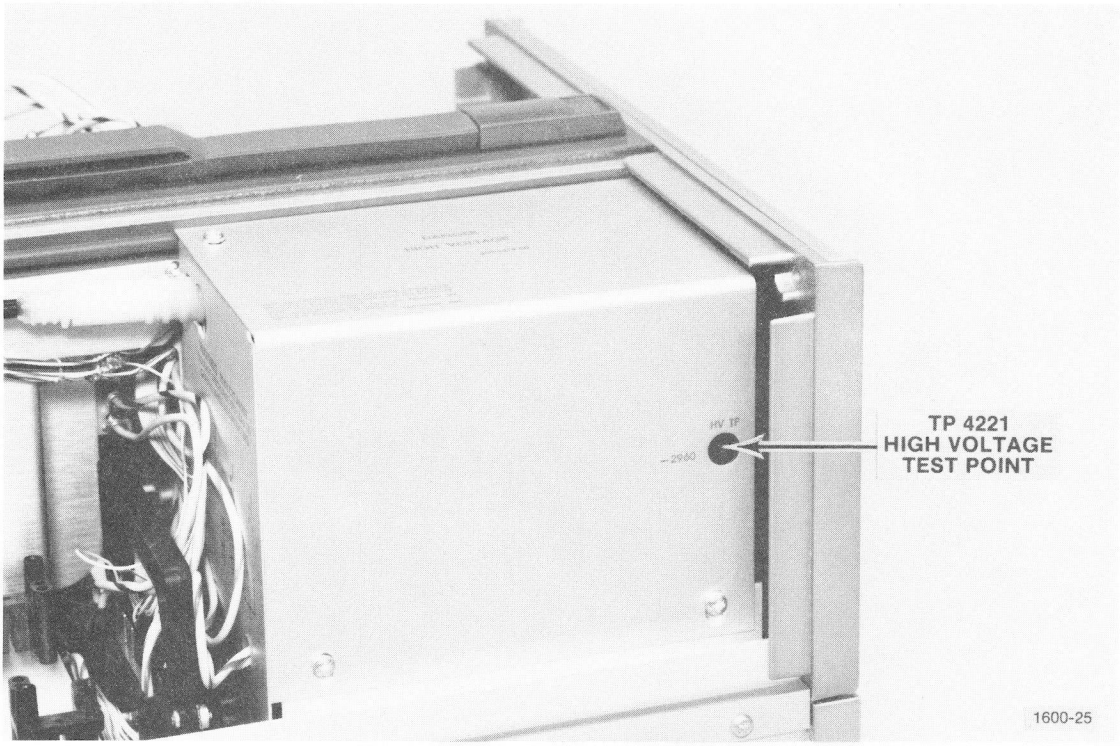

Fig. C-3. High Voltage test point.

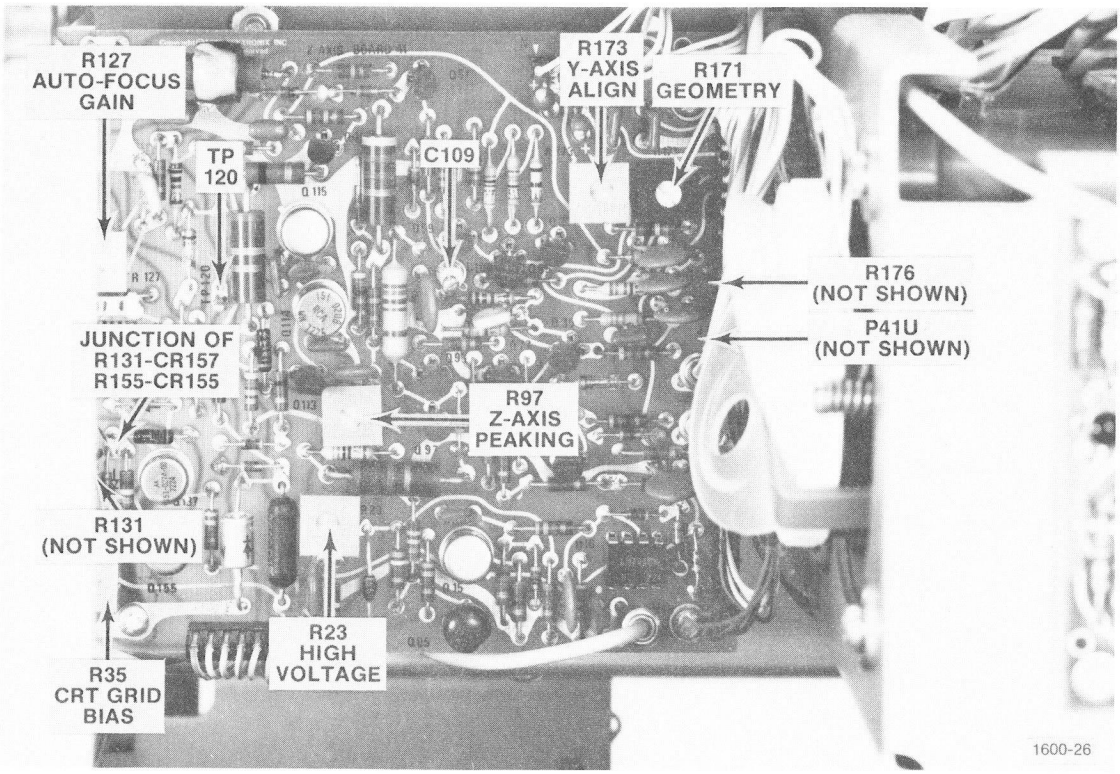

Fig. C-4. D7704 Z-Axis board adjustments and test points.

Fig. C-1 thru C-4

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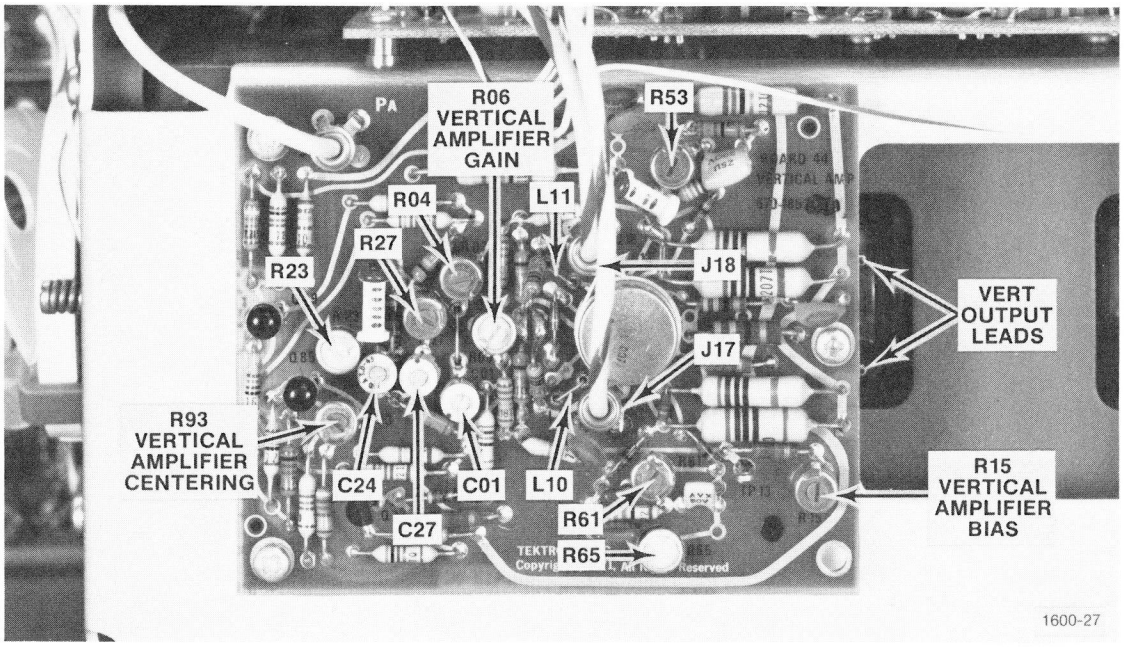


Fig. D-1. D7704 Vertical Amplifier board adjustments and connectors.

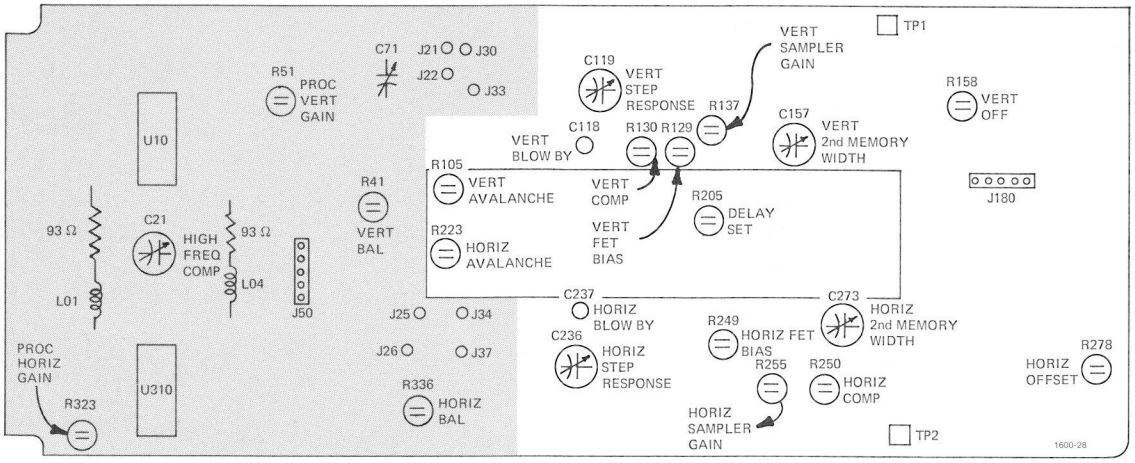


Fig. D-2. P7001 Sample & Hold card adjustments, test points, and connectors.

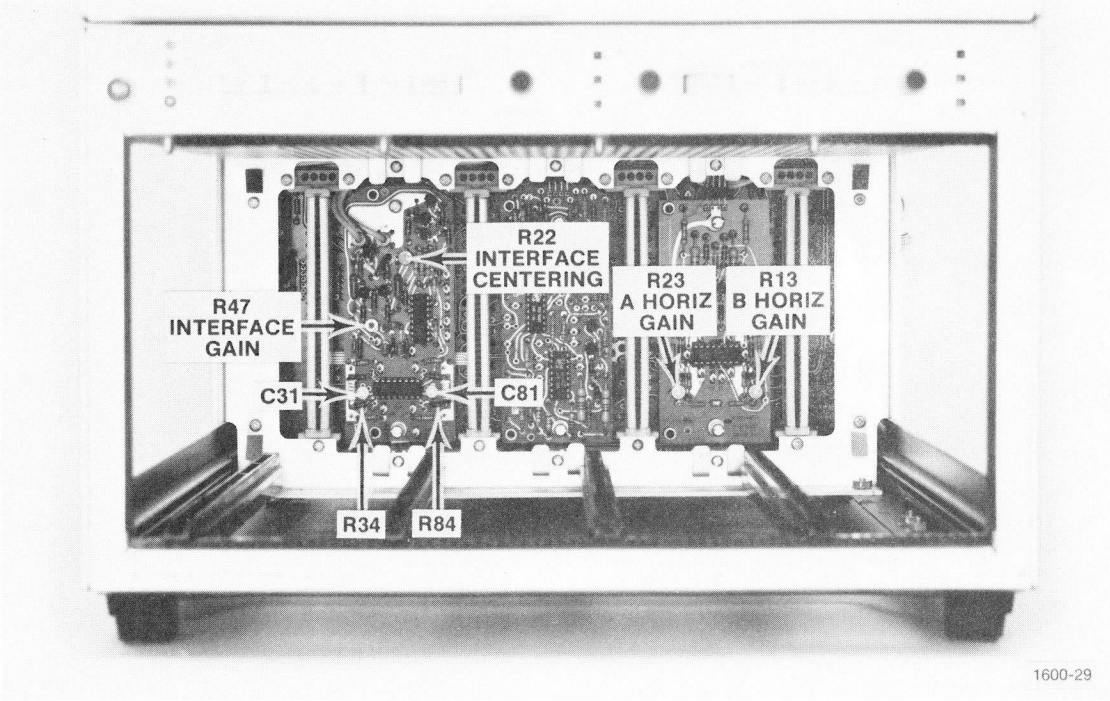


Fig. D-3. A7704 Vertical and Horizontal Interface adjustments.

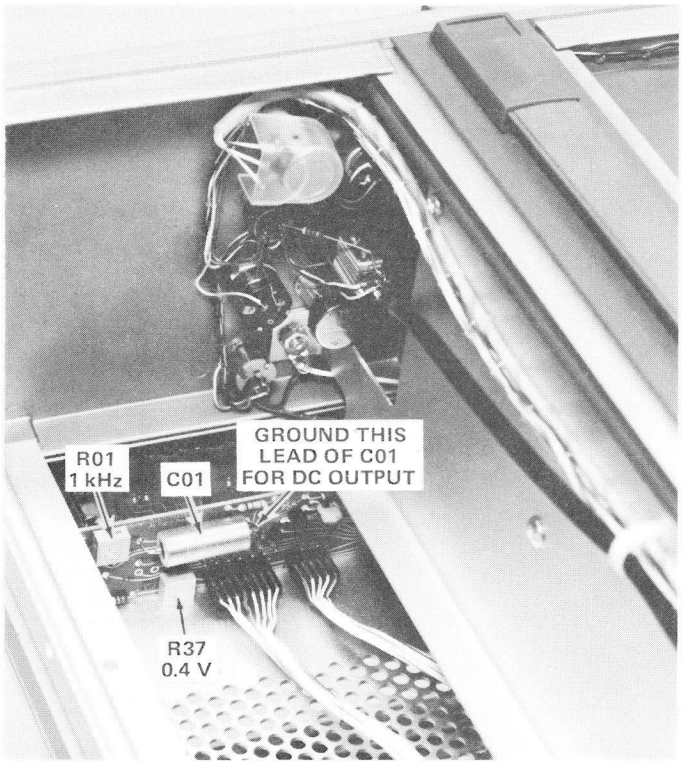
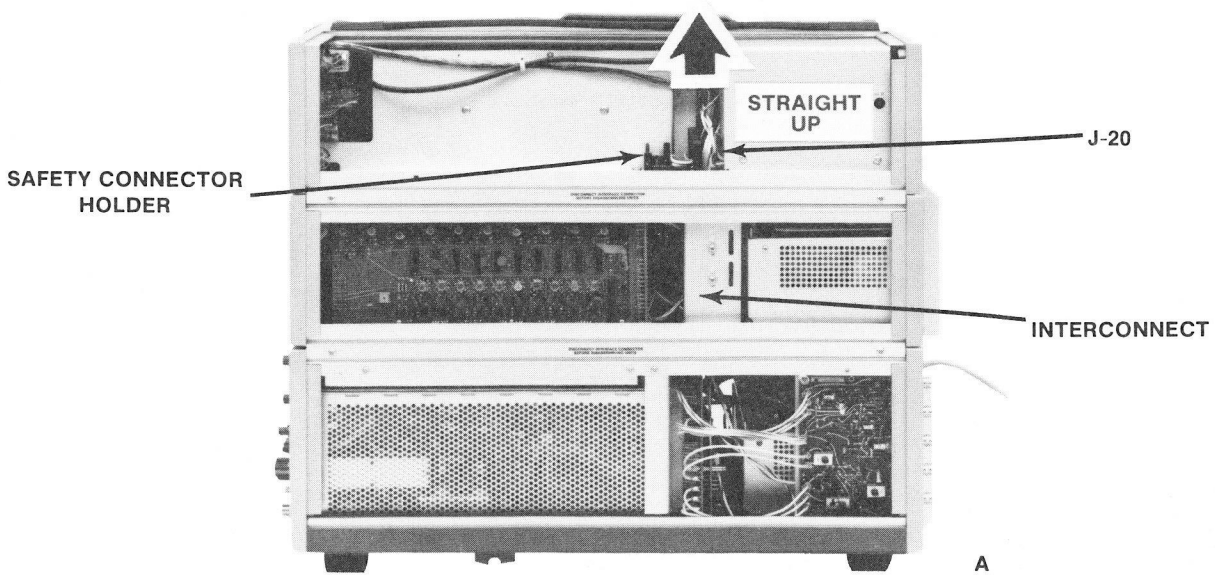


Fig. D-4. A7704 Calibrator board adjustments.



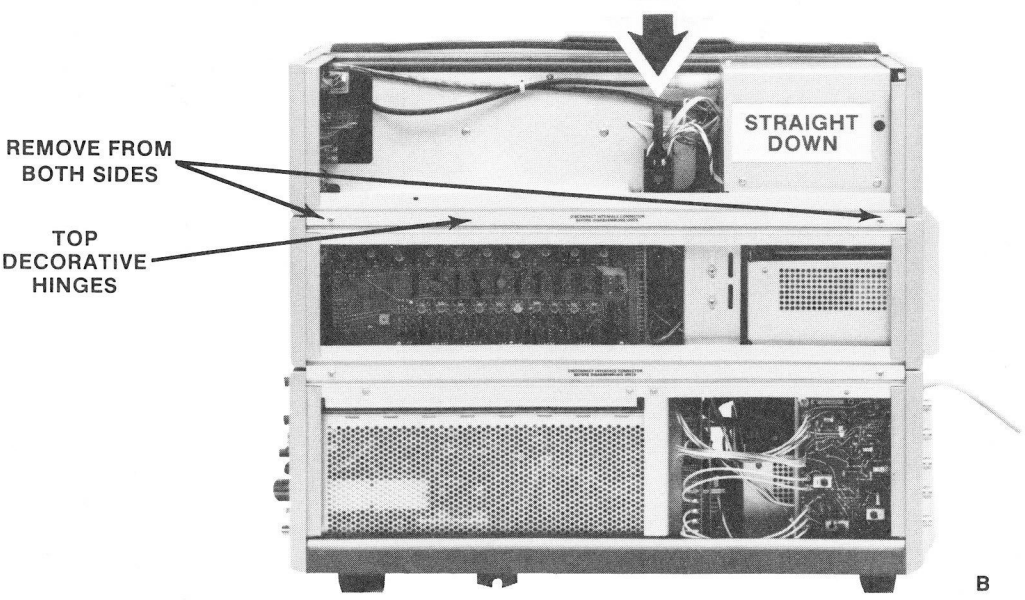
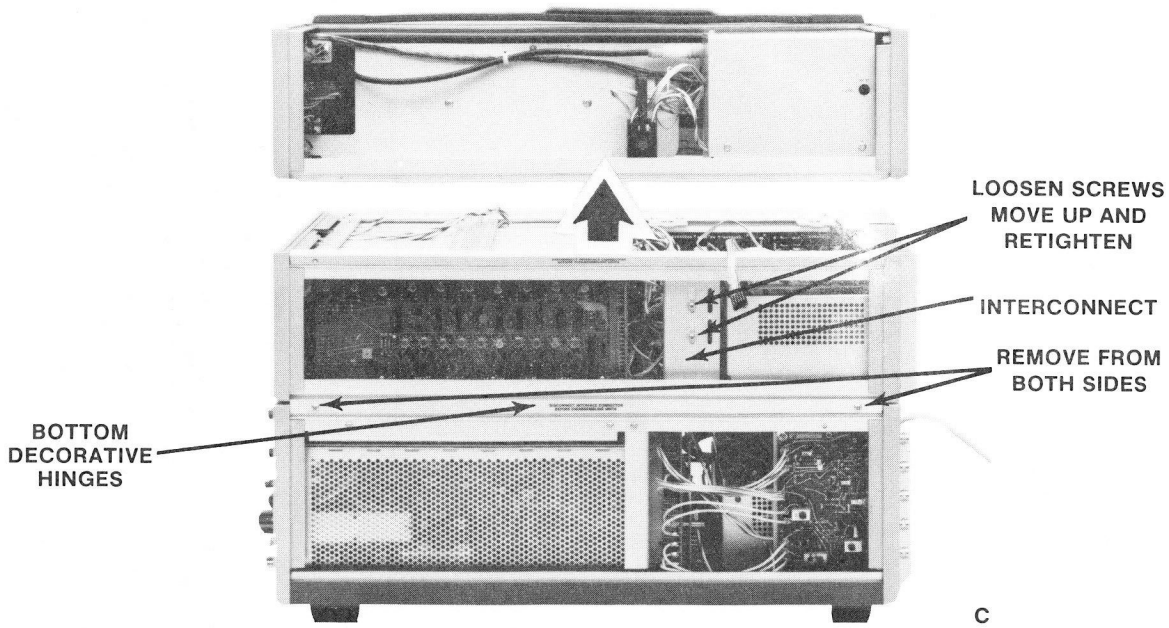


Fig. E-1. DPO disassembl



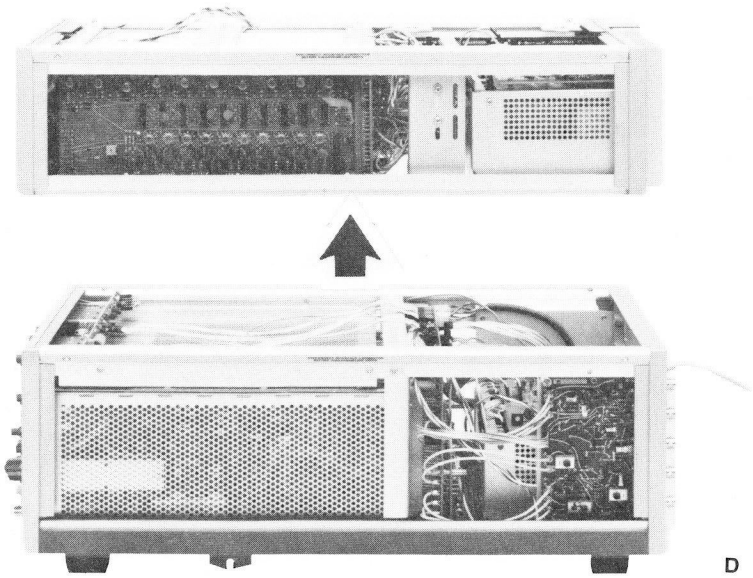


Fig. E-1

PO disassembly.

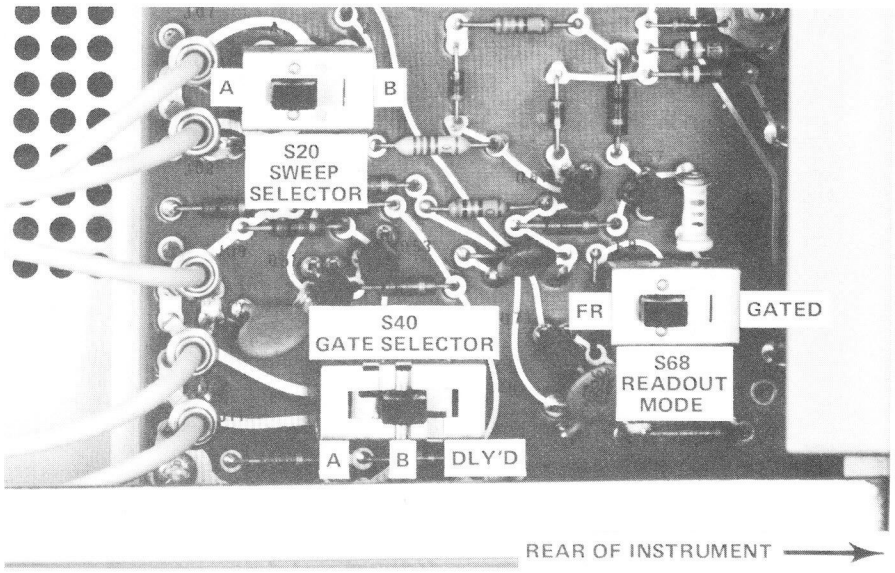


Fig. F-1. A7704 Output Signal board switches.

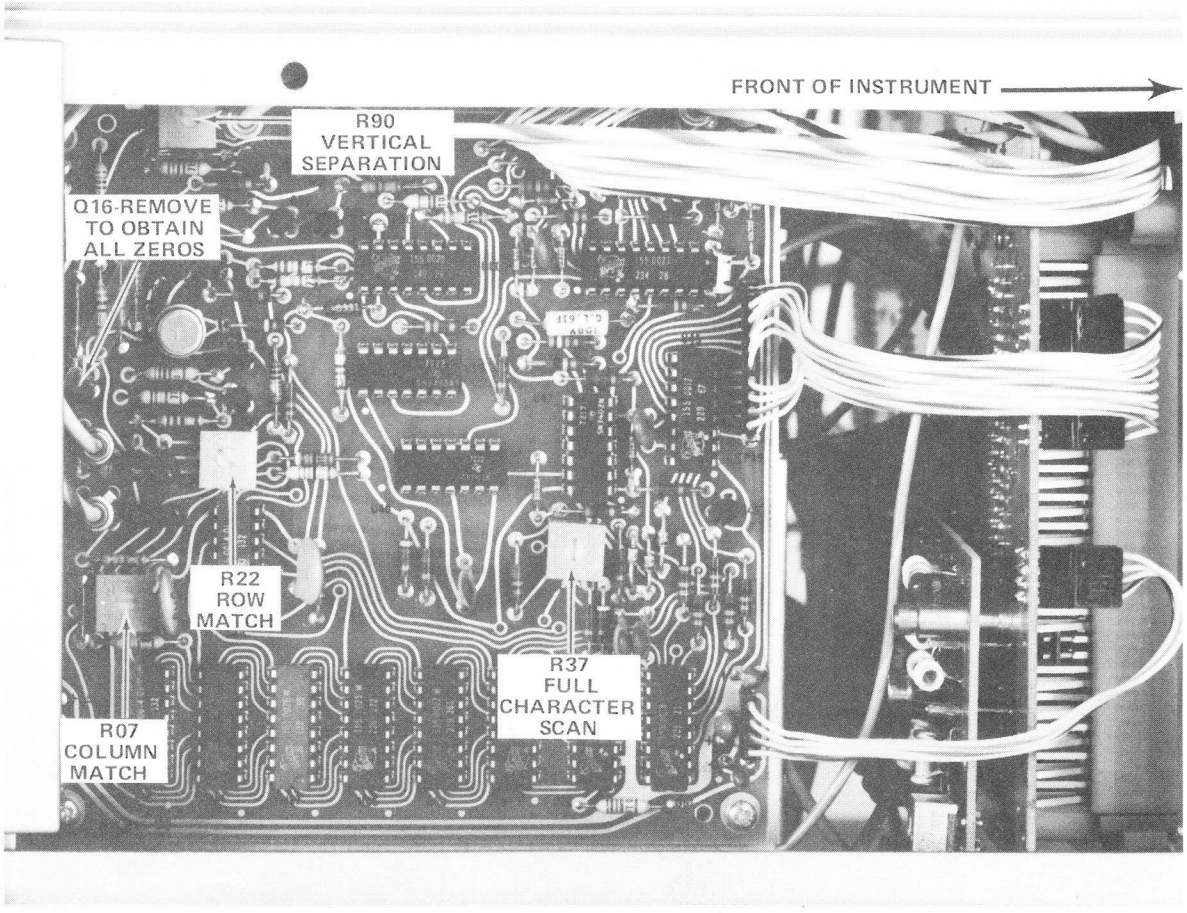


Fig. F-2. A7704 Readout board adjustments.

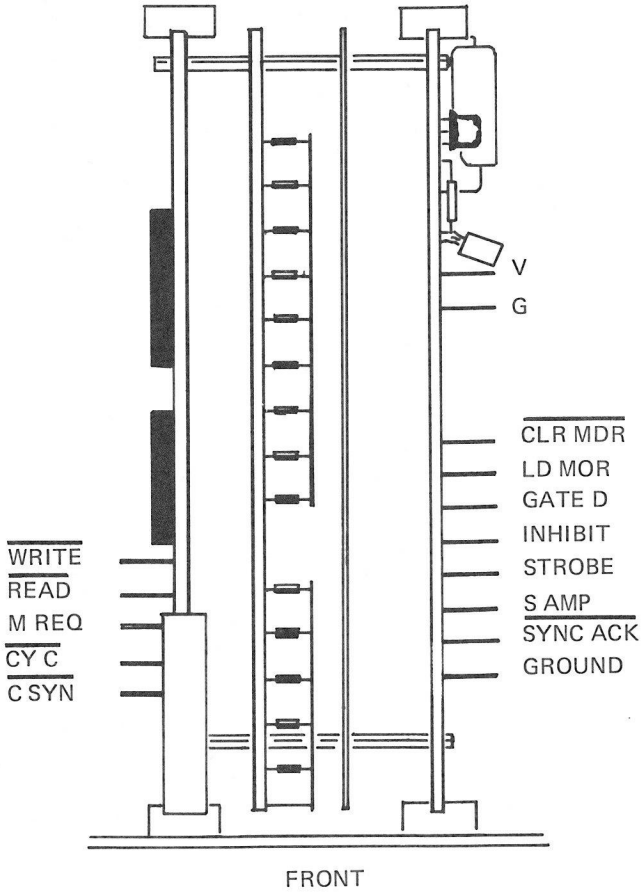


Fig. F-3. Test points on P7001 Core Memory assembly (Controller and Address Driver board and Memory Data Register board).

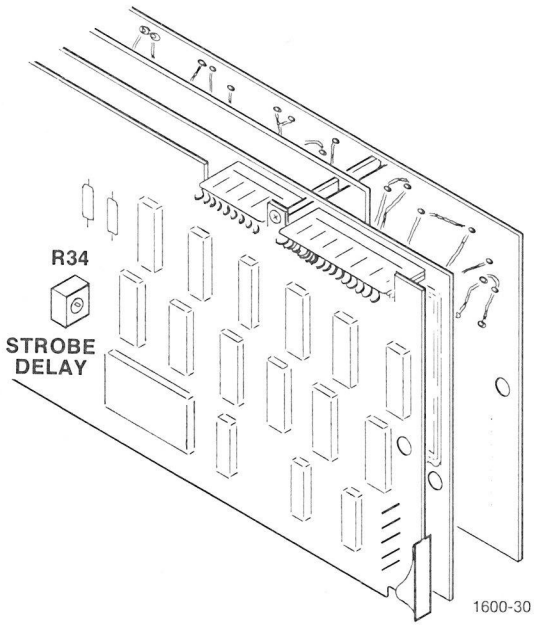


Fig. F-4. Strobe Delay R34 adjustment on P7001 Core Memory Assembly.

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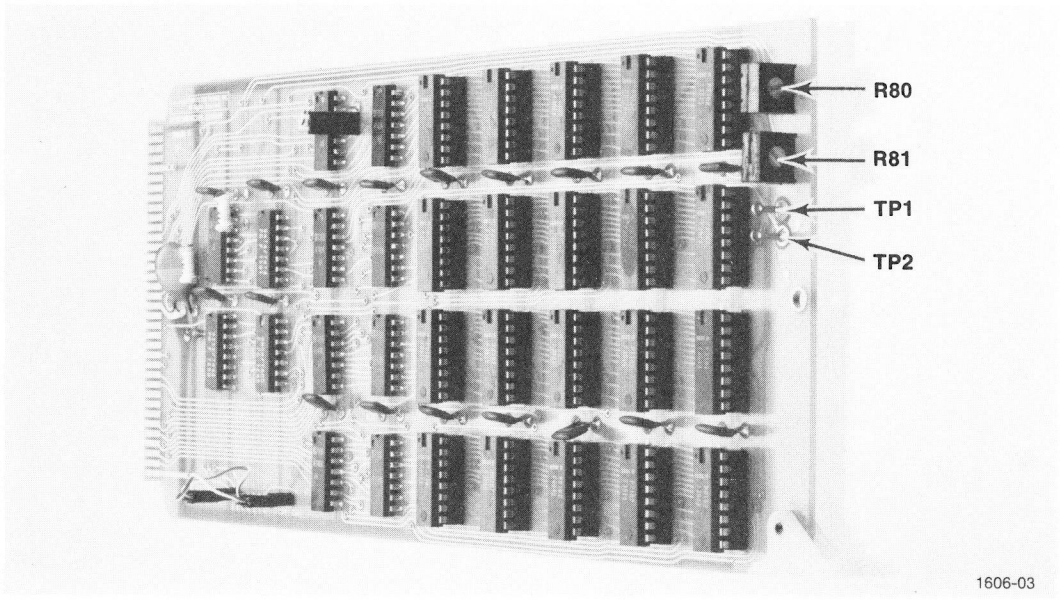

Fig. G-1. P7001 semiconductor memory adjustments and test points.

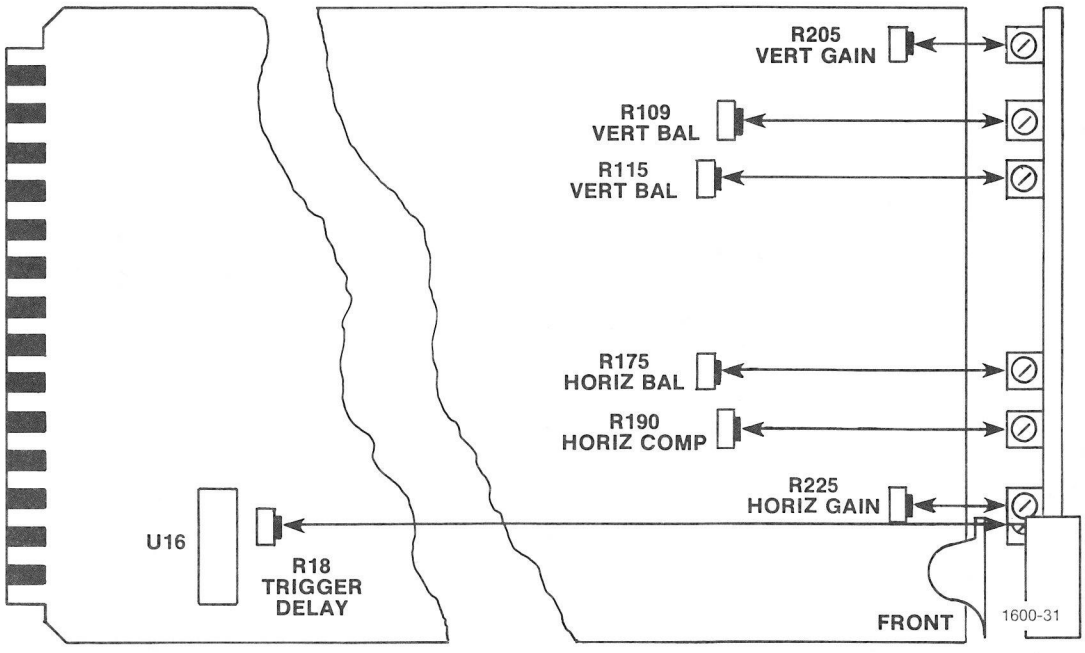

Fig. G-2. P7001 Display Generator card adjustments.

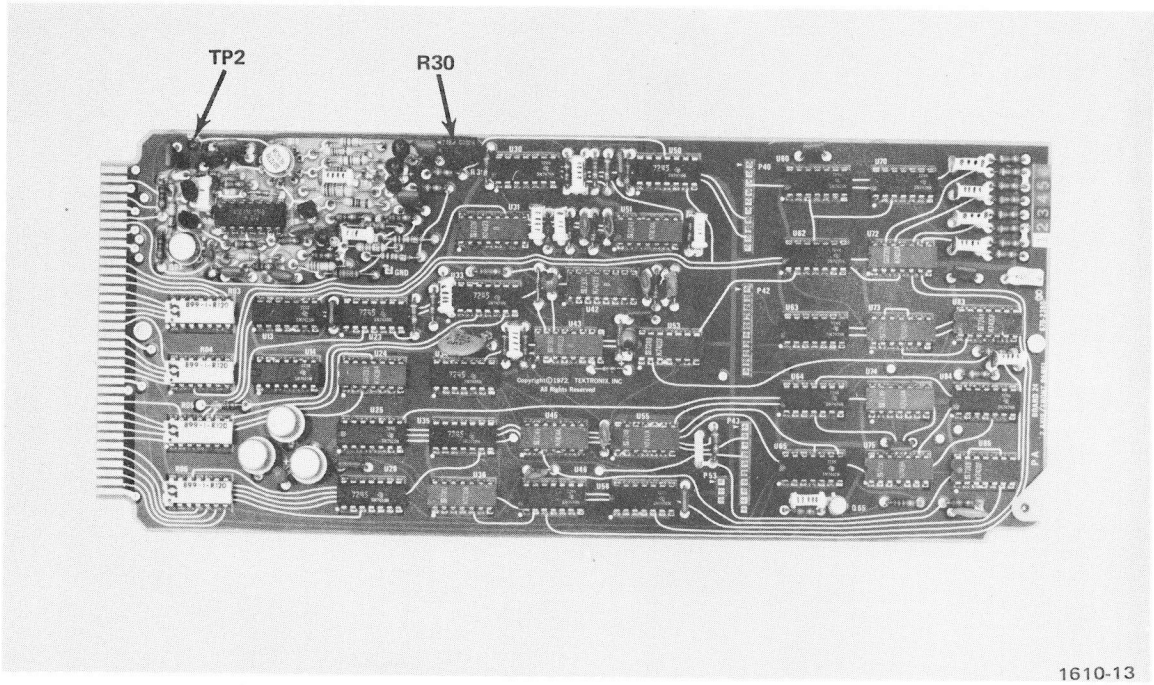

Fig. G-3. P7001 Z-Axis/Front Panel card showing R30 and TP2.

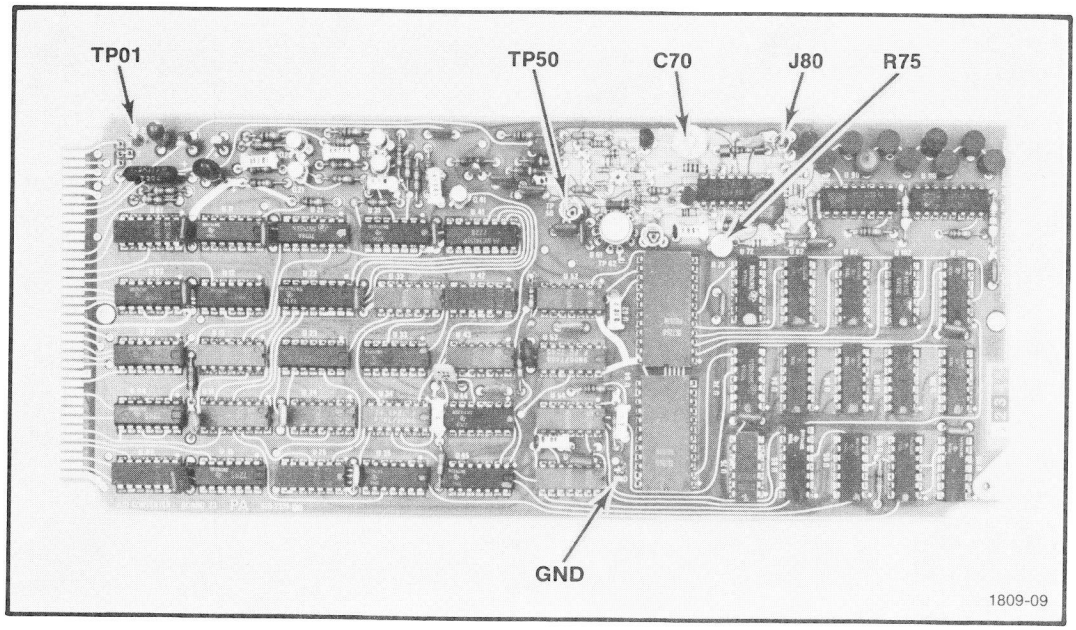

Fig. G-4. P7001 A-D Converter card adjustments and test points.

Fig. G-1 thru G-4